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Developmental Verification of PINSIM-MOD2

R. C. Hagar

Prepared for the U.S. Nuclear Regulatory Commission
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DEVELOPMENTAL VERIFICATION OF PINSIM-MOD2

R. C. Hagar

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CONTENTS

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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.

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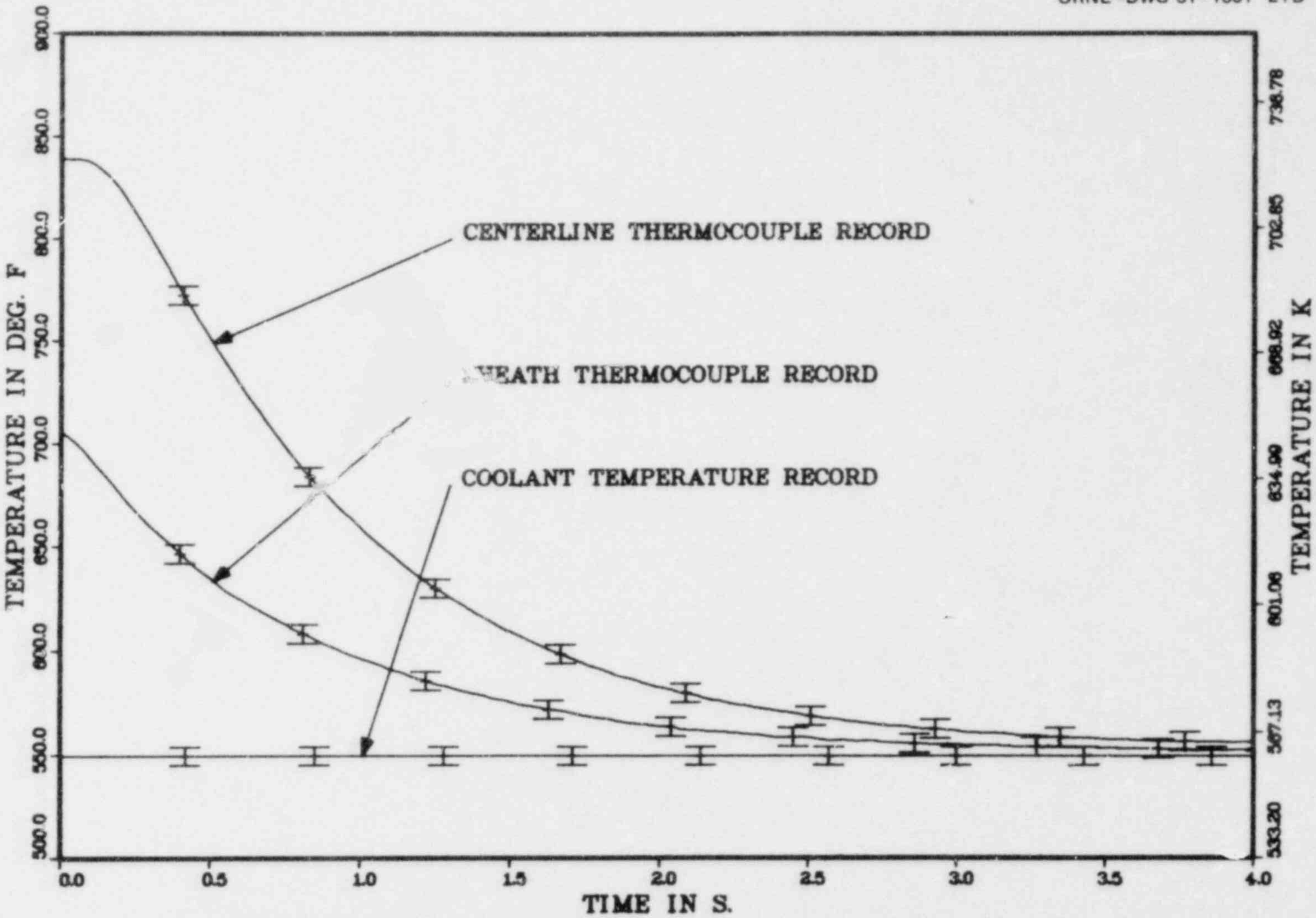

Fig. 1. Power-drop test thermocouple records.

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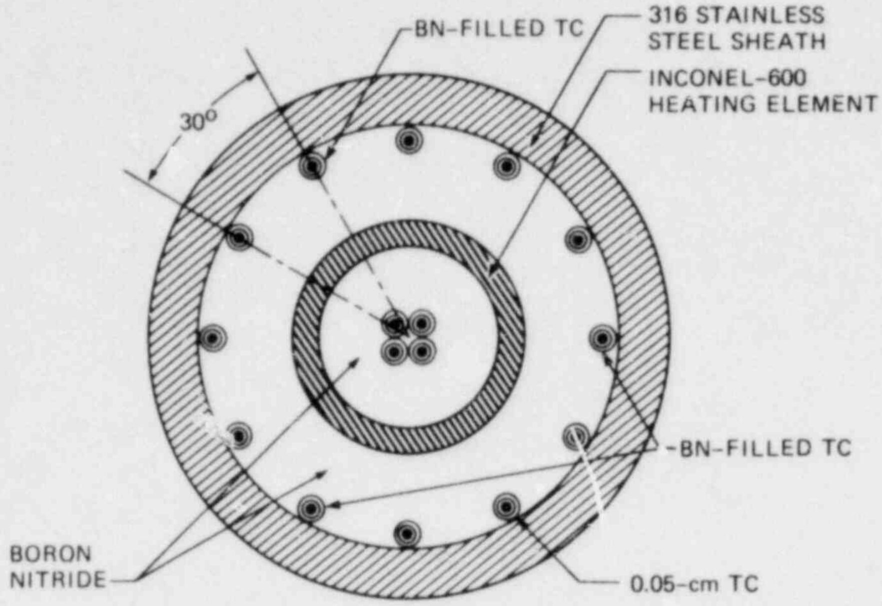

Fig. 2. Schematic of a cross section of a THTF Bundle 3 FRS.

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

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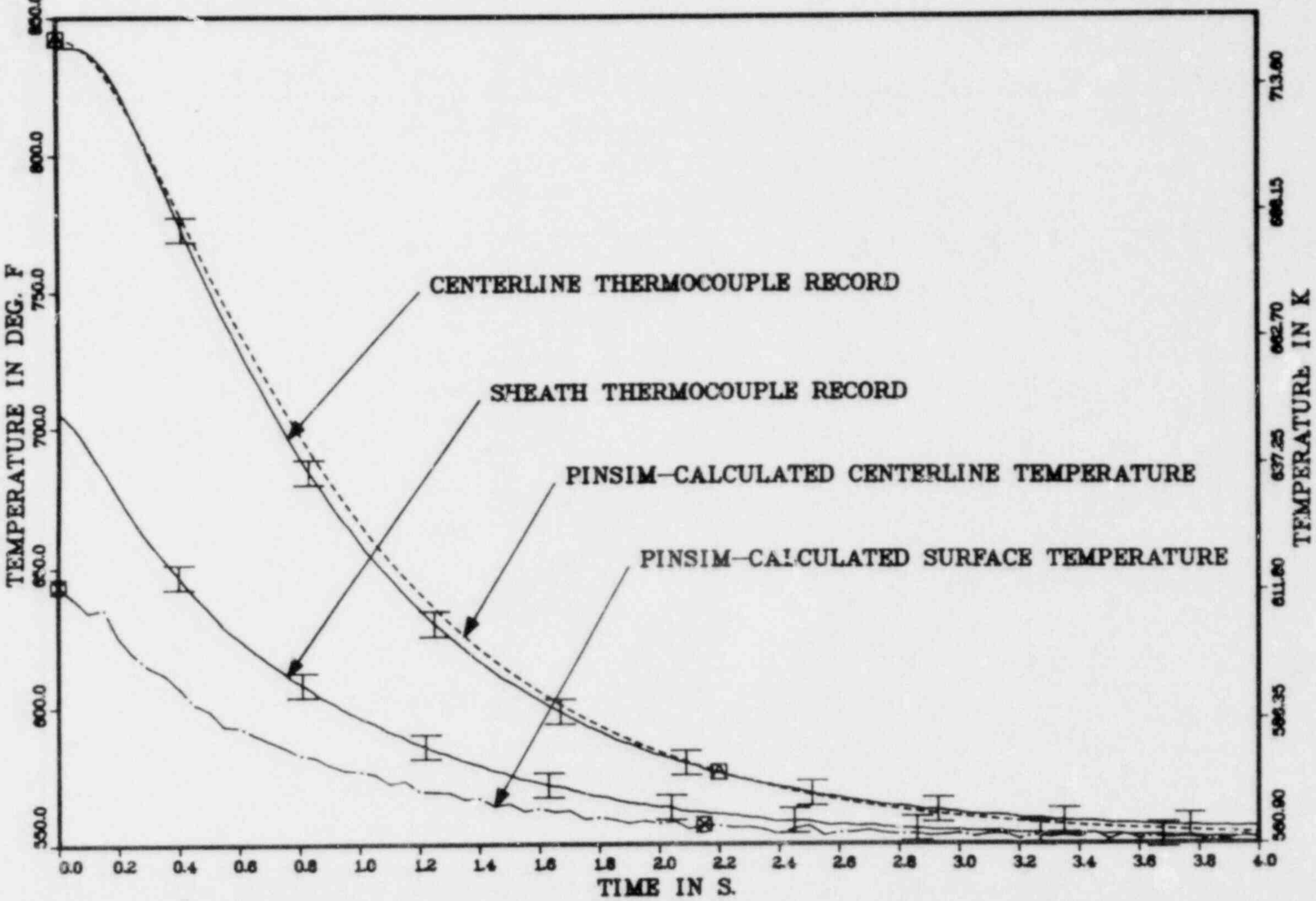

Fig. 3. Comparison of PINSIM inverse conduction problem solution results with original thermocouple records.

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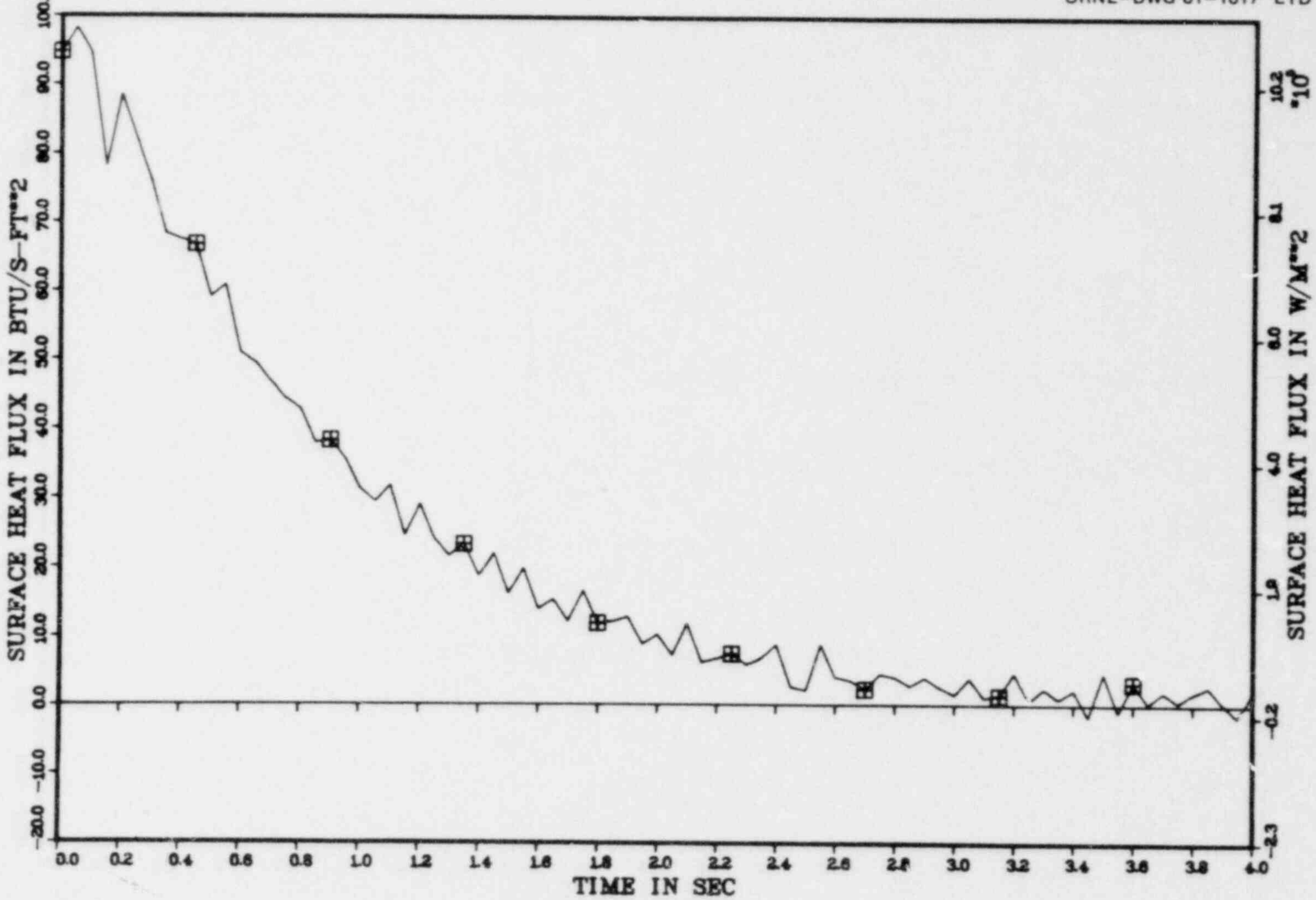

Fig. 4. FRS surface heat flux transient from PINSIM's inverse conduction problem solutions.

