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Developmental Verification of PINSIM-MOD2

R. C. Hagar

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R C Hagar

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DEVELOPMENTAL VERIFICATION OF PINSIM-MOD2

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ABSTRACT

PINSIM-MOD2, a generalized heat conduction code for concentric cylindrical geometries, was developed at Oak Ridge National Laboratory for use in analyzing heat transfer within nuclear fuel pins and various electrically heated fuel pin simulators (FPSs) Verification of PINSIM's calculational abilities is required to support conclusions drawn from the results of PINSIM calculations This study investigated PINSIM's ability to correctly solve inverse, forward, and backward formulations of the heat conduction problem

Data generated during a power-drop test of an electrically heated FPS in a test facility were used to both bound and verify PINSIM calculations The data consisted of (1) the FPS power-generation rate history and (2) responses of thermocouples positioned at the FPS centerline, near the FPS surface (adjacent to the FPS sheath), and in the adjacent coolant channel The PINSIM calculations were validated by comparing these measured parameters with corresponding calculated parameters

The PINSIM code solved an inverse formulation of the heat conduction problem by calculating the internal FPS temperatures, surface temperature, and surface heat flux, using the measured power-generation rate history and sheath thermocouple records as boundary conditions A forward formulation calculated all internal FPS temperatures, surface temperature, and surface heat flux using the measured power-generation rate history, the coolant thermocouple record, and a surface heat transfer coefficient inferred from the results of the inverse conduction problem A backward formulation of the conduction problem was solved by using PINSIM to calculate internal FPS temperatures and power-generation rates using calculated surface temperatures and heat flux from the inverse conduction problem as boundary conditions In each case, good agreement was obtained between (1) measured and calculated parameters, (2) corresponding results of different formulation solutions, and (3) results calculated by PINSIM and those calculated by an established heat transfer code

Thus, PINSIM-MOD2 can correctly solve inverse, forward, and backward formulations of the heat conduction problem in a one-dimensional cylindrical geometry

1 INTRODUCTION

The digital computer codes PINSIM-MOD1 (Ref 1) and PINSIM-MOD2 (Ref 2) have been developed for use in planning and analyzing the results of experiments that use electrically heated rods to simulate nuclear fuel rods during thermal-hydraulic transients Both codes were developed as part of, and have found applications in, the Oak Ridge National Laboratory (ORNL) Pressurized-Water Reactor (PWR) Blowdown Heat Transfer (BDHT) program [3]

The PINSIM code (PINSIM-MOD1 and/or PINSIM-MOD2) is essentially a generalized one-dimensional heat conduction code for cylindrical geometries, it is capable of solving several formulations of the conduction problem employing user-defined multiple axial (up to 20) and radial (up to 10) regions in a cylindrical geometry and user-defined material properties The conduction problem formulations solved by PINSIM may be referred to as forward, backward, and inverse problems The forward conduction problem is the classical one of determining internal rod temperatures and rod surface conditions when both power-generation rate and surface boundary conditions are specified The backward conduction problem is that of determining internal temperatures and power-generation rate when two surface conditions are specified The inverse conduction problem is that of determining internal rod temperatures and surface conditions when both the power-generation rate and an internal temperature are specified The PINSIM-MOD1 code solves the first two problems only, while PINSIM-MOD2 solves all three Conduction problem formulations solved by PINSIM are summarized in Table 1

Table 1 Conduction problem formulations solved by PINSIM[a]

	Forward		Backward		Inverse
	Case 1	Case 2	Case 1	Case 2	
Power generation	K	K	U	U	K
Surface heat flux	U	U	K	K	U
Surface temperature	U	K	U	K	U
One internal temperature	NU	NU	NU	NU	K
Internal temperatures	U	U	U	U	U
Surface boundary conditions (h_1 T_{bulk})	K	NU	K	NU	NU
Solved by PINSIM-MOD1	Y	Y	Y	Y	N
Solved by PINSIM-MOD2	Y	Y	Y	Y	Y

[a]K = known, U = unknown, NU = not used, Y = yes, and N = no

Throughout the development of both PINSIM-MOD1 and PINSIM-MOD2, the validity of various program modules have been verified informally by developmental verification, by which code developers are assured that the modules are functioning properly This report constitutes a formalization of some developmental verification calculations and should serve to assure other interested parties that PINSIM does correctly solve the problems for which it was intended

A series of calculations were performed by PINSIM-MOD2 using data obtained during a relatively low-powered power-drop test conducted in the BDHT program's Forced Convection Test Facility (FCTF)[4] using an internally heated electric fuel pin simulator (FPS) The method (later described in greater detail) used to verify PINSIM is briefly described as follows

1 Develop a PINSIM model of the electric pin used in the FCTF test
2 Create and execute a PINSIM problem model to solve the inverse conduction problem using a record of the sheath thermocouple response and the rod power transient as boundary conditions, determine centerline temperature, surface temperature, and surface heat flux
3 Determine a quasi-experimental surface heat transfer coefficient, based on the surface heat flux and surface temperature from the inverse solution, and the bulk coolant temperature
4 Create and execute a PINSIM problem model to solve the forward conduction problem using the quasi-experimental surface heat transfer coefficient, the bulk coolant temperature, and the rod power transient as boundary conditions, calculate centerline temperature, sheath thermocouple position temperature, surface heat flux, and surface temperature
5 Create and execute PINSIM problem models to solve the backward conduction problem using transient surface heat flux and surface temperatures determined by solving both the inverse and forward conduction problems, determine power transients

The validity of the PINSIM inverse conduction problem solution was investigated by comparing the calculated centerline temperature with the centerline thermocouple record and with the results of a forward calculation by an established heat transfer code The validity of the forward conduction problem solution was investigated by comparing (1) the calculated centerline and sheath thermocouple position temperatures with the thermocouple records and (2) the calculated surface heat flux and surface temperatures with those calculated in solving the inverse conduction problem The validity of the backward conduction problem solution was investigated by comparing (1) the calculated power transients with the rod power transient record, and (2) the calculated centerline and sheath thermocouple position temperatures with the thermocouple records

This method is described in greater detail, and results of the validation comparisons are presented in Sect 2 Comparisons are summarized and conclusions are presented in Sect 4 The PINSIM problem models are entered in the sample problem listings in the appendices

2 METHOD AND RESULTS

2 1 Data Base

The data base used to both bound and verify PINSIM calculations was generated during a power-drop test of an electrically heated rod in the ORNL-PWR-BDHT program's FCTF, it consists of a tabulated record of the rod power transient and the responses of two internal rod thermocouples (a centerline and a sheath thermocouple) and a coolant subchannel thermocouple (located in the coolant subchannel approximately adjacent to the axial plane of the two rod thermocouples) [4] The thermocouple records are plotted in Fig 1, error bars on the curves represent an uncertainty of ±2 5 K (±4 5°F) in the indicated temperature At steady state, the power-generation rate was 10 32 kW/ft (9 786 Btu/s-ft), and at the initiation of the transient the power was turned off and remained at 0 0 throughout the transient

2 2 Electric Pin Model

The electric rod used in the power-drop test (from which the thermocouple records plotted in Fig 1 were taken) was designated 018A in the BDHT program [4] This multiple-region rod consisted of a boron nitride core surrounding a center thermocouple bundle and was itself encircled by an electric heater element made of Inconel (Fig 2) Outside the Inconel heater element is an annular boron nitride region and a stainless steel sheath Sheath thermocouples are placed in the annular boron nitride region, immediately adjacent to the sheath

Rod 018A was fabricated according to relatively strict dimensional specifications, but its exact internal dimensions can be known only by sectioning the rod and actually measuring the internal distances Because rod 018A has not yet been sectioned, its exact dimensions are still unknown However, rod 038 (which should be identical to rod 018A) has been sectioned and measured [5] Measurements at several different positions on the rod are summarized in Table 2 The dimensions listed in the third column of Table 2 were used in the PINSIM model to describe rod 018A

2 3 Inverse Conduction Problem and Results

In the context of this report, the inverse conduction problem involves determining rod surface heat flux and surface temperature when the rod power-generation rate and an internal temperature are specified The model that directs PINSIM to solve this problem using the pin model previously described, the sheath thermocouple record (Fig 1), and the rod power transient are all included in the PINSIM output listing in Appendix A Results of the inverse calculation are plotted in Figs 3 and 4

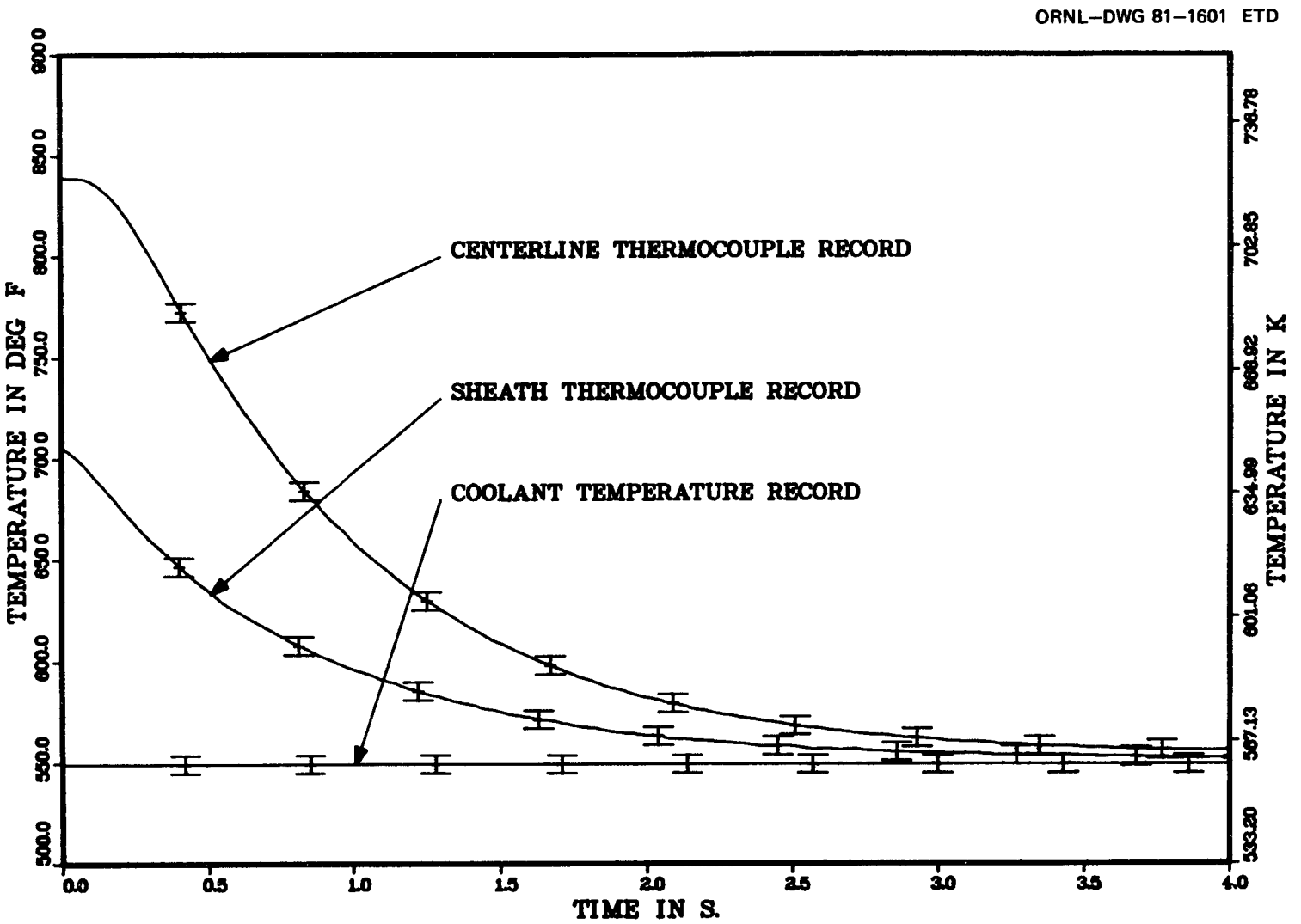

Fig 1 Power-drop test thermocouple records

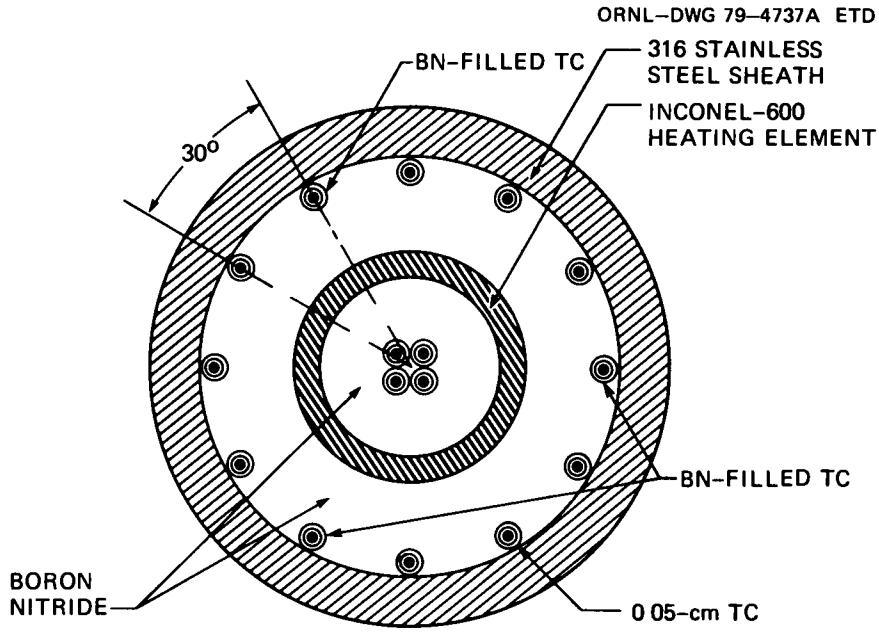

Fig 2 Schematic of a cross section of a THTF Bundle 3 FRS

Table 2 Typical electric rod radial dimensions

Region	Region outer radius (in)	PINSIM model value (in)
Thermocouple bundle	0 0281 ± 0 0013	0 0281
Boron nitride core	0 1089 ± 0 0006	0 1089
Heater element	0 1227 ± 0 0006	0 1227
Annular boron nitride	0 1682 ± 0 0004	0 1682
Sheath	0 1871 ± 0 0003	0 1871

Figure 3 compares the PINSIM-calculated centerline temperature with the centerline thermocouple record and presents both the sheath thermocouple record and the PINSIM-calculated surface temperature The PINSIM-calculated temperatures and the observed temperatures are in reasonably good agreement, but the PINSIM-calculated centerline temperature is slightly higher than the observed centerline temperature between 0 5 and 2 0 s This discrepancy can probably be attributed to (1) a slight mismatch between the rod model material properties and those of rod 018A, or (2) mismatch between the model internal dimensions (Table 2) and those of

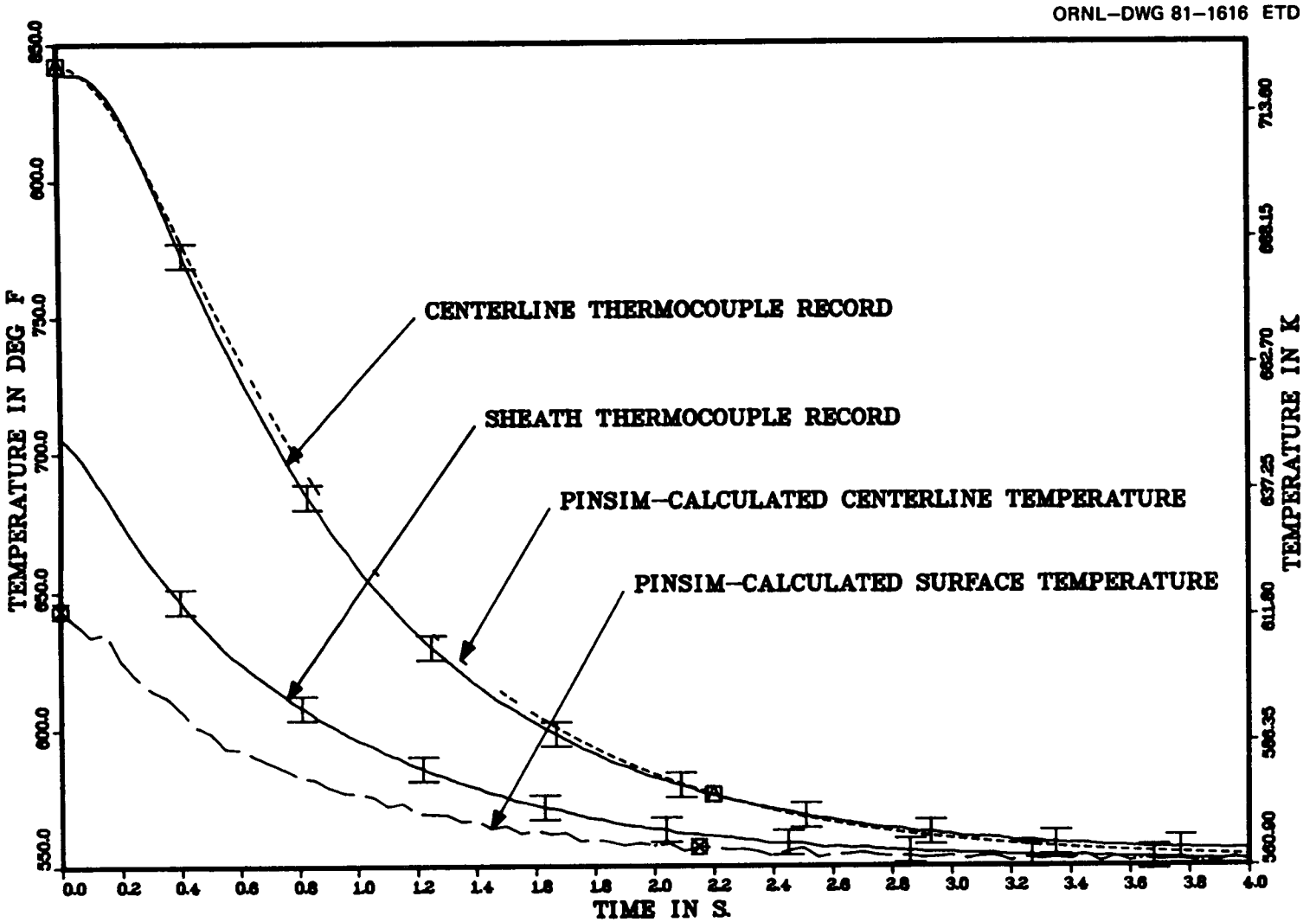

Fig 3 Comparison of PINSIM inverse conduction problem solution results with original thermocouple records

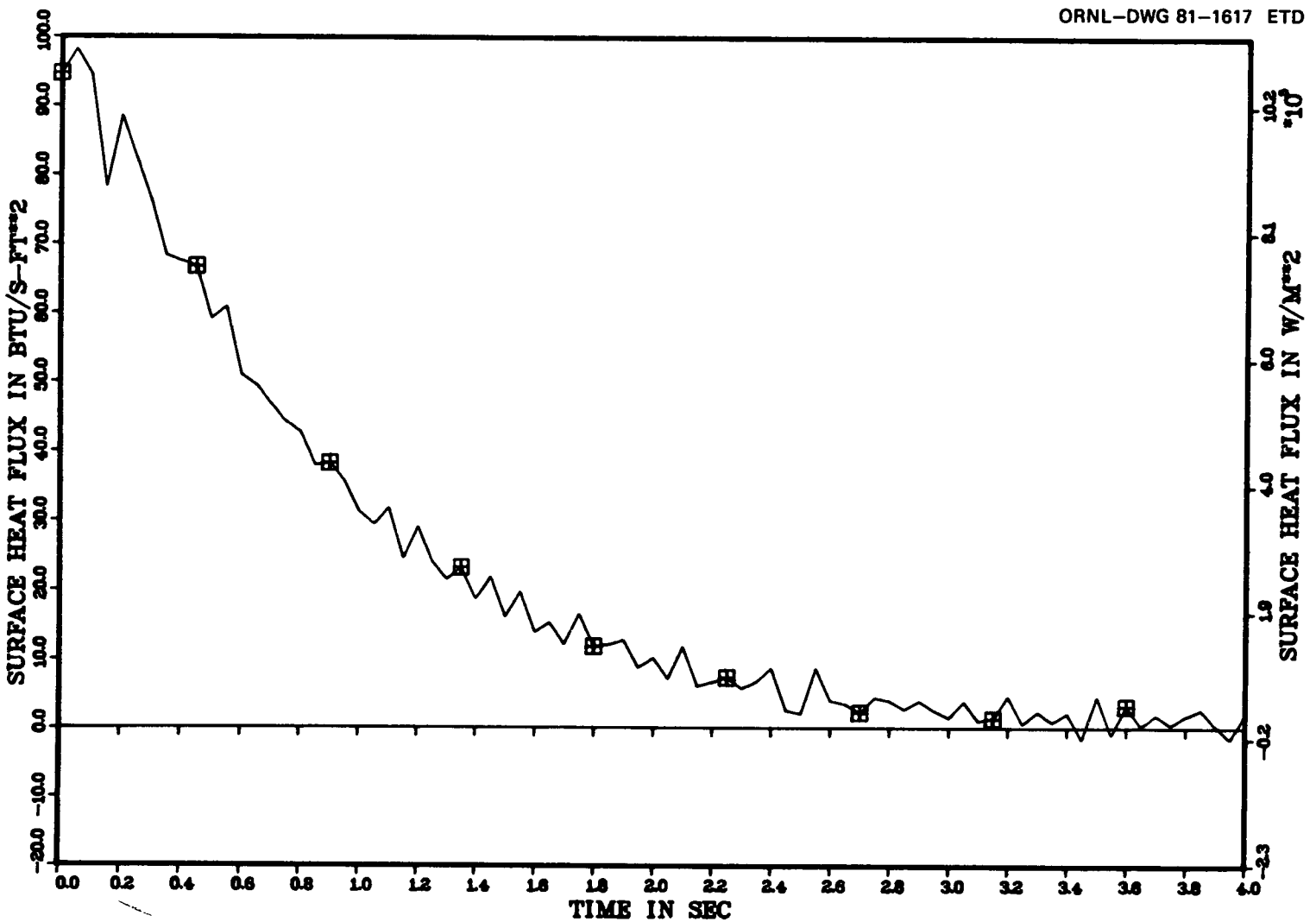

Fig 4 FRS surface heat flux transient from PINSIM's inverse conduction problem solutions

rod 018A, or (3) some combination of both factors Furthermore, the presence of the thermocouple itself perturbs to some extent the temperature distribution within the rod, and PINSIM's one-dimensional models cannot include such effects

No doubt the rod model dimensions and/or materials could be adjusted so that the PINSIM-predicted centerline temperature does match the centerline thermocouple record, but such an exercise is not relevant to the point of this report Aside from differences caused by thermocouple and rod model uncertainties, Fig 3 indicates that PINSIM can correctly determine rod centerline temperature when it solves an inverse conduction problem

The erratic behavior of the PINSIM-calculated rod surface temperature (Fig 3) is even more apparent in the plot of the PINSIM-calculated surface heat flux (Fig 4) This type of behavior is at first glance unexpected the sheath thermocouple record (Fig 1) appears to be a smooth curve However, the derivative of the sheath thermocouple record (Fig 5) indicates that it is not To investigate the relationship between a nonsmooth boundary condition and a nonsmooth result, the inverse conduction problem was reformulated and executed using a smoothed thermocouple record rather than the original This smoothed record was developed by a numerical spline-smoothing algorithm and is compared with the original record in Fig 6 The results of the calculation using the smoothed record are compared with those of the original calculation and with the thermocouple records (Figs 7 and 8) Figure 7 compares temperatures, the PINSIM-calculated centerline temperatures from the original and smoothed calculations are essentially identical Although the surface temperatures are very similar in value, the surface temperature from the smoothed calculation is much less erratic than that from the original calculation The same observation may be made by examining Fig 8, which compares surface heat fluxes, the results from the original and smoothed calculations are very similar in value, but the results from the smoothed calculation are less erratic

By showing good agreement between the PINSIM-calculated centerline temperature and the original centerline thermocouple record, Fig 3 serves to verify PINSIM's solution of the conduction equation, which describes heat transfer between the center of the pin and a radial position corresponding to the position of the sheath thermocouple However this does not verify the solution of the conduction equation between the sheath thermocouple position and the surface of the pin Thus, PINSIM's calculation of surface temperature and surface heat flux is not verified by the results plotted in Fig 3 Because these parameters cannot be directly measured, PINSIM's calculation can only be verified by comparison with the results of a calculation by an established, previously verified heat transfer code

The heat transfer code selected to verify PINSIM's calculation of surface conditions was HEATING5 (Ref 6) a finite-element heat transfer code developed at ORNL A HEATING5 model of the pin modeled in the PINSIM problem was constructed and used by HEATING5 to determine the pin's transient response when the pin experiences both the power transient used in the PINSIM problem and the surface temperature calculated by PINSIM (Fig 3) The results of the HEATING5 calculation are compared with the