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

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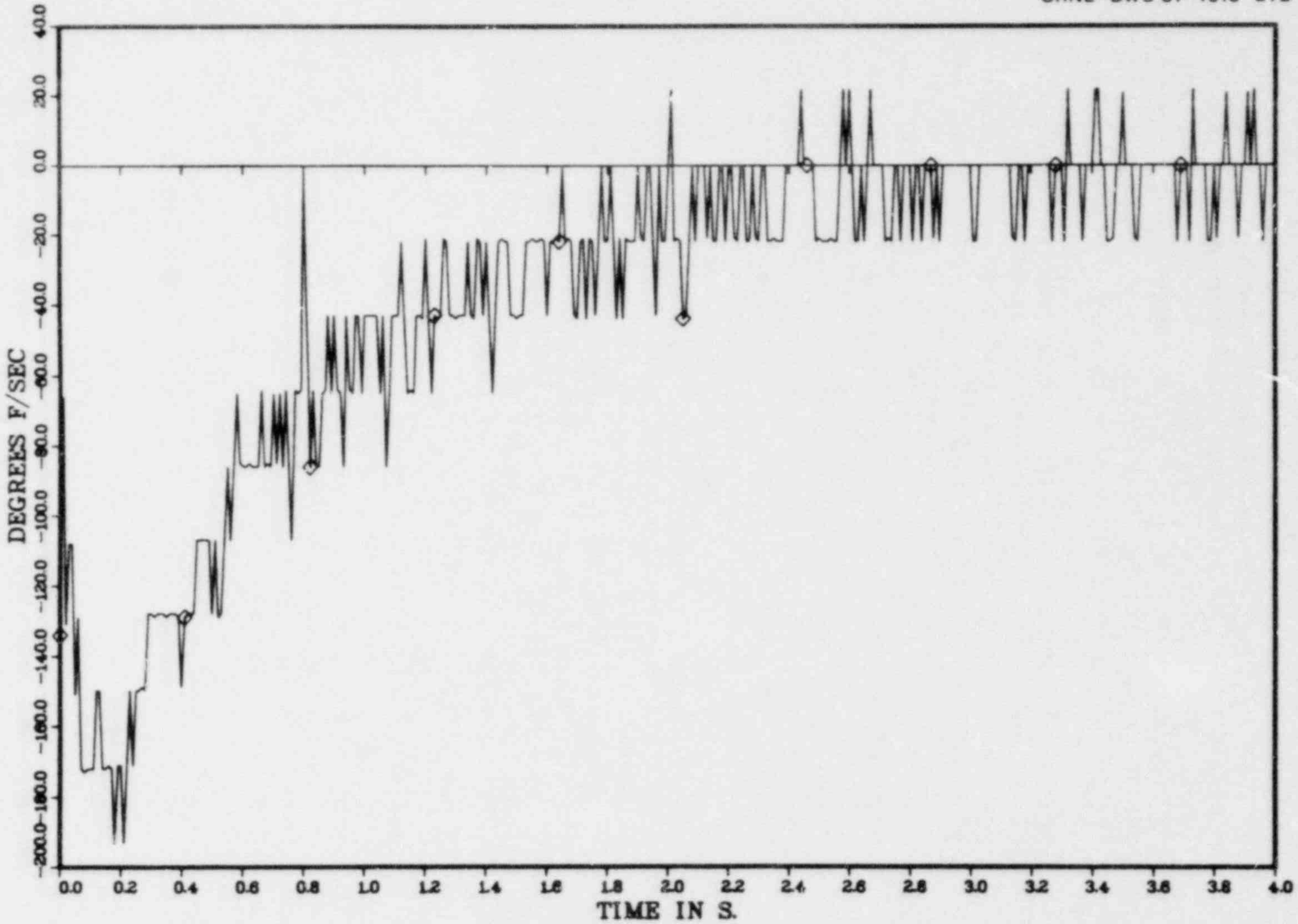

Fig. 5. Derivative of original sheath thermocouple record.

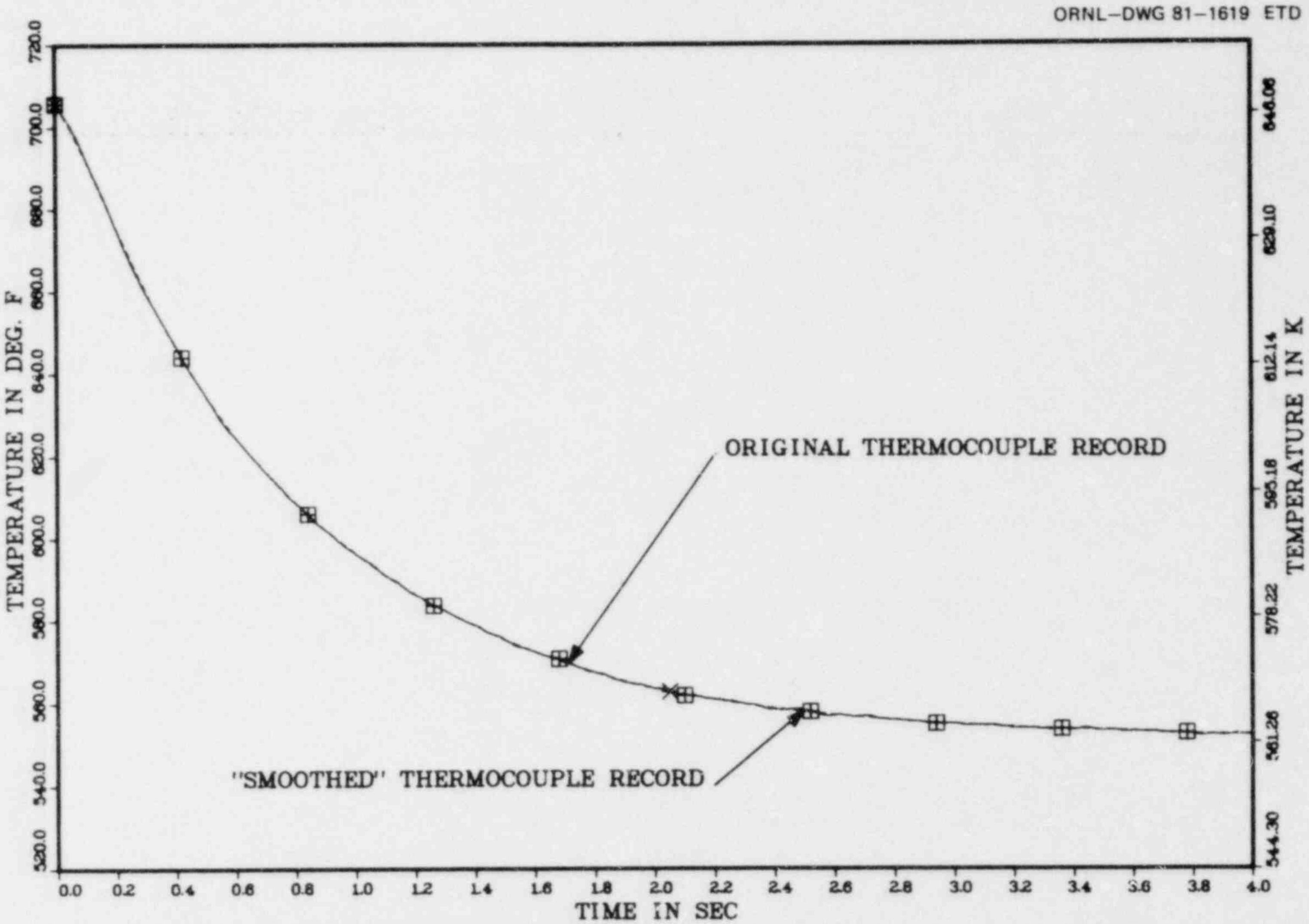

Fig. 6. Comparison of original and smoothed sheath thermocouple records.

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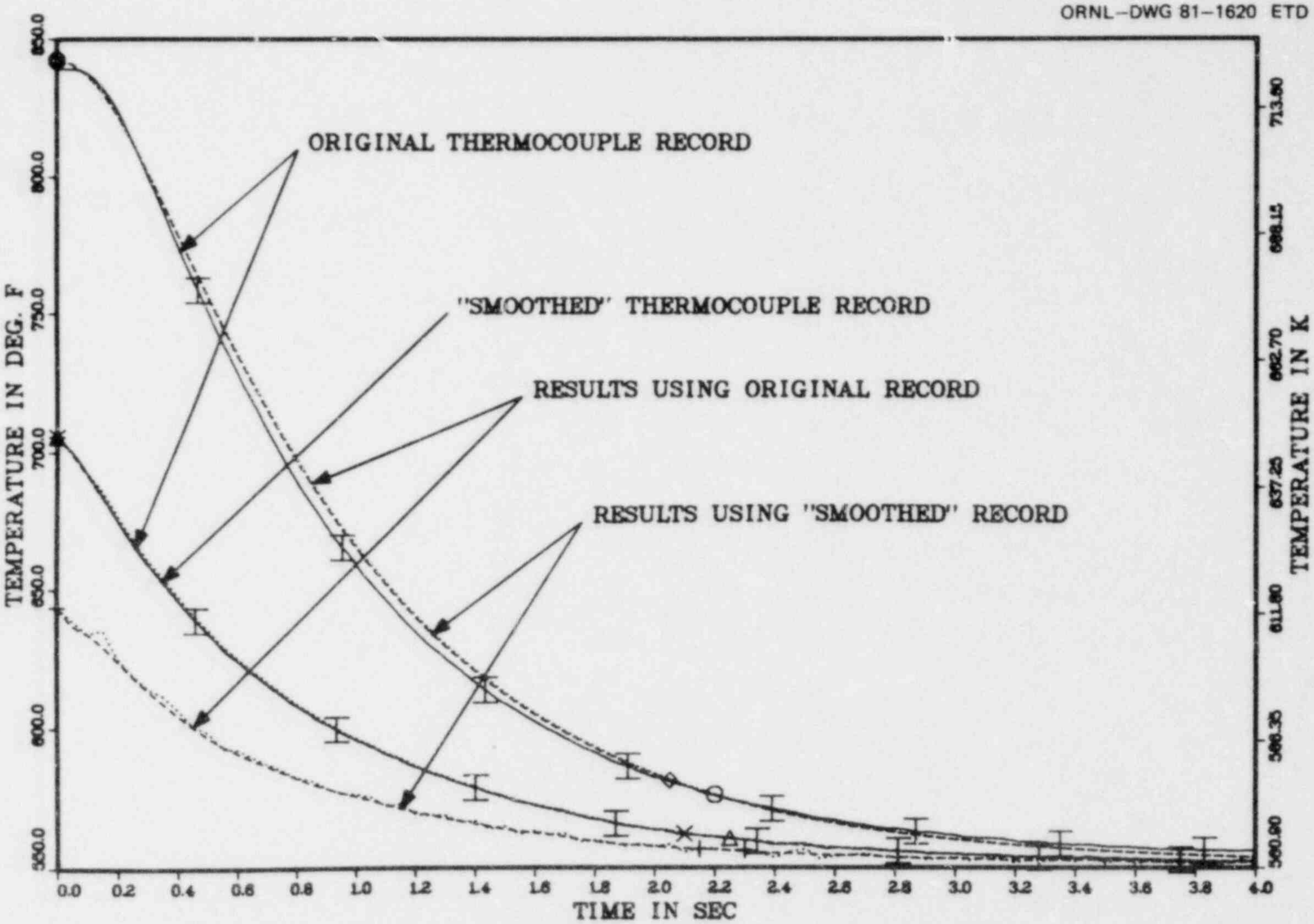

Fig. 7. Comparison of PINSIM-calculated inverse conduction problem solution results using original and smoothed sheath thermocouple records as boundary conditions with original thermocouple records.

ORNL–DWG 81–1621 ETD

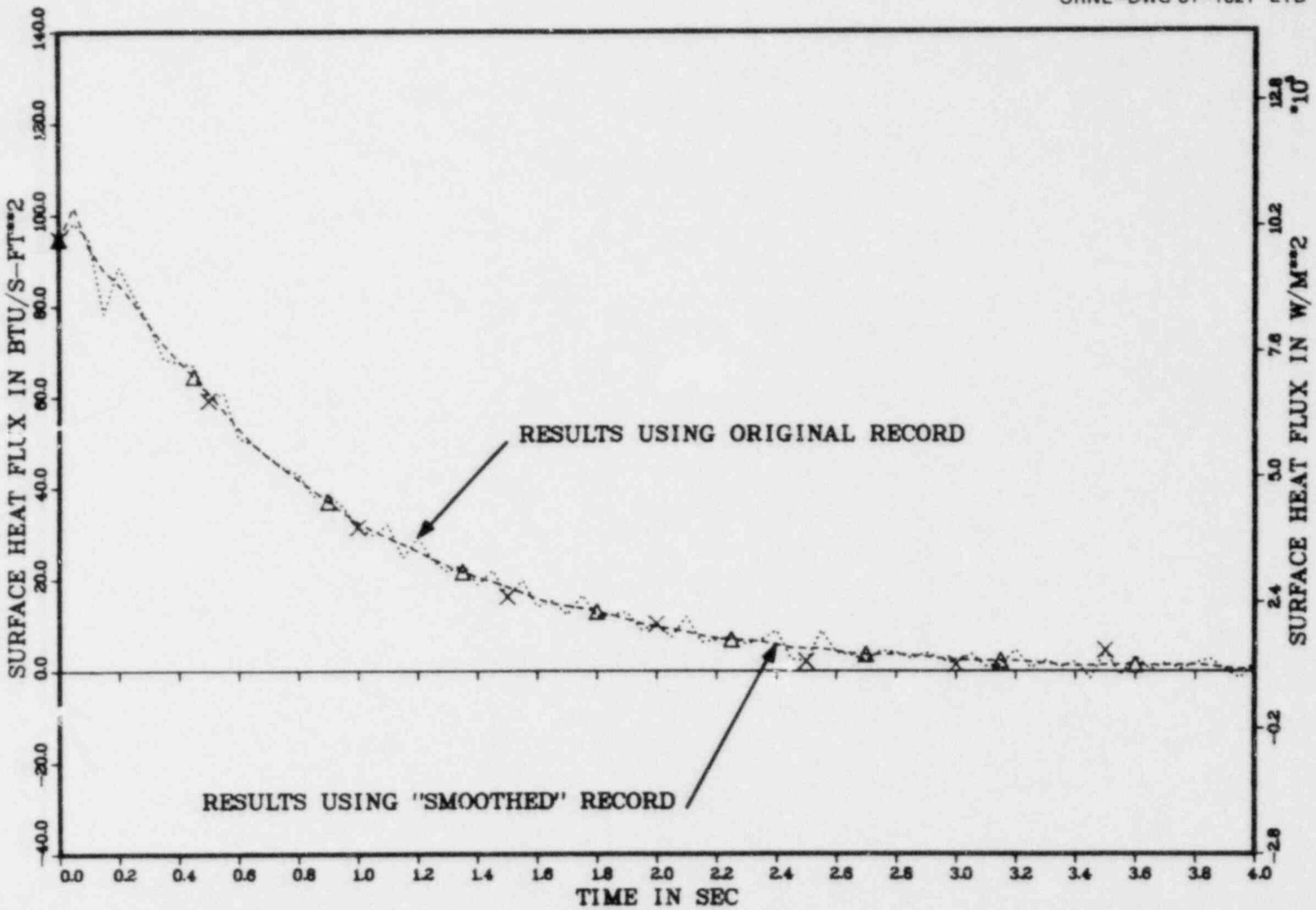

Fig. 8. Comparison of surface heat fluxes calculated by PINSIM (solving the inverse conduction problem) using original and smoothed thermocouple records as boundary conditions.

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.

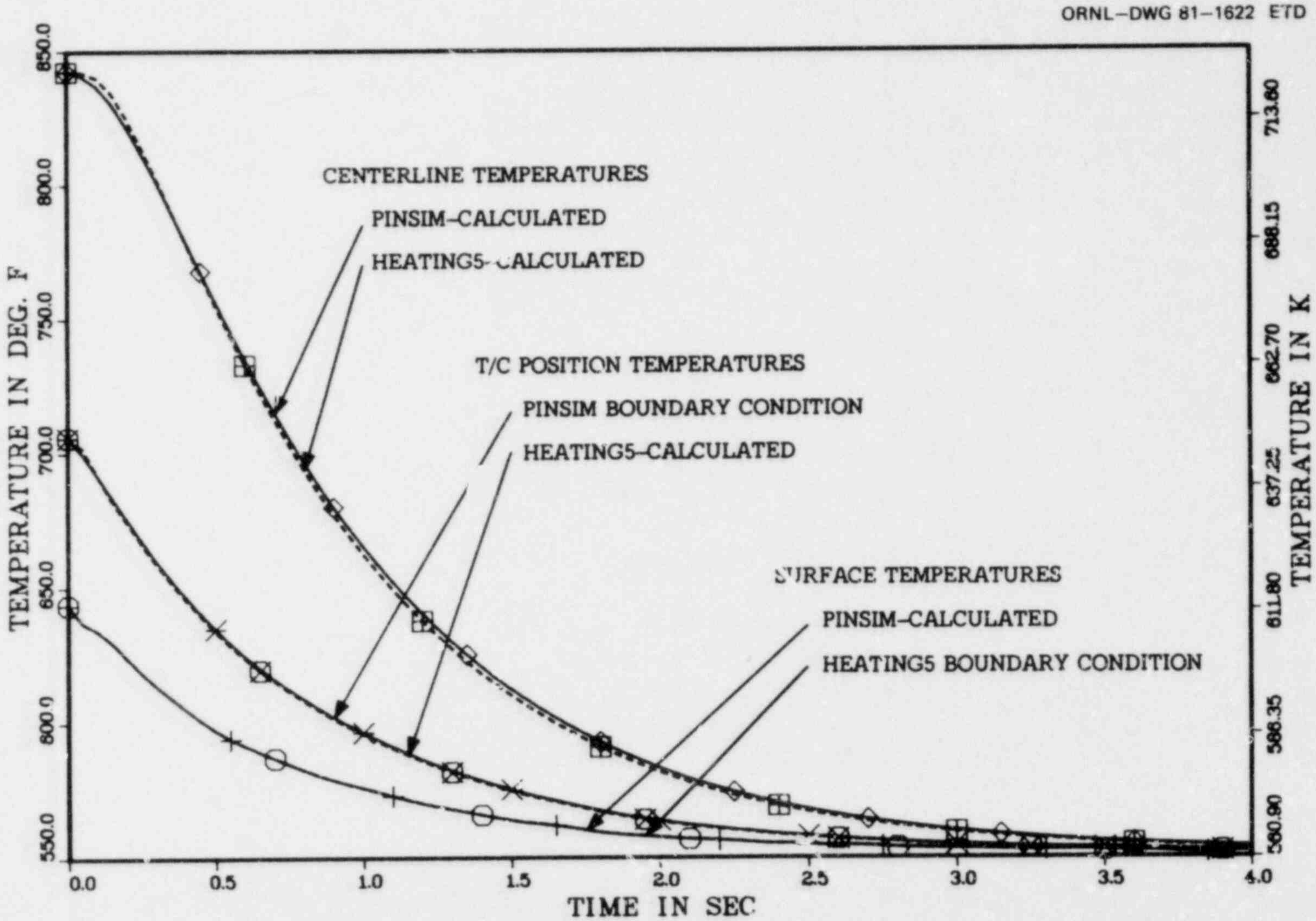

Fig. 9. Comparison of temperatures calculated by PINSIM with temperatures calculated by HEATING5.

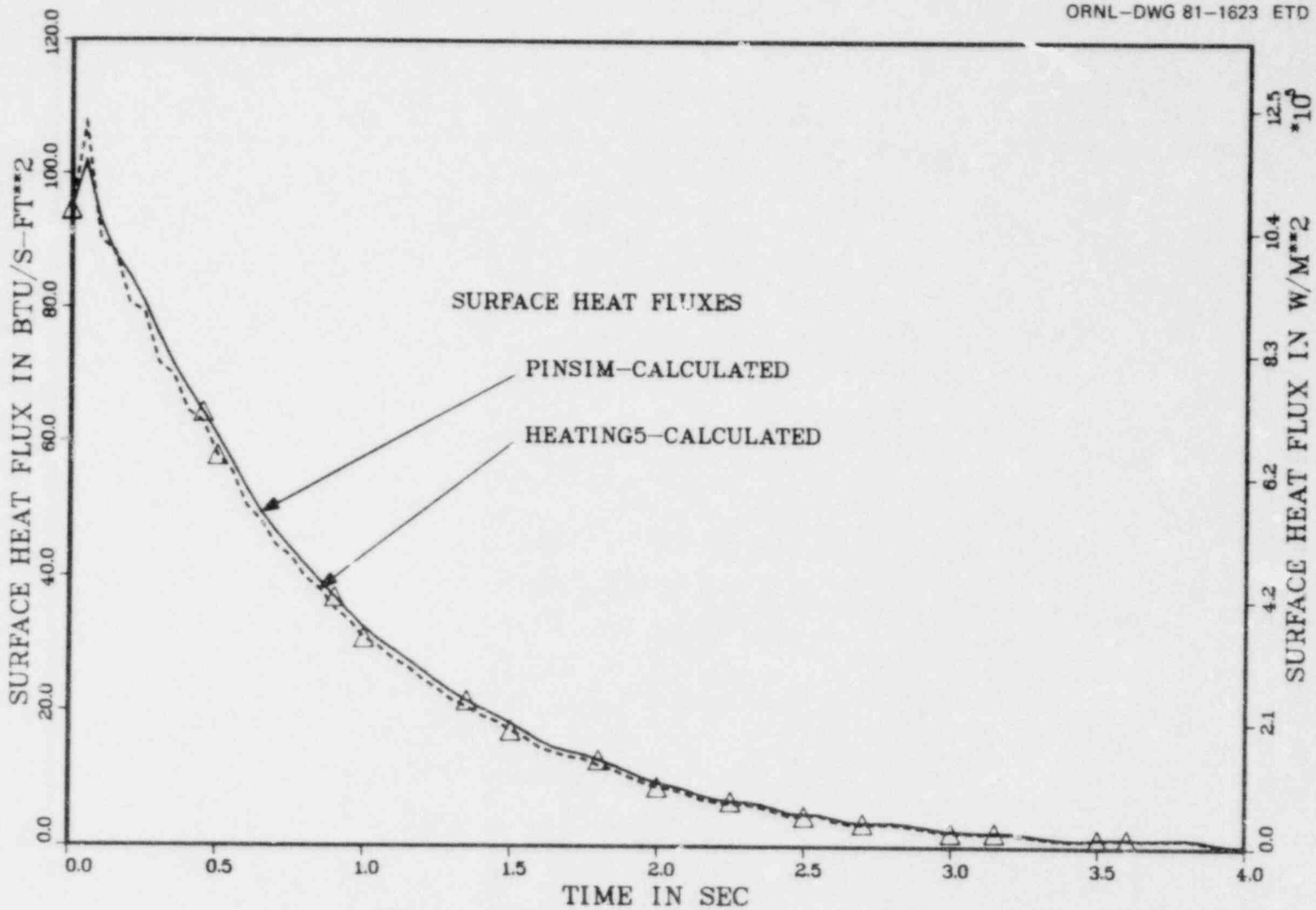

Fig. 10. Comparison of surface heat flux calculated by PINSIM with surface heat flux calculated by HEATING5.

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

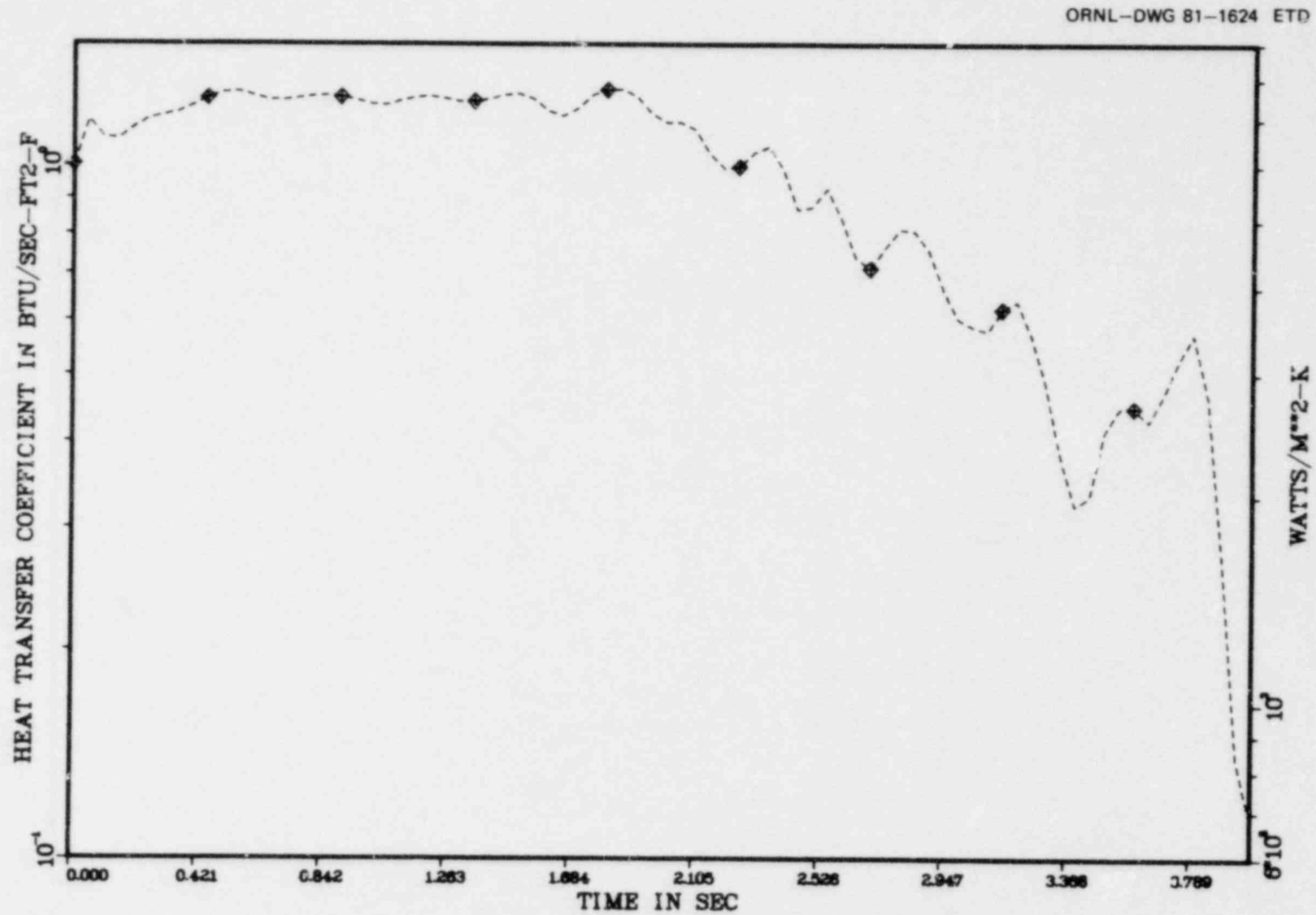

Fig. 11. Transient surface heat transfer coefficient boundary condition that was analytically determined.

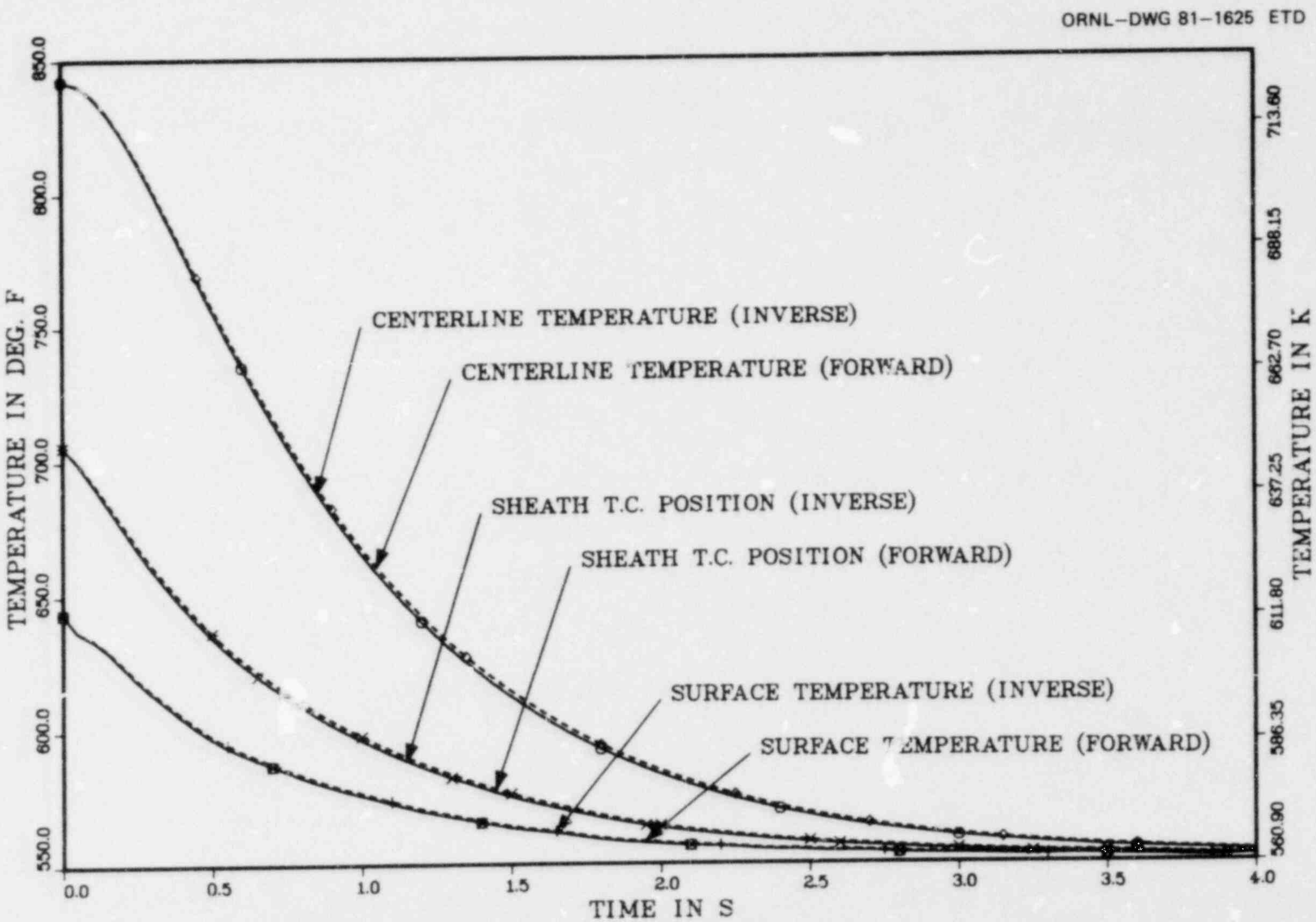

Fig. 12. Comparison of PINSIM-calculated inverse conduction problem solution results with the corresponding forward conduction problem solution results.