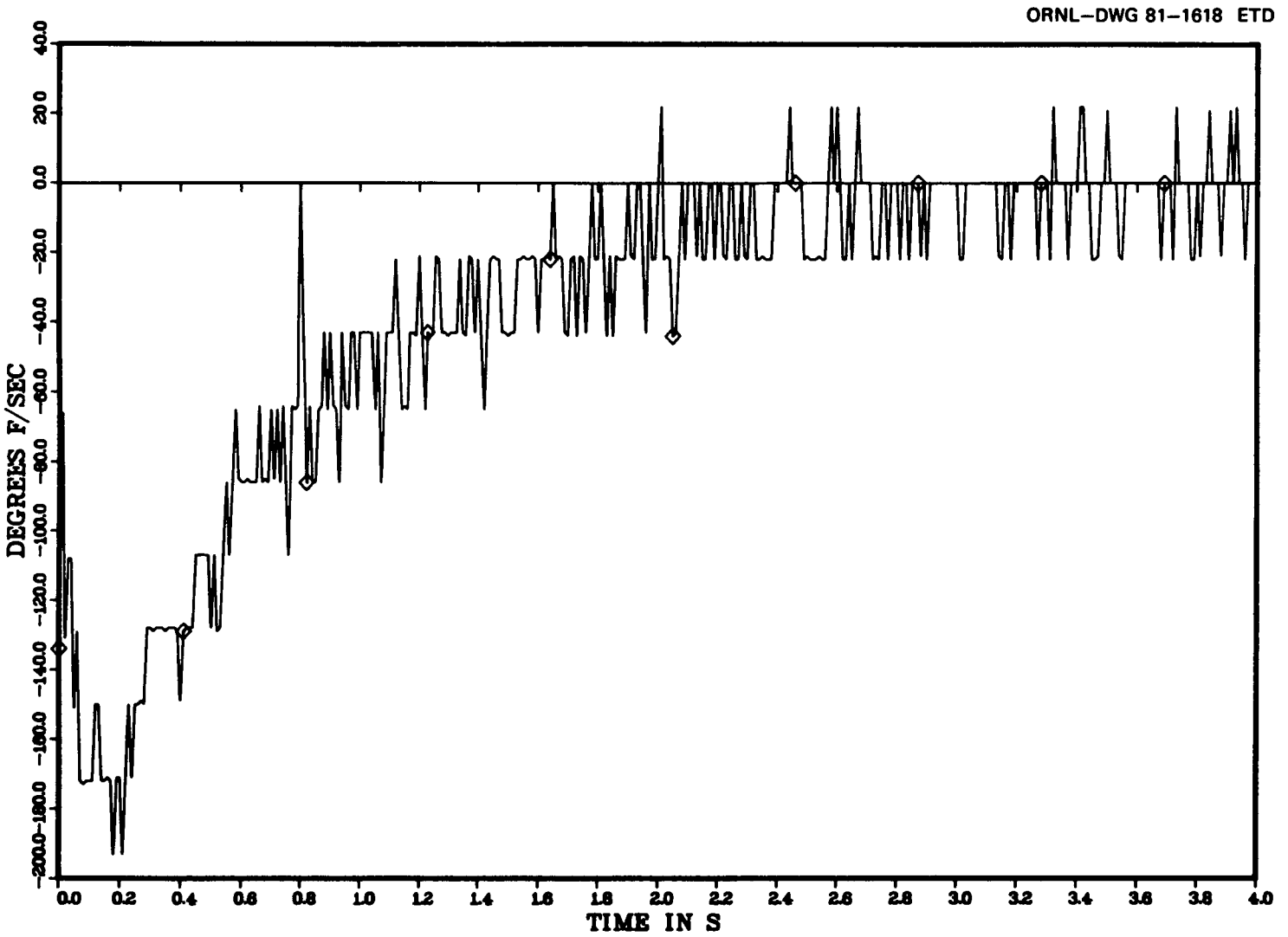

Fig 5 Derivative of original sheath thermocouple record

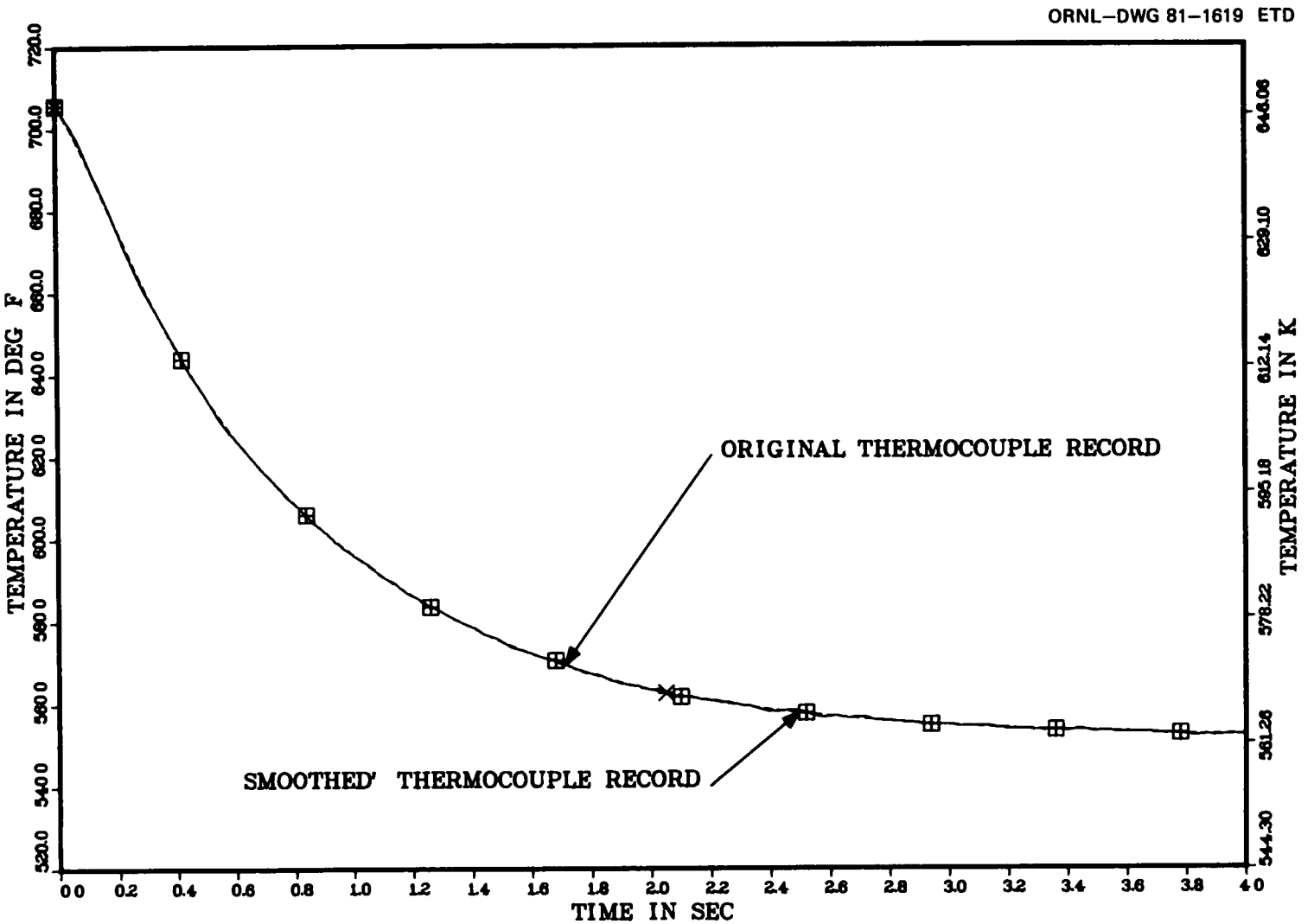

Fig 6 Comparison of original and smoothed sheath thermocouple records

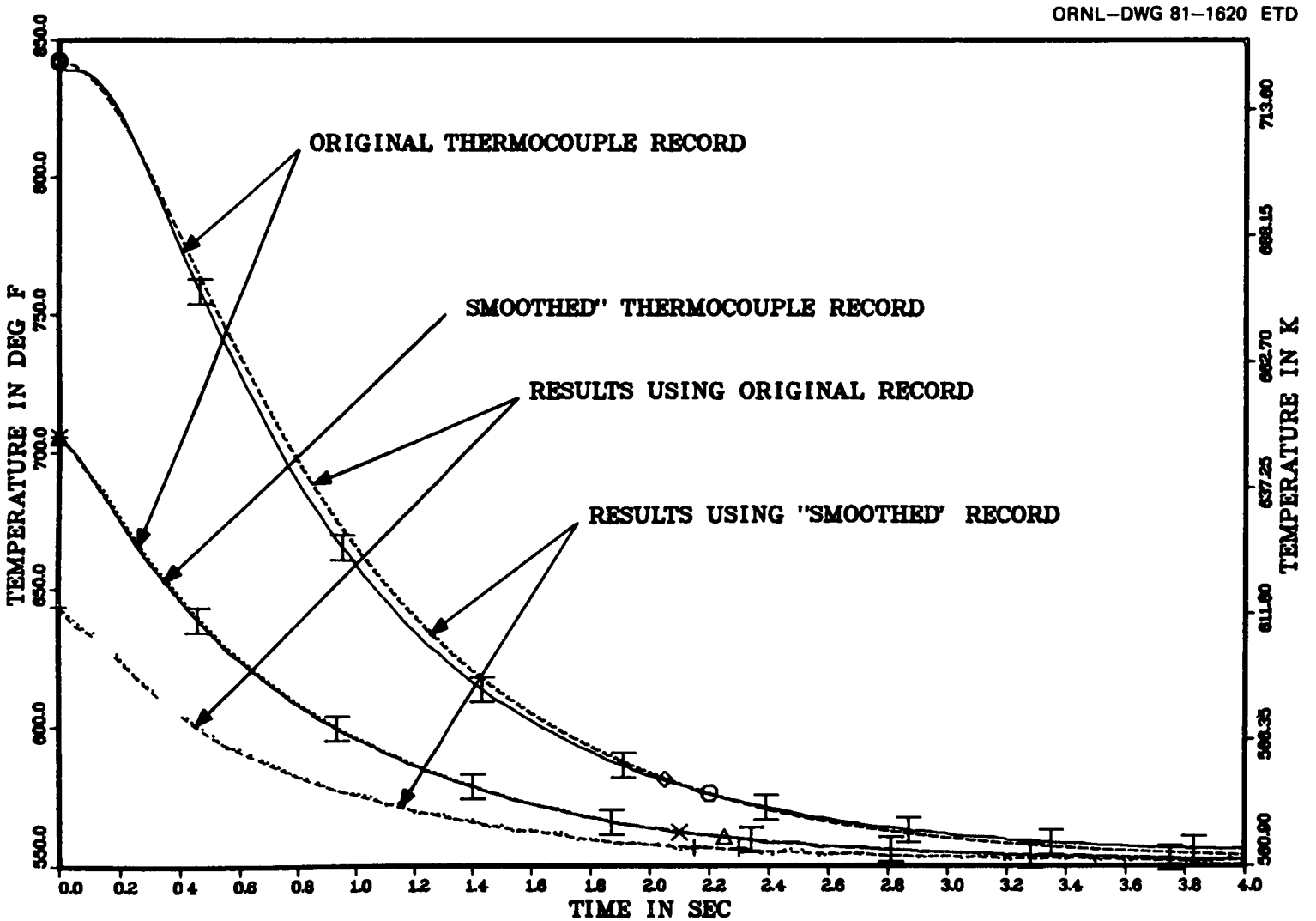

Fig 7 Comparison of PINSIM-calculated inverse conduction problem solution results using original and smoothed sheath thermocouple records as boundary conditions with original thermocouple records

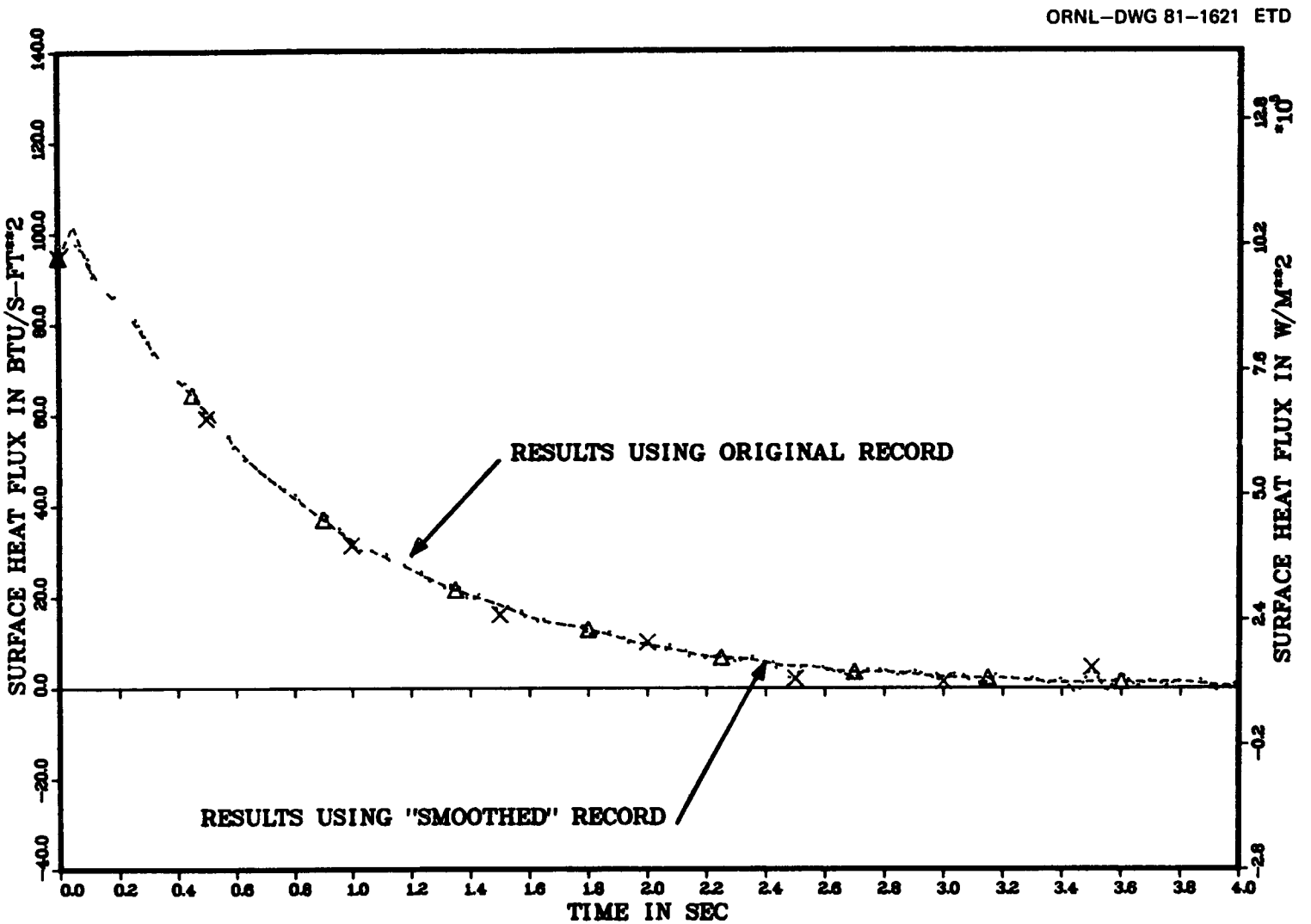

Fig 8 Comparison of surface heat fluxes calculated by PINSIM (solving the inverse conduction problem) using original and smoothed thermocouple records as boundary conditions

PINSIM results in Figs 9 and 10 * These figures show that the HEATING5 results are in good agreement with the PINSIM results, if the HEATING5 results are correct, then so are the PINSIM results

In summary, the results of the original PINSIM inverse conduction problem solution indicate that PINSIM can correctly determine rod centerline temperature when another internal temperature is specified Results of the HEATING5 calculation indicate that PINSIM also correctly determines surface temperature Results of the smoothed inverse problem indicate that any erratic or nonsmooth behavior of the specified internal temperature will be reflected in similarly erratic or nonsmooth calculated surface conditions

2 4 Forward Conduction Problem and Results

The forward conduction problem solved by PINSIM is probably the most common heat transfer problem determining rod internal temperatures, surface heat flux, and surface temperature when rod power-generation rate, surface heat transfer coefficient, and bulk coolant temperature are specified The forward conduction problem model used to generate the following results is included in the PINSIM output listing in Appendix B

The forward conduction problem requires three boundary conditions two of these (power-generation rate and bulk coolant temperature) are available from test data, but the surface heat transfer coefficient must be calculated A quasi-experimental surface heat transfer coefficient can be determined for each time step from the solution of the inverse conduction problem by solving the following equation

$$h(t) = \frac{q''(t)}{T_S(t) - T_B(t)} ,$$

---

*Surface heat flux is not directly calculated by HEATING5 The HEATING5-CALCULATED data (Fig 10) were actually determined from temperatures calculated by HEATING5 for the surface (node N) and the node just inside the surface (node N-1), using the equation

$$q'' = \frac{k\ (T_N - T_{N-1})}{r_N \ln\left(\frac{r_N}{r_{N-1}}\right)} ,$$

where

q'' = surface heat flux,
k = thermal conductivity,
r_i = radial position of node i

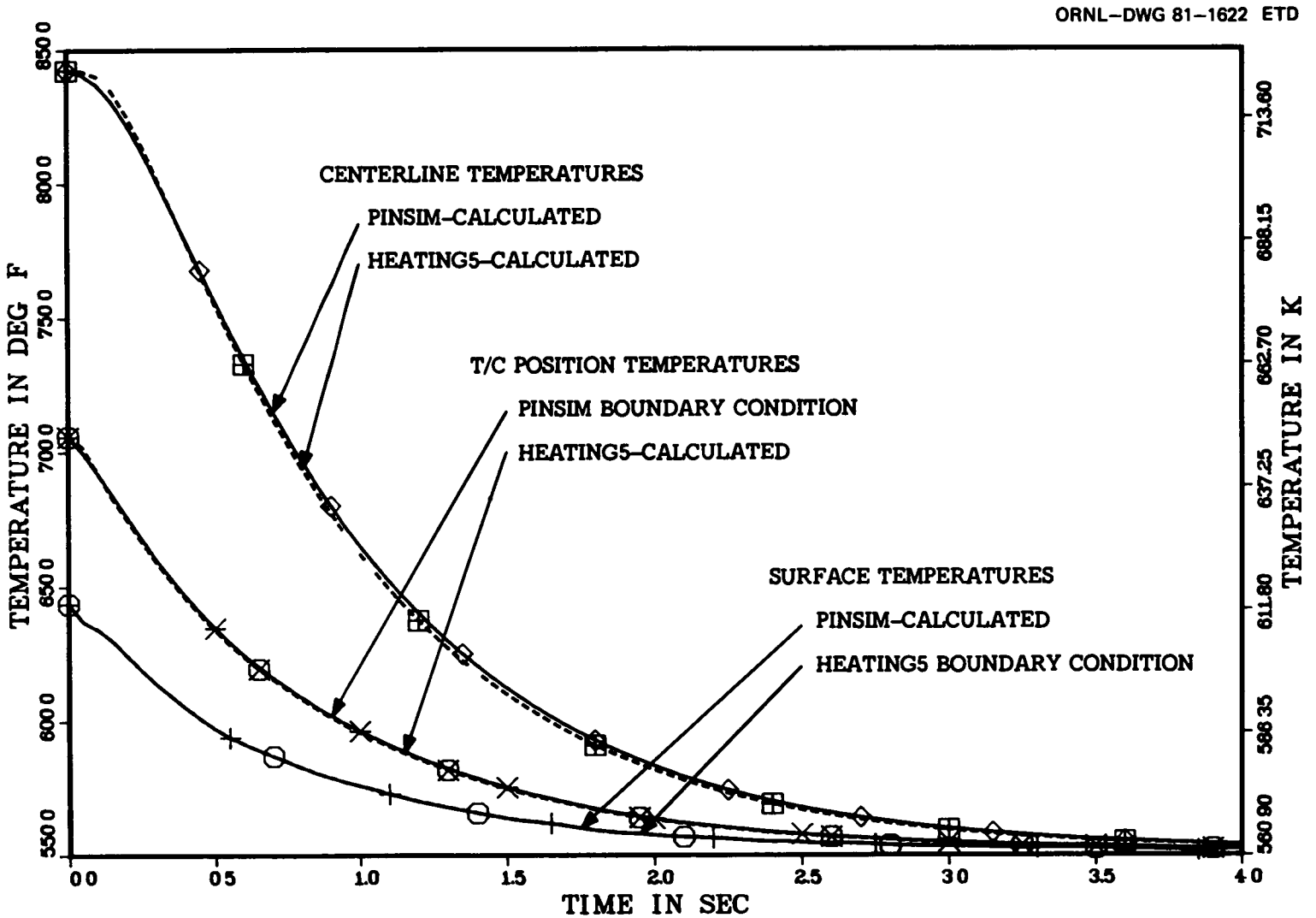

Fig 9 Comparison of temperatures calculated by PINSIM with temperatures calculated by HEATING5

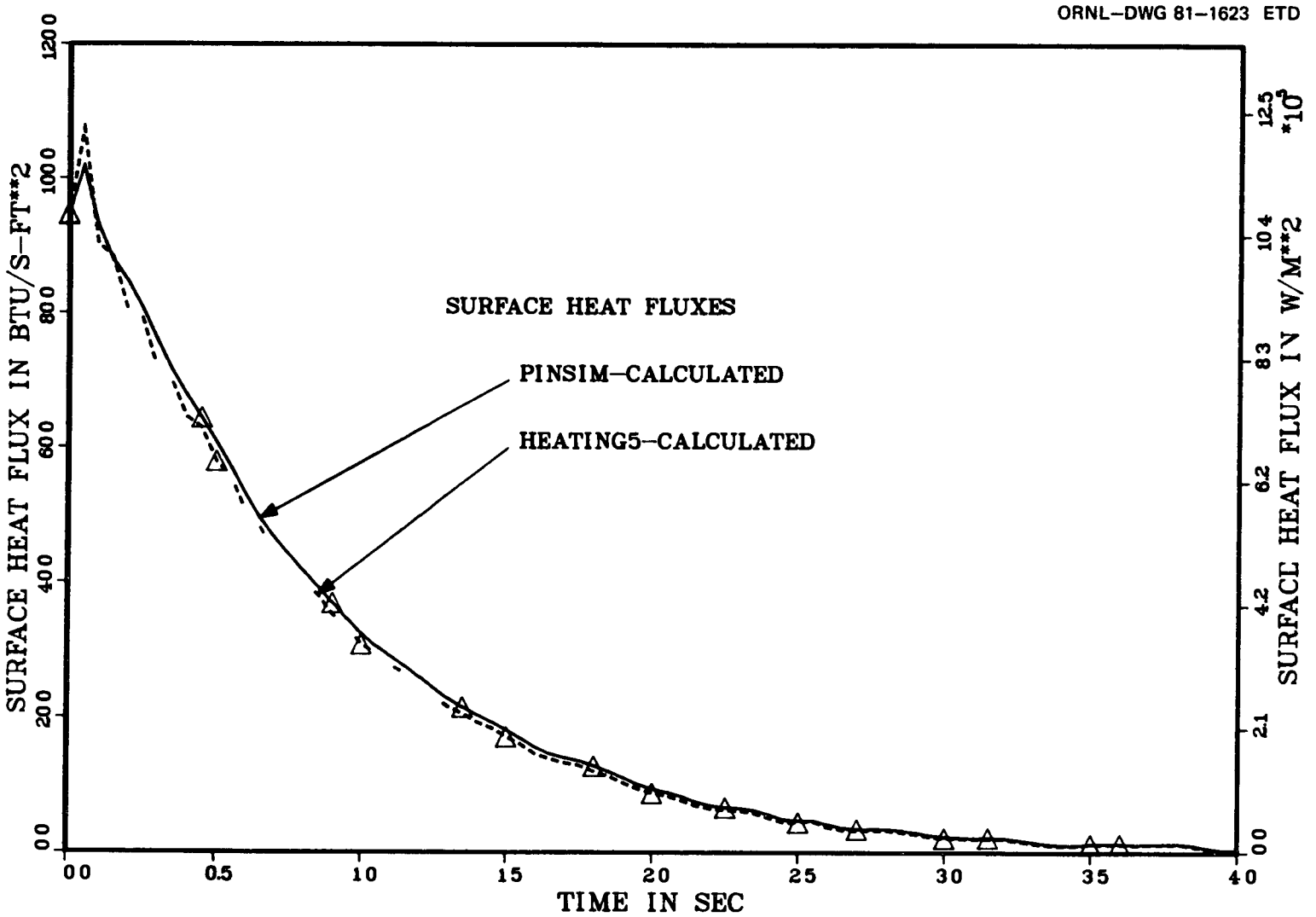

Fig 10 Comparison of surface heat flux calculated by PINSIM with surface heat flux calculated by HEATING5

where

$H(t)$ = heat transfer coefficient at time t,
$q''(t)$ = calculated surface heat flux,
$T_S(t)$ = calculated surface temperature,
$T_B(t)$ = bulk coolant temperature

A surface heat transfer coefficient record thus determined is plotted in Fig 11, results of the forward calculation that used this record are plotted in Fig 12 It indicates that the results of a forward calculation (which used as a boundary condition a surface heat transfer coefficient record plotted in Fig 11) match exactly the results of an inverse calculation

In summary, Fig 9 indicates that PINSIM can correctly solve a forward conduction problem and that, if consistent boundary conditions and pin models are used, the results of a forward calculation will exactly match the results of an inverse calculation

2 5 Backward Conduction Problem and Results

In the backward conduction problem, internal temperatures and power-generation rates must be determined from specified surface conditions, in PINSIM, those surface boundary conditions are surface heat flux and either surface temperature or surface heat transfer coefficient and bulk coolant temperature In this study, both options for specifying boundary conditions were used (1) the surface heat flux and surface temperature transients from PINSIM's inverse conduction problem solution (Figs 3 and 4) were used to bound one backward calculation, and (2) the surface heat flux from the PINSIM solution of the forward conduction problem was used with the heat transfer coefficient and bulk coolant temperature transients to bound a second backward calculation

The results of the backward conduction problem, which used as boundary conditions surface heat flux and surface temperature transients from PINSIM's inverse conduction problem solution, are compared with the inverse conduction problem solution in Fig 13 which compares calculated temperatures (The PINSIM problem model is included in Appendix C) In Fig 13, the two sets of curves (three curves for the inverse solution and three for the backward solution) are identical Figures 14 and 15 compare the backward-calculated power transient with the original power transient The differences between the curves are indistinguishable in Fig 14, but the vertical scale in Fig 15 allows a closeup of the vertical axis that does show the differences However, even on this scale, the differences are minimal

A backward conduction solution was also obtained using as boundary conditions surface heat flux from the first forward conduction problem solution and the heat transfer coefficient and bulk coolant temperature transient that were used to bound the first forward conduction problem The results of this backward conduction problem are presented in Figs 16 through 18, which are analogous to Figs 13 through 15 previously discussed As in Fig 13, the two sets of temperature curves in Fig 16 are

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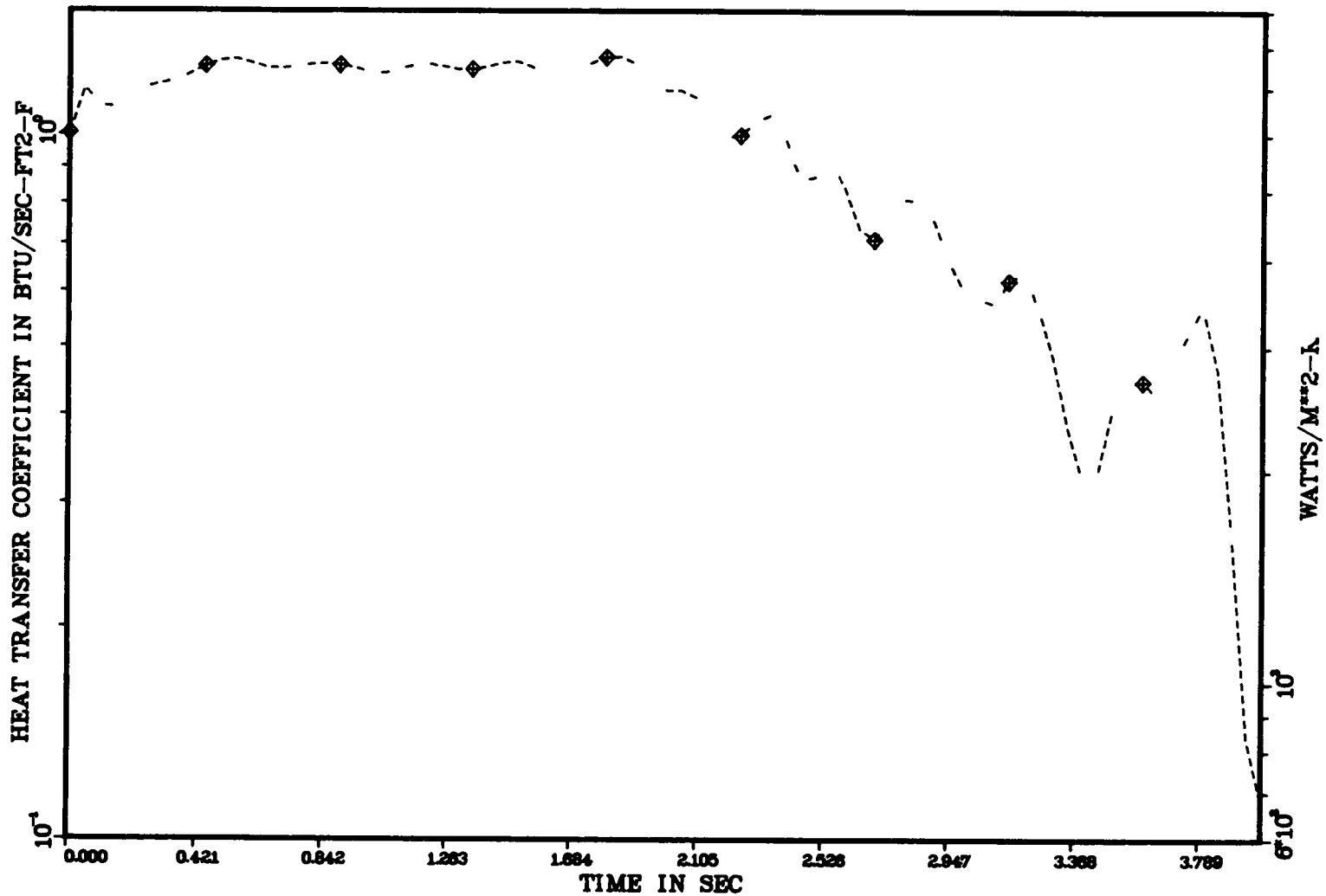

Fig 11 Transient surface heat transfer coefficient boundary condition that was analytically determined

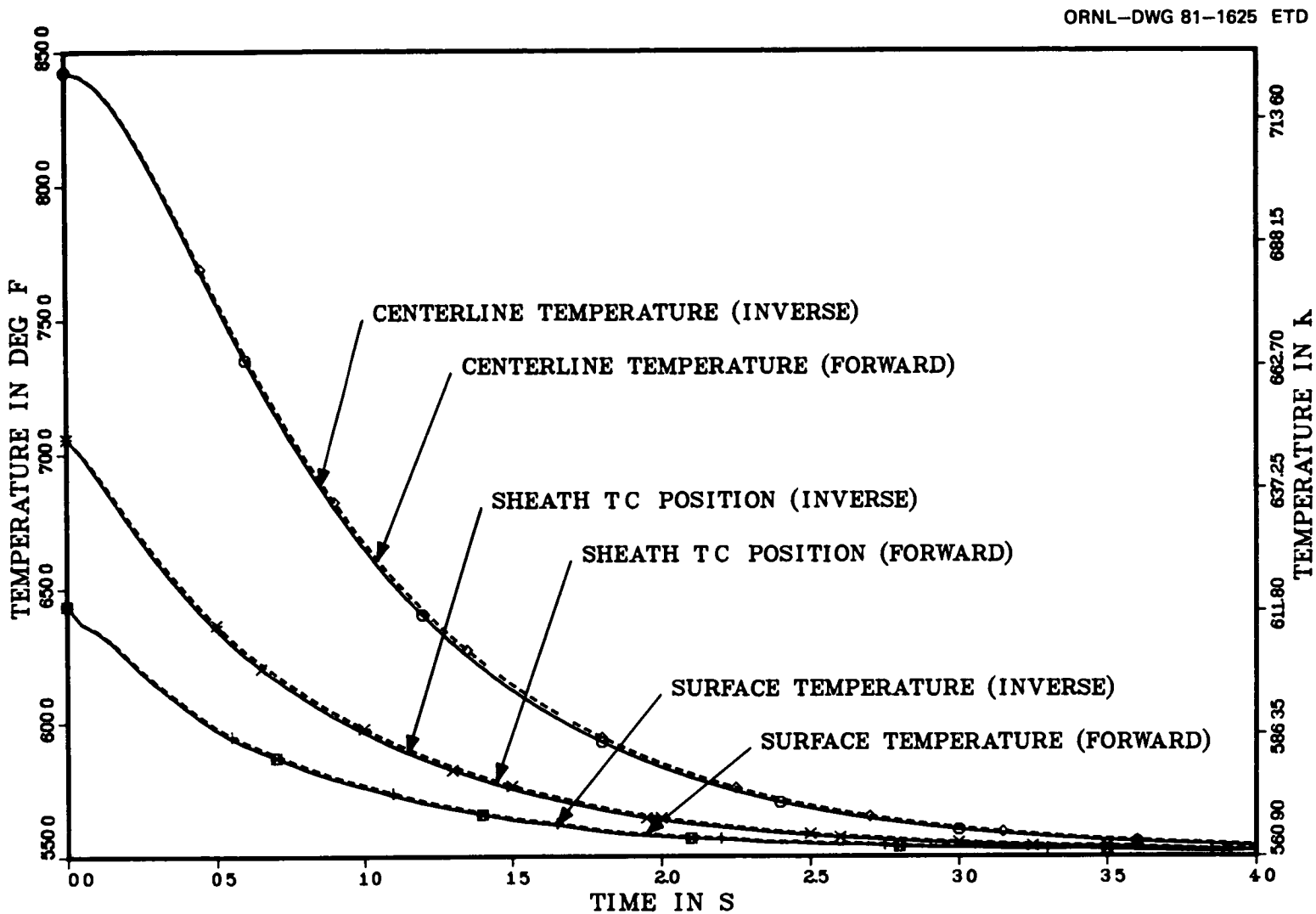

Fig 12 Comparison of PINSIM-calculated inverse conduction problem solution results with the corresponding forward conduction problem solution results

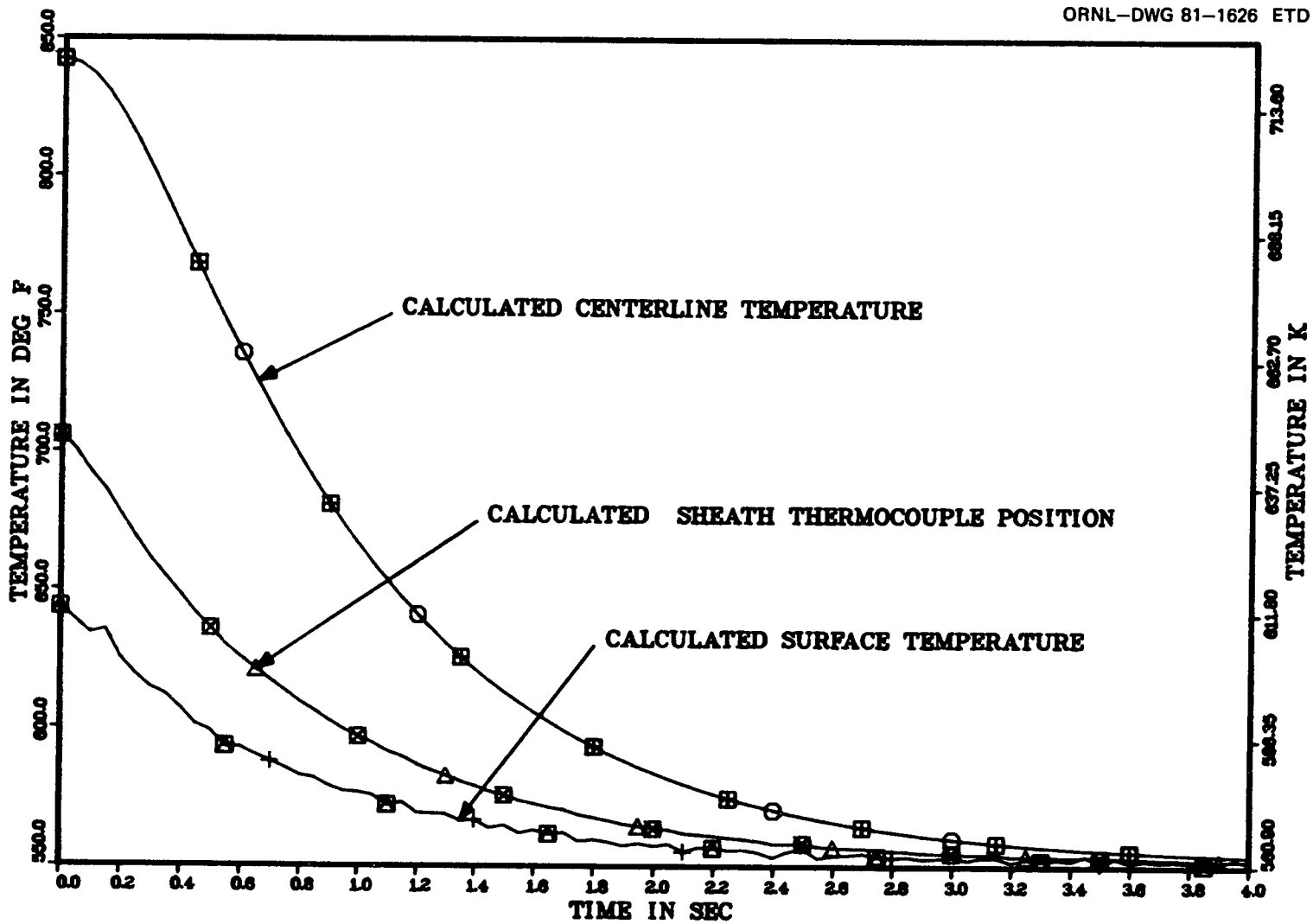

Fig 13 Comparison of PINSIM-calculated inverse conduction problem solution results with the corresponding backward conduction problem solution results