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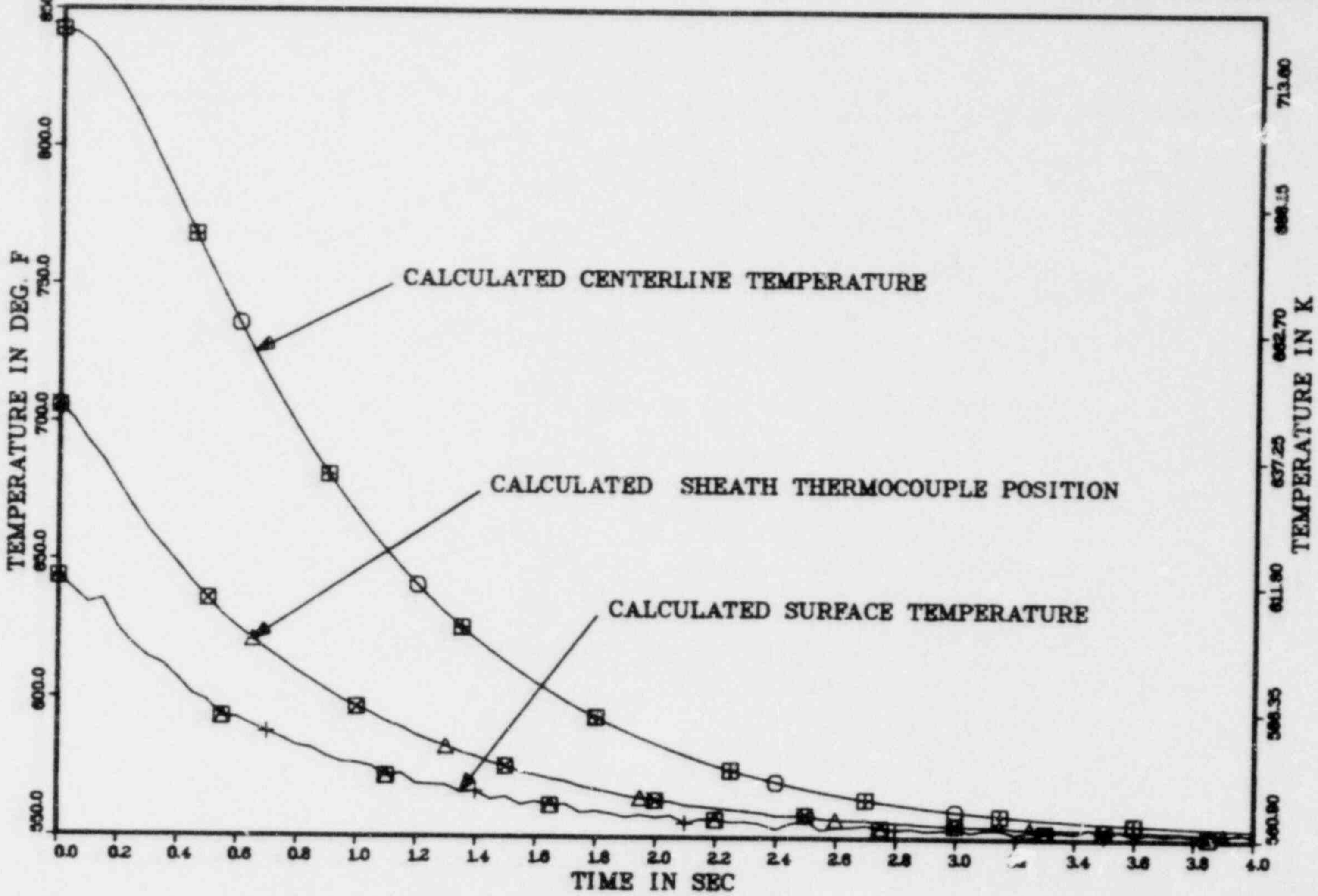

Fig. 13. Comparison of PINSIM-calculated inverse conduction problem solution results with the corresponding backward conduction problem solution results.

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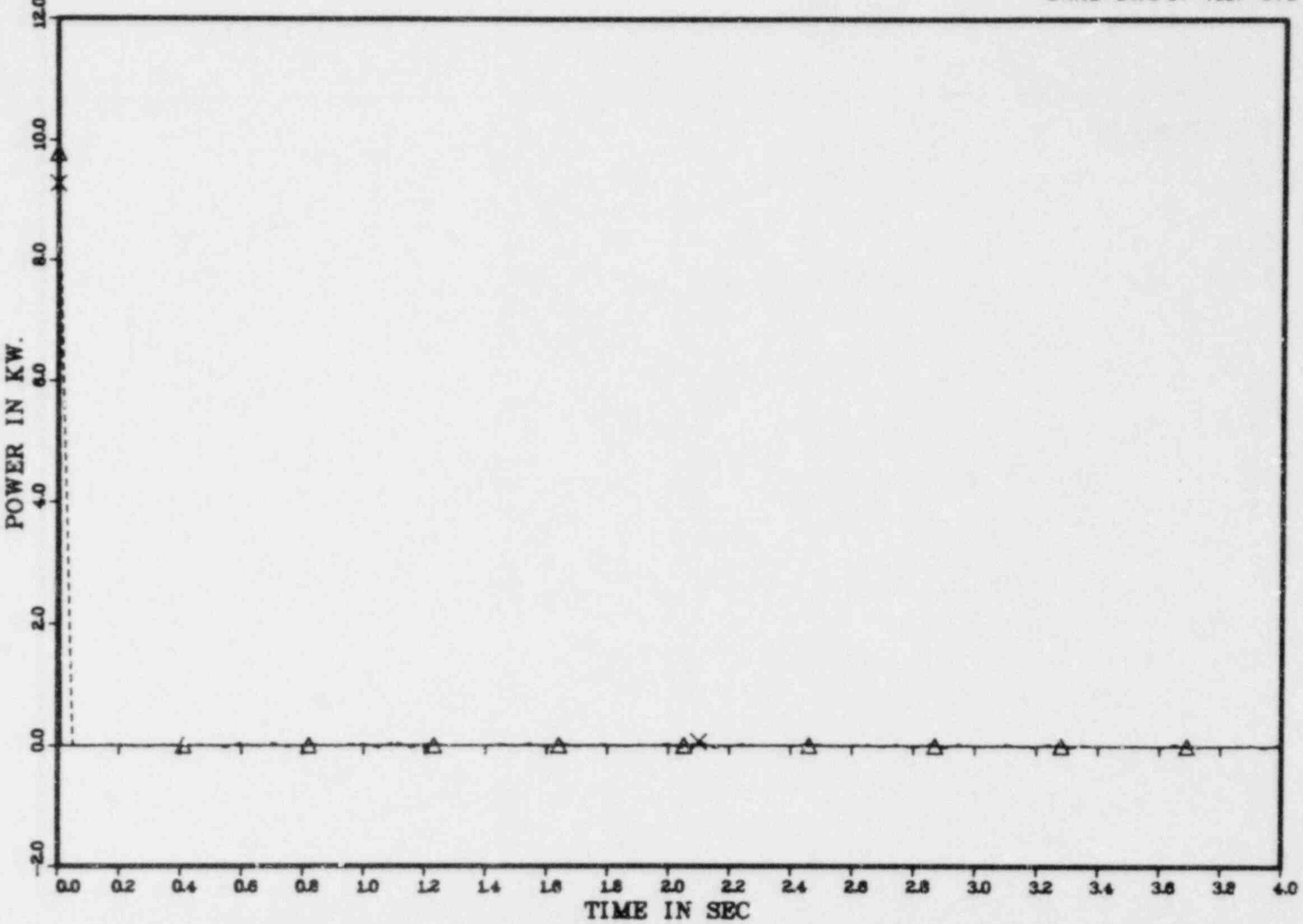

Fig. 14. Comparison (0 to 4 s, −2 to 12 kW) of original power transient (from power-drop test) with PINSIM-calculated power transient (from first backward conduction problem solution results).

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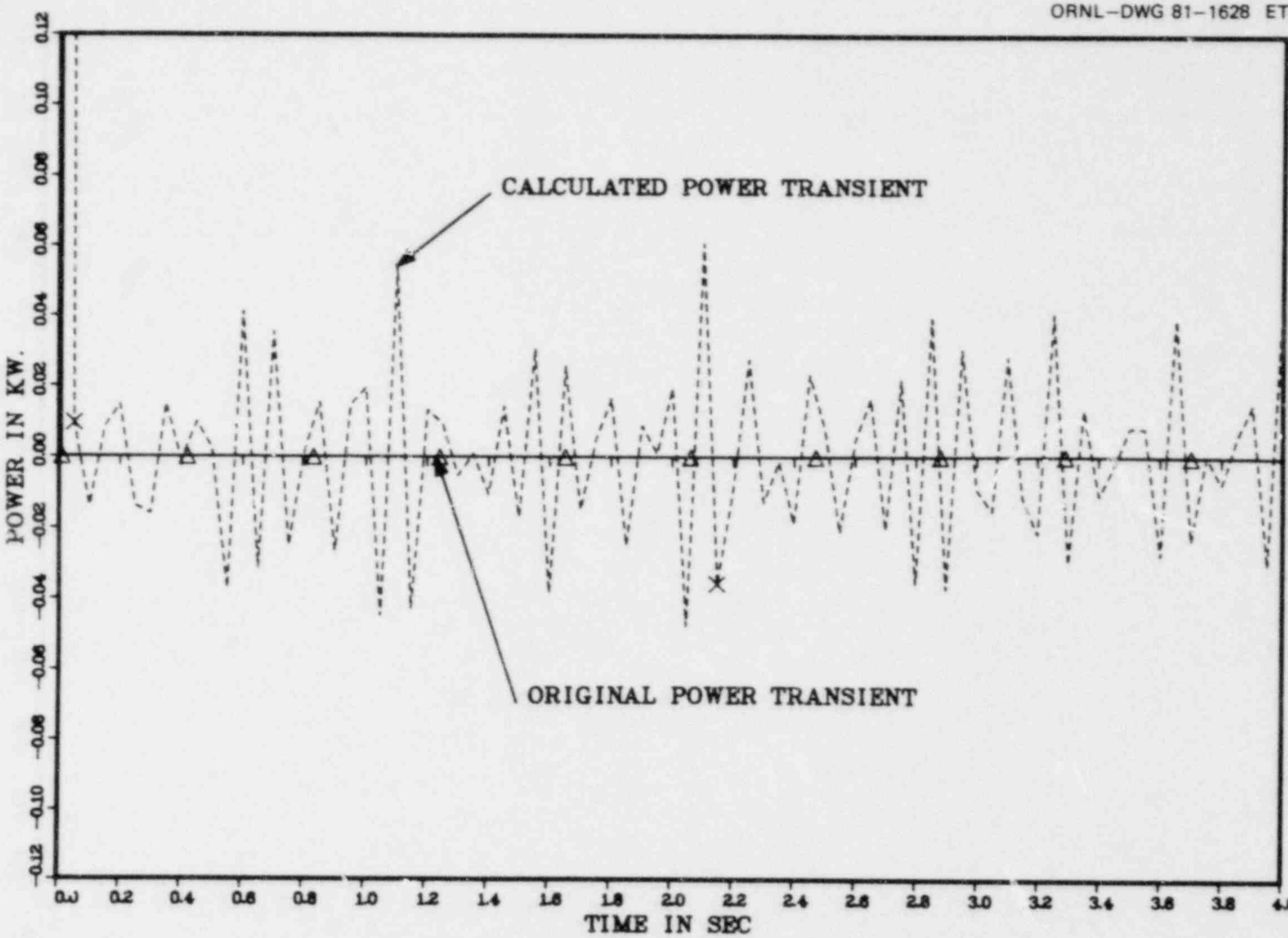

Fig. 15. Comparison (0 to 4 s, −0.1 to 0.1 kW) of original power transient (from power-drop test) with PINSIM-calculated power transient (from first backward conduction problem solution results).

ORNL-DWG 81-1629 ETD

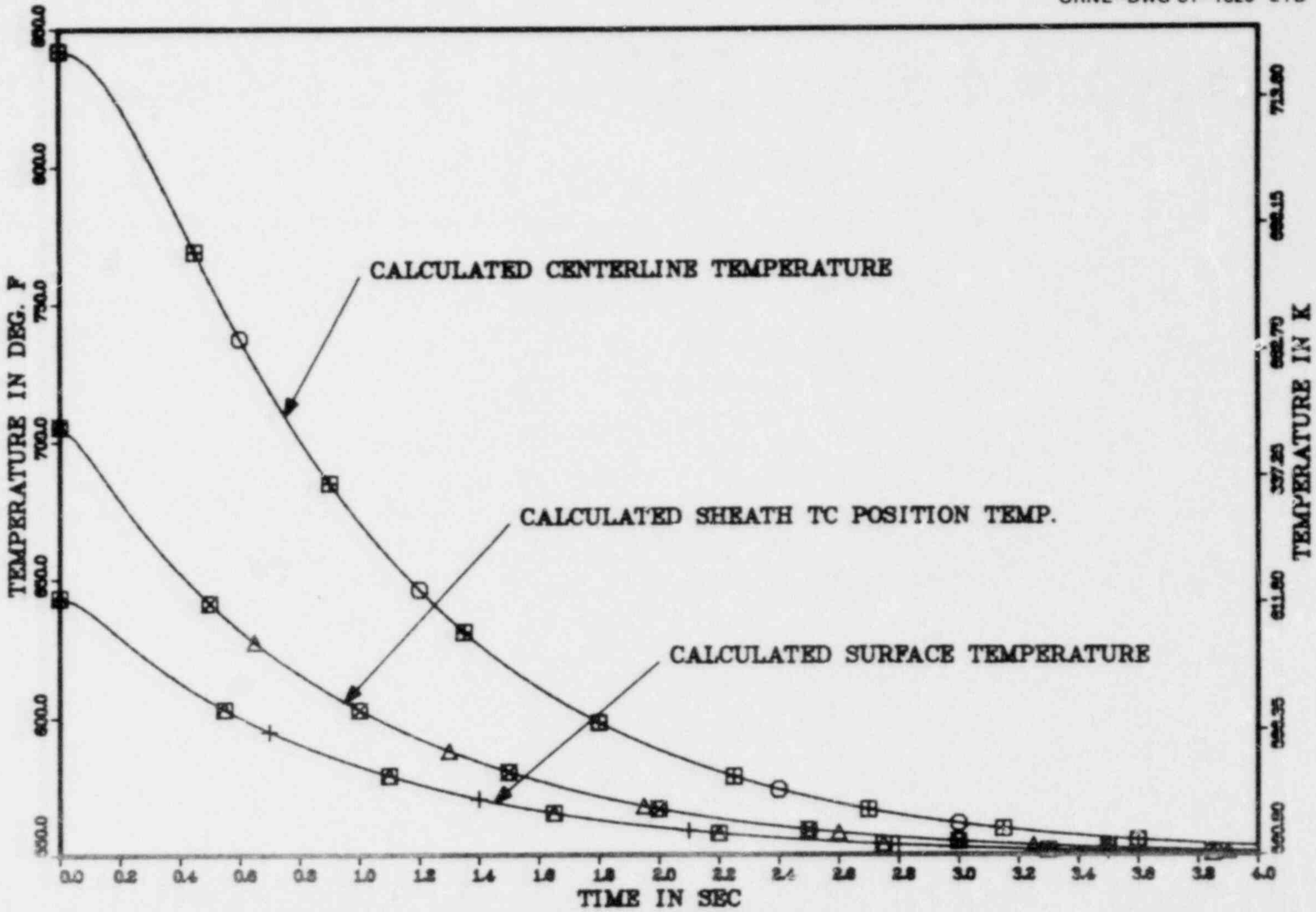

Fig. 16. Comparison of PINSIM-calculated forward conduction problem solution results with corresponding backward conduction problem solution results.