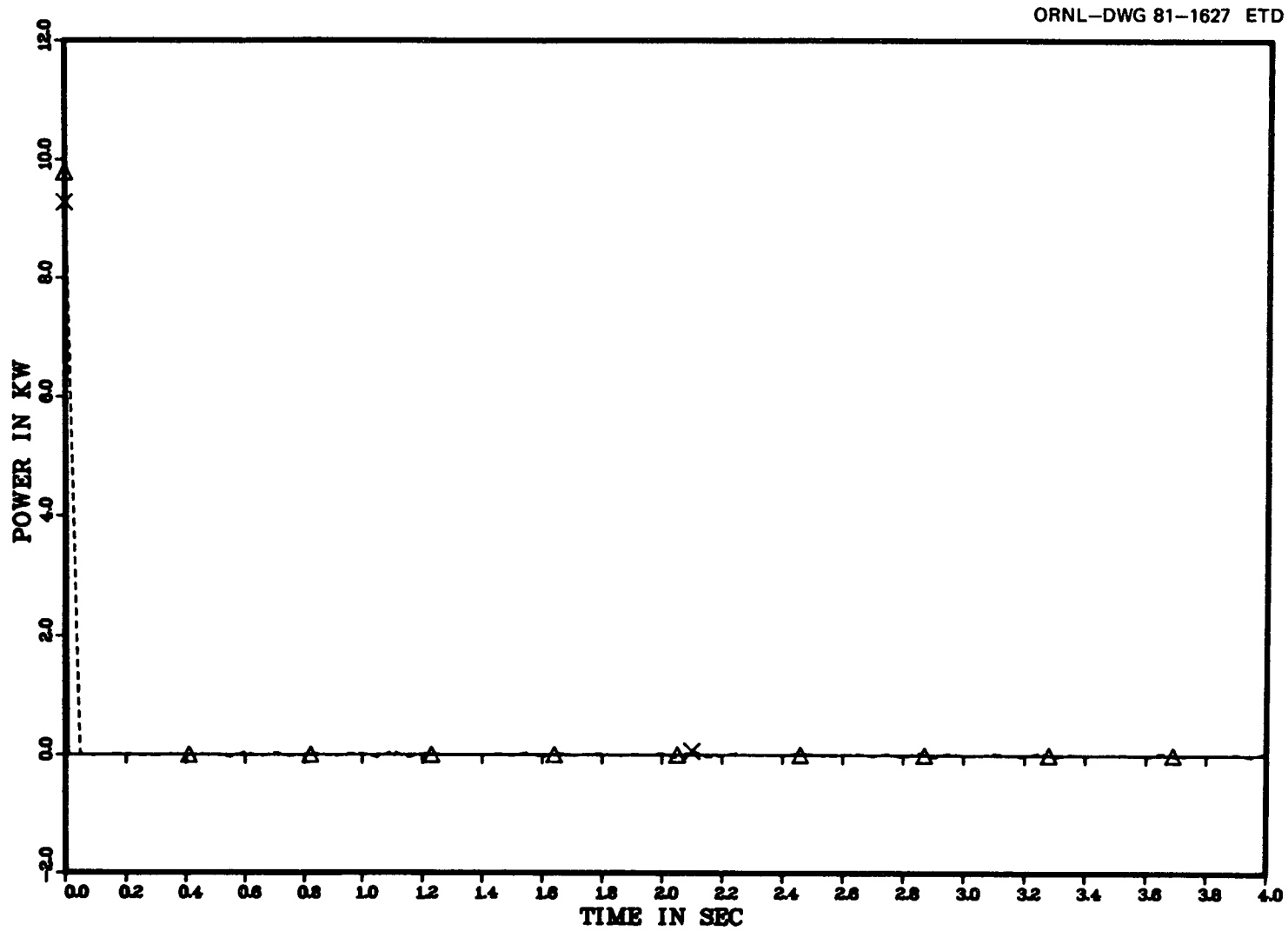

Fig 14 Comparison (0 to 4 s, −2 to 12 kW) of original power transient (from power-drop test) with PINSIM-calculated power transient (from first backward conduction problem solution results)

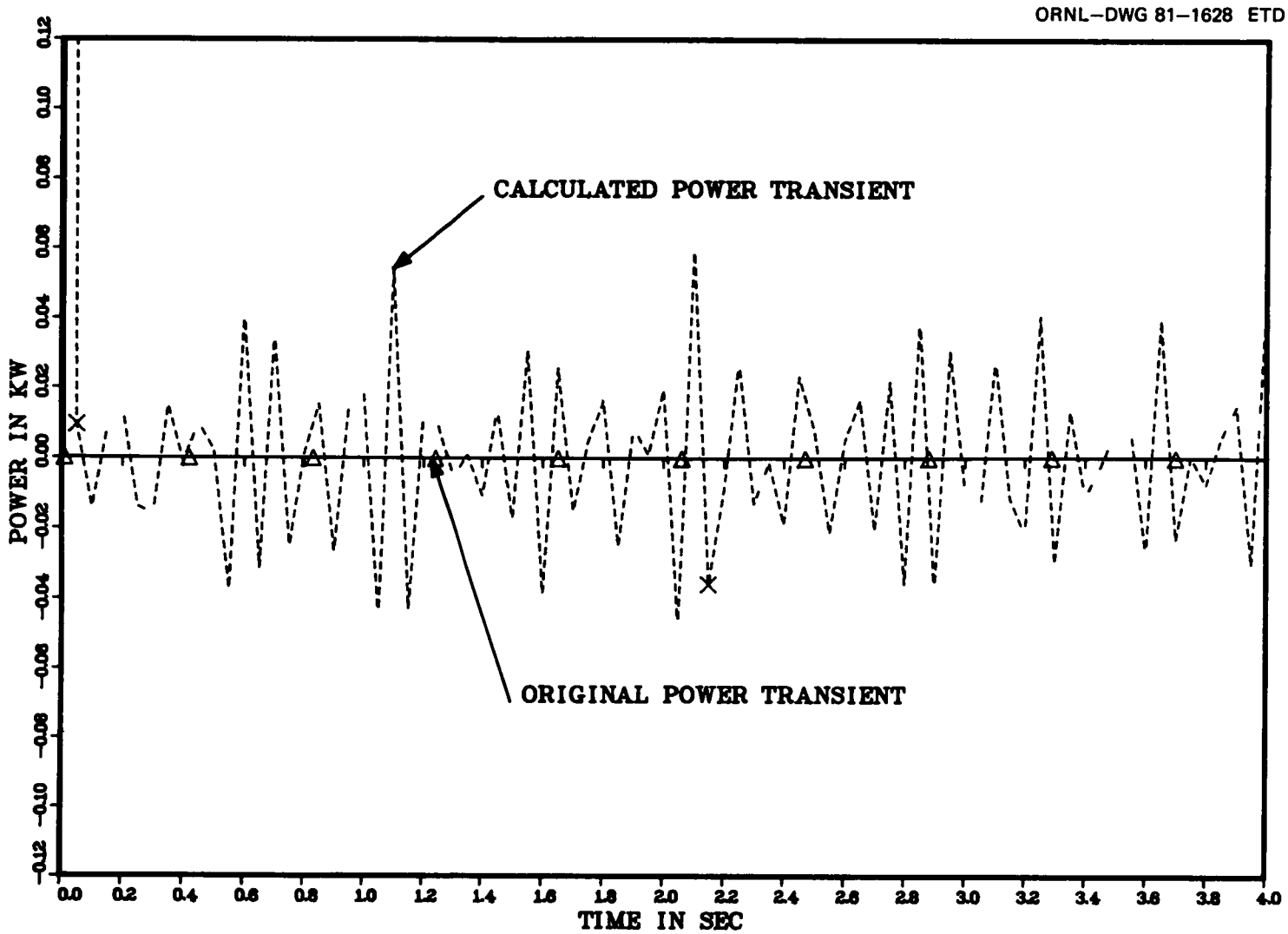

Fig 15 Comparison (0 to 4 s, −0 1 to 0 1 kW) of original power transient (from power-drop test) with PINSIM-calculated power transient (from first backward conduction problem solution results)

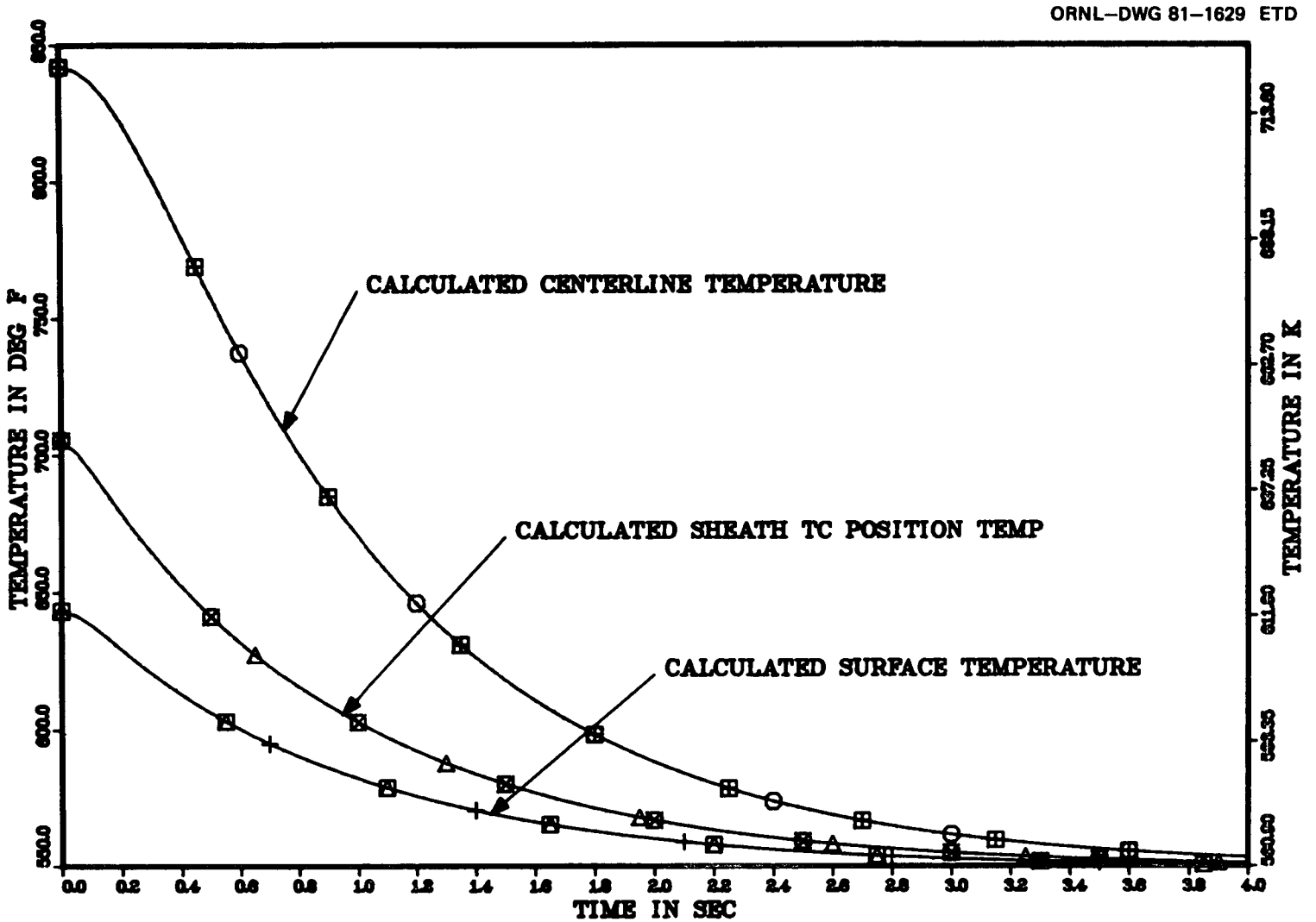

Fig 16 Comparison of PINSIM-calculated forward conduction problem solution results with corresponding backward conduction problem solution results

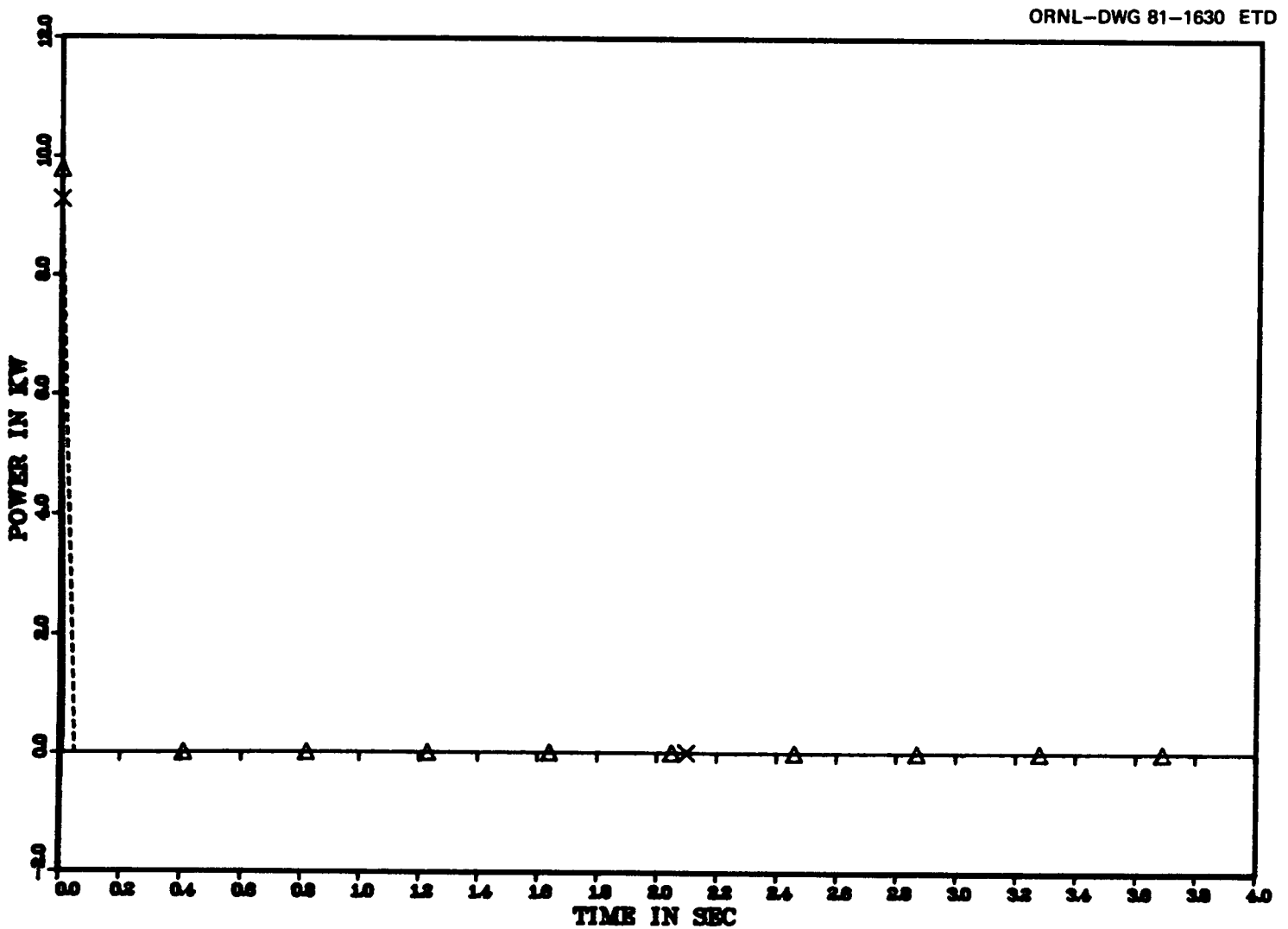

Fig 17 Comparison (0 to 4 s, −2 to 12 kW) of original power transient (from power-drop test) with PINSIM-calculated power transient (from second backward conduction problem solution results)

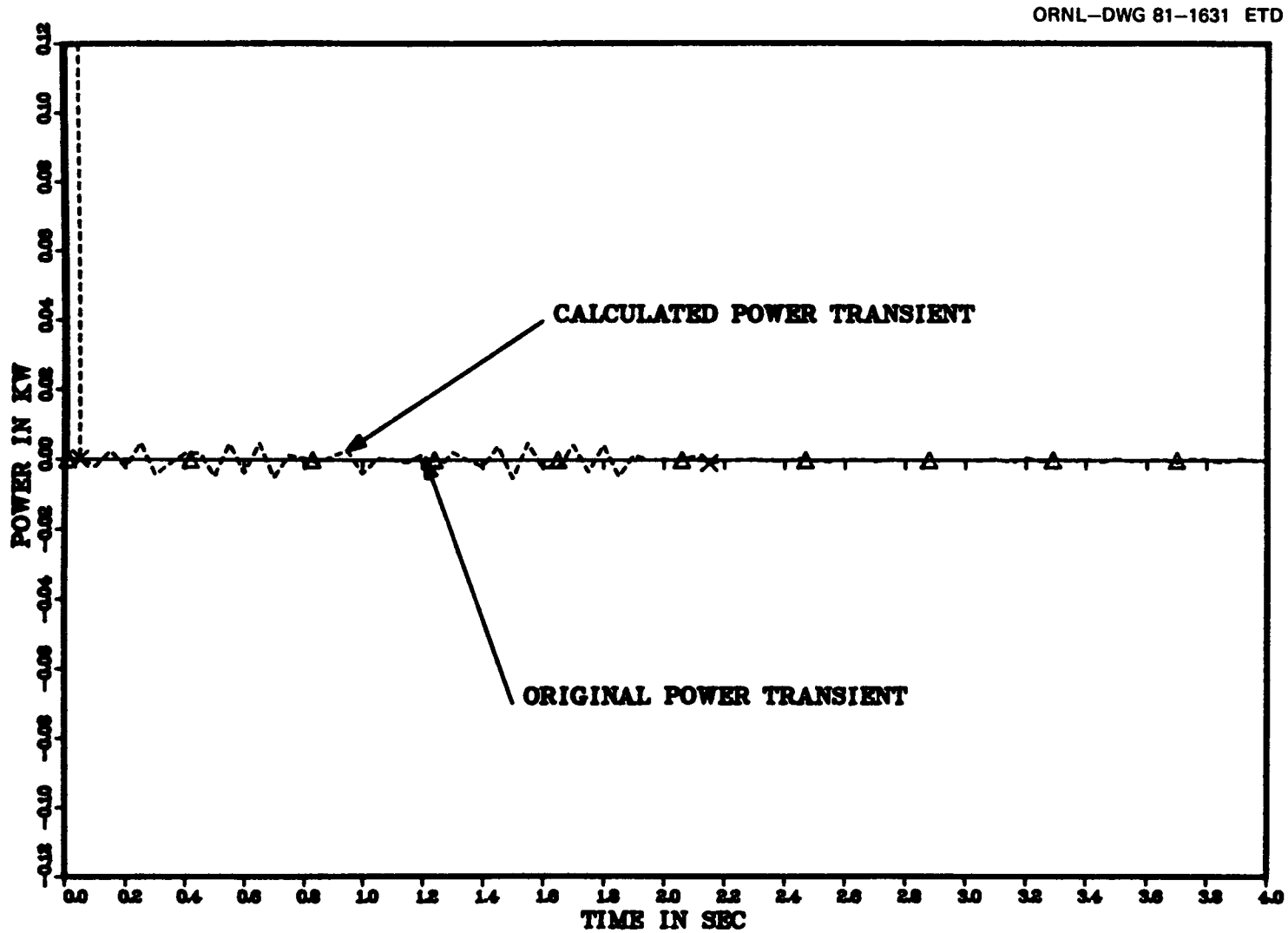

Fig 18 Comparison (0 to 4 s, −0 1 to 0 1 kW) of original power transient (from power-drop test) with PINSIM-calculated power transient (from second backward conduction problem solution results)

virtually identical The full-scale plot comparing the calculated power transient to the original power transient (Fig 17) shows no differences, but the closeup plot (Fig 18) shows that minimal differences exist

In summary, Figs 13 through 15 indicate that PINSIM correctly solves the first formulation of the backward conduction problem, PINSIM can correctly determine the power required to force a pin model to experience specified surface heat flux and surface temperature transients Figures 16 through 18 indicate that PINSIM correctly solves the second formulation of the backward conduction problem, PINSIM can correctly determine the power required to force a pin model to experience a specified surface heat flux transient while it experiences specified surface heat transfer coefficient and bulk coolant temperature transients Figures 13 and 16 indicate that backward-calculated internal temperatures exactly match the corresponding internal temperatures from the inverse-calculated and forward-calculated results that produced the boundary conditions for the backward calculations

3 CONCLUSIONS

Data generated during a power-drop test with an electrically heated fuel rod simulator were used to verify PINSIM-MOD2 solutions of several different formulations of the one-dimensional heat conduction problem The data include records describing (1) the rod power transient and (2) the responses of thermocouples located near the rod centerline, attached to the sheath near the rod surface, and in the coolant channel adjacent to the rod thermocouples Comparisons have been made between the test data and the results of PINSIM-MOD2 calculations and the results of calculations made by an established heat transfer code These comparisons provided evidence to validate the methods of solution in PINSIM

Comparisons between the test data and PINSIM solutions showed that only small differences exist Furthermore, the solutions obtained with PINSIM using the various formulations of the conduction problem were consistent with one another, that is, boundary conditions provided by one formulation produced results in a second, different formulation virtually identical to those of the former Taken together, these observations imply that PINSIM solves the various formulations of the conduction problem correctly and that essentially all differences between PINSIM solutions and test data are the result of causes unrelated to the methods of solution in PINSIM These causes include

1 mismatches between the model's internal dimensions and those of the rod,
2 discrepancies between rod and model material property values,
3 uncertainties associated with the thermocouple record data,
4 inaccuracies in modeling a three-dimensional heat conduction problem using only one-dimensional formulations that further involve approximate nodal (discrete) representations

REFERENCES

1 R C Hagar and R A Hedrick, *PINSIM-MOD1 A Nuclear Fuel Pin/Electric Fuel Pin Simulator Transient Analysis Code*, ORNL/NUREG/TM-291 (January 1980)

2 R C Hagar and D G Morris, *PINSIM-MOD2 A Generalized Heat Conduction Code for Cylindrical Geometries* (to be published)

3 Project Description, *ORNL-PWR Blowdown Heat Transfer Separate-Effects Program — Thermal Hydraulics Test Facility (THTF)*, ORNL/NUREG/TM-2 (February 1976)

4 L J Ott, Oak Ridge National Laboratory, personal communication to R C Hagar, Oak Ridge National Laboratory, Feb 27, 1980

5 L J Ott and J A Smolen, Bundle 3 Fuel Rod Simulator Radial Dimensions, memo to distribution BDHT-2287 (Aug 8, 1979)

6 W D Turner, D C Elrod, and I I Siman-Tov, *HEATING5 — An IBM 360 Heat Conduction Program*, ORNL/CSD/TM-15 (March 1977)

Appendix A

INVERSE CONDUCTION PROBLEM SAMPLE OUTPUT

This appendix includes a copy of the printed output produced by PINSIM-MOD2 during solution of the inverse conduction problem discussed in Sect 2 3 Some results of this calculation are plotted in Figs 3 and 4

LISTING OF INPUT DATA FOR CASE 1

```
 1   ************************************************************PDJOB DAT*
 2   =PINSIM VERIFICATION STUDY PROBLEM   POWER-DROP TEST SIMULATION
 3   *
 4   *       NSYS   NPINS   NFLIP
 5   100100   1      1        0
 6   *
 7   *       IDJOB    RSTRTM   ENDT    NTIM
 8   100000    1        0 0    4 0
 9   *
10   *         TIME  TMIN  TMAX  ITIMFL
11   100001    0 0    05    05     2
12   *
13   *       NITER   CONVERGENCE CRITERIA   TEMP   ENERGY
14   100400   50                          1 00-8  1 00-8
15   *
16   *      NDBUG IGDBUG IHDBUG ISDBUG IFDBUG
17   200000  11      0      6      0
18   *
19   *      MINOUT NMIN DELMIN
20   210000   8     1    0 0
21   *
22   *
23   *      MAJOUT NMAJ DELMAJ
24   220000   6     0    1 0
25   *
26   *         NPLT DELPLT
27   230000     0    0 0
28   *
29   ****** ************* **** ***************************END OF PDJOB DAT*
30   **** * ***********************************************PDPIN DAT*
31   *
32   * APPROXIMATE BUNDLE 3 DESIGN (AS DESCRIBED IN BDHT-2287)
33   *
34   *
35   * MODEL ASSEMBLED ON 3/3/80 BY BOB HAGAR
36   * (THERMAL CONDUCTIVITY OF OUTER BN3 ANNULUS CHANGED BY DGM
37   *  ON 26-MAR-80 TO IMPROVE INV RESULTS)
38   *
39   *
40   ************************************** ***************** ********
41   *
42   *         NLVL  NMAT IPOW  POWFAC   IGAPFL  INFLAG  HTCFAC IDFORM
43   410000     1     4    1     1 0               0       1 0     0
44   *
45   ********************** ********************** ******* ******** ***
46   *
47   *
48   *        NREG    PCVPA     ZLNGTH      NODWAT
49   410100   5       1 0       1 000         0
50   *
51   *          RINREG     ROTREG     PCVP   NNOD  MATRLG
52   410101   0 0        0 0023417  0 0     1     1     * T/C BUNDLE
53   410102   0 0023417  0 009075   0 0     7     1       INNER BN3
54   410103   0 009075   0 010225   1 00    2     3     * HEATER ELEMENT
55   410104   0 010225   0 0140167  0 0     6     2     * OUTER BN3
 o   410105   0 0140167  0 0155917  0 0     3     4     * SS-316
```

```
 57    *
 58    ******************************************************************
 59    * MATERIALS
 60    ******************************************************************
 61    *
 62    * MATERIAL 1   BN3 (CORE)
 63    *
 64    *
 65    419100   0   3   5000
 66    *
 67    *  (THERMAL CONDUCTIVITY)
 68    *
 69    419110   0   0 0   2300 0
 70    *
 71    * (COEFFICIENTS WERE OBTAINED FROM L J OTT ON 3-2-80)
 72    419111  21 286575    -0 0101369   0 0   0 0   0 0
 73    *
 74    *  (SPECIFIC HEAT CAPACITY)
 75    *
 76    419120   0   0 0   2300 0
 77    *
 78    419121    0 167812347  3 70264053D-04  -1 737935240-07
 79    +          3 14486215D-11   0 0
 80    *
 81    *  (DENSITY)
 82    *
 83    419130   -1   0 0   2300 0
 84    *
 85    *  (CORE BN3 DENSITY CORRECTED ON 6-MAY-80 TO CONFORM
 86    *   TO BDHT-2404)
 87    419131   138 3840
 88    *
 89    *
 90    *  MATERIAL 2   BN3 (ANNULUS)
 91    *
 92    *
 93    419200   0   3   5000
 94    *
 95    *  (THERMAL CONDUCTIVITY)
 96    *
 97    419210   0   0 0   2300 0
 98    *
 99    * (COEFFICIENTS WERE OBTAINED FROM L J OTT ON 3-2-80)
100    *
101      (K COEFF  MODIFIED BY DGM CA 26-MAR-80 TO
102    *  IMPROVE INV RESULTS  INCREASE BOTH BY 1 104)
103    *419211  1  56185    -0 36872E-02    0 0   0 0   0 0
104    419211  17 1853    -0 40719E-02    0 0   0 0   0 0
105    *
106    *  (SPECIFIC HEAT CAPACITY)
107
108    419220   0   0 0   2300 0
109
110    419221    0 167812347  3 70264053D-04  -1 737935240-07
111    +           14486215D-11   0 0
112    *
113    *  (DENSITY)
114    *
```

```
419230   -1   0 0   2300 0
*
*  (CORE BN3 DENSITY CORRECTED ON 6-MAY-80 TO CONFORM
*   TO BDHT-2404)
419231   135 468
*
*
*
* MATERIAL 3   INCONEL HEATER ELEMENT
*
419300   5   3     000 0
*
* MATERIAL 4   SS - 316
*
419400   7   3     000 0
*
*****************************************************END OF PDPIN DAT*
*************************************************************PDSYS INV*
*
* SYSTEM INPUT   INVERS CALCULATION
*
*********************************************************************
*
*     ISYSF  IPOWX   PSYS
500000  0     -1    100 0
*
*     * LEVEL CALCULATIONAL CONTROL  LEVEL # 1 *
*
*     NPBACK NLBACK NNBACK IPFL IQFL IHFL ITFL DTSYS   PLVL
500100   1      1      16    20    0    0    20  0 05   9 27696
*
*      BPOWL  BPOWH IPOWF
500101   0 0    0 0   0
*
*      BPHIL  BPHIH IPHIF
500102   0 0    0 0   0
*
*      BTMPL  BTMPH ITMPF
500103  0 0    0 0    0
*
*
*     ITRPFL TTRIP
500150   0   0 0
*
*****************************************************END OF PDSYS INV*
 **   $    $    $    $    $    $    $    $    $    $    $    $
 **   $    $    $    $    $    $    $    $    $    $    $    $
 **   $    $    $    $    $    $    $    $    $    $    $    $
 **    0 100000E+01  TIME IN   $
 **    0 100000E+01  TE-A1 (OUTER)$
500141
 +   0 000000E+00    0 705810E 03
 +   0 100000E-01    0 704470E+03
 +   0 200000E-01    0 703810E+03
 +   0 300000E-01    0 702500E+03
 +   0 400000E-01    0 701420E+03
 +   0 500000E-01    0 700340E+03
 +   0 600000E-01    0 698830E+03
```

173	+	0 700000E-01	0 697540E+03
174	+	0 800000E-01	0 695820E+03
175	+	0 900000E-01	0 694090E+03
176		0 100000E+00	0 692370E+03
177	+	0 110000E 00	0 690650E+03
178	+	0 120000E 00	0 688930E+03
179	+	0 130000E+00	0 687430E+03
180	+	0 140000E 00	0 685930E+03
181	+	0 150000E+00	0 684210E+03
182	+	0 160000E+00	0 682490E+03
183	+	0 170000E+00	0 680780E+03
184	+	0 180000E+00	0 679060E+03
185	+	0 190000E 00	0 677130E+03
186	+	0 200000E+00	0 675420E+03
187	+	0 210000E+00	0 673710E+03
188	+	0 220000E+00	0 671780E+03
189	+	0 230000E+00	0 670070E+03
190	+	0 240000E+00	0 668570E+03
191	+	0 250000E+00	0 666860E+03
192	+	0 260000E+00	0 665360E+03
193	+	0 270000E+00	0 663860E+03
194	+	0 280000E+00	0 662370E+03
195	+	0 290000E+00	0 660870E+03
196	+	0 300000E+00	0 659590E+03
197	+	0 310000E+00	0 658310E+03
198	+	0 320000E+00	0 657020E+03
199	+	0 330000E+00	0 655740E+03
200	+	0 340000E+00	0 654460E+03
201	+	0 350000E+00	0 653180E+03
202	+	0 360000E+00	0 651890E+03
203	+	0 370000E+00	0 650610E+03
204	+	0 380000E+00	0 649330E+03
205	+	0 390000E+00	0 648050E+03
206	+	0 400000E+00	0 646760E+03
207	+	0 410000E+00	0 645270E+03
208	+	0 420000E+00	0 643980E+03
209	+	0 430000E+00	0 642700E+03
210	+	0 440000E+00	0 641420E+03
211	+	0 450000E+00	0 640140E+03
212	+	0 460000E+00	0 639070E+03
213	+	0 470000E+00	0 638000E+03
214	+	0 480000E+00	0 636930E+03
215	+	0 490000E+00	0 635860E+03
216	+	0 500000E+00	0 634790E+03
217	+	0 510000E+00	0 633510E+03
218	+	0 520000E+00	0 632440E+03
219	+	0 530000E+00	0 631150E+03
220	+	0 540000E+00	0 629870E+03
221	+	0 550000E+00	0 628800E+03
222	+	0 560000E+00	0 627940E+03
223	+	0 570000E+00	0 626870E+03
224	+	0 580000E+00	0 626020E+03
225	+	0 590000E+00	0 625370E+03
226	+	0 600000E+00	0 6245 0E+03
227	+	0 610000E+00	0 623660E+03
228		0 620000E 00	0 622800E+03
229	+	0 630000E+00	0 621950E+03
230	+	0 640000E+00	0 621090E+03

231	+	0 650000E+00	0 620230E+03
232	+	0 660000E+00	0 619370E+03
233	+	0 670000E+00	0 618730E+03
234	+	0 680000E+00	0 617870E+03
235	+	0 690000E+00	0 617020E+03
236	+	0 700000E+00	0 616160E+03
237	+	0 710000E+00	0 615510E+03
238	+	0 720000E+00	0 614660E+03
239	+	0 730000E+00	0 614010E+03
240	+	0 740000E+00	0 6131 0E+03
241	+	0 750000E+00	0 612510E+03
242	+	0 760000E+00	0 6116 0E+03
243	+	0 770000E+00	0 610580E+03
244	+	0 780000E+00	0 609940E+03
245	+	0 790000E+00	0 609290E+03
246	+	0 800000E+00	0 608650E+03
247	+	0 810000E+00	0 608000E+03
248	+	0 820000E+00	0 607570E+03
249	+	0 830000E+00	0 606710E+03
250	+	0 840000E+00	0 606070E+03
251	+	0 850000E+00	0 605210E+03
252	+	0 860000E+00	0 604350E+03
253	+	0 870000E+00	0 603700E+03
254	+	0 880000E+00	0 603060E+03
255	+	0 890000E+00	0 602630E+03
256	+	0 900000E+00	0 601960E+03
257	+	0 910000E+00	0 601550E+03
258	+	0 920000E+00	0 600910E+03
259	+	0 930000E+00	0 600260E+03
260	+	0 940000E+00	0 599400E+03
261	+	0 950000E+00	0 598970E+03
262	+	0 960000E+00	0 598330E+03
263	+	0 970000E+00	0 597680E+03
264	+	0 980000E+00	0 597250E+03
265	+	0 990000E+00	0 596820E+03
266	+	0 100000E+01	0 596170E+03
267	+	0 101000E+01	0 595740E+03
268	+	0 102000E+01	0 595310E+03
269	+	0 103000E+01	0 594880E+03
270	+	0 104000E+01	0 594450E+03
271	+	0 105000E+01	0 594020E+03
272	+	0 106000E+01	0 593370E+03
273	+	0 107000E+01	0 592940E+03
274	+	0 108000E+01	0 592080E+03
275	+	0 109000E+01	0 591430E+03
276	+	0 110000E+01	0 591000E+03
277	+	0 111000E+01	0 590570E+03
278	+	0 112000E+01	0 590140E+03
279	+	0 113000E+01	0 589920E+03
280	+	0 114000E+01	0 589490E+03
281	+	0 115000E+01	0 588840E+03
282	+	0 116000E+01	0 588200E+03
283	+	0 117000E+01	0 587550E+03
284	+	0 118000E+01	0 587120E+03
285	+	0 119000E+01	0 586690E+03
286	+	0 120000E+01	0 586250E+03
287	+	0 121000E+01	0 586040E+03
288	+	0 122000E+01	0 585610E+03

289	+	0 123000E 01	0 584960E 03
290	+	0 124000E+01	0 584530E+03
291	+	0 125000E+01	0 584090E+03
292	+	0 126000E+01	0 583660E+03
293	+	0 127000E+01	0 5834 0E 03
294	+	0 128000E 01	0 583230E+03
295	+	0 129000E+01	0 582800E+03
296	+	0 130000E+01	0 582370E+03
297	+	0 131000E+01	0 581930E 03
298	+	0 132000E+01	0 581500E+03
299	+	0 133000E+01	0 581070E+03
300	+	0 134000E+01	0 580640E+03
301	+	0 135000E+01	0 580420E+03
302	+	0 136000E+01	0 579990E+03
303	+	0 137000E 01	0 579550E+03
304	+	0 138000E+01	0 579340E+03
305	+	0 139000E+01	0 579120E 03
306	+	0 140000E+01	0 578690E+03
307	+	0 141000E+01	0 578470E+03
308	+	0 142000E+01	0 578040E+03
309	+	0 143000E 01	0 577390E+03
310	+	0 144000E+01	0 576960E+03
311	+	0 145000E+01	0 576740E+03
312	+	0 146000E+01	0 576530E+03
313	+	0 147000E+01	0 576310E+03
314	+	0 148000E+01	0 576090E 03
315	+	0 149000E+01	0 575660E 03
316	+	0 150000E+01	0 575230E+03
317	+	0 151000E+01	0 574790E+03
318	+	0 152000E+01	0 574360E 03
319	+	0 153000E+01	0 573930E+03
320	+	0 154000E+01	0 573710E+03
321	+	0 155000E+01	0 573490E+03
322	+	0 156000E+01	0 573260E+03
323	+	0 157000E+01	0 573060E+03
324	+	0 158000E+01	0 572840E+03
325	+	0 159000E+01	0 572630E+03
326	+	0 160000E+01	0 572410E+03
327	+	0 161000E+01	0 571980E+03
328	+	0 162000E+01	0 571760E+03
329	+	0 163000E+01	0 571540E+03
330	+	0 164000E+01	0 571330E+03
331	+	0 165000E+01	0 571110E+03
332	+	0 166000E+01	0 571110E+03
333	+	0 167000E+01	0 570890E+03
334	+	0 168000E+01	0 570680E+03
335	+	0 169000E 01	0 570460E+03
336	+	0 170000E+01	0 570030E+03
337	+	0 171000E+01	0 569590E+03
338	+	0 172000E+01	0 569370E+03
339	+	0 173000E+01	0 569160E 03
340	+	0 174000E+01	0 568720E+03
341	+	0 175000E+01	0 568510E+03
342	+	0 176000E+01	0 568290E 03
343	+	0 177000E+01	0 567860E+03
344	+	0 178000E+01	0 567640E+03
345	+	0 179000E+01	0 567640E+03
346	+	0 180000E+01	0 567420E+03

347	+	0 181000E+01	0 567200E 03
348	+	0 182000E+01	0 567200E 03
349	+	0 183000E+01	0 566990E 03
350	+	0 184000E+01	0 566550E+03
351		0 185000E+01	0 566340E 03
352	+	0 186000E+01	0 565900E 03
353		0 187000E+01	0 565690E 03
354	+	0 188000E+01	0 565470E 03
355	+	0 189000E+01	0 5652 0E 03
356	+	0 190000E+01	0 565030E 03
357	+	0 191000E 01	0 565030E+03
358	+	0 192000E+01	0 564820E 03
359	+	0 193000E+01	0 564600E+03
360		0 194000E+01	0 564600E+03
361	+	0 195000E+01	0 564600E 03
362	+	0 196000E+01	0 564380E 03
363	+	0 197000E+01	0 563950E 03
364	+	0 198000E+01	0 563950E+03
365	+	0 199000E+01	0 563730E 03
366	+	0 200000E+01	0 563510E 03
367	+	0 201000E 01	0 563510E+03
368		0 202000E 01	0 563730E 03
369	+	0 203000E 01	0 563510E 03
370	+	0 204000E 01	0 563300E 03
371	+	0 205000E 01	0 563060E 03
372	+	0 206000E 01	0 562640E+03
373	+	0 207000E+01	0 562210E 03
374	+	0 208000E 01	0 561990E+03
375	+	0 209000E 01	0 561990E 03
376	+	0 210000E+01	0 561770E 03
377	+	0 211000E+01	0 561770E+03
378	+	0 212000E+01	0 561770E 03
379	+	0 213000E+01	0 561770E 03
380	+	0 214000E+01	0 561560E+03
381	+	0 215000E+01	0 561560E 03
382	+	0 216000E+01	0 561340E 03
383	+	0 217000E+01	0 561120E+03
384	+	0 218000E 01	0 561120E+03
385	+	0 219000E+01	0 561120E+03
386	+	0 220000E+01	0 560900E 03
387	+	0 221000E+01	0 560900E 03
388	+	0 222000E+01	0 560900E+03
389	+	0 223000E 01	0 560690E+03
390	+	0 224000E+01	0 560470E 03
391	+	0 225000E+01	0 560470E+03
392	+	0 226000E 01	0 560470E 03
393	+	0 227000E+01	0 560250E+03
394		0 228000E+01	0 560030E+03
395	+	0 229000E+01	0 560030E+03
396	+	0 230000E 01	0 559820E 03
397		0 231000E+01	0 559600E 03
398	+	0 232000E+01	0 559600E+03
399	+	0 233000E+01	0 559600E 03
400		0 234000E 01	0 559380E+03
401		0 235000E+01	0 559160E+03
402		0 236000E+01	0 558950E+03
403		0 237000E+01	0 558730E 03
404		0 238000E+01	0 558510E 03

405	+	0 239000E+01	0 558290E 03
406		0 240000E 01	0 558290E+03
407	+	0 241000E+01	0 558290E+03
408	+	0 242000E+01	0 558290E+03
409	+	0 243000E+01	0 558290E+03
410	+	0 244000E+01	0 558290E+03
411	+	0 245000E+01	0 558510E+03
412	+	0 246000E+01	0 558510E+03
413	+	0 247000E+01	0 558510E+03
414	+	0 248000E+01	0 558510E+03
415	+	0 249000E+01	0 558510E+03
416	+	0 250000E+01	0 558290E+03
417	+	0 251000E+01	0 558080E+03
418	+	0 252000E+01	0 557860E+03
419	+	0 253000E+01	0 557640E 03
420	+	0 254000E+01	0 5574 0E+03
421	+	0 255000E+01	0 557210E+03
422	+	0 256000E+01	0 556990E 03
423	+	0 257000E+01	0 556770E+03
424	+	0 258000E+01	0 556770E+03
425	+	0 259000E+01	0 556990E+03
426	+	0 260000E+01	0 556990E+03
427	+	0 261000E+01	0 557210E+03
428	+	0 262000E+01	0 557210E+03
429	+	0 263000E+01	0 556990E+03
430	+	0 264000E+01	0 556770E+03
431	+	0 265000E+01	0 556770E+03
432	+	0 266000E+01	0 556550E+03
433	+	0 267000E+01	0 556550E+03
434	+	0 268000E+01	0 556770E+03
435	+	0 269000E+01	0 556770E+03
436	+	0 270000E+01	0 556770E+03
437	+	0 271000E+01	0 556770E+03
438	+	0 272000E+01	0 556770E+03
439	+	0 273000E+01	0 556550E+03
440	+	0 274000E+01	0 556340E+03
441	+	0 275000E+01	0 556120E 03
442	+	0 276000E+01	0 556120E+03
443	+	0 277000E+01	0 556120E+03
444	+	0 278000E+01	0 555900E+03
445	+	0 279000E+01	0 555900E+03
446	+	0 280000E+01	0 555900E+03
447	+	0 281000E+01	0 555900E+03
448	+	0 282000E+01	0 555680E+03
449	+	0 283000E+01	0 555680E+03
450	+	0 284000E+01	0 555680E+03
451	+	0 285000E+01	0 555460E+03
452	+	0 286000E 01	0 555460E+03
453	+	0 287000E+01	0 555460E+03
454	+	0 288000E+01	0 555460E+03
455	+	0 289000E+01	0 555250E+03
456	+	0 290000E+01	0 555250E+03
457	+	0 291000E+01	0 555030E+03
458	+	0 292000E 01	0 555030E+03
459	+	0 293000E+01	0 555030E+03
460	+	0 294000E+01	0 5550_0E+03
461	+	0 295000E+01	0 555030E+03
462	+	0 296000E+01	0 555030E+03

463	+	0 297000E 01	0 555030E+03
464	+	0 298000E+01	0 555030E+03
465	+	0 299000E+01	0 555030E+03
466	+	0 300000E+01	0 550_0E+03
467	+	0 301000E+01	0 555030E 03
468	+	0 302000E+01	0 554810E+03
469	+	0 303000E+01	0 554590E+03
470	+	0 304000E+01	0 554590E+03
471	+	0 305000E+01	0 554590E+03
472	+	0 306000E 01	0 54590E 03
473	+	0 307000E+01	0 554590E 03
474	+	0 308000E+01	0 554590E+03
475		0 309000E+01	0 554590E+03
476	+	0 310000E+01	0 54590E+03
477	+	0 311000E+01	0 554590E+03
478	+	0 312000E+01	0 54590E+03
479	+	0 313000E+01	0 554590E+03
480	+	0 314000E+01	0 554590E+03
481	+	0 315000E+01	0 554380E+03
482	+	0 316000E+01	0 54160E+03
483	+	0 317000E+01	0 554160E+03
484	+	0 318000E+01	0 554160E+03
485	+	0 319000E+01	0 553940E+03
486	+	0 320000E+01	0 553940E+03
487	+	0 321000E 01	0 553940E 03
488	+	0 322000E+01	0 553940E+03
489	+	0 323000E+01	0 553940E+03
490	+	0 324000E 01	0 553940E+03
491		0 325000E+01	0 553940E+03
492	+	0 326000E+01	0 553940E+03
493	+	0 327000E 01	0 553940E+03
494	+	0 328000E+01	0 553720E+03
495	+	0 329000E+01	0 553720E+03
496	+	0 330000E+01	0 553720E+03
497	+	0 331000E+01	0 553720E 03
498	+	0 332000E+01	0 553500E+03
499	+	0 333000E+01	0 553720E+03
500	+	0 334000E+01	0 553720E+03
501	+	0 335000E+01	0 553720E+03
502	+	0 336000E+01	0 553720E 03
503	+	0 337000E+01	0 553720E 03
504	+	0 338000E+01	0 553500E+03
505	+	0 339000E+01	0 553500E+03
506	+	0 340000E+01	0 553500E+03
507	+	0 341000E+01	0 553500E 03
508	+	0 342000E+01	0 553720E+03
509	+	0 343000E+01	0 553940E+03
510	+	0 344000E+01	0 553940E+03
511	+	0 345000E+01	0 553940E+03
512	+	0 346000E+01	0 553720E+03
513	+	0 347000E+01	0 553500E+03
514	+	0 348000E+01	0 553290E+03
515	+	0 349000E+01	0 553290E+03
516	+	0 350000E+01	0 553290E+03
517	+	0 351000E+01	0 553500E+03
518	+	0 352000E+01	0 553500E+03
519	+	0 353000E+01	0 553500E+03
520	+	0 354000E+01	0 553500E+03

```
 +    0 355000E 01    0 553290E 03
 +    0 356000E 01    0 553070E 03
      0 357000E+01    0 553070E 03
      0 358000E 01    0 553070E 03
      0 359000E+01    0 553070E 03
      0 360000E+01    0 553070E 03
 +    0 361000E 01    0 553070E+03
 +    0 362000E+01    0 553070E+03
      0 363000E 01    0 553070E 03
 +    0 364000E+01    0  53070E+03
 +    0 365000E+01    0 553070E 03
      0 366000E 01    0 553070E 03
 +    0 367000E+01    0 553070E 03
 +    0 368000E 01    0 553070E+03
 +    0 369000E+01    0 552850E+03
 +    0 370000E+01    0  528 0E+03
 +    0 371000E+01    0 552850E 03
      0 372000E+01    0  52850E 03
      0 373000E+01    0 552630E 03
 +    0 374000E 01    0 5528 0E+03
 +    0 375000E 01    0 552850E+03
 +    0 376000E+01    0  52850E 03
 +    0 377000E+01    0 552850E+03
 +    0 378000E+01    0  528 0E+03
 +    0 379000E+01    0 552630E+03
 +    0 380000E+01    0 552410E 03
 +    0 381000E+01    0 552410E+03
 +    0 382000E 01    0 552200E 03
 +    0 383000E+01    0 552200E+03
 +    0 384000E+01    0 552200E+03
 +    0 385000E 01    0 552410E 03
 +    0 386000E+01    0 552410E 03
 +    0 387000E+01    0 552410E 03
 +    0 388000E+01    0 552410E+03
 +    0 389000E 01    0 552200E 03
 +    0 390000E+01    0 552200E 03
 +    0 391000E+01    0 552200E+03
 +    0 392000E 01    0 552410E+03
 +    0 393000E+01    0 552410E+03
 +    0 394000E+01    0 552630E+03
 +    0 395000E+01    0 552630E+03
 +    0 396000E+01    0 552630E+03
 +    0 397000E 01    0 552410E+03
 +    0 398000E+01    0 552410E+03
 +    0 399000E+01    0 552410E+03
 +    0 400000E+01    0 552410E+03
*****************************************************************PDQA DAT**
 **   TIME IN S $
 **     TEMPERATURE IN DEG  F$
 **     0 100000E+01  TIME IN S $
 **     0 100000E+01  LIN HEAT RATE$
500111
 +    0 000000E+00    0 978611E+01
 +    0 100000E-01    0 0000E 00
 +    0 500000E-01    0 0000E+00
 +    0 100000E+00    0 0000E+00
 +    0 200000E+00    0 0000E+00
 +    0 300000E+00    0 0000E+00
```

```
 579     +    0 400000E 00     0 0000E+00
 580     +    0 500000E 00     0 0000E+00
 581     +    0 600000E+00     0 0000E+00
 582     +    0 700000E+00     0 0000E 00
 583     +    0 800000E 00     0 0000E+00
 584     +    0 900000E+00     0 0000E+00
 585     +    0 100000E 01     0 0000E+00
 586          0 200000E 01     0 0000E+00
 587     +    0 300000E 01     0 0000E+00
 588     +    0 400000E 01     0 0000E 00
 589     +    0 500000E+01     0 0000E+00
 590     +    0 600000E 01     0 0000E+00
 591          0 700000E+01     0 0000E 00
 592     +    0 800000E+01     0 0000E+00
 593     +    0 900000E+01     0 0000E+00
 594     +    0 100000E 02     0 0000E+00
 595    ******************************************************END OF PDQA DAT***
 596    ******************************************************************
 597    *
 598    210001  PHIW(1 1)  TWAL(1 1)  POWL(1 1)  TNOD(1 1 1)
 599    +       TNOD(1 1 3)  TNOD(1 1 4)  TNOD(1 1 16)  TNOD(1 1 19)
 600    *
 601    200000 6 0 0 0 1
        CARD ABOVE IS REPLACEMENT CARD
 602    ******************************************************************* *
 603
```

```
                                  ----- DATA DECK DIAGNOSTICS -----

                        MINIMUM LENGTH OF TABLE ARRAY IN COMMON /SCRTCH/ IS   1106 WORDS

                              (LENGTH OF THE ARRAY IS NOW   10000 WORDS)


------------------------------------------------- PROCESSING THE JOB CONTROL CARD -------------------------------------------------

------------------------------------------------- PROCESSING PROBLEM OPTIONS -------------------------------------------------

--------------- ------------------------------------- PROCESSING PIN DATA -------------------------------------------------

--- ---------------------------------------     PROCESSING SYSTEM DATA  SYSTEM #  1-------------------------------------------------

******** CARDS    500020 THROUGH    500020 MISSING

++++++++ WARNING    SYSTEM  1  LEVEL  I
          CARD SERIES   500111 NO  OF TABLE PAIRS SPECIFIED AT      20
         IS BEING RESET TO ACTUAL NO  OF PAIRS FOUND IN INPUT =    22
+++++  + NOTE   CARC 500111 PUWER TABLE IS BEING NORMALIZED TU   0 947972D 00 (PLVL ON CARD 500100)

++++++++ WARNING    SYSTEM  1  LEVEL  1
          CARD SERIES   500141 NO  OF TABLE PAIRS SPECIFIED AT      20
         IS BEING RESET TO ACTUAL NO  OF PAIRS FOUND IN INPUT =   401


------------------------------------------------- INITIALIZING PIN PARAMETERS -------------------------------------------------

------------------------------------------------- PROCESSING EDIT OPTIONS -------------------------------------------------


                        MINIMUM LENGTH OF DATA ARRAY IS       868 WORDS

                              (LENGTH OF THE ARRAY IS NOW    5000 WORDS)
```

```
PINSIM  A NUCLEAR FUEL PIN SIMULATOR-TRANSIENT ANALYSIS CODE  MOD 2        VERSION 002  06/30/80        NO  211 (PINMAN)   PAGE 0014
PINSIM VERIFICATION STUDY PROBLEM   POWER-DROP TEST SIMULATION                           07/16/80

------------------------------------------------ END OF INPUT DATA PROCESSING ------------------------------------------------

                                                 NO FATAL DIAGNOSTICS
PINSIM  A NUCLEAR FUEL PIN SIMULATOR-TRANSIENT ANALYSIS CODE  MOD 2        VERSION 002  06/30/80        NO  211
```

INITIALIZED INPUT DATA

----- GENERAL PROBLEM DATA -----

SYSTEM	SYSTEM FLAG
1	0

PROBLEM END TIME - 4 000000D 00 SEC

TIME STEP CONTROL GROUPS

GROUP NO	BEGINNING TIME(SEC)	MINIMUM TIME STEP SIZE(SEC)	MAXIMUM TIME STEP SIZE(SEC)	STEP SIZE SEL FLAG
1	0 0	5 0000000-02	5 000000D-02	2

OUTPUT CONTROL

	ELAPSED NO OF TIME STEPS	ELPASED TIME	ROUTED TO DEVICE NO
MAJOR EDIT	0	0 100000D 01	6
MINOR EDIT	1	0 0	8
PLOT RECORD	0	0 0	1

PROBLEM CONVERGENCE CRITERIA

TEMPERATURE CONVERGENCE FACTOR	0 100000D-07
ENERGY CONVERGENCE FACTOR	0 100000D-07
MAXIMUM NUMBER OF ITERATIONS	50

****
**********SYSTEM INPUT DATA SYSTEM NO 1**********
****

SYSTEM CONTROL FLAG	POWER CONTROL FLAG/# OF LEVELS	STEADY-STATE POWER KW
0	-1	0 100000D 03

ORDERS OF INTERPOLATION

POWER	FLUX	TEMPERATURE	H T COEFF
2	2	2	2

POWER FILTER PARAMETERS

LOW-PASS BREAKPOINT	HIGH-PASS BREAKPOINT	FILTER FLAG
0 0	0 0	0

****

CALCULATIONAL CONTROL SYSTEM 1 LEVEL # 1

****

CALCULATION LOCATION

PIN	LEVEL	NODE
1	1	16

BOUNDARY CONDITION CONTROL FLAGS

LEVEL POWER	SURFACE HEAT FLUX	SURFACE H T COEFF	TEMPERATURE
22	0	0	401

LEVEL FILTER CONTROL

PARAMETER	LOW-PASS BREAKPOINT	HIGH-PASS BREAKPOINT	FILTER FLAG
LEVEL POWER	0 0	0 0	0
HEAT FLUX	0 0	0 0	0
TEMPERATURE	0 0	0 0	0

POWER TRIP

TEMPERATURE	FLAG
0 0	0

BOUNDARY CONDITION LINKS
(TABLES FOLLOW)

PARAMETER	PIN	LEVEL	NODE/PARAMETER #/ POINTER
LEVEL POWER	0	0	23
HEAT FLUX	0	0	0
H T COEFF	0	0	0
TEMPERATURE	0	0	67

----- POWER TABLE FOR SYSTEM 1 LEVEL 1-----

TIME (SEC)	LEVEL POWER (KW)	TIME (SEC)	LEVEL POWER (KW)	TIME (SEC)	LEVEL POWER (KW)	TIME (SEC)	LEVEL POWER (KW)
0 0	0 927696D 01	0 100000D-01	0 0	0 500000D-01	0 0	0 100000D 00	0 0
0 200000D 00	0 0	0 300000D 00	0 0	0 400000D 00	0 0	0 500000D 00	0 0
0 600000D 00	0 0	0 700000D 00	0 0	0 800000D 00	0 0	0 900000D 00	0 0
0 100000D 01	0 0	0 200000D 01	0 0	0 300000D 01	0 0	0 400000D 01	0 0
0 500000D 01	0 0	0 600000D 01	0 0	0 700000D 01	0 0	0 800000D 01	0 0
0 900000D 01	0 0	0 100000D 02	0 0				

----- TEMPERATURE TABLE -----

TIME (SEC)	TEMPERATURE (F)	TIME (SEC)	TEMPERATURE (F)	TIME (SEC)	TEMPERATURE (F)	TIME (SEC)	TEMPERATURE (F)
0 0	0 705810D 03	0 100000D-01	0 704470D 03	0 200000D-01	0 703810D 03	0 300000D-01	0 702500D 03
0 400000D-01	0 701420D 03	0 500000D-01	0 700340D 03	0 600000D-01	0 698830D 03	0 700000D-01	0 697540D 03
0 800000D-01	0 695820D 03	0 900000D-01	0 694090D 03	0 100000D 00	0 692370D 03	0 110000D 00	0 690650D 03
0 120000D 00	0 688930D 03	0 130000D 00	0 687430D 03	0 140000D 00	0 685930D 03	0 150000D 00	0 684210D 03
0 160000D 00	0 682490D 03	0 170000D 00	0 680780D 03	0 180000D 00	0 679060D 03	0 190000D 00	0 677130D 03
0 200000D 00	0 675420D 03	0 210000D 00	0 673710D 03	0 220000D 00	0 671780D 03	0 230000D 00	0 670070D 03
0 240000D 00	0 668570D 03	0 250000D 00	0 666860D 03	0 260000D 00	0 665360D 03	0 270000D 00	0 663860D 03
0 280000D 00	0 662370D 03	0 290000D 00	0 660870D 03	0 300000D 00	0 659590D 03	0 310000D 00	0 658310D 03
0 320000D 00	0 657020D 03	0 330000D 00	0 655740D 03	0 340000D 00	0 654460D 03	0 350000D 00	0 653180D 03
0 360000D 00	0 651890D 03	0 370000D 00	0 650610D 03	0 380000D 00	0 649330D 03	0 390000D 00	0 648050D 03
0 400000D 00	0 646760D 03	0 410000D 00	0 645270D 03	0 420000D 00	0 643980D 03	0 430000D 00	0 642700D 03
0 440000D 00	0 641420D 03	0 450000D 00	0 640140D 03	0 460000D 00	0 639070D 03	0 470000D 00	0 638000D 03
0 480000D 00	0 636930D 03	0 490000D 00	0 635860D 03	0 500000D 00	0 634790D 03	0 510000D 00	0 633510D 03
0 520000D 00	0 632440D 03	0 530000D 00	0 631150D 03	0 540000D 00	0 629870D 03	0 550000D 00	0 628800D 03
0 560000D 00	0 627540D 03	0 570000D 00	0 626870D 03	0 580000D 00	0 626020D 03	0 590000D 00	0 625370D 03
0 600000D 00	0 624520D 03	0 610000D 00	0 623660D 03	0 620000D 00	0 622800D 03	0 630000D 00	0 621950D 03
0 640000D 00	0 621090D 03	0 650000D 00	0 620230D 03	0 660000D 00	0 619370D 03	0 670000D 00	0 618730D 03
0 680000D 00	0 617870D 03	0 690000D 00	0 617020D 03	0 700000D 00	0 616160D 03	0 710000D 00	0 615510D 03
0 720000D 00	0 614660D 03	0 730000D 00	0 614010D 03	0 740000D 00	0 613150D 03	0 750000D 00	0 612510D 03
0 760000D 00	0 611650D 03	0 770000D 00	0 610580D 03	0 780000D 00	0 609940D 03	0 790000D 00	0 609290D 03
0 800000D 00	0 608650D 03	0 810000D 00	0 608000D 03	0 820000D 00	0 607570D 03	0 830000D 00	0 606710D 03
0 840000D 00	0 606070D 03	0 850000D 00	0 605210D 03	0 860000D 00	0 604350D 03	0 870000D 00	0 603700D 03
0 880000D 00	0 603060D 03	0 890000D 00	0 602630D 03	0 900000D 00	0 601980D 03	0 910000D 00	0 601550D 03
0 920000D 00	0 600910D 03	0 930000D 00	0 600260D 03	0 940000D 00	0 599400D 03	0 950000D 00	0 598970D 03
0 960000D 00	0 598330D 03	0 970000D 00	0 597680D 03	0 980000D 00	0 597250D 03	0 990000D 00	0 596820D 03
0 100000D 01	0 596170D 03	0 101000D 01	0 595740D 03	0 102000D 01	0 595310D 03	0 103000D 01	0 594880D 03
0 104000D 01	0 594450D 03	0 105000D 01	0 594020D 03	0 106000D 01	0 593370D 03	0 107000D 01	0 592940D 03
0 108000D 01	0 592080D 03	0 109000D 01	0 591430D 03	0 110000D 01	0 591000D 03	0 111000D 01	0 590570D 03
0 112000D 01	0 590140D 03	0 113000D 01	0 589920D 03	0 114000D 01	0 589490D 03	0 115000D 01	0 588840D 03
0 116000D 01	0 588200D 03	0 117000D 01	0 587550D 03	0 118000D 01	0 587120D 03	0 119000D 01	0 586690D 03
0 120000D 01	0 586250D 03	0 121000D 01	0 586040D 03	0 122000D 01	0 585610D 03	0 123000D 01	0 584960D 03
0 124000D 01	0 584530D 03	0 125000D 01	0 584090D 03	0 126000D 01	0 583660D 03	0 127000D 01	0 583450D 03
0 128000D 01	0 583230D 03	0 129000D 01	0 582800D 03	0 130000D 01	0 582370D 03	0 131000D 01	0 581930D 03
0 132000D 01	0 581500D 03	0 133000D 01	0 581070D 03	0 134000D 01	0 580640D 03	0 135000D 01	0 580420D 03
0 136000D 01	0 579990D 03	0 137000D 01	0 579550D 03	0 138000D 01	0 579340D 03	0 139000D 01	0 579120D 03
0 140000D 01	0 578690D 03	0 141000D 01	0 578470D 03	0 142000D 01	0 578040D 03	0 143000D 01	0 577390D 03
0 144000D 01	0 576960D 03	0 145000D 01	0 576740D 03	0 146000D 01	0 576530D 03	0 147000D 01	0 576310D 03
0 148000D 01	0 576090D 03	0 149000D 01	0 575660D 03	0 150000D 01	0 575230D 03	0 151000D 01	0 574790D 03
0 152000D 01	0 574360D 03	0 153000D 01	0 573930D 03	0 154000D 01	0 573710D 03	0 155000D 01	0 573490D 03
0 156000D 01	0 57 280D 03	0 157000D 01	0 573060D 03	0 158000D 01	0 572840D 03	0 159000D 01	0 572630D 03
0 160000D 01	0 572410D 03	0 161000D 01	0 571980D 03	0 162000D 01	0 571760D 03	0 163000D 01	0 571540D 03
0 164000D 01	0 571330D 03	0 165000D 01	0 571110D 03	0 166000D 01	0 571110D 03	0 167000D 01	0 570890D 03
0 168000D 01	0 570680D 03	0 169000D 01	0 570460D 03	0 170000D 01	0 570030D 03	0 171000D 01	0 569590D 03
0 172000D 01	0 569370D 03	0 173000D 01	0 569160D 03	0 174000D 01	0 568720D 03	0 175000D 01	0 568510D 03
0 176000D 01	0 568290D 03	0 177000D 01	0 567860D 03	0 178000D 01	0 567640D 03	0 179000D 01	0 567640D 03
0 180000D 01	0 567420D 03	0 181000D 01	0 567200D 03	0 182000D 01	0 567200D 03	0 183000D 01	0 566990D 03
0 184000D 01	0 566550D 03	0 185000D 01	0 566340D 03	0 186000D 01	0 565900D 03	0 187000D 01	0 565690D 03
0 188000D 01	0 565470D 03	0 189000D 01	0 565250D 03	0 190000D 01	0 565030D 03	0 191000D 01	0 565030D 03
0 192000D 01	0 564820D 03	0 193000D 01	0 564600D 03	0 194000D 01	0 564600D 03	0 195000D 01	0 564600D 03
0 196000D 01	0 564380D 03	0 197000D 01	0 563950D 03	0 198000D 01	0 563950D 03	0 199000D 01	0 563730D 03