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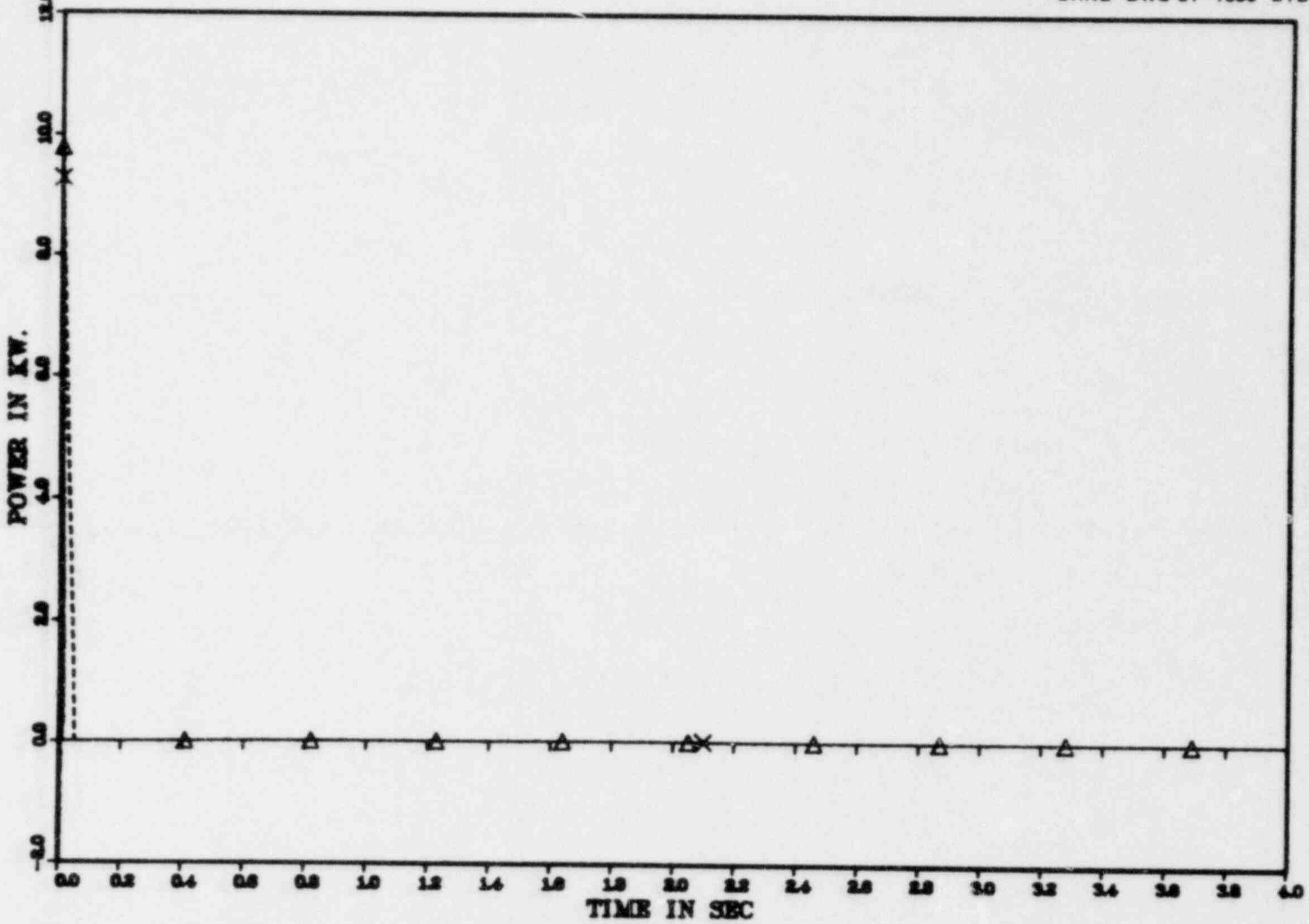

Fig. 17. Comparison (0 to 4 s, −2 to 12 kW) of original power transient (from power-drop test) with PINSIM-calculated power transient (from second backward conduction problem solution results).

ORNL–DWG 81–1631 ETD

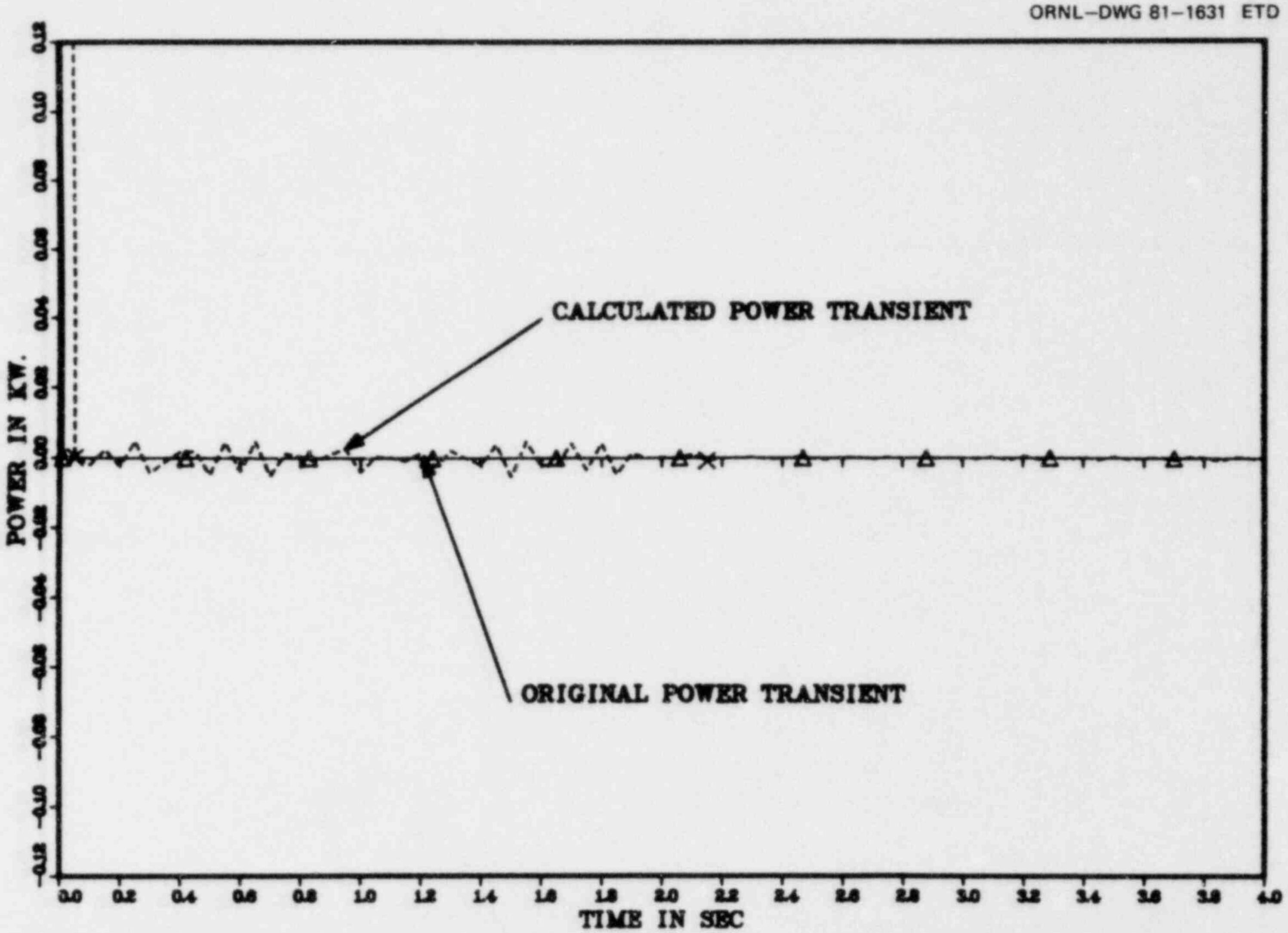

Fig. 18. Comparison (0 to 4 s, −0.1 to 0.1 kW) of original power transient (from power-drop test) with PINSIM-calculated power transient (from second backward conduction problem solution results).

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.

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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.

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PINSIM: A NUCLEAR FUEL PIN SIMULATOR-TRANSIENT ANALYSIS CODE. MOD 2        VERSION 002. 06/30/80        NO. 211 (PINMAN)   PAGE 0002

LISTING OF INPUT DATA FOR CASE  1

*******************************************************************PDJOB.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
*
*       MINCUT KMIN DELMIN
210000   8      1    0.0
*
*
*       MAJCUT KMAJ DELMAJ
220000   6      0    1.0
*
*         NPLT DELPLT
230000     0    0.0
*
*********************************************************END OF PDJOB.DAT*
*******************************************************************PDPIN.DAT*
*
* APPROXIMATE BUNDLE 3 DESIGN (AS DESCRIBED IN BDHT-2267)
*
*
* 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     PCVPA      ZLNGTH       NODMAT
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      * INNER 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-316
```

```
*
*****************************************************************************
* MATERIALS
*****************************************************************************
*
* MATERIAL 1 : BN3 (CORE)
*
*
419100   0   3   5000.
*
*  (THERMAL CONDUCTIVITY)
*
419110   0   0.0   2300.0
*
* (COEFFICIENTS WERE OBTAINED FROM L.J.OTT ON 3-2-80)
419111  21.286575    -0.0101365   0.0   0.0   0.0
*
*  (SPECIFIC HEAT CAPACITY)
*
419120   0   0.0   2300.0
*
419121     0.167812347  3.70264053D-04  -1.73793524D-07
+          3.14486215D-11   0.0
*
*  (DENSITY)
*
419130   -1   0.0   2300.0
*
*  (CORE BN3 DENSITY CORRECTED ON 6-MAY-80 TO CONFORM
*   TO BDHT-2404)
419131   138.3840
*
*
*  MATERIAL 2 : BN3 (ANNULUS)
*
*
419200   0   3   5000.
*
*  (THERMAL CONDUCTIVITY)
*
419210   0   0.0   2300.0
*
* (COEFFICIENTS WERE OBTAINED FROM L.J.OTT ON 3-2-80)
*
* (K COEFFS MODIFIED BY DGM ON 26-MAR-80 TO
*   IMPROVE INV RESULTS: INCREASE BOTH BY 1.104)
* 19211  15.56185    -0.36872E-02    0.0   0.0   0.0
419211  17.1853    -0.40719E-02    0.0   0.0   0.0
*
*  (SPECIFIC HEAT CAPACITY)
*
419220   0   0.0   2300.0
*
419221     0.167812347  3.70264053D-04  -1.73793524D-07
+          3.14486215D-11   0.0
*
*  (DENSITY)
*
```

```
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 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 S.$
 **      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	0.682450E+03
183	+	0.170000E+00	0.680790E+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	0.624520E+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	0.613150E+03
241	+	0.750000E+00	0.612510E+03
242	+	0.760000E+00	0.611650E+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	0.589450E+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	0.583450E+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	0.573280E+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	0.565250E+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	0.563080E+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	0.557420E+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	0.555030E+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	0.555030E+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	0.554590E+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	0.554590E+03
477	+	0.311000E+01	0.554590E+03
478	+	0.312000E+01	0.554590E+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	0.554160E+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   0.553250E+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
+   0.350000E+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   0.553070E+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   0.552850E+03
+   0.371000E+01   0.552850E+03
+   0.372000E+01   0.552850E+03
+   0.373000E+01   0.552630E+03
+   0.374000E+01   0.552850E+03
+   0.375000E+01   0.552850E+03
+   0.376000E+01   0.552850E+03
+   0.377000E+01   0.552850E+03
+   0.378000E+01   0.552850E+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  LI  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
```

```
 +    0.400000E+00    0.0000E+00
 +    0.500000E+00    0.0000E+00
 +    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 PUQA.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 )
CARD ABOVE IS REPLACEMENT CARD.
********************************************************************************
*
```

----- 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  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:  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)

```
------------------------------------------------ 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 = 4.0000000D 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	5.0000000D-02	5.0000000D-02	2

OUTPUT CONTROL

	ELAPSED NO. OF TIME STEPS	ELPASED TIME	ROUTED TO DEVICE NO.
MAJOR EDIT	0	0.1000000D 01	6
MINOR EDIT	1	0.0	8
PLOT RECORD	0	0.0	1

PROBLEM CONVERGENCE CRITERIA

TEMPERATURE CONVERGENCE FACTOR	0.1000000D-07
ENERGY CONVERGENCE FACTOR	0.1000000D-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	0.1000000D 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

1

----- 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	0.9276960 01	0.1000000-01	0.0	0.5000000-01	0.0	0.1000000 00	0.0
0.2000000 00	0.0	0.3000000 00	0.0	0.4000000 00	0.0	0.5000000 00	0.0
0.6000000 00	0.0	0.7000000 00	0.0	0.8000000 00	0.0	0.9000000 00	0.0
0.1000000 01	0.0	0.2000000 01	0.0	0.3000000 01	0.0	0.4000000 01	0.0
0.5000000 01	0.0	0.6000000 01	0.0	0.7000000 01	0.0	0.8000000 01	0.0
0.9000000 01	0.0	0.1000000 02	0.0				