0 200000D 01	0 563510D 03	0 201000D 01	0 563510D 03	0 202000D 01	0 563730D 03
0 204000D 01	0 563300D 03	0 205000D 01	0 563080D 03	0 206000D 01	0 562640D 03
0 208000D 01	0 561990D 03	0 209000D 01	0 561990D 03	0 210000D 01	0 561770D 03
0 212000D 01	0 561770D 03	0 213000D 01	0 561770D 03	0 214000D 01	0 561560D 03
0 216000D 01	0 561340D 03	0 217000D 01	0 561120D 03	0 218000D 01	0 561120D 03
0 220000D 01	0 560900D 03	0 221000D 01	0 560900D 03	0 222000D 01	0 560900D 03
0 224000D 01	0 560470D 03	0 225000D 01	0 560470D 03	0 226000D 01	0 560470D 03
0 228000D 01	0 560030D 03	0 229000D 01	0 560030D 03	0 230000D 01	0 559820D 03
0 232000D 01	0 559600D 03	0 233000D 01	0 559600D 03	0 234000D 01	0 559380D 03
0 236000D 01	0 558950D 03	0 237000D 01	0 558730D 03	0 238000D 01	0 558510D 03
0 240000D 01	0 558290D 03	0 241000D 01	0 558290D 03	0 242000D 01	0 558290D 03
0 244000D 01	0 558290D 03	0 245000D 01	0 558510D 03	0 246000D 01	0 558510D 03
0 248000D 01	0 558510D 03	0 249000D 01	0 558510D 03	0 250000D 01	0 558290D 03
0 252000D 01	0 557860D 03	0 253000D 01	0 557640D 03	0 254000D 01	0 557420D 03
0 256000D 01	0 556990D 03	0 257000D 01	0 556770D 03	0 258000D 01	0 556770D 03
0 260000D 01	0 556990D 03	0 261000D 01	0 557210D 03	0 262000D 01	0 557210D 03
0 264000D 01	0 556770D 03	0 265000D 01	0 556770D 03	0 266000D 01	0 556550D 03
0 268000D 01	0 556770D 03	0 269000D 01	0 556770D 03	0 270000D 01	0 556770D 03
0 272000D 01	0 556770D 03	0 273000D 01	0 556550D 03	0 274000D 01	0 556340D 03
0 276000D 01	0 556120D 03	0 277000D 01	0 556120D 03	0 278000D 01	0 555900D 03
0 280000D 01	0 555900D 03	0 281000D 01	0 555900D 03	0 282000D 01	0 555680D 03
0 284000D 01	0 555680D 03	0 285000D 01	0 555460D 03	0 286000D 01	0 555460D 03
0 288000D 01	0 555460D 03	0 289000D 01	0 555250D 03	0 290000D 01	0 555250D 03
0 292000D 01	0 55 030D 03	0 293000D 01	0 555030D 03	0 294000D 01	0 555030D 03
0 296000D 01	0 555030D 03	0 297000D 01	0 555030D 03	0 298000D 01	0 555030D 03
0 300000D 01	0 555030D 03	0 301000D 01	0 555030D 03	0 302000D 01	0 554810D 03
0 304000D 01	0 554590D 03	0 305000D 01	0 554590D 03	0 306000D 01	0 554590D 03
0 308000D 01	0 554590D 03	0 309000D 01	0 554590D 03	0 310000D 01	0 554590D 03
0 312000D 01	0 554590D 03	0 313000D 01	0 554590D 03	0 314000D 01	0 554590D 03
0 316000D 01	0 554160D 03	0 317000D 01	0 554160D 03	0 318000D 01	0 554160D 03
0 320000D 01	0 553940D 03	0 321000D 01	0 553940D 03	0 322000D 01	0 553940D 03
0 324000D 01	0 553940D 03	0 325000D 01	0 553940D 03	0 326000D 01	0 553940D 03
0 328000D 01	0 553720D 03	0 329000D 01	0 553720D 03	0 330000D 01	0 553720D 03
0 332000D 01	0 553500D 03	0 333000D 01	0 553720D 03	0 334000D 01	0 553720D 03
0 336000D 01	0 553720D 03	0 337000D 01	0 553720D 03	0 338000D 01	0 553500D 03
0 340000D 01	0 553500D 03	0 341000D 01	0 553500D 03	0 342000D 01	0 553720D 03
0 344000D 01	0 553540D 03	0 345000D 01	0 553940D 03	0 346000D 01	0 553720D 03
0 348000D 01	0 553290D 03	0 349000D 01	0 553290D 03	0 350000D 01	0 553290D 03
0 352000D 01	0 553500D 03	0 353000D 01	0 553500D 03	0 354000D 01	0 553500D 03
0 356000D 01	0 553070D 03	0 357000D 01	0 553070D 03	0 358000D 01	0 553070D 03
0 360000D 01	0 553070D 03	0 361000D 01	0 553070D 03	0 362000D 01	0 553070D 03
0 364000D 01	0 553070D 03	0 365000D 01	0 553070D 03	0 366000D 01	0 553070D 03
0 368000D 01	0 553070D 03	0 369000D 01	0 552850D 03	0 370000D 01	0 552850D 03
0 372000D 01	0 552850D 03	0 373000D 01	0 552630D 03	0 374000D 01	0 552850D 03
0 376000D 01	0 552850D 03	0 377000D 01	0 552850D 03	0 378000D 01	0 552850D 03
0 380000D 01	0 552410D 03	0 381000D 01	0 552410D 03	0 382000D 01	0 552200D 03
0 384000D 01	0 552200D 03	0 385000D 01	0 552410D 03	0 386000D 01	0 552410D 03
0 388000D 01	0 552410D 03	0 389000D 01	0 552200D 03	0 390000D 01	0 552200D 03
0 392000D 01	0 552410D 03	0 393000D 01	0 552410D 03	0 394000D 01	0 552630D 03
0 396000D 01	0 552630D 03	0 397000D 01	0 552410D 03	0 398000D 01	0 552410D 03
0 400000D 01	0 552410D 03				

0 203000D 01	0 563510D 03
0 207000D 01	0 562210D 03
0 211000D 01	0 561770D 03
0 215000D 01	0 561560D 03
0 219000D 01	0 561120D 03
0 223000D 01	0 560690D 03
0 227000D 01	0 560250D 03
0 231000D 01	0 559600D 03
0 235000D 01	0 559160D 03
0 239000D 01	0 558290D 03
0 243000D 01	0 558290D 03
0 247000D 01	0 558510D 03
0 251000D 01	0 558080D 03
0 255000D 01	0 557210D 03
0 259000D 01	0 556990D 03
0 263000D 01	0 556990D 03
0 267000D 01	0 556550D 03
0 271000D 01	0 556770D 03
0 275000D 01	0 556120D 03
0 279000D 01	0 555900D 03
0 283000D 01	0 555680D 03
0 287000D 01	0 555460D 03
0 291000D 01	0 555030D 03
0 295000D 01	0 555030D 03
0 299000D 01	0 555030D 03
0 303000D 01	0 554590D 03
0 307000D 01	0 554590D 03
0 311000D 01	0 554590D 03
0 315000D 01	0 554360D 03
0 319000D 01	0 553940D 03
0 323000D 01	0 553940D 03
0 327000D 01	0 553940D 03
0 331000D 01	0 553720D 03
0 335000D 01	0 553720D 03
0 339000D 01	0 553500D 03
0 343000D 01	0 553940D 03
0 347000D 01	0 553500D 03
0 351000D 01	0 553500D 03
0 355000D 01	0 553290D 03
0 359000D 01	0 553070D 03
0 363000D 01	0 553070D 03
0 367000D 01	0 553070D 03
0 371000D 01	0 552850D 03
0 375000D 01	0 552850D 03
0 379000D 01	0 552630D 03
0 383000D 01	0 552200D 03
0 387000D 01	0 552410D 03
0 391000D 01	0 552200D 03
0 395000D 01	0 552630D 03
0 399000D 01	0 552410D 03

----- PIN DATA -----
(PIN NO 1)

POWER SYSTEM	POWER FLAG	PIN TO AVG POW PEAK FAC	TOTAL PIN LENGTH FT	NUMBER OF AXIAL LEVELS	NUMBER OF MATERIALS
0	1	0 1000D 01	1 00	1	4

GAP CALCULATION FLAG	INTERNAL DATA FLAG	HEAT TRANSFER AREA SCALING FACTOR	PIN DEFORMATION FLAG
0	0	0 1000000D 01	0

FLUX DEPRESSION FACTORS

WERE NOT USED

----- LEVEL DATA -----
(PIN NO 1)

LEVEL NO	SURFACE HEAT TRANSFER AREA (FT**2)	AXIAL LENGTH (FT)	AXIAL PIN POWER FRACTION	ASSOCIATED WATER NODE	NO OF RADIAL REGIONS	NO OF RADIAL NODES
	0 9796550-01	1 000	1 0000	0	5	19

----- REGION DATA -----
(PIN NO 1)

LEVEL NO	REGION NO	REGION INNER RADIUS FT	REGION OUTER RADIUS FT	RADIAL PO ER PEAK FACTOR	NO OF NODES	MATERIAL I D NO
1	1	0 0	0 2342D-02	0 0	1	1
1	2	0 2342D-02	0 9075D-02	0 0	7	1
1	3	0 9075D-02	0 1023D-01	0 1000D 01	2	3
1	4	0 1023D-01	0 1402D-01	0 0	6	2
1	5	0 1402D-01	0 1559D-01	0 0	3	4

----- NODE DATA -----
(PIN NO 1)

LEVEL NO	NODE NO	NODE INNER RADIUS FT	NODE CENTER RADIUS FT	NODE OUTER RADIUS FT	NODE VOLUME FT3	RADIAL POWER PEAKING FACTOR	MATERIAL I D NO
1	1	0 0	0 165583D-02	0 234170D-02	0 172271D-04	0 0	1
1	2	0 234170D-02	0 331277D-02	0 405774D-02	0 345001D-04	0 0	1
1	3	0 405774D-02	0 468574D-02	0 523899D-02	0 345001D-04	0 0	1
1	4	0 523899D-02	0 573915D-02	0 619909D-02	0 345001D-04	0 0	1
1	5	0 619909D-02	0 66 719D-02	0 702926D-02	0 345001D-04	0 0	1
1	6	0 702926D-02	0 740954D-02	0 777124D-02	0 345001D-04	0 0	1
1	7	0 777124D-02	0 811684D-02	0 844831D-02	0 345001D-04	0 0	1
1	8	0 844831D-02	0 876726D-02	0 907500D-02	0 345001D-04	0 0	1
1	9	0 907500D-02	0 9_7573D-02	0 966712D-02	0 348638D-04	0 500000D 00	3
1	10	0 966712D-02	0 994997D-02	0 102250D-01	0 348638D-04	0 500000D 00	3
1	11	0 102250D-01	0 10_929D-01	0 109485D-01	0 481278D-04	0 0	2
1	12	0 109485D-01	0 112929D-01	0 116271D-01	0 481278D-04	0 0	2
1	13	0 116271D-01	0 119 20D-01	0 122682D-01	0 481278D-04	0 0	2
1	14	0 122682D-01	0 125765D-01	0 128775D-01	0 481278D-04	0 0	2
1	15	0 128775D-01	0 131715D-01	0 134591D-01	0 481278D-04	0 0	2
1	16	0 134591D-01	0 137407D-01	0 140167D-01	0 481278D-04	0 0	2
1	17	0 140167D-01	0 142913D-01	0 145606D-01	0 488342D-04	0 0	4
1	18	0 145606D-01	0 148251D-01	0 150850D-01	0 488342D-04	0 0	4
1	19	0 150850D-01	0 153404D-01	0 155917D-01	0 488342D-04	0 0	4

----- MATERIAL DATA -----
(PIN NO 1)

IDENTIFIED MATERIALS

MATERIAL NO 3 IS INCONEL

MATERIAL NO 4 IS STAINLESS STEEL 316

FOLLOWING ARE DESCRIPTIONS OF THE OTHER MATERIALS

----- MATERIAL DATA -----
(PIN NO 1)

MATERIAL NO 1

MELTING TEMPERATURE (F)
5000 00

THERMAL CONDUCTIVITY
(BTU/HR-FT-F)

ALLOWED TEMPERATURE RANGE

HIGH	LOW
2300 00	0 0

K = C0 + C1*T + C2*T**2 + C3*T**3 + C4*T**4

C0	C1	C2	C3	C4
0 212866D 02	-0 101369D-01	0 0	0 0	0 0

SPECIFIC HEAT CAPACITY
(BTU/LBM-F)

ALLOWED TEMPERATURE RANGE

HIGH	LOW
2300 00	0 0

CP = C0 + C1*T + C2*T**2 + C3*T**3 + C4*T**4

C0	C1	C2	C3	C4
0 167812D 00	0 370264D-03	-0 173794D-06	0 314486D-10	0 0

DENSITY
(LBM/FT**3)
0 138384D 03

----- MATERIAL DATA -----
(PIN NO 1)

MATERIAL NO 2

MELTING TEMPERATURE (F)
5000 00

THERMAL CONDUCTIVITY
(BTU/HR-FT-F)

ALLOWED TEMPERATURE RANGE

HIGH	LOW
2300 00	0 0

K = C0 + C1*T + C2*T**2 + C3*T**3 + C4*T**4

C0	C1	C2	C3	C4
0 171853D 02	-0 407190D-02	0 0	0 0	0 0

SPECIFIC HEAT CAPACITY
(BTU/LBM-F)

ALLOWED TEMPERATURE RANGE

HIGH	LOW
2300 00	0 0

CP = C0 + C1*T + C2*T**2 + C3*T**3 + C4*T**4

C0	C1	C2	C3	C4
0 167812D 00	0 370264D-03	-0 1737940-06	0 314486D-10	0 0

DENSITY
(LBM/FT**3)
0 135468D 03

----- END OF INPUT DATA PROCESSING -----

STEADY-STATE OUTPUT

SYSTEM # 1 LEVEL # 1

CALCULATION LOCATION

PIN	LEVEL	NODE
1	1	16

LEVEL BOUNDARY CONDITIONS

	UNFILTERED	FILTERED
POWER (KW)	0 927696D 01	0 927696D 01
HEAT TRANSFER COEFFICIENT (BTU/SEC-FT2-F)	0 0	
TEMPERATURE (DEG F)	0 705810D 03	0 705810D 03

INVERSE CALCULATION

CALCULATED RESULTS

SURFACE HEAT FLUX (BTU/SEC-FT2)	0 946962D 02
SURFACE TEMPERATURE (DEG F)	0 643595D 03

TEMPERATURE DISTRIBUTION
PIN 1 LEVEL 1

LEVEL NO	NODE 1	2	3	4	5	6	7	8	9	10
1	842 25	842 25	842 25	842 25	842 25	842 25	842 25	842 25	842 25	829 27

LEVEL NO	NODE 11	12	13	14	15	16	17	18	19
1	803 82	779 45	758 00	738 85	721 56	705 81	688 51	669 69	652 03

SUMMARY OF PIN CONDITIONS PIN NO 1

TAU (SEC)	DELT (SEC)
0 0	0 0

	BTU/SEC	KW
PIN POWER	0 0	0 0

SYSTEM IDENTIFICATION PIN 1

LEVEL	SYSTEM #	SYSTEM LEVEL
1	1	1

LEVEL NO	LEVEL POWER (BTU/SEC)	SURF HEAT TRAN (BTU/SEC)	SURF HEAT FLUX (BTU/SEC-FT**2)	CENTERLINE TEMP (F)	HEATER NODE TEMP(F)	SURFACE TEMP (F)	ADJACENT COOL TEMP(F)	S URF HT TRANS COEFF(B/S-FT2-F)
1	0 927696D 01	0 927696D 01	0 946562D 02	0 842254D 03	0 829270D 03	0 643595D 03	0 705810D 03	0 0

LEVEL	EQUIVALENT GAP CONDUCTIVITY (BTU/SEC-FT-F)	GAP CONDUCTANCE (BTU/SEC-FT**2-F)	GAP THICKNESS (FT)	STEADY STATE GAP THICKNESS (FT)	NO OF ITERATIONS IN H T SOLUTION
1	0 0	0 0	0 0	0 0	5

SUMMARY OF PIN CONDITIONS PIN NO 1

PIN TEMPERATURE DISTRIBUTION

LEVEL NO	NODE 1	2	3	4	5	6	7	8	9	10
1	842 25	842 25	842 25	842 25	842 25	842 25	842 25	842 25	842 25	829 27

LEVEL NO	NODE 11	12	13	14	15	16	17	18	19
1	803 82	779 45	758 00	738 85	721 56	705 81	688 51	669 69	652 03

SUMMARY OF PIN CONDITIONS PIN NO 1

TOTAL STORED ENERGY PIN 1 = 0 307978D 02 BTU

LEVEL	STORED ENERGY PER LEVEL(BTU)
1	0 307978D 02

TOTAL NODAL STORED ENERGY (BTU)

LEVEL NO	NODE 1	2	3	4	5	6	7	8	9	10
1	0 7247D 00	0 1451D 01	0 1451D 01	0 1451D 01	0 1451D 01	0 1451D 01	0.1451D 01	0 1451D 01	0 1862D 01	0 1830D 01

LEVEL NO	NODE 11	12	13	14	15	16	17	18	19
1	1 86	1 78	1 71	1 66	1 60	1 55	2 08	2 02	1 95

RESTART	TIME(SEC)	SRF HT FLUX B/S-FT2 (1 1)	SURF TEMP DEG F (1 1)	LEVEL POWR BTU/SEC (1 1)	NODAL TEMP (DEG F) (1 1 1)	NODAL TEMP (DEG F) (1 1 3)	NODAL TEMP (DEG F) (1 1 4)	NODAL TEMP (DEG F) (1 1 16)	NODAL TEMP (DEG F) (1 1 19)
0	0	94 696	643 59	9 2770	842 25	842 25	842 25	705 81	652 0[illegible]
0	500000D-01	100 59	637 80	0 0	840 83	838 40	836 20	700 34	646 78
0	100000D 00	97 057	632 67	0 0	837 02	831 02	826 37	692 37	641 35
0	150000	89 965	628 71	0 0	830 76	821 45	815 00	684 21	636 77
0	200000	89 722	621 47	0 0	822 50	810 73	803 13	675 42	629 54
0	250000	85 287	615 34	0 0	812 80	799 44	791 21	666 86	623 03
0	300000	76 376	612 26	0 0	802 19	787 94	779 42	659 59	619 16
0	350000	70 820	609 14	0 0	791 07	776 47	767 91	653 18	615 54
0	400000	69 545	604 23	0 0	779 75	765 16	756 72	646 76	610 53
0	450000	68 698	598 54	0 0	768 43	754 11	745 89	640 14	604 78
0	500000	59 650	597 01	0 0	757 28	743 36	735 43	634 79	602 46
0	550000	62 887	590 86	0 0	746 37	732 97	725 35	628 80	596 60
0	600000	51 187	591 33	0 0	735 78	722 95	715 67	624 52	596 00
0	650000	51 153	588 27	0 0	725 57	713 34	706 43	620 23	592 94
0	700000	48 040	585 98	0 0	715 76	704 17	697 62	616 16	590 37
0	750000	44 283	584 41	0 0	706 38	695 43	689 24	612 [illegible]1	588 46
0	800000	44 220	581 25	0 0	697 45	687 12	681 29	608 65	585 30
0	850000	40 245	579 73	0 0	688 95	679 23	673 75	605 21	[illegible]83 42
0	900000	38 130	577 91	0 0	680 88	671 75	666 59	601 98	581 41
0	950000	35 757	576 34	0 0	673 24	664 66	659 82	598 97	579 62
1	00000	33 16	574 91	0 0	666 01	657 95	653 41	596 17	577 99
1	05000	28 895	575 03	0 0	659 17	651 63	647 37	594 02	577 69
1	10000	32 984	571 11	0 0	652 72	645 65	641 67	591 00	574 15
1	15000	26 395	571 51	0 0	646 64	640 02	636 28	588 84	573 94
1	20000	28 607	568 71	0 0	640 90	634 70	631 20	586 25	571 35
1	25000	24 890	568 13	0 0	635 49	629 68	626 39	584 09	[illegible]70 42
1	30000	22 043	567 96	0 0	630 38	624 94	621 86	582 37	569 99
1	35000	22 749	566 22	0 0	625 [illegible]7	620 48	617 59	580 42	[illegible]68 32
1	40000	20 468	565 58	0 0	621 05	616 27	613 57	578 69	567 47
1	45000	21 127	563 71	0 0	616 79	612 31	609 78	576 74	[illegible]65 66
1	50000	17 846	563 61	0 0	612 77	608 58	606 21	575 23	565 26
1	55000	18 864	561 86	0 0	608 99	605 06	602 83	573 49	563 61
1	60000	14 419	562 63	0 0	605 43	601 74	599 65	572 41	563 96
1	65000	15 586	561 35	0 0	602 08	598 63	596 67	571 11	562 79
1	70000	13 16	561 21	0 0	598 93	595 70	593 87	570 03	562 46
1	75000	15 565	559 18	0 0	595 98	592 95	591 23	568 51	560 62
1	80000	12 367	559 31	0 0	593 20	590 36	588 75	567 42	560 45
1	85000	12 311	558 55	0 0	590 58	587 92	586 41	566 34	559 69
1	90000	13 110	557 09	0 0	588 11	585 61	584 19	565 03	558 30
1	95000	7 7552	558 77	0 0	585 79	583 44	582 11	564 60	559 49

RESTART

TIME(SEC)	SRF HT FLUX B/S-FT2 (1 1)	SURF TEMP DEG F (1 1)	LEVEL FOWR BTU/SEC (1 1)	NODAL TEMP (DEG F) (1 1 1)	NODAL TEMP (DEG F) (1 1 3)	NODAL TEMP (DEG F) (1 1 4)	NODAL TEMP (DEG F) (1 1 16)	NODAL TEMP (DEG F) (1 1 19)
2 00000	11 699	556 65	0 0	583 61	581 41	580 15	563 51	557 74
2 05000	7 0462	557 92	0 0	581 56	579 50	578 33	563 08	558 57
2 10000	12 085	555 04	0 0	579 64	577 70	576 61	561 77	556 17
2 15000	4 9947	557 34	0 0	577 83	576 02	575 00	561 56	557 80
2 20000	8 1561	555 99	0 0	576 14	574 45	573 49	560 90	556 75
2 25000	6 0580	556 34	0 0	574 56	572 99	572 09	560 47	556 90
2 30000	7 1853	555 45	0 0	573 09	571 62	570 79	559 82	556 12
2 35000	6 7721	554 95	0 0	571 71	570 34	569 56	559 16	555 58
2 40000	7 7341	553 77	0 0	570 41	569 13	568 40	558 29	554 48
2 45000	1 4839	556 38	0 0	569 20	568 00	567 31	558 51	556 51
2 50000	4 29	555 50	0 0	568 07	566 95	566 32	558 29	555 93
2 55000	8 4226	552 88	0 0	567 01	565 97	565 38	557 21	553 66
2 60000	2 9453	554 47	0 0	566 02	565 05	564 49	556 99	554 74
2 65000	3 6717	554 33	0 0	565 10	564 18	563 66	556 77	54 67
2 70000	2 1927	554 99	0 0	564 23	563 38	562 90	556 77	555 19
2 75000	5 6820	553 16	0 0	563 42	562 63	562 18	556 12	53 69
2 80000	2 6366	553 91	0 0	562 67	561 93	561 51	555 90	554 15
2 85000	4 1748	553 06	0 0	561 97	561 28	560 88	555 46	553 45
2 90000	2 6024	553 41	0 0	561 30	560 65	560 28	555 25	553 65
2 95000	2 7741	553 25	0 0	560 68	560 07	559 72	555 03	553 51
3 00000	1 4266	553 82	0 0	560 10	559 53	559 20	555 03	53 95
3 05000	3 8626	552 57	0 0	559 55	559 02	558 72	554 59	552 93
3 10000	0 98372	553 55	0 0	559 05	558 55	558 27	5 4 9	553 64
3 15000	2 4545	552 97	0 0	558 57	558 11	557 85	554 38	553 20
3 20000	3 3864	552 12	0 0	558 13	557 69	557 45	553 94	552 44
3 25000	0 78965	553 04	0 0	557 71	557 30	557 07	553 94	53 12
3 30000	2 3262	552 42	0 0	557 32	556 93	556 72	553 72	552 64
3 35000	0 82089	552 95	0 0	556 95	556 59	556 39	553 72	553 03
3 40000	2 1418	552 34	0 0	556 61	556 27	556 08	553 50	552 53
3 45000	-1 7261	554 22	0 0	556 29	555 98	555 81	553 94	554 06
3 50000	4 6453	551 41	0 0	556 00	555 72	555 56	553 29	51 84
3 55000	0 83821E-01	552 76	0 0	555 73	555 47	555 32	553 29	552 77
3 60000	1 9539	552 05	0 0	555 48	555 23	555 09	553 07	52 23
3 65000	0 48355	552 55	0 0	555 24	555 00	554 87	553 07	552 60
3 70000	1 8450	551 90	0 0	555 01	554 79	554 66	552 8	52 08
3 75000	0 40970	552 39	0 0	554 79	554 59	554 47	552 85	552 43
3 80000	2 9780	551 04	0 0	554 59	554 39	554 27	552 41	551 32
3 85000	0 20643	551 94	0 0	554 39	554 19	554 08	552 41	551 96
3 90000	1 7686	551 29	0 0	554 19	554 00	553 89	552 20	551 46
3 95000	-1 9573	553 10	0 0	554 01	553 83	553 73	552 63	552 92

RESTART

TIME(SEC)	SRF HT FLUX B/S-FT2 (1 1)	SURF TEMP DEG F (1 1)	LEVEL POWR BTU/SEC (1 1)	NODAL TEMP (DEG F) (1 1 1)	NODAL TEMP (DEG F) (1 1 3)	NODAL TEMP (DEG F) (1 1 4)	NODAL TEMP (DEG F) (1 1 16)	NODAL TEMP (DEG F) (1 1 19)
4 00000	2 0325	551 63	0 0	553 84	553 67	553 58	552 41	551 82

Appendix B

FORWARD CONDUCTION PROBLEM SAMPLE OUTPUT

This appendix includes a copy of the printed output produced by PINSIM-MOD2 during solution of the forward conduction problem discussed in Sect 2 4 Some of the results of this calculation are plotted in Fig 10

LISTING OF INPUT DATA FOR CASE 1

```
 1   ************************************************ *********PDJOB DAT*
 2   =PINSIM VERIFICATION STUDY PROBLEM   POWER-DROP TEST SIMULATION
 3   *
 4   *       NSYS   NPINS   NFLIP
 5   100100   1      1        0
 6   *
 7   *       IDJOB    RSTRTN   ENDT    NTIM
 8   100000    1        0 0    4 0     1
 9   *
10   *         TIME  TMIN  TMAX  ITIMFL
11   100001    0 0    05    05     2
12   *
13   *       NITER   CONVERGENCE CRITERIA   TEMP   ENERGY
14   100400   50                          1 0D-8  1 0D-8
15   *
16   *      NDBUG IGDBUG IHDBUG ISDBUG IFDBUG
17   200000  11      0      6      0     3
18   *
19   *      MINOUT NMIN DELMIN
20   210000   8     1    0 0
21   *
22   *
23   *      MAJOUT NMAJ DELMAJ
24   220000   6     0    1 0
25   *
26   *         NPLT DELPLT
27   230000     0    0 0
28   *
29   ****************************************************END OF PDJOB DAT*
30   ************************************************************PDPIN DAT*
31   *
32   * APPROXIMATE BUNDLE 3 DESIGN (AS DESCRIBED IN BDHT-2287)
33   *
34   *
35   * MODEL ASSEMBLED ON 3/3/80 BY BOB HAGAR
36   * (THERMAL CONDUCTIVITY OF OUTER BN3 ANNULUS CHANGED BY DGM
37   *  ON 26-MAR-80 TO IMPROVE INV RESULTS)
38   *
39   *
40   ********************************************************************
41   *
42   *         NLVL  NMAT IPOW  POWFAC   IGAPFL  INFLAG  HTCFAC IDFORM
43   410000     1     4    1     1 0      0        0       1 0     0
44   *
45   ********************************************************************
46   *
47   *
48   *        NREG    POVPA     ZLNGTH      NODWAT
49   410100    5       1 0      1 000         0
50   *
51   *          RINREG     ROTREG     POVP   NNOD  MATREG
52   410101    0 0        0 0023417  0 0     1      1     * T/C BUNDLE
53   410102    0 0023417  0 009075   0 0     7      1     * INNER BN3
54   410103    0 009075   0 010225   1 00    2      3     * HEATER ELEMENT
55   410104    0 010225   0 0140167  0 0     6      2     * OUTER BN3
56   410105    0 0140167  0 0155917  0 0     3      4     * SS-316
```

```
 57    *
 58    ***********************************************************************
 59    * MATERIALS
 60    ***********************************************************************
 61    *
 62    * MATERIAL 1   BN3 (CORE)
 63    *
 64    *
 65    419100   0   3   5000
 66    *
 67    *  (THERMAL CONDUCTIVITY)
 68    *
 69    419110   0   0 0   2300 0
 70    *
 71    * (COEFFICIENTS WERE OBTAINED FROM L J OTT ON 3-2-80)
 72    419111  21 286575    -0 0101369   0 0   0 0   0 0
 73    *
 74    *  (SPECIFIC HEAT CAPACITY)
 75    *
 76    419120   0   0 0   2300 0
 77    *
 78    419121     0 167812347  3 70264053D-04  -1 73793524D-07
 79    +          3 14486215D-11   0 0
 80    *
 81    *  (DENSITY)
 82    *
 83    419130   -1   0 0   2300 0
 84    *
 85    *  (CORE BN3 DENSITY CORRECTED ON 6-MAY-80 TO CONFORM
 86    *   TO BDHT-2404)
 87    419131   138 3840
 88    *
 89    *
 90    *  MATERIAL 2   BN3 (ANNULUS)
 91    *
 92    *
 93    419200   0   3   5000
 94    *
 95    *  (THERMAL CONDUCTIVITY)
 96    *
 97    419210   0   0 0   2300 0
 98    *
 99    * (COEFFICIENTS WERE OBTAINED FROM L J OTT ON 3-2-80)
100    *
101    * (K COEFFS MODIFIED BY DGM ON 26-MAR-80 TO
102    *  IMPROVE INV RESULTS  INCREASE BOTH BY 1 104)
103    *419211  15 56185    -0 36872E-02    0 0   0 0   0 0
104    419211  17 1853    -0 40719E-02    0 0   0 0   0 0
105    *
106    *  (SPECIFIC HEAT CAPACITY)
107    *
108    419220   0   0 0   2300 0
109    *
110    419221     0 167812347  3 70264053D-04  -1 737935240-07
111    +          - 14486215D-11   0.0
112    *
113    *  (DENSITY)
114    *
```

```
115    419230   -1   0 0   2300 0
116    *
117    *  (CORE BN3 DENSITY CORRECTED ON 6-MAY-80 TO CONFORM
118    *   TO BDHT-2404)
119    419231   135 468
120    *
121    *
122    *
123    * MATERIAL 3   INCONEL HEATER ELEMENT
124    *
125    419300   5   3    5000 0
126    *
127    * MATERIAL 4   SS - 316
128    *
129    419400   7   3    5000 0
130    *
131    ***************************************************END OF PDPIN DAT*
132    ************************************************************PDSYS FWD*
133    *
134    * SYSTEM INPUT   FORWARD CALCULATION
135    *
136    ***********************************************************************
137    *
138    *     ISYSF  IPOWX   PSYS
139    500000  0      1    100 0
140    *
141    *     * LEVEL CALCULATIONAL CONTROL  LEVEL # 1 *
142    *
143    *     NPBACK NLBACK NNBACK IPFL IQFL IHFL ITFL DTSYS   PLVL
144    500100   1      1      0     20    0  -20   20  0 05   9 27696
145    *
146    *      BPOWL  BPOWH IPOWF
147    500101   0 0    0 0   0
148    *
149    *      BPHIL  BPHIH IPHIF
150    500102   0 0    0 0   0
151    *
152    *      BTMPL  BTMPH ITMPF
153    500103  0 0    0 0    0
154    *
155    *
156    *     ITRPFL TTRIP
157    500150   0   0 0
158    *
159    ***************************************************END OF PDSYS FWD*
160    ************************************************************PDBT DAT**
161    **   TIME IN S $
162    **  TEMPERATURE IN F$
163    **    0 100000E+01  TIME IN S $
164    **    0 100000E+01 T BULK$
165    500141
166     +   0 000000E+00     0 5494E+03
167     +   0 100000E-01     0 5494E+03
168     +   0 500000E-01     0 5494E+03
169     +   0 100000E+00     0 5494E+03
170     +   0 200000E+00     0 5494E+03
171     +   0 300000E+00     0 5494E+03
172     +   0 400000E+00     0 5494E+03
```

```
173     +    0 500000E+00     0 5494E+03
174     +    0 600000E+00     0 5494E+0_
175     +    0 700000E+00     0 5494E+03
176     +    0 800000E+00     0 5494E+03
177     +    0 900000E+00     0 5494E+03
178     +    0 100000E+01     0 5494E+03
179     +    0 200000E+01     0 5494E+03
180     +    0 300000E+01     0 5494E+03
181     +    0 400000E+01     0 5494E+03
182     +    0 500000E+01     0 5494E+0_
183     +    0 600000E+01     0 5494E+03
184     +    0 700000E+01     0 5494E+03
185     +    0 800000E+01     0 5494E+03
186     +    0 900000E+01     0 5494E+0_
187     +    0 100000E+02     0 5494E+03
188    ***************************************************END OF POBT DAT**
189    *    0 100000E+01  TIME IN SEC$
190    *    0 100000E+01  CALC  HTC SM4$
191    500131
192    +   0 000000E+00     0 100537E+01
193    +   0 500000E-01     0 116394E+01
194    +   0 100000E+00     0 109901E+01
195    +   0 150000E+00     0 109350E+01
196    +   0 200000E+00     0 113472E+01
197    +   0 250000E+00     0 116801E+01
198    +   0 300000E+00     0 118214E+01
199    +   0 350000E+00     0 119427E+01
200    +   0 400000E+00     0 122083E+01
201    +   0 450000E+00     0 125284E+01
202    +   0 500000E+00     0 127474E+01
203    +   0 550000E+00     0 128060E+01
204    +   0 600000E+00     0 126251E+01
205    +   0 650000E+00     0 124510E+01
206    +   0 700000E+00     0 124208E+01
207    +   0 750000E+00     0 124956E+01
208    +   0 800000E+00     0 125861E+01
209    +   0 850000E+00     0 126265E+01
210    +   0 900000E+00     0 125737E+01
211    +   0 950000E+00     0 124360E+01
212    +   0 100000E+01     0 122660E+01
213    +   0 105000E+01     0 122320E+01
214    +   0 110000E+01     0 124050E+01
215    +   0 115000E+01     0 125505E+01
216    +   0 120000E+01     0 126048E+01
217    +   0 125000E+01     0 125021E+01
218    +   0 130000E+01     0 123835E+01
219    +   0 135000E+01     0 123983E+01
220    +   0 140000E+01     0 124877E+01
221    +   0 145000E+01     0 126649E+01
222    +   0 150000E+01     0 127065E+01
223    +   0 155000E+01     0 124768E+01
224    +   0 160000E+01     0 120108E+01
225    +   0 165000E+01     0 118139E+01
226    +   0 170000E+01     0 121209E+01
227    +   0 175000E+01     0 126738E+01
228    +   0 180000E+01     0 128893E+01
229    +   0 185000E+01     0 129086E+01
230    +   0 190000E+01     0 125993E+01
```

```
 231    +  0 195000E+01    0 119187E+01
 232    +  0 200000E+01    0 115700E+01
 233    +  0 205000E+01    0 115607E+01
 234    +  0 210000E+01    0 113042E+01
 235    +  0 215000E+01    0 104328E+01
 236    +  0 220000E+01    0 993686E+00
 237    +  0 225000E+01    0 999775E 00
 238    +  0 230000E+01    0 104802E+01
 239    +  0 235000E+01    0 106885E+01
 240    +  0 240000E+01    0 990900E+00
 241    +  0 245000E+01    0 864824E+00
 242    +  0 250000E+01    0 873163E+00
 243    +  0 255000E+01    0 928471E+00
 244    +  0 260000E+01    0 839920E+00
 245    +  0 265000E+01    0 735571E+00
 246    +  0 270000E+01    0 711394E+00
 247    +  0 275000E+01    0 764113E+00
 248    +  0 280000E+01    0 811528E+00
 249    +  0 285000E+01    0 805683E+00
 250    +  0 290000E+01    0 753778E+00
 251    +  0 295000E+01    0 662001E+00
 252    +  0 300000E+01    0 601403E+00
 253    +  0 305000E+01    0 585730E+00
 254    +  0 310000E+01    0 576918E+00
 255    +  0 315000E+01    0 621723E+00
 256    +  0 320000E+01    0 638393E+00
 257    +  0 325000E+01    0 569455E+00
 258    +  0 330000E+01    0 483052E+00
 259    +  0 335000E+01    0 383215E+00
 260    +  0 340000E+01    0 322919E+00
 261    +  0 345000E+01    0 332632E+00
 262    +  0 350000E+01    0 411358E+00
 263    +  0 355000E+01    0 446039E+00
 264    +  0 360000E+01    0 447153E+00
 265    +  0 365000E+01    0 426364E+00
 266    +  0 370000E 01    0 467196E+00
 267    +  0 375000E+01    0 523360E+00
 268    +  0 380000E+01    0 571915E+00
 269    +  0 385000E+01    0 464291E+00
 270    +  0 390000E+01    0 265464E+00
 271    +  0 395000E+01    0 139752E+00
 272    +  0 400000E+01    0 113822E+00
 273    +
 274    ***********************************************************PDGA DAT**
 275     **   TIME IN S $
 276     **    TEMPERATURE IN DEG  FS
 277     **    0 100000E+01  TIME IN S $
 278     **    0 100000E+01  LIN HEAT RATE$
 279    500111
 280     +   0 000000E+00    0 978611E+01
 281     +   0 100000E-01    0 0000E+00
 282     +   0 500000E-01    0 0000E+00
 283     +   0 100000E+00    0 0000E+00
 284     +   0 200000E+00    0 0000E+00
 285     +   0 300000E+00    0 0000E+00
 286     +   0 400000E+00    0 0000E 00
 287     +   0 500000E+00    0 0000E+00
 288     +   0 600000E+00    0 0000E+00
```

```
 +    0 700000E+00    0 0000E+00
 +    0 800000E+00    0 0000E+00
 +    0 900000E+00    0 0000E+00
 +    0 100000E+01    0 0000E+00
 +    0 200000E+01    0 0000E+00
 +    0 300000E+01    0 0000E+00
 +    0 400000E+01    0 0000E+00
 +    0 500000E+01    0 0000E+00
 +    0 600000E+01    0 0000E+00
 +    0 700000E+01    0 0000E+00
 +    0 800000E+01    0 0000E+00
 +    0 900000E+01    0 0000E+00
 +    0 100000E+02    0 0000E+00
*****************************************************END OF PDQA DAT***
*****************************************************************
*
210001  PHIW(1 1)  TWAL(1 1)  POWL(1 1)  TNOD(1 1 1)
+       TNOD(1 1 3)  TNOD(1 1 4)  TNOD(1 1 16)  TNOD(1 1 19)
*
200000 6 0 0 0 1
CARD ABOVE IS REPLACEMENT CARD
*
*     NPBACK NLBACK NNBACK IPFL IQFL IHFL ITFL DTSYS   PLVL
500100   1      1      0     20    0   20   20  0 05   9 27696
CARD ABOVE IS REPLACEMENT CARD
*
*****************************************************************
```

```
                                        ----- DATA DECK DIAGNOSTICS -----

                                MINIMUM LENGTH OF TABLE ARRAY IN COMMON /SCRTCH/ IS     492 WORDS

                                        (LENGTH OF THE ARRAY IS NOW   10000 WORDS)


------------------------------------------------ PROCESSING THE JOB CONTROL CARD ------------------------------------------------

------------------------------------------------- PROCESSING PROBLEM OPTIONS -------------------------------------------------

-------------------------------------------------- PROCESSING PIN DATA --------------------------------------------------

------------------------------------------------ PROCESSING SYSTEM DATA  SYSTEM #  1------------------------------------------------

******** CARDS     500020 THROUGH     500020 MISSING

++++++++ WARNING     SYSTEM  1  LEVEL  1
          CARD SERIES   500111 NO  OF TABLE PAIRS SPECIFIED AT      20
         IS BEING RESET TO ACTUAL NO  OF PAIRS FOUND IN INPUT =    22
++++++++ NOTE   CARD 500111 POWER TABLE IS BEING NORMALIZED TO   0 947972D 00 (PLVL ON CARD 500100)

++++++++ WARNING     SYSTEM  1  LEVEL  1
          CARD SERIES   500131 NO  OF TABLE PAIRS SPECIFIED AT      20
         IS BEING RESET TO ACTUAL NO  OF PAIRS FOUND IN INPUT =    81

++++++++ WARNING     SYSTEM  1  LEVEL  1
          CARD SERIES   500141 NO  OF TABLE PAIRS SPECIFIED AT      20
         IS BEING RESET TO ACTUAL NO  OF PAIRS FOUND IN INPUT =    22


------------------------------------------------ INITIALIZING PIN PARAMETERS ------------------------------------------------

------------------------------------------------- PROCESSING EDIT OPTIONS ----------------------------------------------------


                                MINIMUM LENGTH OF DATA ARRAY IS        272 WORDS

                                        (LENGTH OF THE ARRAY IS NOW    5000 WORDS)
```

```
PINSIM  A NUCLEAR FUEL PIN SIMULATOR-TRANSIENT ANALYSIS CODE  MOD 2        VERSION 002  06/30/80        NO  211 (PINMAN)    PAGE 0009
PINSIM VERIFICATION STUDY PROBLEM   POWER-DROP TEST SIMULATION                           07/16/80

------------------------------------------------------- END OF INPUT DATA PROCESSING -------------------------------------------------------

                                                   NO FATAL DIAGNOSTICS
PINSIM  A NUCLEAR FUEL PIN SIMULATOR-TRANSIENT ANALYSIS CODE  MOD 2        VERSION 002  06/30/80        NO  211
```

INITIALIZ D INPUT DATA

----- GENERAL PROBLEM DATA -----

SYSTEM	SYSTEM FLAG
1	0

PROBLEM END TIME = 4 000000D 00 SEC

TIME STEP CONTROL GROUPS

GROUP NO	BEGINNING TIME(SEC)	MINIMUM TIME STEP SIZE(SEC)	MAXIMUM TIME STEP SIZE(SEC)	STEP SIZE SEL FLAG
1	0 0	5 000000D-02	5 000000D-02	2

OUTPUT CONTROL

	ELAPSED NO OF TIME STEPS	ELPASED TIME	ROUTED TO DEVICE NO
MAJOR EDIT	0	0 100000D 01	6
MINOR EDIT	1	0 0	8
PLOT RECORD	0	0 0	1

PROBLEM CONVERGENCE CRITERIA

TEMPERATURE CONVERGENCE FACTOR	0 100000D-07
ENERGY CONVERGENCE FACTOR	0 100000D-07
MAXIMUM NUMBER OF ITERATIONS	50

****
**********SYSTEM INPUT DATA SYSTEM NO 1**********
****

SYSTEM CONTROL FLAG	POWER CONTROL FLAG/# OF LEVELS	STEADY-STATE POWER KW
0	1	0 100000D 03

ORDERS OF INTERPOLATION

POWER	FLUX	TEMPERATURE	H T COEFF
2	2	2	2

POWER FILTER PARAMETERS

LOW-PASS BREAKPOINT	HIGH-PASS BREAKPOINT	FILTER FLAG
0 0	0 0	0

****

CALCULATIONAL CONTROL SYSTEM 1 LEVEL # 1

****

CALCULATION LOCATION

PIN	LEVEL	NODE
1	1	0

BOUNDARY CONDITION CONTROL FLAGS

LEVEL POWER	SURFACE HEAT FLUX	SURFACE H T COEFF	TEMPERATURE
22	0	81	22

LEVEL FILTER CONTROL

PARAMETER	LOW-PASS BREAKPOINT	HIGH-PASS BREAKPOINT	FILTER FLAG
LEVEL POWER	0 0	0 0	0
HEAT FLUX	0 0	0 0	0
TEMPERATURE	0 0	0.0	0

POWER TRIP

TEMPERATURE	FLAG
0 0	0

BOUNDARY CONDITION LINKS
(TABLES FOLLOW)

PARAMETER	PIN	LEVEL	NODE/PARAMETER #/ POINTER
LEVEL POWER	0	0	23
HEAT FLUX	0	0	0
H.T COEFF	0	0	67
TEMPERATURE	0	0	229

----- POWER TABLE FOR SYSTEM 1 LEVEL 1-----

TIME (SEC)	LEVEL POWER (KW)	TIME (SEC)	LEVEL POWER (KW)	TIME (SEC)	LEVEL POWER (KW)	TIME (SEC)	LEVEL POWER (KW.)
0 0	0 927696D 01	0 100000D-01	0 0	0 500000D-01	0 0	0 100000D 00	0 0
0 200000D 00	0 0	0 300000D 00	0 0	0 400000D 00	0 0	0 500000D 00	0 0
0 600000D 00	0 0	0 700000D 00	0 0	0 800000D 00	0 0	0 900000D 00	0 0
0 100000D 01	0 0	0 200000D 01	0 0	0 300000D 01	0 0	0 400000D 01	0 0
0 500000D 01	0 0	0 600000D 01	0 0	0 700000D 01	0 0	0 800000D 01	0 0
0 900000D 01	0 0	0 100000D 02	0 0				

----- SURFACE HEAT TRANSFER COEFFICIENT TABLE -----

TIME (SEC)	COEFFICIENT (BTU/SEC-FT**2-F)	TIME (SEC)	COEFFICIENT (BTU/SEC-FT**2-F)	TIME (SEC)	COEFFICIENT (BTU/SEC-FT**2-F)	TIME (SEC)	COEFFICIENT (BTU/SEC-FT**2-F)
0 0	0 100537D 01	0 500000D-01	0 116394D 01	0 100000D 00	0 109901D 01	0 150000D 00	0 109350D 01
0 200000D 00	0 113472D 01	0 250000D 00	0 116801D 01	0 300000D 00	0 118214D 01	0 350000D 00	0 119427D 01
0 400000D 00	0 122083D 01	0 450000D 00	0 125284D 01	0 500000D 00	0 127474D 01	0 550000D 00	0 128060D 01
0 600000D 00	0 126251D 01	0 650000D 00	0 124510D 01	0 700000D 00	0 124208D 01	0 750000D 00	0 124956D 01
0 800000D 00	0 125861D 01	0 850000D 00	0 126265D 01	0 900000D 00	0 125737D 01	0 950000D 00	0 124360D 01
0 100000D 01	0 122660D 01	0 105000D 01	0 122320D 01	0 110000D 01	0 124050D 01	0 115000D 01	0 125505D 01
0 120000D 01	0 126048D 01	0 125000D 01	0 125021D 01	0 130000D 01	0 123835D 01	0 135000D 01	0 123983D 01
0 140000D 01	0 124877D 01	0 145000D 01	0 126649D 01	0 150000D 01	0 127065D 01	0 155000D 01	0 124768D 01
0 160000D 01	0 120108D 01	0 165000D 01	0 118139D 01	0 170000D 01	0 121209D 01	0 175000D 01	0 126738D 01
0 180000D 01	0 128893D 01	0 185000D 01	0 129086D 01	0 190000D 01	0 125993D 01	0 195000D 01	0 119187D 01
0 200000D 01	0 115700D 01	0 205000D 01	0 115607D 01	0 210000D 01	0 113042D 01	0 215000D 01	0 104328D 01
0 220000D 01	0 993686D 00	0 225000D 01	0 999775D 00	0 230000D 01	0 104802D 01	0 235000D 01	0 106885D 01
0 240000D 01	0 990900D 00	0 245000D 01	0 864824D 00	0 250000D 01	0 873163D 00	0 255000D 01	0 928471D 00
0 260000D 01	0 839920D 00	0 265000D 01	0 735571D 00	0 270000D 01	0 711394D 00	0 275000D 01	0 764113D 00
0 280000D 01	0 811528D 00	0 285000D 01	0 805683D 00	0 290000D 01	0 753778D 00	0 295000D 01	0 662001D 00
0 300000D 01	0 601403D 00	0 305000D 01	0 585730D 00	0 310000D 01	0 576918D 00	0 315000D 01	0 621723D 00
0 320000D 01	0 638393D 00	0 325000D 01	0 569455D 00	0 330000D 01	0 483052D 00	0 335000D 01	0 383215D 00
0 340000D 01	0 322919D 00	0 345000D 01	0 332632D 00	0 350000D 01	0 411358D 00	0 355000D 01	0 446039D 00
0 360000D 01	0 447153D 00	0 365000D 01	0 426364D 00	0 370000D 01	0 467196D 00	0 375000D 01	0 523360D 00
0 380000D 01	0 571915D 00	0 385000D 01	0 464291D 00	0 390000D 01	0 265464D 00	0 395000D 01	0 139752D 00
0 400000D 01	0 113822D 00						

---- TEMPERATURE TABLE -----

TIME (SEC)	TEMPERATURE (F)	TIME (SEC)	TEMPERATURE (F)	TIME (SEC)	TEMPERATURE (F)	TIME (SEC)	TEMPERATURE (F)
0 0	0 549400D 03	0 100000D-01	0 549400D 03	0 500000D-01	0 549400D 03	0 100000D 00	0 549400D 03
0 200000D 00	0 549400D 03	0 300000D 00	0 549400D 03	0 400000D 00	0 549400D 03	0 500000D 00	0 549400D 03
0 600000D 00	0 549400D 03	0 700000D 00	0 549400D 03	0 800000D 00	0 549400D 03	0 900000D 00	0 549400D 03
0 100000D 01	0 549400D 03	0 200000D 01	0 549400D 03	0 300000D 01	0 549400D 03	0 400000D 01	0 549400D 03
0 500000D 01	0 549400D 03	0 600000D 01	0 549400D 03	0 700000D 01	0 549400D 03	0 800000D 01	0 549400D 03
0 900000D 01	0 549400D 03	0 100000D 02	0 549400D 03				

----- PIN DATA -----
(PIN NO 1)

POWER SYSTEM	POWER FLAG	PIN TO AVG POW PEAK FAC	TOTAL PIN LENGTH FT	NUMBER OF AXIAL LEVELS	NUMBER OF MATERIALS
0	1	0 1000D 01	1 00	1	4

GAP CALCULATION FLAG	INTERNAL DATA FLAG	HEAT TRANSFER AREA SCALING FACTOR	PIN DEFORMATION FLAG
0	0	0 100000D 01	0

FLUX DEPRESSION FACTORS

WERE NOT USED

----- LEVEL DATA -----
(PIN NO 1)

LEVEL NO	SURFACE HEAT TRANSFER AREA (FT**2)	AXIAL LENGTH (FT)	AXIAL PIN POWER FRACTION	ASSOCIATED WATER NODE	NO OF RADIAL REGIONS	NO OF RADIAL NODES
1	0 979655D-01	1 000	1 0000	0	5	19

----- REGION DATA -----
(PIN NO 1)

LEVEL NO	REGION NO	REGION INNER RADIUS FT	REGION OUTER RADIUS FT	RADIAL POWER PEAK FACTOR	NO OF NODES	MATERIAL I D NO
1	1	0 0	0 2342D-02	0 0	1	1
1	2	0 2342D-02	0 9075D-02	0 0	7	1
1	3	0 9075D-02	0 1023D-01	0 1000D 01	2	3
1	4	0 1023D-01	0 1402D-01	0 0	6	2
1	5	0 1402D-01	0 1559D-01	0 0	3	4

----- NODE DATA -----
(PIN NO 1)

LEVEL NO	NODE NO	NODE INNER RADIUS FT	NODE CENTER RADIUS FT	NODE OUTER RADIUS FT	NODE VOLUME FT3	RADIAL POWER PEAKING FACTOR	MATERIAL I D NO
1	1	0 0	0 165583D-02	0 234170D-02	0 172271D-04	0 0	1
1	2	0 234170D-02	0 331277D-02	0 405774D-02	0 345001D-04	0 0	1
1	3	0 405774D-02	0 468574D-02	0 523899D-02	0 345001D-04	0 0	1
1	4	0 523899D-02	0 573915D-02	0 619909D-02	0 345001D-04	0 0	1
1	5	0 619909D-02	0 662719D-02	0 702926D-02	0 345001D-04	0 0	1
1	6	0 702926D-02	0 740954D-02	0 777124D-02	0 345001D-04	0 0	1
1	7	0 777124D-02	0 811684D-02	0 844831D-02	0 345001D-04	0 0	1
1	8	0 844831D-02	0 876726D-02	0 907500D-02	0 345001D-04	0 0	1
1	9	0 907500D-02	0 937573D-02	0 966712D-02	0 348638D-04	0 500000D 00	3
1	10	0 966712D-02	0 994997D-02	0 102250D-01	0 348638D-04	0 500000D 00	3
1	11	0 102250D-01	0 10 929D-01	0 109485D-01	0 481278D-04	0 0	2
1	12	0 109485D-01	0 112929D-01	0 116271D-01	0 481278D-04	0 0	2
1	13	0 116271D-01	0 119520D-01	0 122682D-01	0 481278D-04	0 0	2
1	14	0 122682D-01	0 125765D-01	0 128775D-01	0 481278D-04	0 0	2
1	15	0 128775D-01	0 131715D-01	0 134591D-01	0 481278D-04	0 0	2
1	16	0 134591D-01	0 137407D-01	0 140167D-01	0 481278D-04	0 0	2
1	17	0 140167D-01	0 142913D-01	0 145606D-01	0 488342D-04	0 0	4
1	18	0 145606D-01	0 148251D-01	0 150850D-01	0 488342D-04	0 0	4
1	19	0 150850D-01	0 153404D-01	0 155917D-01	0 488342D-04	0 0	4

----- MATERIAL DATA -----
(PIN NO 1)

IDENTIFIED MATERIALS

MATERIAL NO 3 IS INCONEL

MATERIAL NO 4 IS STAINLESS STEEL 316

FOLLOWING ARE DESCRIPTIONS OF THE OTHER MATERIALS

----- MATERIAL DATA -----
(PIN NO 1)

MATERIAL NO 1

MELTING TEMPERATURE (F)
5000 00

THERMAL CONDUCTIVITY
(BTU/HR-FT-F)

ALLOWED TEMPERATURE RANGE

HIGH	LOW
2300 00	0 0

K = C0 + C1*T + C2*T**2 + C3*T**3 + C4*T**4

C0	C1	C2	C3	C4
0 212866D 02	-0 101369D-01	0 0	0 0	0 0

SPECIFIC HEAT CAPACITY
(BTU/LBM-F)

ALLOWED TEMPERATURE RANGE

HIGH	LOW
2300 00	0 0

CP = C0 + C1*T + C2*T**2 + C3*T**3 + C4*T**4

C0	C1	C2	C3	C4
0 167812D 00	0 370264D-03	-0 173794D-06	0 314486D-10	0 0

DENSITY
(LBM/FT**3)
0 138384D 03

----- MATERIAL DATA -----
(PIN NO 1)

MATERIAL NO 2

MELTING TEMPERATURE (F)
5000 00

THERMAL CONDUCTIVITY
(BTU/HR-FT-F)

ALLOWED TEMPERATURE RANGE

HIGH	LOW
2300 00	0 0

K = C0 + C1*T + C2*T**2 + C3*T**3 + C4*T**4

C0	C1	C2	C3	C4
0 171853D 02	-0 407190D-02	0 0	0 0	0 0

SPECIFIC HEAT CAPACITY
(BTU/LBM-F)

ALLOWED TEMPERATURE RANGE

HIGH	LOW
2300 00	0 0

CP = C0 + C1*T + C2*T**2 + C3*T**3 + C4*T**4

C0	C1	C2	C3	C4
0 167812D 00	0 370264D-03	-0 173794D-06	0 314486D-10	0 0

DENSITY
(LBM/FT**3)
0 135468D 03

---------- END OF INPUT DATA PROCESSING ----------

STEADY-STATE OUTPUT

SYSTEM # 1 LEVEL # 1

CALCULATION LOCATION

PIN	LEVEL	NODE
1	1	0

LEVEL BOUNDARY CONDITIONS

	UNFILTERED	FILTERED
POWER (KW)	0 927696D 01	0 927696D 01
HEAT TRANSFER COEFFICIENT (BTU/SEC-FT2-F)	0 100537D 01	
TEMPERATURE (DEG F)	0 549400D 03	0 549400D 03

FORWARD CALCULATION

CALCULATED RESULTS

SURFACE HEAT FLUX (BTU/SEC-FT2)	0 946962D 02
SURFACE TEMPERATURE (DEG F)	0 643590D 03

TEMPERATURE DISTRIBUTION
PIN 1 LEVEL 1

LEVEL NO	NODE 1	2	3	4	5	6	7	8	9	10
1	842 25	842 25	842 2	842 25	842 25	842 25	842 25	842 25	842 25	829 27

LEVEL NO	NODE 11	12	13	14	15	16	17	18	19
1	803 81	779 45	758 00	738 84	721 56	705 81	688 50	669 69	652 02

SUMMARY OF PIN CONDITIONS PIN NO 1

TAU (SEC)	DELT (SEC)
0 0	0 0

	BTU/SEC	K#
PIN POWER	0 0	0 0

SYSTEM IDENTIFICATION PIN 1

LEVEL	SYSTEM #	SYSTEM LEVEL
1	1	1

LEVEL NO	LEVEL POWER (BTU/SEC)	SURF HEAT TRAN (BTU/SEC)	SURF HEAT FLUX (BTU/SEC-FT**2)	CENTERLINE TEMP (F)	HEATER NODE TEMP(F)	SURFACE TEMP (F)	ADJACENT COOL TEMP(F)	S URF HT TRANS COEFF(B/S-FT2-F)
1	0 927696D 01	0 927696D 01	0 946962D 02	0 842249D 03	0 829266D 03	0 643590D 03	0 549400D 03	0 100 37D 01