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

TIME (SEC.)	TEMPERATURE (F)	TIME (SEC.)	TEMPERATURE (F)	TIME (SEC.)	TEMPERATURE (F)	TIME (SEC.)	TEMPERATURE (F)
0.0	0.7058100D 03	0.1000000D-01	0.7044700D 03	0.2000000D-01	0.7038100D 03	0.3000000D-01	0.7025000D 03
0.4000000D-01	0.7014200D 03	0.5000000D-01	0.7003400D 03	0.6000000D-01	0.6988300D 03	0.7000000D-01	0.6975400D 03
0.8000000D-01	0.6958200D 03	0.9000000D-01	0.6940900D 03	0.1000000D 00	0.6923700D 03	0.1100000D 00	0.6906500D 03
0.1200000D 00	0.6889300D 03	0.1300000D 00	0.6874300D 03	0.1400000D 00	0.6859300D 03	0.1500000D 00	0.6842100D 03
0.1600000D 00	0.6824900D 03	0.1700000D 00	0.6807800D 03	0.1800000D 00	0.6790600D 03	0.1900000D 00	0.6771300D 03
0.2000000D 00	0.6754200D 03	0.2100000D 00	0.6737100D 03	0.2200000D 00	0.6717800D 03	0.2300000D 00	0.6700700D 03
0.2400000D 00	0.6685700D 03	0.2500000D 00	0.6668600D 03	0.2600000D 00	0.6653600D 03	0.2700000D 00	0.6638600D 03
0.2800000D 00	0.6623700D 03	0.2900000D 00	0.6608700D 03	0.3000000D 00	0.6595900D 03	0.3100000D 00	0.6583100D 03
0.3200000D 00	0.6570200D 03	0.3300000D 00	0.6557400D 03	0.3400000D 00	0.6544600D 03	0.3500000D 00	0.6531600D 03
0.3600000D 00	0.6518900D 03	0.3700000D 00	0.6506100D 03	0.3800000D 00	0.6493300D 03	0.3900000D 00	0.6480500D 03
0.4000000D 00	0.6467600D 03	0.4100000D 00	0.6452700D 03	0.4200000D 00	0.6439800D 03	0.4300000D 00	0.6427000D 03
0.4400000D 00	0.6414200D 03	0.4500000D 00	0.6401400D 03	0.4600000D 00	0.6390700D 03	0.4700000D 00	0.6380000D 03
0.4800000D 00	0.6365300D 03	0.4900000D 00	0.6358600D 03	0.5000000D 00	0.6347900D 03	0.5100000D 00	0.6335100D 03
0.5200000D 00	0.6324400D 03	0.5300000D 00	0.6311500D 03	0.5400000D 00	0.6298700D 03	0.5500000D 00	0.6288000D 03
0.5600000D 00	0.6275400D 03	0.5700000D 00	0.6268700D 03	0.5800000D 00	0.6260200D 03	0.5900000D 00	0.6253700D 03
0.6000000D 00	0.6245200D 03	0.6100000D 00	0.6236600D 03	0.6200000D 00	0.6228000D 03	0.6300000D 00	0.6219500D 03
0.6400000D 00	0.6210900D 03	0.6500000D 00	0.6202300D 03	0.6600000D 00	0.6193700D 03	0.6700000D 00	0.6187300D 03
0.6800000D 00	0.6178700D 03	0.6900000D 00	0.6170200D 03	0.7000000D 00	0.6161600D 03	0.7100000D 00	0.6155100D 03
0.7200000D 00	0.6146600D 03	0.7300000D 00	0.6140100D 03	0.7400000D 00	0.6131500D 03	0.7500000D 00	0.6125100D 03
0.7600000D 00	0.6116500D 03	0.7700000D 00	0.6105800D 03	0.7800000D 00	0.6099400D 03	0.7900000D 00	0.6092900D 03
0.8000000D 00	0.6086500D 03	0.8100000D 00	0.6089000D 03	0.8200000D 00	0.6075700D .3	0.8300000D 00	0.6067100D 03
0.8400000D 00	0.6060700D 03	0.8500000D 00	0.6052100D 03	0.8600000D 00	0.6043500D 03	0.8700000D 00	0.6037000D 03
0.8800000D 00	0.6030600D 03	0.8900000D 00	0.6026300D 03	0.9000000D 00	0.6019800D 03	0.9100000D 00	0.6015500D 03
0.9200000D 00	0.6009100D 03	0.9300000D 00	0.5002600D 03	0.9400000D 00	0.5994000D 03	0.9500000D 00	0.5989700D 03
0.9600000D 00	0.5983300D 03	0.9700000D 00	0.5976800D 03	0.9800000D 00	0.5972500D 03	0.9900000D 00	0.5968200D 03
0.1000000D 01	0.5961700D 03	0.1010000D 01	0.5957400D 03	0.1020000D 01	0.5953100D 03	0.1030000D 01	0.5948800D 03
0.1040000D 01	0.5944500D 03	0.1050000D 01	0.5940200D 03	0.1060000D 01	0.5933700D 03	0.1070000D 01	0.5929400D 03
0.1080000D 01	0.5920800D 03	0.1090000D 01	0.5914300D 03	0.1100000D 01	0.5910000D 03	0.1110000D 01	0.5905700D 03
0.1120000D 01	0.5901400D 03	0.1130000D 01	0.5899200D 03	0.1140000D 01	0.5894900D 03	0.1150000D 01	0.5888400D 03
0.1160000D 01	0.5882000D 03	0.1170000D 01	0.5875500D 03	0.1180000D 01	0.5871200D 03	0.1190000D 01	0.5866900D 03
0.1200000D 01	0.5862500D 03	0.1210000D 01	0.5860400D 03	0.1220000D 01	0.5856100D 03	0.1230000D 01	0.5849600D 03
0.1240000D 01	0.5845300D 03	0.1250000D 01	0.5840900D 03	0.1260000D 01	0.5836600D 03	0.1270000D 01	0.5834500D 03
0.1280000D 01	0.5832300D 03	0.1290000D 01	0.5828000D 03	0.1300000D 01	0.5823700D 03	0.1310000D 01	0.5819300D 03
0.1320000D 01	0.5815000D 03	0.1330000D 01	0.5810700D 03	0.1340000D 01	0.5806400D 03	0.1350000D 01	0.5804200D 03
0.1360000D 01	0.5799900D 03	0.1370000D 01	0.5795500D 03	0.1380000D 01	0.5793400D 03	0.1390000D 01	0.5791200D 03
0.1400000D 01	0.5786900D 03	0.1410000D 01	0.5784700D 03	0.1420000D 01	0.5780400D 03	0.1430000D 01	0.5773900D 03
0.1440000D 01	0.5769600D 03	0.1450000D 01	0.5767400D 03	0.1460000D 01	0.5765300D 03	0.1470000D 01	0.5763100D 03
0.1480000D 01	0.5760900D 03	0.1490000D 01	0.5756600D 03	0.1500000D 01	0.5752300D 03	0.1510000D 01	0.5747900D 03
0.1520000D 01	0.5743600D 03	0.1530000D 01	0.5739300D 03	0.1540000D 01	[illegible]	0.1550000D 01	0.5734900D 03
0.1560000D 01	0.5732800D 03	0.1570000D 01	0.5730600D 03	0.1580000D 01	0.5728400D 03	0.1590000D 01	0.5726300D 03
0.1600000D 01	0.5724100D 03	0.1610000D 01	0.5719800D 03	0.1620000D 01	0.5717600D 03	0.1630000D 01	0.5715400D 03
0.1640000D 01	0.5713300D 03	0.1650000D 01	0.5711100D 03	0.1660000D 01	0.5711100D 03	0.1670000D 01	0.5708900D 03
0.1680000D 01	0.5706800D 03	0.1690000D 01	0.5704600D 03	0.1700000D 01	0.5700300D 03	0.1710000D 01	0.5695900D 03
0.1720000D 01	0.5693700D 03	0.1730000D 01	0.5691600D 03	0.1740000D 01	0.5687200D 03	0.1750000D 01	0.5685100D 03
0.1760000D 01	0.5682900D 03	0.1770000D 01	0.5678600D 03	0.1780000D 01	0.5676400D 03	0.1790000D 01	0.5676400D 03
0.1800000D 01	0.5674200D 03	0.1810000D 01	0.5672000D 03	0.1820000D 01	0.5672000D 03	0.1830000D 01	0.5669900D 03
0.1840000D 01	0.5665500D 03	0.1850000D 01	0.5663400D 03	0.1860000D 01	0.5659000D 03	0.1870000D 01	0.5656900D 03
0.1880000D 01	0.5654700D 03	0.1890000D 01	0.5652500D 03	0.1900000D 01	0.5650300D 03	0.1910000D 01	0.5650300D 03
0.1920000D 01	0.5648200D 03	0.1930000D 01	0.5646000D 03	0.1940000D 01	0.5646000D 03	0.1950000D 01	0.5646000D 03
0.1960000D 01	0.5643800D 03	0.1970000D 01	0.5639500D 03	0.1980000D 01	0.5639500D 03	0.1990000D 01	0.5637300D 03

PINSIM: A NUCLEAR FUEL PIN SIMULATOR-TRANSIENT ANALYSIS CODE, MOD 2 VERSION 002, 06/30/80 NO. 211 (PINMAN) PAGE 0021
PINSIM VERIFICATION STUDY PROBLEM : POWER-DROP TEST SIMULATION 07/16/80

0.2000000D 01	0.5635100D 03	0.2010000D 01	0.5635100D 03	0.2020000D 01	0.5637300D 03	0.2030000D 01	0.5635100D 03
0.2040000D 01	0.5633000D 03	0.2050000D 01	0.5630800D 03	0.2060000D 01	0.5626400D 03	0.20[illegible]0000D 01	0.5622[illegible]0D 03
0.2080000D 01	0.5619900D 03	0.2090000D 01	0.5619900D 03	0.2100000D 01	0.5617700D 03	0.2110000D 01	0.5617700D 03
0.2120000D 01	0.5617700D 03	0.2130000D 01	0.5617700D 03	0.2140000D 01	0.5615600D 03	0.2150000D 01	0.5615600D 03
0.2160000D 01	0.5613400D 03	0.2170000D 01	0.5611200D 03	0.2180000D 01	0.5611200D 03	0.2190000D 01	0.5611200D 03
0.2200000D 01	0.5609000D 03	0.2210000D 01	0.5609000D 03	0.2220000D 01	0.5609000D 03	0.2230000D 01	0.5606900D 03
0.2240000D 01	0.5604700D 03	0.2250000D 01	0.5604700D 03	0.2260000D 01	0.5604700D 03	0.2270000D 01	0.5602500D 03
0.2280000D 01	0.5600300D 03	0.2290000D 01	0.5600300D 03	0.2300000D 01	0.5598200D 03	0.2310000D 01	0.5596000D 03
0.2320000D 01	0.5596000D 03	0.2330000D 01	0.5596000D 03	0.2340000D 01	0.5593800D 03	0.2350000D 01	0.5591600D 03
0.2360000D 01	0.5589500D 03	0.2370000D 01	0.5587300D 03	0.2380000D 01	0.5585100D 03	0.2390000D 01	0.5582900D 03
0.2400000D 01	0.5582900D 03	0.2410000D 01	0.5582900D 03	0.2420000D 01	0.5582900D 03	0.2430000D 01	0.5582900D 03
0.2440000D 01	0.5582900D 03	0.2450000D 01	0.5585100D 03	0.2460000D 01	0.5585100D 03	0.2470000D 01	0.5585100D 03
0.2480000D 01	0.5585100D 03	0.2490000D 01	0.5585100D 03	0.2500000D 01	0.5582900D 03	0.2510000D 01	0.5580800D 03
0.2520000D 01	0.5578600D 03	0.2530000D 01	0.5576400D 03	0.2540000D 01	0.5574200D 03	0.2550000D 01	0.5572100D 03
0.2560000D 01	0.5569900D 03	0.2570000D 01	0.5567700D 03	0.2580000D 01	0.5567700D 02	0.2590000D 01	0.5569900D 03
0.2600000D 01	0.5569900D 03	0.2610000D 01	0.5572100D 03	0.2620000D 01	0.5572100D 03	0.2630000D 01	0.5569900D 03
0.2640000D 01	0.5567700D 03	0.2650000D 01	0.5567700D 03	0.2660000D 01	0.5565500D 03	0.2670000D 01	0.5565500D 03
0.2680000D 01	0.5567700D 03	0.2690000D 01	0.5567700D 03	0.2700000D 01	0.5567700D 03	0.2710000D 01	0.5567700D 03
0.2720000D 01	0.5567700D 03	0.2730000D 01	0.5565500D 03	0.2740000D 01	0.5563400D 03	0.2750000D 01	0.5561200D 03
0.2760000D 01	0.5561200D 03	0.2770000D 01	0.5561200D 03	0.2780000D 01	0.5559000D 03	0.2790000D 01	0.5559000D 03
0.2800000D 01	0.5559000D 03	0.2810000D 01	0.5559000D 03	0.2820000D 01	0.5556800D 03	0.2830000D 01	0.5556800D 03
0.2840000D 01	0.5556800D 03	0.2850000D 01	0.5554600D 03	0.2860000D 01	0.5554600D 03	0.2870000D 01	0.5554600D 03
0.2880000D 01	0.5554600D 03	0.2890000D 01	0.5552500D 03	0.2900000D 01	0.5552500D 03	0.2910000D 01	0.5550300D 03
0.2920000D 01	0.5550300D 03	0.2930000D 01	0.5550300D 03	0.2940000D 01	0.5550300D 03	0.2950000D 01	0.5550300D 03
0.2960000D 01	0.5550300D 03	0.2970000D 01	0.5550300D 03	0.2980000D 01	0.5550300D 03	0.2990000D 01	0.5550300D 03
0.3000000D 01	0.5550300D 03	0.3010000D 01	0.5550300D 03	0.3020000D 01	0.5548100D 03	0.3030000D 01	0.5545900D 03
0.3040000D 01	0.5545900D 03	0.3050000D 01	0.5545900D 03	0.3060000D 01	0.5545900D 0[illegible]	0.3070000D 01	0.5545900D 03
0.3080000D 01	0.5545900D 03	0.3090000D 01	0.5545900D 03	0.3100000D 01	0.5545900D 03	0.3110000D 01	0.5545900D 03
0.3120000D 01	0.5545900D 03	0.3130000D 01	0.5545900D 03	0.3140000D 01	0.5545900D 03	0.3150000D 01	0.5543800D 03
0.3160000D 01	0.5541600D 03	0.3170000D 01	0.5541600D 03	0.3180000D 01	0.5541600D 03	0.3190000D 01	0.5539400D 03
0.3200000D 01	0.5539400D 03	0.3210000D 01	0.5539400D 03	0.3220000D 01	0.5539400D 03	0.3230000D 01	0.5539400D 03
0.3240000D 01	0.5539400D 03	0.3250000D 01	0.5539400D 03	0.3260000D 01	0.5539400D 03	0.3270000D 01	0.5539400D 03
0.3280000D 01	0.5537200D 03	0.3290000D 01	0.5537200D 03	0.3300000D 01	0.5537200D 03	0.3310000D 01	0.5537200D 03
0.3320000D 01	0.5535000D 03	0.3330000D 01	0.5537200D 03	0.3340000D 01	0.5537200D 03	0.3350000D 01	0.5537200D 03
0.3360000D 01	0.5537200D 03	0.3370000D 01	0.5537200D 03	0.3380000D 01	0.5535000D 03	0.3390000D 01	0.5535000D 03
0.3400000D 01	0.5535000D 03	0.3410000D 01	0.5535000D 03	0.3420000D 01	0.5537200D 03	0.3430000D 01	0.5539400D 03
0.3440000D 01	0.5539400D 03	0.3450000D 01	0.5539400D 03	0.3460000D 01	0.5537200D 03	0.3470000D 01	0.5535000D 03
0.3480000D 01	0.5532900D 03	0.3490000D 01	0.5532900D 03	0.3500000D 01	0.5532900D 03	0.3510000D 01	0.5535000D 03
0.3520000D 01	0.5535000D 03	0.3530000D 01	0.5535000D 03	0.3540000D 01	0.5535000D 03	0.3550000D 01	0.5532900D 03
0.3560000D 01	0.5530700D 03	0.3570000D 01	0.5530700D 03	0.3580000D 01	0.5530700D 03	0.3590000D 01	0.5530700D 03
0.3600000D 01	0.5530700D 03	0.3610000D 01	0.5530700D 03	0.3620000D 01	0.5530700D 03	0.3630000D 01	0.5530700D 03
0.3640000D 01	0.5530700D 03	0.3650000D 01	0.5530700D 03	0.3660000D 01	0.5530700D 03	0.3670000D 01	0.5530700D 03
0.3680000D 01	0.5530700D 03	0.3690000D 01	0.5528500D 03	0.3700000D 01	0.5528500D 03	0.3710000D 01	0.5528500D 03
0.3720000D 01	0.5528500D 03	0.3730000D 01	0.5526300D 03	0.3740000D 01	0.5528500D 03	0.3750000D 01	0.5528500D 03
0.3760000D 01	0.5528500D 03	0.3770000D 01	0.5528500D 03	0.3780000D 01	0.5528500D 03	0.3790000D 01	0.5526300D 03
0.3800000D 01	0.5524100D 03	0.3810000D 01	0.5524100D 03	0.3820000D 01	0.5522000D 03	0.3830000D 01	0.5522000D 03
0.3[illegible]0000D 01	0.5522000D 03	0.3850000D 01	0.5524100D 03	0.3860000D 01	0.5524100D 03	0.3870000D 01	0.5524100D 03
0.3880000D 01	0.5524100D 03	0.3890000D 01	0.5522000D 03	0.3900000D 01	0.5522000D 03	0.3910000D 01	0.5522000D 03
0.3920000D 01	0.5524100D 03	0.3930000D 01	0.5524100D 03	0.3940000D 01	0.5526300D 03	0.3950000D 01	0.5526300D 03
0.3960000D 01	0.5526300D 03	0.3970000D 01	0.5524100D 03	0.3980000D 01	0.5524100D 03	0.3990000D 01	0.5524100D 03
0.4000000D 01	0.5524100D 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	0.1000000 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
	0.979655D-01	1.000	1.0000	0	5	19