LEVEL	EQUIVALENT GAP CONDUCTIVITY (BTU/SEC-FT-F)	GAP CONDUCTANCE (BTU/SEC-FT**2-F)	GAP THICKNESS (FT)	STEADY STATE GAP THICKNESS (FT)	NO OF ITERATIONS IN H T OLUTION
1	0 0	0 0	0 0	0 0	5

SUMMARY OF PIN CONDITIONS PIN NO 1

PIN TEMPERATURE DISTRIBUTION

LEVEL NO	NODE 1	2	3	4	5	6	7	8	9	10
1	842 25	842 25	842 25	842 25	842 25	842 25	842 25	842 25	842 25	829 27

LEVEL NO	NODE 11	12	13	14	15	16	17	18	19
1	803 81	779 45	758 00	738 84	721 56	705 81	688 50	669 69	652 02

SUMMARY OF PIN CONDITIONS PIN NO 1

TOTAL STORED ENERGY PIN 1 = 0 307976D 02 BTU

LEVEL	STORED ENERGY PER LEVEL(BTU)
1	0 307976D 02

TOTAL NODAL STORED ENERGY (BTU)

LEVEL NO	NODE 1	2	3	4	5	6	7	8	9	10
1	0 7247D 00	0 1451D 01	0 1451D 01	0 1451D 01	0 1451D 01	0 1451D 01	0 1451D 01	0 1451D 01	0 1862D 01	0 1830D 01

LEVEL NO	NODE 11	12	13	14	15	16	17	18	19
1	1 86	1 78	1 71	1 66	1 60	1 55	2 08	2 02	1 95

RESTART	TIME(SEC)	SRF HT FLUX B/S-FT2 (1 1)	SURF TEMP DEG F (1 1)	LEVEL POWR BTU/SEC (1 1)	NODAL TEMP (DEG F) (1 1 1)	NODAL TEMP (DEG F) (1 1 3)	NODAL TEMP (DEG F) (1 1 4)	NODAL TEMP (DEG F) (1 1 16)	NODAL TEMP (DEG F) (1 1 19)
0	0	94 696	643 59	9 2770	842 25	842 25	842 25	705 81	652 02
0	500000D-01	101 98	637 02	0 0	840 82	838 39	836 19	700 09	646 12
0	100000D 00	93 354	634 34	0 0	837 01	831 01	826 37	692 75	642 69
0	150000	88 466	630 30	0 0	830 75	821 46	815 01	684 95	638 22
0	200000	85 571	624 81	0 0	822 51	810 78	803 21	676 91	632 49
0	250000	81 733	619 38	0 0	812 87	799 58	791 40	669 02	626 73
0	300000	77 060	614 59	0 0	802 34	788 20	779 76	661 61	621 54
0	350000	72 635	610 22	0 0	791 33	776 86	768 38	654 73	616 78
0	400000	69 006	605 92	0 0	780 12	765 68	757 33	648 2	612 17
0	450000	65 646	601 80	0 0	768 93	754 74	746 61	642 12	607 75
0	500000	62 075	598 10	0 0	757 89	744 12	736 26	636 39	603 74
0	550000	58 298	594 92	0 0	747 11	733 84	726 30	631 10	600 23
0	600000	54 263	592 38	0 0	736 64	723 94	716 73	626 3	597 32
0	650000	50 698	590 1_	0 0	726 53	714 43	707 58	621 96	594 74
0	700000	47 789	587 88	0 0	716 83	705 34	698 85	617 90	592 24
0	750000	45 270	585 63	0 0	707 54	696 67	690 54	614 0_	_89 77
0	800000	42 874	583 46	0 0	698 68	688 43	682 64	610 38	587 39
0	850000	40 483	581 46	0 0	690 25	680 59	675 14	606 91	585 17
0	900000	38 065	579 67	0 0	682 24	673 15	668 02	603 67	583 16
0	950000	35 681	578 09	0 0	674 65	666 10	661 28	600 66	581 37
1	00000	33 439	576 66	0 0	667 45	659 43	654 91	597 86	579 73
1	05000	31 579	575 22	0 0	660 65	653 13	648 88	595 21	578 12
1	10000	30 099	573 66	0 0	654 22	647 17	643 19	592 65	576 43
1	15000	28 575	572 17	0 0	648 15	641 54	637 81	590 18	74 80
1	20000	26 979	570 80	0 0	642 43	636 23	632 72	587 83	573 29
1	25000	25 288	569 63	0 0	637 02	631 21	627 92	585 65	71 96
1	30000	23 720	568 55	0 0	631 92	626 47	623 38	583 61	570 74
1	35000	22 412	567 48	0 0	627 11	622 00	619 10	581 68	69 54
1	40000	21 232	566 40	0 0	622 57	617 78	615 06	579 84	568 36
1	45000	20 171	565 33	0 0	618 30	613 80	611 25	578 07	567 19
1	50000	19 010	564 36	0 0	614 27	610 05	607 65	576 39	566 12
1	55000	17 698	563 58	0 0	610 47	606 51	604 26	574 85	565 22
1	60000	16 331	563 00	0 0	606 88	603 17	601 06	573 46	64 51
1	65000	15 324	562 37	0 0	603 51	600 03	598 05	572 17	563 79
1	70000	14 742	561 56	0 0	600 34	597 07	595 22	570 90	562 93
1	75000	14 263	560 65	0 0	597 35	594 29	592 55	569 61	561 97
1	80000	13 499	559 87	0 0	594 54	591 67	590 03	568 37	561 12
1	85000	12 663	559 21	0 0	591 89	589 19	587 66	567 22	560 38
1	90000	11 722	558 70	0 0	589 39	586 86	585 41	566 18	559 79
1	95000	10 695	558 37	0 0	587 04	584 66	583 30	565 26	559 36

RESTART

TIME(SEC)	SRF HT FLUX B/S-FT2 (1 1)	SURF TEMP DEG F (1 1)	LEVEL POWR BTU/SEC (1 1)	NODAL TEMP (DEG F) (1 1 1)	NODAL TEMP (DEG F) (1 1 3)	NODAL TEMP (DEG F) (1 1 4)	NODAL TEMP (DEG F) (1 1 16)	NODAL TEMP (DEG F) (1 1 19)
2 00000	9 9691	558 02	0 0	584 82	582 59	581 31	564 43	558 94
2 05000	9 4612	557 58	0 0	582 74	580 64	579 45	563 63	558 46
2 10000	8 8383	557 22	0 0	580 78	578 82	577 70	562 88	558 04
2 15000	7 9771	557 05	0 0	578 95	577 10	576 06	562 23	557 79
2 20000	7 3966	556 84	0 0	577 22	575 50	574 52	561 64	557 53
2 25000	7 1089	556 51	0 0	575 61	574 00	573 09	561 06	557 17
2 30000	6 9737	556 05	0 0	574 10	572 60	571 75	560 4	556 70
2 35000	6 6688	555 64	0 0	572 69	571 29	570 49	559 84	556 26
2 40000	5 9966	555 45	0 0	571 37	570 05	569 31	559 31	556 01
2 45000	5 2291	555 45	0 0	570 13	568 90	568 20	558 90	555 93
2 50000	5 0828	555 22	0 0	568 96	567 81	567 16	558 49	555 69
2 55000	5 0688	554 86	0 0	567 88	566 80	566 19	558 04	555 33
2 60000	4 4940	554 75	0 0	566 86	565 85	565 28	557 66	555 17
2 65000	3 9365	554 75	0 0	565 90	564 97	564 43	557 36	555 12
2 70000	3 7303	554 64	0 0	565 01	564 14	563 64	557 07	554 99
2 75000	3 7925	554 36	0 0	564 18	563 37	562 90	556 75	554 72
2 80000	3 7731	554 05	0 0	563 41	562 64	562 21	556 39	554 40
2 85000	3 5584	553 82	0 0	562 68	561 96	561 56	556 04	554 15
2 90000	3 2293	553 68	0 0	562 00	561 33	560 94	555 75	553 98
2 95000	2 8201	553 66	0 0	561 35	560 72	560 37	555 51	553 92
3 00000	2 467	553 63	0 0	560 75	560 16	559 82	555 31	53 87
3 05000	2 4295	553 55	0 0	560 19	559 63	559 32	555 12	553 77
3 10000	2 290	553 44	0 0	559 66	559 14	558 85	554 93	553 65
3 15000	2 3814	553 23	0 0	559 16	558 68	558 40	554 71	553 45
3 20000	2 238	553 04	0 0	558 70	558 25	557 99	554 48	553 26
3 25000	2 0385	552 98	0 0	558 27	557 84	557 60	554 29	53 17
3 30000	1 7367	553 00	0 0	557 86	557 46	557 23	554 15	553 16
3 35000	1 4114	553 08	0 0	557 47	557 10	556 89	554 06	53 21
3 40000	1 2132	553 16	0 0	557 12	556 77	556 57	554 01	553 27
3 45000	1 2371	553 12	0 0	556 78	556 46	556 28	553 93	553 23
3 50000	1 4 12	552 93	0 0	556 48	556 18	556 01	553 80	553 06
3 55000	1 4941	552 75	0 0	556 19	555 92	555 76	553 65	552 89
3 60000	1 4371	552 61	0 0	555 93	555 67	555 52	553 49	552 75
3 65000	1 3308	552 52	0 0	555 68	555 43	555 29	553 35	552 64
3 70000	1 3836	552 36	0 0	555 44	555.21	555 08	553 19	552 49
3 75000	1 4485	552 17	0 0	555 21	554 99	554 87	553 02	552 30
3 80000	1 4722	551 97	0 0	555 00	554 78	554 66	552 84	552 11
3 85000	1 1852	551 95	0 0	554 79	554 58	554 46	552 71	52 06
3 90000	0 72152	552 12	0 0	554 58	554 39	554 27	552 67	552 18
3 95000	0 40747	552 32	0 0	554 39	554 20	554 10	552 69	552 35

RESTART

TIME(SEC)	SRF HT FLUX B/S-FT2 (1 1)	SURF TEMP DEG F (1 1)	LEVEL POWR BTU/SEC (1 1)	NODAL TEMP (DEG F) (1 1 1)	NODAL TEMP (DEG F) (1 1 3)	NODAL TEMP (DEG F) (1 1 4)	NODAL TEMP (DEG F) (1 1 16)	NODAL TEMP (DEG F) (1 1 19)
4 00000	0 34417	552 42	0 0	554 21	554 04	553 94	552 72	552 46

Appendix C

BACKWARD CONDUCTION PROBLEM SAMPLE OUTPUT

This appendix includes a copy of the printed output produced by PINSIM-MOD2 during solution of the backward conduction problems discussed in Sect 2 4 Some of the results of this calculation are plotted in Figs 11 through 13

LISTING OF INPUT DATA FOR CASE 1

```
*************************************************************** DJOB DAT*
=PINSIM VERIFICATION STUDY PROBLEM   POWER-DROP TEST SIMULATION
*
*        NSYS    NPINS   NFLIP
100100    1       1       0
*
*        IDJOB     RSTRTM    ENDT     NTIM
100000     1         0 0     4 0      1
*
*          TIME   TMIN   TMAX   ITIMFL
100001     0 0     05     05      2
*
*        NITER    CONVERGENCE CRITERIA    TEMP    ENERGY
100400    50                             1 0D-8   1 0D-8
*
*       NDBUG IGDBUG IHDBUG ISDBUG IFDBUG
200000  11      0      6      0      3
*
*       MINOUT NMIN DELMIN
210000   8      1    0 0
*
*
*       MAJOUT NMAJ DELMAJ
220000   6      0    1 0
*
*          NPLT DELPLT
230000      0    0 0
*
*******************************************************END OF DJOB DAT*
*************************************************************** DPIN DAT*
*
* APPROXIMATE BUNDLE 3 DESIGN (AS DESCRIBED IN BDHT-2287)
*
*
* MODEL ASSEMBLED ON 3/3/80 BY BOB HAGAR
* (THERMAL CONDUCTIVITY OF OUTER BN3 ANNULUS CHANGED BY DGM
*  ON 26-MAR-80 TO IMPROVE INV RESULTS)
*
*
*********************************************************************
*
*          NLVL   NMAT IPOW   POWFAC    IGAPFL   INFLAG   HTCFAC IDFORM
410000      1      4    1      1 0       0        0        1 0      0
*
*********************************************************************
*
*
*         NREG     POVPA      ZLNGTH       NODWAT
410100    5         1 0       1 000          0
*
*           RINREG      ROTREG      POVP    NNOD   MATREG
410101    0 0         0 0023417   0 0      1       1      * T/C BUNDLE
410102    0 0023417   0 009075    0 0      7       1      * INN R BN3
410103    0 009075    0 010225    1 00     2       3      * HEATER ELEMENT
410104    0 010225    0 0140167   0 0      6       2      * OUTER BN3
410105    0 0140167   0 0155917   0 0      3       4      * SS-315
```

```
 57    *
 58    ************************************ ******* * ***** ***** ** **    *
 59    * MATERIALS
 60    ***************************** ************* *** **** ** ***  *********
 61    *
 62    * MATERIAL 1    BN3 (CORE)
 63    *
 64    *
 65    419100   0   3   5000
 66    *
 67    *  (THERMAL CONDUCTIVITY)
 68    *
 69    419110   0   0 0   2300 0
 70    *
 71    * (COEFFICIENT  WERE OBTAINED FROM L J OTT ON 3-2-80)
 72    419111  21 286575    -0 0101369   0 0   0 0   0 0
 73    *
 74       (SPECIFIC HEAT CAPACITY)
 75    *
 76    419120   0   0 0   2300 0
 77    *
 78    419121    0 167812347    70264053D-04   1 73793524D 07
 79    +          3 14486215D-11   0 0
 80    *
 81    *  (DENSITY)
 82    *
 83    419130   -1   0 0   2300 0
 84    *
 85    *  (CORE BN3 DENSITY CORRECTED ON 6-MAY-80 TO CONFORM
 86    *   TO BDHT-2404)
 87    419131   138 3840
 88    *
 89    *
 90       MATERIAL 2   BN3 (ANNULUS)
 91    *
 92    *
 93    419200   0   3    000
 94    *
 95    *  (THERMAL CONDUCTIVITY)
 96    *
 97    419210   0   0 0   2300 0
 98    *
 99    * (COEFFICIENTS WERE OBTAINED FROM L J OTT ON 3-2-80)
100    *
101    * (K COEFFS MODIFIED BY DGM ON 26-MAR-80 TO
102    *  IMPROVE INV RESULTS  INCREASE BOTH BY 1 104)
103    *419211  15 56185    -0 36872E-02    0 0   0 0   0 0
104    419211  17 185     -0 40719E-02    0 0   0 0   0 0
105    *
106    *  (SPECIFIC HEAT CAPACITY)
107    *
108    419220   0   0 0   2300 0
109    *
110    419221    0 167812347  3 70264053D-04  -1 73793 24D 07
111    +          3 14486215D-11   0 0
112    *
113    *  (DENSITY)
114    *
```

```
419230   -1   0 0   2300 0
*
*  (CORE BN3 DENSITY CORRECTED ON 6-MAY-80 TO CONFORM
*   TO BDHT-2404)
419231   135 468
*
*
*
* MATERIAL 3   INCONEL HEATER ELEMENT
*
419300   5   3    5000 0
*
* MATERIAL 4   SS - 316
*
419400   7   3    5000 0
*
*****************************************************END OF  DPIN DAT*
*********************************************************** DSYS BKQ*
*
* SYSTEM INPUT   BACK-CALCULATION
*
* SYSTEM MODEL TO BACK-CALCULATE ON PIN 1  LEVEL 1
* BOUNDARY CONDITICNS   SURFACE FLUX  SURFACE TEMPERATJRE
*
*****************************************************************
*
*     ISYSF  IPOWX   PSYS
500000 -1      1      0 0
*
*     * LEVEL CALCULATIONAL CONTROL  LEVEL # 1 *
*
*     NPBACK NLEACK NNBACK IPFL IQFL IHFL ITFL DTSYS   PLVL
500100   1      1      0      0   20   0    20  0 05   9 2769
*
*      BPOWL  BPOWH IPOWF
500101  0 0    0 0   0
*
*      BPHIL  BPH1H IPHIF
500102   0 0    0 0   0
*
*      BTMPL  BTMPH ITMPF
500103  0 0    0 0    0
*
*
*     ITRPFL TTRIP
500150   0   0 0
*
*****************************************************END OF PDSYS BKQ*
 **    PINSIM 002#206  1286 PININV /80165 0052 PDINV DAT$
 **   TIME IN SEC$                        $    $    $    $    $    $
 **    TEMPERATURE IN DEG  F$
 **    0 100000E+01  TIME IN SEC$
 **    0 100000E+01  TWAL(()1 1()) INV$
500141
 +   0 000000E+00    0 643590E+03
 +   0 500000E-01    0 637800E+03
 +   0 100000E+00    0 632670E+03
 +   0 150000E+00    0 628710E+03
```

173	+	0 200000E+00	0 621470E+03
174	+	0 250000E+00	0 615340E+03
175	+	0 300000E+00	0 612260E+03
176	+	0 350000E+00	0 609140E+03
177	+	0 400000E+00	0 604230E+03
178		0 450000E+00	0 598540E+03
179	+	0 500000E+00	0 597010E+03
180	+	0 550000E+00	0 590860E+03
181	+	0 600000E+00	0 91330E+03
182	+	0 650000E+00	0 588270E+03
183	+	0 700000E+00	0 585980E+03
184	+	0 750000E+00	0 584410E+03
185	+	0 800000E+00	0 581 50E+03
186	+	0 850000E+00	0 579730E+03
187	+	0 900000E+00	0 577910E 03
188	+	0 950000E+00	0 576340E+03
189	+	0 100000E+01	0 574910E+03
190	+	0 105000E+01	0 575030E+03
191	+	0 110000E+01	0 571110E+03
192	+	0 115000E+01	0 571510E+03
193	+	0 120000E+01	0 568710E+03
194	+	0 125000E+01	0 568130E+03
195	+	0 130000E+01	0 567960E+03
196	+	0 135000E+01	0 5662_0E+03
197	+	0 140000E+01	0 565580E+03
198	+	0 145000E+01	0 563710E+03
199	+	0 150000E+01	0 563610E+03
200	+	0 155000E+01	0 561860E+03
201	+	0 160000E+01	0 562630E+03
202	+	0 165000E+01	0 561350E+03
203	+	0 170000E+01	0 561210E+03
204	+	0 175000E+01	0 559180E 03
205	+	0 180000E+01	0 559310E+03
206	+	0 185000E+01	0 558550E+03
207	+	0 190000E+01	0 557090E+03
208	+	0 195000E+01	0 558770E+03
209	+	0 200000E+01	0 556650E+03
210	+	0 205000E+01	0 557920E+03
211	+	0 210000E+01	0 555040E+03
212	+	0 215000E+01	0 557340E+03
213	+	0 220000E+01	0 555990E+03
214	+	0 225000E+01	0 556340E+03
215	+	0 230000E+01	0 555450E+03
216	+	0 235000E+01	0 554950E+03
217	+	0 240000E+01	0 553770E+03
218	+	0 245000E+01	0 556380E+03
219	+	0 250000E+01	0 555500E+03
220	+	0 255000E+01	0 552880E+03
221	+	0 260000E+01	0 554470E+03
222	+	0 265000E+01	0 554330E+03
223	+	0 270000E+01	0 554990E+03
224	+	0 275000E+01	0 553160E+03
225	+	0 280000E+01	0 553910E+03
226	+	0 285000E+01	0 553060E+03
227	+	0 290000E+01	0 553410E+03
228	+	0 295000E+01	0 553250E+03
229	+	0 300000E+01	0 553820E+03
230	+	0 305000E+01	0 552570E+03

```
 231     +   0 310000E+01     0 553550E+03
 232     +   0 315000E+01     0 552970E 03
 233     +   0 320000E+01     0 552120E 03
 234     +   0 325000E+01     0 553040E+03
 235         0 330000E+01     0 552420E+03
 236     +   0 335000E+01     0 552950E+03
 237         0 340000E+01     0 552340E 03
 238     +   0 345000E+01     0 554220E+03
 239     +   0 350000E+01     0 551410E+03
 240     +   0 355000E+01     0 552760E 03
 241     +   0 360000E+01     0 552050E+03
 242     +   0 365000E+01     0 552050E+03
 243     +   0 370000E+01     0 551900E+03
 244     +   0 375000E+01     0 552390E 03
 245     +   0 380000E+01     0 551040E+03
 246     +   0 385000E+01     0 551940E+03
 247     +   0 390000E+01     0 551290E 03
 248     +   0 395000E+01     0 553100E+03
 249     +   0 400000E+01     0 551630E+03
 250     **    PINSIM 002#206  1286 PININV /80165 0052 PDINV DATS
 251     **   TIME IN SEC$                          $    $    $    $          $
 252     **    SURFACE HEAT FLUX IN BTU/S FT**2$ $
 253     **    0 100000E+01  TIME IN SEC$
 254     **    0 100000E+01  PHIW(()1 1()) INV$
 255    500121
 256     +   0 000000E+00     0 946960E+02
 257     +   0 500000E-01     0 100590E+03
 258     +   0 100000E+00     0 970570E+02
 259     +   0 150000E+00     0 899650E+02
 260     +   0 200000E+00     0 897220E+02
 261     +   0 250000E+00     0 852870E+02
 262     +   0 300000E+00     0 763760E+02
 263     +   0 350000E+00     0 708200E+02
 264     +   0 400000E+00     0 695450E+02
 265     +   0 450000E+00     0 686980E+02
 266     +   0 500000E+00     0 598500E 02
 267     +   0  50000E+00     0 628870E+02
 268     +   0 600000E+00     0 511870E+02
 269     +   0 650000E+00     0 511530E 02
 270     +   0 700000E+00     0 480400E+02
 271         0 750000E+00     0 442830E+02
 272     +   0 800000E+00     0 442200E 02
 273     +   0 850000E+00     0 402450E 02
 274     +   0 900000E+00     0 381300E+02
 275     +   0 950000E+00     0 357570E 02
 276     +   0 100000E+01     0 335160E+02
 277         0 105000E 01     0 288950E+02
 278     +   0 110000E+01     0  29840E 02
 279     +   0 115000E+01     0 263950E 02
 280     +   0 120000E+01     0  86070E 02
 281         0 125000E 01     0 248900E+02
 282         0 130000E+01     0 220430E 02
 283     +   0 135000E+01     0 227490E 02
 284     +   0 140000E+01     0 204680E+02
 285         0 145000E 01     0 211270E 02
  86         0 150000E+01     0 178450E+02
 287         0 155000E+01     0 188640E 02
 288         0 160000E+01       144190E+02
```

```
+    0 165000E+01    0 155860E+02
+    0 170000E+01    0 135160E+02
+    0 175000E+01    0 155650E+02
+    0 180000E+01    0 123670E+02
+    0 185000E+01    0 123110E+02
+    0 190000E+01    0 131100E+02
+    0 195000E+01    0 775520E+01
+    0 200000E+01    0 116990E+02
+    0 205000E+01    0 704620E+01
+    0 210000E+01    0 120850E+02
+    0 215000E+01    0 499470E+01
+    0 220000E 01    0 815610E+01
+    0 225000E+01    0 605800E+01
+    0 230000E+01    0 718530E+01
+    0 235000E+01    0 677210E+01
+    0 240000E+01    0 773410E+01
+    0 245000E+01    0 148390E 01
+    0 250000E+01    0 455290E+01
+    0 255000E+01    0 842260E+01
+    0 260000E+01    0 294530E+01
+    0 265000E+01    0 367170E+01
+    0 270000E+01    0 219270E+01
+    0 275000E+01    0 568200E+01
+    0 280000E+01    0 263660E+01
+    0 285000E+01    0 417480E+01
+    0 290000E+01    0 260240E+01
+    0 295000E+01    0 277410E+01
+    0 300000E+01    0 142660E+01
+    0 305000E+01    0 386260E+01
+    0 310000E+01    0 983720E+00
+    0 315000E+01    0 245450E+01
+    0 320000E+01    0 338640E+01
+    0 325000E+01    0 789650E+00
+    0 330000E+01    0 232620E+01
+    0 335000E+01    0 820890E 00
+    0 340000E+01    0 214180E+01
+    0 345000E+01   -0 172610E+01
+    0 350000E+01    0 464530E+01
+    0 355000E+01    0 838210E-01
+    0 360000E+01    0 195390E+01
+    0 365000E+01    0 483550E+00
+    0 370000E+01    0 184500E 01
+    0 375000E+01    0 409700E+00
+    0 380000E+01    0 297800E+01
+    0 385000E+01    0 206430E+00
+    0 390000E+01    0 176860E+01
+    0 395000E+01   -0 195730E+01
+    0 400000E+01    0 203250E+01
*************************************************************** DQA DAT**
**   TIME IN S $
**    TEMPERATURE IN DEG  F$
**    0 100000E+01  TIME IN S $
**    0 100000E 01  LIN HEAT RATE$
500111
+    0 000000E+00    0 978611E+01
+    0 100000E-01    0 0000E+00
+    0 500000E-01    0 0000E+00
+    0 100000E+00    0 0000E+00
```

```
 347     +    0 200000E+00     0 0000E+00
 348     +    0 300000E+00     0 0000E+00
 349     +    0 400000E+00     0 0000  00
 350     +    0 500000E 00     0 0000E 00
 351     +    0 600000E 00     0 0000E+00
 352          0 700000E+00     0 0000E+00
 353          0 800000E 00     0 0000E+00
 354     +    0 900000E+00     0 0000E 00
 355          0 100000E+01     0 0000E+00
 356     +    0 200000E 01     0 0000E 00
 357          0 300000E+01     0 0000 +00
 358     +    0 400000E+01     0 0000 +00
 359          0 500000E 01     0 0000E+00
 360     +    0 600000E+01     0 0000E 00
 361          0 700000E+01     0 0000E+00
 362          0 800000E 01     0 0000E+00
 363     +    0 900000E 01     0 0000E+00
 364          0 100000E+02     0 0000E+00
 365     ******************** ********* **** ****** ** * *****END OF  D A DAT**
 366     *************************  **  **** **  ********* ******* **  *******
 367     *
 368     210001  PHIW(1 1)  TWAL(1 1)  POWL(1 1)  TNOD(1 1 1)
 369     +       TNOD(1 1 3)  TNOD(1 1 4)  TNOD(1 1 16)  TNOD(1 1 19)
 370     *
 371     220000 6 0 0 1
         CARD ABOVE IS REPLACEMENT CARD
 372     ************************************************** ** **** * *** * *
 373
```

```
                                  ----- DATA DECK DIA NOSTICS -----

                          MINIMUM LENGTH OF TABLE ARRAY IN COMMON /S RTCH/ IS     615 WORDS

                                (LENGTH OF THE ARRAY IS NOW   10000 WORDS)


---------------------------------- ------ ---- PROCESSING TH  JO   ONTROL CARD ---- --- ------------------------------------

------------------------------------------------ PROCESSING PROBLEM OPTIONS ------------------------------------------------

------------------------------- -------- --------- PROCESSIN  PIN DATA --------- ------  -- ------------------------------

---------------------------------------- --- PROCESSING  YST M DATA  SYST M #  1- - ----------------------------------------

******** CARDS    500020 THROUGH    500020 MISSING

++++++ + WARNING    SYSTEM  1  LEVEL  1
         CARD SERIES   500121 NO  OF TABLE PAIRS SPECIFIED AT      20
        IS BEING RESET TO ACTUAL NO  OF PAIRS FOUND IN INPUT =    81

++++++++ WARNING    SYSTEM  1  LEVEL  1
         CARD SERIES   500141 NO  OF TABLE PAIRS SPECIFIED AT      20
        IS BEING RESET TO ACTUAL NO  OF PAIRS FOUND IN INPUT =    81


---------------------------- ------------- ------ INITIALIZIN  PIN PARAMETERS ---- - ----  ---- ------------------------------

------------------------------------------------ PROCESSING  DIT OPTIONS ------------------------------------------------

******** TOO MANY NUMBERS ON CARDS    220000 THROUGH    220030


                          MINIMUM LENGTH OF DATA ARRAY IS       346 WORDS

                               (LENGTH OF THE ARRAY IS NOW     000 WORDS)
```

```
PINSIM  A NUCLEAR FUEL PIN SIMULATOR-TRANSIENT ANALYSIS COD   MOD 2       V RSION 002  06/10/80        NC  206 (PINMAN)   PAGE 0010
PINSIM VERIFICATION STUDY PROBLEM   POWER-DROP TEST SIMULATION                            06/13/80

*******  THE FOLLOWING CARDS WERE NOT USED

          500111
                 ********* TAU =   0 0          WARN HAS BEEN CA   D  PO SIBLE PROBL M ER OR  ********

------------------------------- ------- -----  END OF INPUT DATA PROCESSING   ----- --------- --------------------------------

                                                NO FATAL DIAGNOSTICS
```

INITIALIZED INPUT DATA

----- GENERAL PROBLEM DATA -----

SYSTEM	SYSTEM FLAG
1	-1

PROBLEM END TIME - 4.0000000 00 SEC

TIME STEP CONTROL GROUPS

GROUP NO	BEGINNING TIME(SEC)	MINIMUM TIME STEP SIZE (SEC)	MAXIMUM TIME STEP SIZE(SEC)	STEP SIZE SEL FLAG
1	0.0	5.0000000-02	5.0000000-02	2

OUTPUT CONTROL

	ELAPSED NO OF TIME STEP	ELAPSED TIME	ROUTED TO DEVICE NO
MAJOR EDIT	3	0.1000000 01	6
MINOR EDIT	1	0.0	8
PLOT RECORD	3	0.0	1

PROBLEM CONVERGENCE CRITERIA

TEMPERATURE CONVERGENCE FACTOR	0.1000000 07
ENERGY CONVERGENCE FACTOR	0.1000000-07
MAXIMUM NUMBER OF ITERATIONS	50

SYSTEM INPUT DATA SYSTEM NO 1

SYSTEM CONTROL FLAG	POWER CONTROL FLAG/# J L V S	STEADY-STATE POWER KW
-1	1	0 0

ORDERS OF INTERPOLATION

POWER	FLUX	TEMPERATURE	HEAT COEFF
2	2	2	2

POWER FILTER PARAMETERS

LOW-PASS BREAKPOINT	HIGH PASS BREAKPOINT	FILTER FLAG
0 0	0 0	0

CALCULATIONAL CONTRO SY TEM 1 LEVEL # 1

CALCULATION LOCATION

PIN	LEV L	NODE
1	1	0

BOUNDARY CONDITION CONTROL FLAGS

LEVEL POWER	URFACE HEAT FLUX	U FACE H T COEFF	TEMPERATURE
0	81	0	81

LEVEL FILTER OI TROL

PARAMETER	LOW-PASS BREAKPJINT	HIGH-PASS BREAKPOINT	FILTER FLAG
LEVEL POWER	0 0	0 0	0
HEAT FLUX	0 0	0 0	0
TEMPERATURE	0 0	0 0	0