PINSIM: A NUCLEAR FUEL PIN SIMULATOR-TRANSIENT ANALYSIS CODE, MOD 2 VERSION 002, 06/30/80 NO. 211 (PINMAN) PAGE 0024
PINSIM VERIFICATION STUDY PROBLEM : POWER-DROP TEST SIMULATION 07/16/80

----- 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	0.8116[illegible]-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	0.105929D-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	16

LEVEL BOUNDARY CONDITIONS

	UNFILTERED	FILTERED
POWER (KW)	0.9276960 01	0.9276960 01
HEAT TRANSFER COEFFICIENT (BTU/SEC-FT2-F)	0.0	
TEMPERATURE (DEG. F)	0.7058100 03	0.7058100 03

INVERSE CALCULATION

CALCULATED RESULTS

SURFACE HEAT FLUX (BTU/SEC-FT2)	0.9469620 02
SURFACE TEMPERATURE (DEG. F)	0.6435950 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	0.9276960 01	0.9276960 01	0.9465620 02	0.8422540 03	0.8292700 03	0.6435950 03	0.7058100 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

PINSIM: A NUCLEAR FUEL PIN SIMULATOR-TRANSIENT ANALYSIS CODE. MOD 2 VERS ON 002. 06/30/80 NO. 211 (PINMAN) PAGE 0037
PINSIM VERIFICATION STUDY PROBLEM : POWER-DROP TEST SIMULATION 07/16/80

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	2	13	14	15	16	17	18	19
1	803.82	7[illegible].45	758.00	738.85	721.56	70[illegible].81	686.51	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)

	NODE									
LEVEL NO	1	2	3	4	5	6	7	8	9	10
1	0.72470 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

	NODE								
LEVEL NO	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

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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	652.03
0.5000000D-01	100.59	637.80	0.0	840.83	838.40	836.20	700.34	646.76
0.1000000D 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	612.51	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	583.42
0.900000	36.130	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	33.516	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	570.42
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	625.57	620.48	617.59	580.42	568.32
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	565.66
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	13.516	561.21	0.0	598.93	595.70	593.87	570.03	562.4[illegible]
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

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TIME(SEC)	SRF HT FLUX B/S-FT2 (1, 1)	SURF TEMP DFG 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, 1,10)	NODAL TEMP (DEG F) (1, 1,19)
2.00000	11.699	556.65	0.0	583.61	581.61	580.15	563.51	557.74
2.05000	7.0462	557.92	0.0	581.56	579.50	578.33	563.06	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	577.63	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	6.5580	556.34	0.0	574.56	572.99	572.09	560.47	556.90
2.30000	7.1653	555.45	0.0	573.09	571.62	570.79	559.62	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	5.4839	556.38	0.0	569.20	568.00	567.31	558.51	556.51
2.50000	4.5529	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	554.67
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	553.69
2.80000	2.6366	553.91	0.0	562.67	561.93	561.51	555.98	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	553.95
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	554.55	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	0.76565	553.04	0.0	557.71	557.30	557.01	553.94	553.12
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	551.84
3.55000	0.83821E-01	552.76	0.0	555.73	555.47	555.32	553.29	552.77
3.60000	1.5539	552.05	0.0	555.48	555.23	555.09	553.07	552.23
3.65000	0.48355	552.55	0.0	555.24	555.00	554.87	553.07	552.10
3.70000	1.8450	551.90	0.0	555.01	554.79	554.66	552.85	552.08
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

```
*****************************************************************PDJOB.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 PDJOB.DAT*
****************************************************************PDPIN.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    PCVPA      ZLNGTH       NODWAT
410100     5        1.0       1.000          0
*
*             RINREG      ROTREG      FOVP   NNOD  MATREG
410101     0.0          0.0023417   0.0     1      1     * T/C BUNDLE
410102     0.0023417    0.009075    0.0     7      1     * INNER 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-316
```

```
*
******************************************************************************
* MATERIALS
******************************************************************************
*
* MATERIAL 1 : BN3 (CORE)
*
*
419100   0   3   5000.
*
*  (THERMAL CONDUCTIVITY)
*
419110   0   0.0   2300.0
*
* (COEFFICIENTS WERE OBTAINED FROM L.J.OTT ON 3-2-80)
419111  21.286575    -0.0101369   0.0   0.0   0.0
*
*  (SPECIFIC HEAT CAPACITY)
*
419120   0   0.0   2300.0
*
419121      0.167812347  3.702640530-04  -1.737935240-07
+           3.144862150-11   0.0
*
*  (DENSITY)
*
419130   -1   0.0   2300.0
*
*  (CORE BN3 DENSITY CORRECTED ON 6-MAY-80 TO CONFORM
*   TO BDHT-2404)
419131   138.3840
*
*
*  MATERIAL 2 : BN3 (ANNULUS)
*
*
419200   0   3   5000.
*
*  (THERMAL CONDUCTIVITY)
*
419210   0   0.0   2300.0
*
* (COEFFICIENTS WERE OBTAINED FROM L.J.OTT ON 3-2-80)
*
* (K COEFFS MODIFIED BY DGM ON 26-MAR-80 TO
*  IMPROVE INV RESULTS: INCREASE BOTH BY 1.104)
*419211  15.56185    -0.36872E-02    0.0   0.0   0.0
419211  17.1853    -0.40719E-02    0.0   0.0   0.0
*
*  (SPECIFIC HEAT CAPACITY)
*
419220   0   0.0   2300.0
*
419221      0.167812347  3.702640530-04  -1.737935240-07
+           3.144862150-11    0.0
*
*  (DENSITY)
*
```

```
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 PDPIN.DAT*
****************************************************************PDSYS.FWD*
*
* SYSTEM INPUT : FORWARD 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      0     20    0  -20   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.FWD*
***************************************************************PDBT.DAT**
**    TIME IN S.$
**   TEMPERATURE IN F$
**     0.100000E+01  TIME IN S.$
**     0.100000E+01  T BULK$
500141
 +   0.000000E+00     0.5494E+03
 +   0.100000E-01     0.5494E+03
 +   0.500000E-01     0.5494E+03
 +   0.100000E+00     0.5494E+03
 +   0.200000E+00     0.5494E+03
 +   0.300000E+00     0.5494E+03
 +   0.400000E+00     0.5494E+03
```

```
 +   0.500000E+00    0.5494E+03
 +   0.600000E+00    0.5494E+02
 +   0.700000E+00    0.5494E+03
 +   0.800000E+00    0.5494E+03
 +   0.900000E+.?    0.5494E+03
 +   0.100000E+01    0.5494E+03
 +   0.200000E+01    0.5494E+03
 +   0.300000E+01    0.5494E+03
 +   0.400000E+01    0.5494E+03
 +   0.500000E+01    0.5494E+03
 +   0.600000E+01    0.5494E+03
 +   0.700000E+01    0.5494E+02
 +   0.800000E+01    0.5494E+03
 +   0.900000E+01    0.5494E+02
 +   0.100000E+02    0.5494E+03
******************************** ... **********************END OF POST.DAT**
 *   0.100000E+01  TIME IN SECS
 *   0.100000E+01  CALC. HTC.SM4S
S00131
 +  0.000000E+00    0.100537E+01
 +  0.500000E-01    0.116394E+0'
 +  0.100000E+00    0.109901E+0
 +  0.150000E+00    0.109350E+01
 +  0.200000E+00    0.113472E+01
 +  0.250000E+00    0.116801   01
 +  0.300000E+00    0.11621-   01
 +  0.350000E+00    0.119427E+01
 +  0.400000E+00    0.122083E+01
 +  0.450000E+00    0.125284E+01
 +  0.500000E+00    0.127474E+01
 +  0.550000E+00    0.126060E+01
 +  0.600000E+00    0.126251E+01
 +  0.650000E+00    0.124510E+01
 +  0.700000E+00    0.124209E+01
 +  0.750000E+00    0.124956E+01
 +  0.800000E+00    0.125861E+01
 +  0.850000E+00    0.126265E+01
 +  0.900000E+00    0.125737E+01
 +  0.950000E+00    0.124360E+01
 +  0.100000E+01    0.122660E+01
 +  0.105000E+01    0.122320E+01
 +  0.110000E+01    0.124050E+01
 +  0. 15000E+01    0.125505E+01
 +  0.120000E+01    0.126048E+01
 +  0.125000E+01    0.125021E+01
 +  0.130000E+01    0.123835E+01
 +  0.135000E+01    0.123983E+01
 +  0.140000E+01    0.124877E+01
 +  0.145000E+01    0.126649E+01
 +  0.150000E+01    0.127065E+01
 +  0.155000E+01    0.124768E+01
 +  0.160000E+01    0.120108E+01
 +  0.165000E+01    0.118139E+01
 +  0.170000E+01    0.121209E+01
 +  0.175000E+01    0.126738E+01
 +  0.180000E+01    0.128893E+01
 +  0.185000E+01    0.129086E+01
 +  0.190000E+01    0.125993F 01
```

```
+  0.195000E+01    0.119187E+01
+  0.200000E+01    0.115700E+01
+  0.205000E+01    0.115607E+01
+  0.210000E+01    0.113042E+01
+  0.215000E+01    0.104328E+01
+  0.220000E+01    0.993686E+00
+  0.225000E+01    0.999775E+00
+  0.230000E+01    0.104802E+01
+  0.235000E+01    0.106885E+01
+  0.240000E+01    0.990900E+00
+  0.245000E+01    0.864824E+00
+  0.250000E+01    0.873163E+00
+  0.255000E+01    0.928471E+00
+  0.260000E+01    0.839920E+00
+  0.265000E+01    0.735571E+00
+  0.270000E+01    0.711394E+00
+  0.275000E+01    0.764113E+00
+  0.280000E+01    0.811528E+00
+  0.285000E+01    0.805683E+00
+  0.290000E+01    0.753778E+00
+  0.295000E+01    0.662001E+00
+  0.300000E+01    0.601403E+00
+  0.305000E+01    0.585730E+00
+  0.310000E+01    0.576918E+00
+  0.315000E+01    0.621723E+00
+  0.320000E+01    0.638393E+00
+  0.325000E+01    0.569455E+00
+  0.330000E+01    0.483052E+00
+  0.335000E+01    0.383215E+00
+  0.340000E+01    0.322919E+00
+  0.345000E+01    0.332632E+00
+  0.350000E+01    0.411358E+00
+  0.355000E+01    0.446039E+00
+  0.360000E+01    0.447153E+00
+  0.365000E+01    0.426364E+00
+  0.370000E+01    0.467196E+00
+  0.375000E+01    0.523360E+00
+  0.380000E+01    0.571915E+00
+  0.385000E+01    0.464291E+00
+  0.390000E+01    0.265464E+00
+  0.395000E+01    0.139752E+00
+  0.400000E+01    0.113822E+00
+
*****************************************************************PDCA.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
 +    0.400000E+00    0.0000E+00
 +    0.500000E+00    0.0000E+00
 +    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
```

INITIALIZED INPUT DATA

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

SYSTEM	SYSTEM FLAG
1	0

PROBLEM END TIME = 4.0000000D 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	5.0000000D-02	5.0000000D-02	2

OUTPUT CONTROL

	ELAPSED NO. OF TIME STEPS	ELPASED TIME	ROUTED TO DEVICE NO.
MAJOR EDIT	0	0.1000000 01	6
MINOR EDIT	1	0.0	8
PLOT RECORD	0	0.0	1

PROBLEM CONVERGENCE CRITERIA

TEMPERATURE CONVERGENCE FACTOR	0.1000000D-07
ENERGY CONVERGENCE FACTOR	0.1000000D-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	0.1000000 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

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

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

TIME (SEC.)	LEVEL POWER (KW.)	TIME (SEC.)	LEVEL POWER (KW.)	TIME (SEC.)	LEVEL POWER (K	TIME (SEC.)	LEVEL POWER (KW.)
0.0	0.927696D 01	0.1000000D-01	0.0	0.5000000D-01	0.0	0.1000000D 00	0.0
0.2000000D 00	0.0	0.3000000D 00	0.0	0.4000000D 00	0.0	0.5000000D 00	0.0
0.6000000D 00	0.0	0.7000000D 00	0.0	0.8000000D 00	0.0	0.9000000D 00	0.0
0.1000000D 01	0.0	0.2000000D 01	0.0	0.3000000D 01	0.0	0.4000000D 01	0.0
0.5000000D 01	0.0	0.6000000D 01	0.0	0.7000000D 01	0.0	0.8000000D 01	0.0
0.9000000D 01	0.0	0.1000000D 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	0.1005370 01	0.5000000-01	0.1163940 01	0.1000000 00	0.1099010 01	0.1500000 00	0.1093[illegible]0 01
0.2000000 00	0.1134720 01	0.2500000 00	0.1168010 01	0.3000000 00	0.1182140 01	0.3500000 00	0.1194270 01
0.4000000 00	0.1220830 01	0.4500000 00	0.1252840 01	0.5000000 00	0.1274740 01	0.5500000 00	0.1280600 01
0.6000000 00	0.1262510 01	0.6500000 00	0.1245100 01	0.7000000 00	0.1242080 01	0.7500000 00	0.124[illegible]560 01
0.8000000 00	0.1258610 01	0.8500000 00	0.1262650 01	0.9000000 00	0.1257370 01	0.9500000 00	0.1243600 01
0.1000000 01	0.1226600 01	0.1050000 01	0.1223200 01	0.1100000 01	0.1240500 01	0.1150000 01	0.1255050 01
0.1200000 01	0.1260480 01	0.1250000 01	0.1250210 01	0.1300000 01	0.1238350 01	0.1350000 01	0.1239830 01
0.1400000 01	0.1248770 01	0.1450000 01	0.1266490 01	0.1500000 01	0.12706[illegible]0 01	0.1550000 01	0.1247680 01
0.1600000 01	0.1201080 01	0.1650000 01	0.1181390 01	0.1700000 01	0.1212090 01	0.1750000 01	0.1267380 01
0.1800000 01	0.1288930 01	0.1850000 01	0.1290860 01	0.1900000 01	0.1259930 01	0.1950000 01	0.1191870 01
0.2000000 01	0.1157000 01	0.2050000 01	0.1156070 01	0.2100000 01	0.1130420 01	0.2150000 01	0.1043280 01
0.2200000 01	0.9936860 00	0.2250000 01	0.9997750 00	0.2300000 01	0.1048020 01	0.2350000 01	0.1068[illegible]50 01
0.2400000 01	0.9909000 00	0.2450000 01	0.8648240 00	0.2500000 01	0.87[illegible]1630 00	0.2550000 01	0.9284710 00
0.2600000 01	0.8399200 00	0.2650000 01	0.7355710 00	0.2700000 01	0.7113940 00	0.2750000 01	0.7[illegible]1130 00
0.2800000 01	0.8115280 00	0.2850000 01	0.8056830 00	0.2900000 01	0.7537780 00	0.2950000 01	0.6[illegible]0010 00
0.3000000 01	0.6014030 00	0.3050000 01	0.5857300 00	0.3100000 01	0.5769180 00	0.3150000 01	0.62[illegible]7230 00
0.3200000 01	0.6383930 00	0.3250000 01	0.5694550 00	0.3300000 01	0.4830520 00	0.3350000 01	0.3832150 00
0.3400000 01	0.3229190 00	0.3450000 01	0.3326320 00	0.3500000 01	0.4113560 00	0.3550000 01	0.4460390 00
0.3600000 01	0.4471530 00	0.3650000 01	0.4263640 00	0.3700000 01	0.4671960 00	0.3750000 01	0.5233600 00
0.3800000 01	0.5719150 00	0.3850000 01	0.4642910 00	0.3900000 01	0.2654640 00	0.3950000 01	0.1397[illegible]0 00
0.4000000 01	0.1138220 00						