POW R TRI

TEMPERATURE	FLAG
0 0	0

BOUNDARY CONDITION LINKS
(TABLES FOLLOW)

PARAMETER	PIN	LEVEL	NODE/PARAMETER #/ POINTER
LEVEL POWER	0	0	0
HEAT FLUX	0	0	23
H T COEFF	0	0	0
TEMPERATURE	0	0	185

----- SURFAC HEAT FLUX TABLE -----

TIME (SEC)	HEAT FLUX (BTU/SEC-FT**2)	TIME (SEC)	HEAT FLUX (BTU/SEC-FT**)	TIME (SEC)	HEAT FLUX (BTU/SEC-FT* 2)	TIME (SEC)	H AT FLUX (BTU/SEC-FT**2)
0 0	0 946960D 02	0 500000D-01	0 100590D 03	0 1000000D 00	0 970570D 02	0 1 0000D 00	0 899650D 02
0 200000D 00	0 897220D 02	0 250000D 00	0 852870D 02	0 3000000D 00	0 76 760D 02	0 350000D 00	0 708200D 02
0 400000D 00	0 695450D 02	0 450000D 00	0 686980D 02	0 500000D 00	0 598500D 02	0 550000D 00	0 628870D 02
0 600000D 00	0 511870D 02	0 650000D 00	0 511530D 02	0 700000D 00	0 480400D 02	0 500000D 00	0 4423_0D 02
0 800000D 00	0 442200D 02	0 850000D 00	0 402450D 02	0 900000D 00	0 381300D 02	0 950000D 00	0 357570D 02
0 100000D 01	0 335160D 02	0 105000D 01	0 288950D 02	0 1100000D 01	0 329840D 02	0 115000D 01	0 263950D 02
0 120000D 01	0 286070D 02	0 125000D 01	0 248900D 02	0 1 0000D 01	0 220430D 02	0 13 000D 01	0 227490D 02
0 140000D 01	0 204680D 02	0 145000D 01	0 211270D 02	0 1 000D 01	0 178460D 02	0 155000D 01	0 188640D 02
0 160000D 01	0 144190D 02	0 165000D 01	0 155860D 02	0 1700000D 01	0 135160D 02	0 17 000D 01	0 1 5650D 02
0 180000D 01	0 123670D 02	0 185000D 01	0 123110D 02	0 1900000D 01	0 131100D 02	0 195000D 01	0 775520D 01
0 200000D 01	0 116990D 02	0 205000D 01	0 704620D 01	0 2100000D 01	0 120850D 0	0 215000D 01	0 499470D 01
0 220000D 01	0 815610D 01	0 225000D 01	0 605800D 01	0 2300000D 01	0 718530D 01	0 235000D 01	0 677210D 01
0 240000D 01	0 773410D 01	0 245000D 01	0 148390D 01	0 2 0000D 01	0 455290D 01	0 25 000D 01	0 842260D 01
0 260000D 01	0 294530D 01	0 265000D 01	0 367170D 01	0 2700000D 01	0 219270D 01	0 275000D 01	0 568200D 01
0 280000D 01	0 263660D 01	0 285000D 01	0 417480D 01	0 2900000D 01	0 260240D 01	0 295000D 01	0 277410D 01
0 300000D 01	0 142660D 01	0 305000D 01	0 386260D 01	0 3100000D 01	0 983720D 00	0 _1 000D 01	0 245450D 01
0 320000D 01	0 338640D 01	0 325000D 01	0 789600D 00	0 3300000D 01	0 232620D 01	0 335000D 01	0 820890D 00
0 340000D 01	0 214180D 01	0 345000D 01	- 172610D 01	0 3500000D 01	0 464530D 01	0 3 000D 01	0 8 8210D-01
0 360000D 01	0 195390D 01	0 365000D 01	0 483550D 00	0 3700000D 01	0 184500D 01	0 375000D 01	0 409700D 00
0 380000D 01	0 297800D 01	0 385000D 01	0 206430D 00	0 3900000D 01	0 176850D 01	0 395000D 01	- 195730D 01
0 400000D 01	0 203250D 01						

----- TEMPERATURE TABLE - --

TIME (SEC)	TEMPERATURE (F)	TIME (SEC)	TEMPERATURE (F)	TIME (SEC)	TEMPERATURE (F)	TIME (SEC)	TEMP RATURE (F)
0 0	0 643590D 03	0 500000D 01	0 637800D 03	0 100000D 00	0 632670D 03	0 150000D 00	0 628710D 03
0 200000D 00	0 621470D 03	0 250000D 00	0 615340D 03	0 300000D 00	0 612260D 03	0 350000D 00	0 609140D 03
0 400000D 00	0 604230D 03	0 450000D 00	0 598540D 03	0 500000D 00	0 597010D 03	0 550000D 00	0 590860D 03
0 600000D 00	0 591330D 03	0 650000D 00	0 588270D 03	0 700000D 00	0 585980D 03	0 750000D 00	0 584410D 03
0 800000D 00	0 581250D 03	0 850000D 00	0 579730D 03	0 900000D 00	0 577910D 03	0 950000D 00	0 576340D 03
0 100000D 01	0 574910D 03	0 105000D 01	0 575030D 03	0 110000D 01	0 571110D 03	0 115000D 01	0 571510D 03
0 120000D 01	0 568710D 03	0 125000D 01	0 568130D 03	0 130000D 01	0 567960D 03	0 135000D 01	0 566220D 03
0 140000D 01	0 565580D 03	0 145000D 01	0 563710D 03	0 150000D 01	0 563610D 03	0 155000D 01	0 561860D 03
0 160000D 01	0 562630D 03	0 165000D 01	0 561350D 03	0 170000D 01	0 561210D 03	0 175000D 01	0 559180D 03
0 180000D 01	0 559310D 03	0 185000D 01	0 558550D 03	0 190000D 01	0 557090D 03	0 195000D 01	0 558770D 03
0 200000D 01	0 556650D 03	0 205000D 01	0 557920D 03	0 210000D 01	0 555040D 03	0 215000D 01	0 557340D 03
0 220000D 01	0 555990D 03	0 225000D 01	0 556340D 03	0 230000D 01	0 555450D 03	0 235000D 01	0 554950D 03
0 240000D 01	0 553770D 03	0 245000D 01	0 556380D 03	0 250000D 01	0 555500D 03	0 2 5000D 01	0 552880D 03
0 260000D 01	0 554470D 03	0 265000D 01	0 554330D 03	0 270000D 01	0 554990D 03	0 275000D 01	0 553160D 03
0 280000D 01	0 553910D 03	0 285000D 01	0 553060D 03	0 290000D 01	0 553410D 03	0 295000D 01	0 553250D 03
0 300000D 01	0 553820D 03	0 305000D 01	0 552570D 03	0 310000D 01	0 553550D 03	0 315000D 01	0 552970D 03
0 320000D 01	0 552120D 03	0 325000D 01	0 553040D 03	0 330000D 01	0 552420D 03	0 33 000D 01	0 5 2950D 03
0 340000D 01	0 552340D 03	0 345000D 01	0 554220D 03	0 350000D 01	0 551410D 03	0 355000D 01	0 552760D 03
0 360000D 01	0 552050D 03	0 365000D 01	0 552550D 03	0 370000D 01	0 5 1900D 03	0 75000D 01	0 552390D 03

- --- TEMPERATUR TABLE -- --

TIM (SEC)	TEMPERATURE (F)	TIMF (SEC)	TEMPEPATURE (F)	TIME (EC)	TEMPERATURE ( )	TIMF (SEC)	T MPERATURE (F)
0 3800000 01	0 5510400 03	0 3850000 01	0 5519400 03	0 3900000 01	0 5129000 0	0 395 000 01	0 5 3100D 03
0 4000000 01	0 5516300 03						

----- PIN DATA -----
(PIN NO 1)

POWER SYSTEM	POWER FLAG	PIN TO AVG POW PEAK FAC	TOTAL PIN LEN TH FT	NUMBER OF AXIAL LEVELS	NUMBER OF MATERIALS
0	1	0 1000D 01	1 00	1	4

GAP CALCULATION FLAG	INTERNAL DATA FLAG	H AT TRANSFER AREA SCALING FACTOR	PIN DEFORMATION FLAG
0	0	0 100000D 01	0

FLUX DEPR SSION FACTORS

WER NOT USED

----- LEVEL DATA -----
(PIN NO 1)

LEVEL NO	SURFACE HEAT TRANSFER AREA (FT**2)	AXIAL LENGTH (FT)	AXIAL PIN POWER FRACTION	ASSOCIATED WATER NODE	NO OF RADIAL REGIONS	NO OF RADIAL NODES
1	0 979655D-01	1 000	1 0000	0	5	19

----- REGION DATA -----
(PIN NO 1)

LEVEL NO	REGION NO	REGION INNER RADIUS FT	REGION OUTER RADIUS FT	RADIAL POWER PEAK FACTOR	NO OF NODES	MATERIAL I D NO
1	1	0 0	0 2342D-02	0 0	1	1
1	2	0 2342D-02	0 9075D-02	0 0	7	1
1	3	0 9075D-02	0 1023D-01	0 1000D 01	2	3
1	4	0 1023D-01	0 1402D-01	0 0	6	2
1	5	0 1402D-01	0 1559D-01	0 0	3	4

----- NODE DATA -----
(PIN NO 1)

LEVEL NO	NODE NO	NODE INNER RADIUS FT	NODE CENTER RADIUS FT	NODE OUTER RADIUS FT	NODE VOLUME FT3	RADIAL POWER PEAKING FACTOR	MATERIAL ID NO
1	1	0 0	0 165583D-02	0 341700D-02	0 172271D-04	0 0	1
1	2	0 234170D-02	0 331277D-02	0 405774D-02	0 3 5001D-04	0 0	1
1	3	0 405774D-02	0 468574D-02	0 523899D-02	0 345001D 04	0 0	1
1	4	0 523899D-02	0 573915D-02	0 619909D-02	0 345001D-04	0 0	1
1	5	0 619909D-02	0 662719D-02	0 702926D-02	0 345001D-04	0 0	1
1	6	0 702926D-02	0 740954D-02	0 777 245 02	0 345001D-04	0 0	1
1	7	0 777124D-02	0 811684D-02	0 844831D-02	0 345001D-04	0 0	1
1	8	0 844831D-02	0 876726D-02	0 907 000 02	0 345001D 04	0 0	1
1	9	0 907500D-02	0 937573D-02	0 966712D-02	0 343638D-04	0 0 0000D 00	3
1	10	0 966712D-02	0 994997D-02	0 10 250D-01	0 3 8638D-04	0 50000 D 00	3
1	11	0 102250D-01	0 105929D-01	0 1094 50-01	0 481278D 04	0 0	2
1	12	0 109485D-01	0 112929D-01	0 116 71D 01	0 481278D-04	0 0	2
1	13	0 116271D-01	0 119520D-01	0 122 82D 01	0 481278D-04	0 0	2
1	14	0 122682D-01	0 125765D-01	0 128775D 01	0 481278D-04	0 0	
1	15	0 128775D-01	0 131715D-01	0 134591D-01	0 481278D-04	0 0	2
1	16	0 134591D-01	0 137407D-01	0 1401 7D 01	0 481 78D-04	0 0	2
1	17	0 140167D-01	0 142913D-01	0 145 06D-01	0 488342D 04	0 0	4
1	18	0 145606D-01	0 1482 1D-01	0 1 0850D 01	0 488342D 04	0 0	4
1	19	0 150850D-01	0 153404D-01	0 155917D-01	0 48 8342D 04	0 0	4

----- MATERIAL DATA -----
(PI NO 1)

IDENTIFIED MATERIALS

MATERIAL NO 3 IS INCONEL

MATERIAL NO 4 IS STAINLESS STEEL 316

FOLLOWING ARE DESCRIPTIONS OF THE OTHER MATERIALS

----- MATERIAL DATA --- -
(PIN NO 1)

MATERIA NO 1

MELTIN T MPERATURE (F)
5000 00

THERMAL CONDUCTIVITY
(BTU/HR-FT-)

ALLOWED TEMPERATUR RANGE
HIGH LOW
2300 00 0 0

K = C0 + C1*T + C2*T* 2 + C3*T**3 + C4*T**4

C0	C1	C2	C3	C4
0 212866D 02	-0 101369D-01	0 0	0 0	0 0

SPECIFIC HEAT CAPACITY
(BTU/LBM)

ALLOWED T MP RATURE RANGE
HIGH LOW
2300 00 0 0

CP = C0 + C1*T + C2*T**2 + C3*T**3 + C4*T**4

C0	C1	C2	C3	C4
0 167812D 00	0 370264D-03	-0 173794D 06	0 314486D-10	0 0

D NSITY
(LBM/FT**3)
0 138384D 03

```
----- MATERIAL DATA --
(PIN NO 1)

MATERIA NO 2

MELTIN T MPERATURE (F)
000 00

THERMAL DNDUCTIVITY
(BTU/HR FT- )

ALLOWED T MP RATUR RANGE
HI H LOW
2300 00 0 0

K = C0 + C1*T + C2*T**2 C3*T**3 + C4*T**4

C0 C1 C2 C3 C4
0 171853D 02 -0 407190D-02 0 0 0 0 0 0

SPECIFIC H AT CAPACITY
(BTU/LBM- )

ALLOWED T MP RATUR RANGE
HIGH LOW
2300 00 0 0

CP = C0 + C1*T C2*T**2 C *T**3 C4*T**4

C0 C1 C2 C3 C4
0 167812D 00 0 370264D-03 -0 173794D 06 0 314486D-10 0 0

D NSITY
(LBM/FT *3)
0 135468D 03
```

----- ---------- ------- ----- END OF INPUT DATA ROCES ING ----- - - - ------- - - ---------- ----------

STEADY-STAT OUTPUT

YSTEM # 1 L VEL # 1

CALCULATION LOCATION

PIN	LEVEL	NOD
1	1	0

LEVEL BOUNDARY CONDITION

	UNFILTE ED	ILTE D
HEAT TRANSFER CO FFICIENT (BTU/SEC-FT2-F)	0 0	
SURFACE HEAT FLUX (BTU/SEC-FT2)	0 9 5600 0	0 946960L 0
TEMPERATURE (DEG F)	0 64 59 0 03	643590L 0

BACK CA ULATION

CALCULATED R SULTS

	UNFI T RED	ILTERED
POWER (KW)	0 0 7694D 01	0 927 9 D 01
SURFACE HEAT FLUX (BTU/SEC-FT2)	0 0469 0D 02	
URFACE TEMP RATURE (DEG F)	0 (4 590D 03	

T MP RATUR ISTRIBUTION
PIN I L EL 1

LEVEL	NO	1	2	3	4	5	6	7	8	9	10
1		842	842 25	8 2 25	842 25	342 5	842	84 2	84 25	842 25	829 26

LEVEL	NO	11	12	13	14	15	1	17	18	19
1		803 81	779 45	7 8 10	738 84	7 0	0 80	688 0	6 5	652 02

SUMMARY OF PIN CONDITIONS PIN NO 1

TAU (SEC)	DELT (SE)
0 0	0 0

	BTU/S C	KW
PIN POWER	0 0	0 0

SYSTEM IDENTIFI ATION PIN 1

LEVEL	YSTEM #	SYSTEM LEVEL
1	1	1

LEVEL NO	LEVEL POWER (BTU/SEC)	SURF HEAT TRAN (BTU/SEC)	SURF HEAT FLUX (BTU/ EC-FT**2)	CENTERLIN ( ) TEMP	HEATER NODE TEMP(F)	SURFACE TEMP (F)	ADJACENT COOL TEMP(F)	S URF HT TRANS COEFF(B/S-FT2-F)
1	0 927694D 01	0 927694D 01	0 946960D 02	0 842248D 03	0 892650 03	0 643590D 03	0 643590D 03	0 0

LEVEL	EQUIVALENT GAP CONDUCTIVITY (BTU/SEC-FT-F)	GAP CONDUCTANCE (BTU/SEC-FT**2-F)	AP THICKNESS (FT)	STEADY STATE GAP THICKNESS (FT)	NO OF ITERATIONS IN H T SOLUTION
1	0 0	0 0	0 0	0 0	5

SUMMARY OF PIN CONDITIONS PIN NO 1

PIN TEMPERATURE DISTRIBUTION

	NODE									
LEVEL NO	1	2	3	4	5	6	7	8	9	10
1	842 25	842 25	842 25	842 25	842 2	842 25	842 25	842 2	842 25	829 26

	NODE								
LEVEL NO	11	12	13	14	15	16	17	18	19
1	803 81	779 45	758 00	738 84	721 56	705 80	688 50	669 69	652 02

SUMMARY OF PIN CONDITIONS PIN NO 1

TOTAL STORED ENERGY IN 1 0 30797 D 02 BTU

LEVEL	STORED ENER Y E? LEVE (BTU)
1	0 30797 0 02

TOTAL NODAL STOR D EN RGY (BTU)

LEVEL NO	NOD 1	2	3	4	5	6	7	8	9	10
1	0 72 7D 00	0 1451D 01	0 1451D 01	0 1451D 01	0 1451D 01	0 1451D 01	0 1451D 01	0 1451D 01	0 1862D 01	0 1830D 01

LEVEL NO	NODE 11	12	13	14	1	16	17	18	19
1	1 86	1 78	1 71	1 66	1 0	1	2 08	2 02	1 95

TRANSIENT OUTPUT

```
*********************************************      MAJOR EDIT NUMBER    1        ****************** ***************************
*********************************************    TIME STEP NUMBER     20         ********** *********  * * *** ** ********** ***
*********************************************    TRANSIENT TIME =   1.0000 SEC   ******* * *************    *** **** *** * ****
```

TYPE OF OUTPUT	CURRENT NO OF RECORDS WRITTEN
MAJOR EDIT	1
MINOR EDIT	20
PLOT RECORD	0

SYSTEM # 1 L VEL # 1

CALCULATION LOCATION

PIN	LEV L	NODE
1	1	0

LEVEL BOUNDARY CONDITIONS

	UNFILTERED	FILTFRED
HEAT TRANSFER COEFFICIENT (BTU/SEC-FT2-F)	0 0	
SURFACE HEAT FLUX (BTU/SEC-FT2)	0 3 5160D 02	0 35160D 02
TEMPERATURE (DEG F)	0 574910D 03	0 574910D 03

BACK CALCULATION

CALCULATED RESJLTS

	UNFILTERED	FILTERED
POWER (KW)	-0 454080D-01	-0 454080D-01
SURFACE HEAT FLUX (BTU/SEC-FT2)	0 335160D 02	
SURFACE TEMPERATURE (DEG F)	0 574910D 03	

TEMPERATURE DISTRIBUTION
PIN 1 L VEL 1

	NODE									
LEVEL NO	1	2	3	4	5	6	7	8	9	10
1	666 01	662 74	657 96	653 41	649 01	644 73	640 55	636 49	631 83	626 43

	NODE								
LEVEL NO	11	12	13	14	15	16	17	18	19
1	620 97	615 60	610 44	605 50	600 74	596 17	590 70	584 26	577 99

SUMMARY OF PIN CONDITIONS IN NO 1

TAU (S C)	DELT (S C)
0 100D 01	0 00D-01

	BTU/S C	KW
PIN POWER	0 0	0 0

SYSTEM IDENTIFICATION PIN 1

LEVEL	SYSTEM #	SYSTEM LEVEL
1	1	1

LEVEL NO	LEVEL POWER (BTU/SEC)	SURF HEAT TRAN (BTU/SEC)	SURF HEAT FLUX (BTU/SEC-FT**2)	CENTERLIN TEMP ( )	HEATE NODE TEM ( )	SURFACE TEMP (F)	ADJACENT COOL TEMP(F)	URF HT TRANS COEFF(B/S-FT2-F)
1	-0 454080D-01	0 328341D 01	0 33 160D 02	0 6660090 03	0 626427D 03	0 749100 03	0 574910D 0	0 0

LEVEL	EQUIVALENT GAP CONDUCTIVITY (BTU/SEC-FT-F)	GAP CONDUCTANCE (BTU/SEC-FT**2-F)	GAP THICKNES (T)	STEADY STAT GAP THICKNESS (FT)	NO OF ITERATIONS IN H T SOLUTION
1	0 0	0 0	0 0	0 0	1

SUMMARY OF PIN CONDITIONS PIN NO 1

PIN TEMPERATURE DISTRIBUTION

LEVEL NO	NODE 1	2	3	4	5	6	7	8	9	10
1	666 01	662 74	657 96	653 41	649 01	644 73	640 56	636 49	631 83	626 43

LEVEL NO	NODE 11	12	13	14	15	16	17	18	19
1	620 97	615 60	610 44	605 50	600 74	596 17	590 70	84 26	577 99

SUMMARY OF PIN CONDITIJNS PIN NU 1

TOTAL STORED ENERGY PIN 1 - 0 2299120 02 BTU

LEVEL	STORED ENERGY ER LEVEL(BTU)
1	0 229912D 02

TOTAL NODAL STORED N RGY (BTU)

LEVEL NO	NODE 1	2	3	4	5	6	7	8	9	10
1	0 5239D 00	0 1042D 01	0 1031D 01	0 1022D 01	0 1012D 01	0 1003D 01	0 9935D 00	0 9847D 00	0 1336D 01	0 1323D 01

LEVEL NO	NODE 11	12	13	14	15	16	17	18	19
1	1 30	1 28	1 27	1 25	1 24	1 23	1 74	1 72	1 69

RESTART	TIME(SEC)	SRF HT FLUX B/S-FT2 (1 1)	SURF TEMP DEG F (1 1)	LEVEL POWR BTU/SEC (1 1)	NODAL TEMP (DEG F) (1 1 1)	NODAL TEMP (DEG F) (1 1 3)	NODAL TEMP (DEG F) (1 1 4)	NODAL TEMP (DEG F) (1 1 16)	NODAL TEMP (DEG F) (1 1 19)
0	0	94 696	643 59	9 2769	842 25	842 25	842 25	705 80	6 2 02
0	500000D-01	100 59	637 80	0 87261E-02	840 32	838 40	836 20	700 34	646 78
0	100000D 00	97 057	632 67	-0 93931E-02	837 01	831 01	826 37	692 37	641 35
0	150000	89 965	628 71	0 15451E-01	830 75	821 45	815 00	684 21	636 77
0	200000	89 722	621 47	-0 27487E-01	822 49	810 72	803 12	675 41	629 53
0	250000	85 287	615 34	0 17808E-01	812 80	799 43	791 20	666 86	623 03
0	300000	76 376	612 26	-0 65907E-03	802 19	787 94	779 42	659 59	619 15
0	350000	70 820	609 14	0 16918E-02	791 07	776 47	767 91	653 18	615 54
0	400000	69 545	604 23	-0 53198E-02	779 75	765 16	756 72	646 76	610 53
0	450000	68 698	598 54	-0 14572E-02	768 43	754 10	745 88	640 14	604 78
0	500000	9 850	97 01	-0 19655E-02	757 27	743 36	735 42	634 78	602 45
0	550000	62 887	590 86	-0 13994E-03	746 36	732 96	725 34	628 79	596 59
0	600000	51 187	591 33	0 15690E-01	735 78	722 95	715 68	624 5	596 00
0	650000	51 153	588 27	-0 15230E-02	725 57	713 35	706 44	620 23	592 94
0	700000	48 040	585 98	-0 27879E-01	715 76	704 16	697 61	616 15	590 37
0	750000	44 283	584 41	0 44222E-01	706 38	695 43	689 26	612 52	588 46
0	800000	44 220	581 25	-0 43582E-01	697 45	587 12	681 29	608 64	585 30
0	850000	40 245	579 73	0 33305E-01	688 95	579 23	673 75	605 21	583 42
0	900000	38 130	577 91	-0 35047E-01	680 38	671 74	666 58	601 97	581 41
0	950000	35 757	576 34	0 54657E-01	673 24	664 67	659 84	598 98	579 62
1	00000	33 516	574 91	-0 43408E-01	666 01	657 96	653 41	596 17	577 99
1	05000	28 895	575 03	-0 97887E-02	659 17	651 61	647 35	594 01	577 69
1	10000	32 984	71 11	0 43551E-01	652 72	645 66	641 67	591 00	574 15
1	15000	26 395	571 51	-0 19565E-01	646 64	640 03	636 29	588 84	573 94
1	20000	28 607	568 71	-0 19805E-01	640 90	634 69	631 19	586 24	571 35
1	25000	24 890	568 13	0 41477E-01	635 49	629 68	626 40	584 10	570 42
1	30000	22 043	567 96	-0 42961E-01	630 38	624 94	621 85	582 37	569 99
1	35000	22 749	566 22	0 14909E-01	625 57	620 47	617 58	580 41	568 32
1	40000	20 468	565 58	0 22075E-01	621 05	616 28	613 58	578 70	567 47
1	45000	21 127	563 71	-0 37284E-01	616 79	612 31	609 77	576 73	565 66
1	50000	17 846	563 61	0 31268E-01	612 77	608 58	606 21	575 25	565 26
1	55000	18 864	561 86	-0 26748E-01	608 99	605 05	602 82	573 48	563 60
1	60000	14 419	562 63	0 43414E-01	60 43	601 75	599 67	572 42	563 96
1	65000	15 586	561 35	-0 60286E-01	602 08	98 62	596 65	571 10	562 79
1	70000	13 516	561 21	0 39671E-01	598 3	95 70	593 86	570 03	562 46
1	75000	15 565	559 18	0 40619E-02	595 98	92 96	591 24	568 52	560 62
1	80000	12 367	559 31	-0 10950E-01	593 20	90 36	588 75	567 42	560 45
1	85000	12 311	8 55	-0 22501E-01	590 58	87 91	586 39	566 33	559 69
1	90000	13 110	557 09	0 49042E-01	588 12	85 62	584 20	565 04	558 30
1	95000	7 7552	556 77	-0 40807E-01	585 79	83 44	582 11	564 60	559 49

RESTART

TIME(SEC)	SRF HT FLUX B/S-FT2 (1 1)	SURF TEMP DEG F (1 1)	LEVEL POWR BTU/SEC (1 1)	NODAL TEMP (DEG F) (1 1 1)	NODAL TEMP (DEG F) (1 1)	NODAL TEMP (DEG F) (1 1 4)	NODAL TEMP (DEG F) (1 1 16)	NODAL TEMP (DEG F) (1 1 19)
2 00000	11 699	556 65	0 11712E-01	58 1	581 40	580 15	563 51	5 7 7
2 05000	7 0462	557 92	0 22904E-02	581 6	79 50	578 33	563 08	558 57
2 10000	12 085	555 04	-0 14672E-01	579 3	77 70	576 60	561 76	5 6 16
2 15000	4 9947	557 34	0 30206E-01	577 3	76 03	575 00	561 56	557 80
2 20000	8 1561	55 99	0 35709E-01	576 14	74 44	573 48	560 89	556 75
2 25000	6 0580	556 34	0 30787E-01	574 6	572 99	572 10	560 47	556 90
2 30000	7 1853	555 45	0 18220E-01	573 03	571 62	570 78	559 82	5 6 12
2 35000	6 7721	554 95	-0 22526E-02	571 70	570 33	569 55	559 15	55 58
2 40000	7 7341	55 77	0 35168E-01	570 42	69 14	568 41	58 30	554 49
2 45000	1 4839	556 38	-0 31738E-01	569 0	568 00	567 3	558 51	556 52
2 50000	4 5529	55 50	-0 12156E-01	568 07	566 94	566 30	55 28	555 92
2 55000	8 4226	552 88	0 36789E-01	567 01	65 97	565 39	557 21	553 66
2 60000	2 9453	554 47	-0 27023E-01	566 02	65 05	564 49	556 99	5 4 74
2 65000	3 6717	554 33	0 21774E-01	565 10	64 19	563 67	556 78	554 67
2 70000	2 1927	554 99	-0 15066E-01	564 23	63 38	562 90	556 77	555 19
2 75000	5 6820	553 16	0 13977E-02	563 45	562 64	562 18	55 12	55 09
2 80000	2 6366	553 91	0 15606E-02	562 7	561 94	561 52	555 90	554 15
2 85000	4 1748	553 06	-0 8165 E-02	561 97	561 27	560 88	55 46	5 4
2 90000	2 6024	553 41	0 12859E-01	561 30	60 66	560 29	555 25	553 65
2 95000	2 7741	553 25	-0 42815E-02	560 98	60 07	559 72	55 03	51
3 00000	1 4266	53 82	0 61344E-02	560 10	559 53	559 21	5 5 04	5 3 95
3 05000	3 8626	552 57	0 24370E-01	559 55	59 01	558 71	554 58	552 93
3 10000	0 98372	5 55	0 30144E-01	559 05	558 55	558 27	5 4 59	64
3 15000	2 4545	552 97	0 16619E-01	558 7	58 11	557 85	554 38	53 20
3 20000	3 3864	552 12	-0 39528E-02	558 13	557 69	557 44	553 94	5 2 43
3 25000	0 7896	53 04	-0 71054E-03	557 71	57 30	57 06	5 3 93	53 11
3 30000	2 3262	552 42	0 22964E-01	557 32	56 94	5 6 72	553 73	5 2 64
3 35000	0 82089	52 95	0 30357E-01	5 6 35	56 09	5 6 38	553 7	5 03
3 40000	2 1418	552 34	0 38546E-01	556 61	56 3	556 09	553 51	552 54
3 45000	-1 7261	554 22	0 45223E-01	556 9	55 98	555 80	553 93	4 0
3 50000	4 54 3	551 41	0 40585E-01	556 00	55 72	555 57	5 3 30	5 1 84
3 55000	0 83921E-01	552 76	0 41424E-01	555 73	55 46	555 30	5 3 8	552 77
3 60000	1 9539	552 05	0 30678E-01	5 7	55 23	555 09	553 07	552 2
3 65000	0 48355	552 55	-0 78483E-02	555 4	5 00	554 87	53 07	5 2 9
3 70000	1 9450	551 90	0 12174E-01	555 01	554 78	554 65	552 84	552 07
3 75000	0 40970	2 39	0 31879E-01	5 4 80	554 59	554 44	552 86	552 43
3 80000	2 9780	551 04	0 48203E-01	554 8	54 38	554 25	552 40	551 3
3 85000	0 20643	1 94	0 45409E-01	54 39	554 19	554 09	552 41	5 1 96
3 90000	1 7686	551 29	0 26095E-01	554 19	4 00	553 89	552 20	551 45
3 95000	-1 9573	553 10	0 23368E-02	554 00	553 82	553 72	552 62	552 92

RESTART

TIME(SEC)	SRF HT FLUX B/S FT2 (1 1)	SURF TEMP DEG F (1 1)	LEVEL POWR BTU/SEC (1 1)	NODAL TEM (DEG) (1 1 1)	NODAL TEMP (DEG F) (1 1 3)	NODAL TEMP (DEG F) (1 1 4)	NODAL TEMP (DEG F) (1 1 16)	NODAL TEM (DE F) (1 1 19)
4 00 0	2 0325	551 63	0 14696E-01	5 3 3	553 67	5 3 58	552 1	551 8

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