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

TIME (SEC.)	TEMPERATURE (F)	TIME (SEC.)	TEMPERATURE (F)	TIME (SEC.)	TEMPERATURE (F)	TIME (SEC.)	TEMPERATURE (F)
0.0	0.5494000D 03	0.1000000D-01	0.5494000D 03	0.5000000D-01	0.5494000D 03	0.1000000D 00	0.5494000D 03
0.2000000D 00	0.5494000D 03	0.3000000D 00	0.5494000D 03	0.4000000D 00	0.5494000D 03	0.5000000D 00	0.5494000D 03
0.6000000D 00	0.5494000D 03	0.7000000D 00	0.5494000D 03	0.8000000D 00	0.5494000D 03	0.9000000D 00	0.5494000D 03
0.1000000D 01	0.5494000D 03	0.2000000D 01	0.5494000D 03	0.3000000D 01	0.5494000D 03	0.4000000D 01	0.5494000D 03
0.5000000D 01	0.5494000D 03	0.6000000D 01	0.5494000D 03	0.7000000D 01	0.5494000D 03	0.8000000D 01	0.5494000D 03
0.9000000D 01	0.5494000D 03	0.1000000D 02	0.5494000D 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	0.1000000 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-0[illegible]	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	0.23420-02	0.0	1	1
1	2	0.23420-02	0.90750-02	0.0	7	1
1	3	0.90750-02	0.10230-01	0.10000 01	2	3
1	4	0.10230-01	0.14020-01	0.0	6	2
1	5	0.14020-01	0.15590-01	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	0.466574D-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	0.105929D-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	0.153[illegible]04D-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)
0.135460D 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)	0.549[illegible]0D 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	84[illegible].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	[illegible]	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.	KW.
PIN POWER	0.0	0.0

SYSTEM IDENTIFICATION, PIN 1

LEVEL	SYSTEM #	SYSTEM LEVEL
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)	SURF.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	0.100537D 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. SOLUTION
1	0.0	0.0	0.0	0.0	5

PINSIM: A NUCLEAR FUEL PIN SIMULATOR-TRANSIENT ANALYSIS CODE, MOD 2 VERSION 002, 06/30/80 NO. 211 (PINMAN) PAGE 0030
PINSIM VERIFICATION STUDY PROBLEM : POWER-DROP TEST SIMULATION 07/16/80

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	842.25	842.25	842.25	842.25	842.25	829.27

	NODE								
LEVEL NO	11	12	13	14	15	1[illegible]	17	18	19
1	803.81	779.45	758.00	738.84	721.56	7[illegible]81	688.50	669.69	652.02

PINSIM: A NUCLEAR FUEL PIN SIMULATOR-TRANSIENT ANALYSIS CODE, MOD 2   VERSION 002, 06/30/80   NO. 211 (PINMAN)   PAGE 0031
PINSIM VERIFICATION STUDY PROBLEM : POWER-DROP TEST SIMULATION   07/16/80

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
0.5000000-01	101.98	637.02	0.0	840.82	838.39	830.19	700.09	646.12
0.1000000 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	776.96	768.38	654.73	616.78
0.400000	69.006	605.92	0.0	780.12	765.68	757.33	648.25	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	636.35	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	626.32	597.32
0.650000	50.698	590.12	0.0	726.53	714.43	707.[illegible]	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	614.05	589.77
0.800000	42.874	583.4[illegible]	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	574.80
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	571.96
1.30000	23.720	568.55	0.0	631.92	626.47	623.38	583.61	570.74
1.35000	22.412	567.46	0.0	627.11	622.00	619.10	581.68	569.54
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	576.35	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	564.51
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	556.02	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	560.45	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	566.15	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	3.7525	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	2.5467	553.63	0.0	560.75	560.16	559.82	555.31	553.87
3.05000	2.4295	553.55	0.0	560.19	559.63	559.32	555.12	553.77
3.10000	2.3290	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	2.3238	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	553.17
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	553.21
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	1.4512	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	552.06
3.90000	0.72152	552.1[illegible]	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, 1,15)
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

```
****************************************************************POJOB.DAT*
=PINSIM VERIFICATION STUDY PROBLEM 1 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 KMIN DELMIN
210000    8      1    0.0
*
*
*       MAJOUT KMAJ DELMAJ
220000    6      0    1.0
*
*          NPLT DELPLT
230000      0    0.0
*
*********************************************************END OF POJOB.DAT*
****************************************************************POPIN.DAT*
*
* APPROXIMATE BUNDLE 3 DESIGN (AS DESCRIBED IN RDHT-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 IJFORM
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    * INNER 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-316
```

```
*
**************************************************************************
* MATERIALS
**************************************************************************
*
* MATERIAL 1 : BN3 (CORE)
*
*
419100   0   3   5000.
*
*  (THERMAL CONDUCTIVITY)
*
419110   0   0.0   2300.0
*
* (COEFFICIENTS WERE OBTAINED FROM L.J.OTT ON 3-2-83)
419111  21.286575    -0.0101369   0.0   0.0   0.0
*
*  (SPECIFIC HEAT CAPACITY)
*
419120   0   0.0   2300.0
*
419121     0.167812347  3.70264053D-04  -1.73793524D-07
+          3.14486215D-11   0.0
*
*  (DENSITY)
*
419130   -1   0.0   2300.0
*
*  (CORE BN3 DENSITY CORRECTED ON 6-MAY-80 TO CONFORM
*   TO BDHT-2404)
419131   138.3640
*
*
*  MATERIAL 2 : BN3 (ANNULUS)
*
*
419200   0   3   5000.
*
*  (THERMAL CONDUCTIVITY)
*
419210   0   0.0   2300.0
*
* (COEFFICIENTS WERE OBTAINED FROM L.J.OTT ON 3-2-83)
*
* (K COEFFS MODIFIED BY DGM ON 26-MAR-80 TO
*  IMPROVE INV RESULTS: INCREASE BOTH BY 1.104)
*419211  15.56185    -0.368726E-02    0.0   0.0   0.0
419211  17.1853    -0.40719E-02    0.0   0.0   0.0
*
*  (SPECIFIC HEAT CAPACITY)
*
419220   0   0.0   2300.0
*
419221     0.167812347  3.70264053D-04  -1.73793524D-07
+          3.14486215D-11   0.0
*
*  (DENSITY)
*
```

```
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 PDPIN.DAT*
****************************************************************PDSYS.BKD*
*
* SYSTEM INPUT : BACK-CALCULATION
*
* SYSTEM MODEL TO BACK-CALCULATE ON PIN 1, LEVEL 1
* BOUNDARY CONDITIONS : SURFACE FLUX, SURFACE TEMPERATURE
*
****************************************************************************
*
*       ISYSF   IFC*X    PSYS
500000 -1        1        0.0
*
*       * LEVEL CALCULATIONAL CONTROL: LEVEL # 1 *
*
*       NPBACK NLBACK 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   EPHIH IPHIF
500102   0.0      0.0   0
*
*        BTMPL   ETMPH ITMPF
500103  0.0      0.0    0
*
*
*       ITRPFL TTRIP
500150   0    0.0
*
****************************************************************END OF PDSYS.BKD*
 **     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	0.591330E+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	0.581250E+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	0.566220E+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

```
 +   0.310000E+01   0.553550E+03
 +   0.315000E+01   0.552970E+03
 +   0.320000E+01   0.552120E+03
 +   0.325000E+01   0.553040E+03
 +   0.330000E+01   0.552420E+03
 +   0.335000E+01   0.552950E+03
 +   0.340000E+01   0.552340E+03
 +   0.345000E+01   0.554220E+03
 +   0.350000E+01   0.551410E+03
 +   0.355000E+01   0.552760E+03
 +   0.360000E+01   0.552050E+03
 +   0.365000E+01   0.552550E+03
 +   0.370000E+01   0.551900E+03
 +   0.375000E+01   0.552390E+03
 +   0.380000E+01   0.551040E+03
 +   0.385000E+01   0.551940E+03
 +   0.390000E+01   0.551290E+03
 +   0.395000E+01   0.553100E+03
 +   0.400000E+01   0.551630E+03
 **    PINSIM:002#206, 1286,PININV /80165.0052,PDINV.DAT*
 **   TIME IN SEC$                              $    $    $    $    $    $
 **    SURFACE HEAT FLUX IN BTU/S-FT**2$ $
 **    0.100000E+01  TIME IN SEC$
 **    0.100000E+01  PHI*(()1:1()).INV$
500121
 +   0.000000E+00   0.946960E+02
 +   0.500000E-01   0.100590E+03
 +   0.100000E+00   0.970570E+02
 +   0.150000E+00   0.899650E+02
 +   0.200000E+00   0.857220E+02
 +   0.250000E+00   0.852870E+02
 +   0.300000E+00   0.763760E+02
 +   0.350000E+00   0.708200E+02
 +   0.400000E+00   0.695450E+02
 +   0.450000E+00   0.686980E+02
 +   0.500000E+00   0.598500E+02
 +   0.550000E+00   0.628870E+02
 +   0.600000E+00   0.511870E+02
 +   0.650000E+00   0.511530E+02
 +   0.700000E+00   0.480400E+02
 +   0.750000E+00   0.442830E+02
 +   0.800000E+00   0.442200E+02
 +   0.850000E+00   0.402450E+02
 +   0.900000E+00   0.381300E+02
 +   0.950000E+00   0.357570E+02
 +   0.100000E+01   0.335160E+02
 +   0.105000E+01   0.288950E+02
 +   0.110000E+01   0.329840E+02
 +   0.115000E+01   0.263950E+02
 +   0.120000E+01   0.286070E+02
 +   0.125000E+01   0.248900E+02
 +   0.130000E+01   0.220430E+02
 +   0.135000E+01   0.227490E+02
 +   0.140000E+01   0.204680E+02
 +   0.145000E+01   0.211270E+02
 +   0.150000E+01   0.178460E+02
 +   0.155000E+01   0.188640E+02
 +   0.160000E+01   0.144190E+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    0.184560E+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
********************************************************************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
```

```
347    +   0.200000E+00   0.0000E+00
348    +   0.300000E+00   0.0000E+00
349    +   0.400000E+00   0.0000E+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   0.0000E+00
358    +   0.400000E+01   0.0000E+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 PDGA.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 DIAGNOSTICS -----

MINIMUM LENGTH OF TABLE ARRAY IN COMMON /SCRTCH/ IS    615 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:  500121 NO. OF TABLE PAIRS SPECIFIED AT       23
         IS BEING RESET TO ACTUAL NO. OF PAIRS FOUND IN INPUT =    31

******** WARNING....SYSTEM  1, LEVEL  1
          CARD SERIES:  500141 NO. OF TABLE PAIRS SPECIFIED AT       23
         IS BEING RESET TO ACTUAL NO. OF PAIRS FOUND IN INPUT =    31


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

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

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


MINIMUM LENGTH OF DATA ARRAY IS       346 WORDS.

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

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

        50011.
              ********* TAU =   0.0        : WARN HAS BEEN CALLED; POSSIBLE PROBLEM ERROR *********

------------------------------------------- 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 STEPS	ELPASED TIME	ROUTED TO DEVICE NO.
MAJOR EDIT	0	0.1000000D 01	6
MINOR EDIT	1	0.0	8
PLOT RECORD	0	0.0	1

PROBLEM CONVERGENCE CRITERIA

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

SYSTEM INPUT DATA, SYSTEM NO. 1

SYSTEM CONTROL FLAG	POWER CONTROL FLAG/# OF LEVELS	STEADY-STATE POWER, KW
-1	1	0.0

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
0	81	0	81

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	0
HEAT FLUX	0	0	23
H.T.COEFF.	0	0	0
TEMPERATURE	0	0	185

113

----- SURFACE HEAT FLUX TABLE -----

TIME (SEC.)	HEAT FLUX (BTU/SEC-FT**2)	TIME (SEC.)	HEAT FLUX (BTU/SEC-FT**2)	TIME (SEC.)	HEAT FLUX (BTU/SEC-FT**2)	TIME (SEC.)	HEAT FLUX (BTU/SEC-FT**2)
0.0	0.9469600D 02	0.5000000D-01	0.1005900D 03	0.1000000D 00	0.9705700D 02	0.1500000D 00	0.3996500D 02
0.2000000D 00	0.8972200D 02	0.2500000D 00	0.8528700D 02	0.3000000D 00	0.7627600D 02	0.3500000D 00	0.7082000D 02
0.4000000D 00	0.6954500D 02	0.4500000D 00	0.6869800D 02	0.5000000D 00	0.5985000D 02	0.5500000D 00	0.6288700D 02
0.6000000D 00	0.5118700D 02	0.6500000D 00	0.5115300D 02	0.7000000D 00	0.4804000D 02	0.7500000D 00	0.4428300D 02
0.8000000D 00	0.4422000D 02	0.8500000D 00	0.4024500D 02	0.9000000D 00	0.3813300D 02	0.9500000D 00	0.3575700D 02
0.1000000D 01	0.3351600D 02	0.1050000D 01	0.2889500D 02	0.1100000D 01	0.3298400D 02	0.1150000D 01	0.2639500D 02
0.1200000D 01	0.2860700D 02	0.1250000D 01	0.2489000D 02	0.1300000D 01	0.2204300D 02	0.1350000D 01	0.2274900D 02
0.1400000D 01	0.2046800D 02	0.1450000D 01	0.2112700D 02	0.1500000D 01	0.1784600D 02	0.1550000D 01	0.1886400D 02
0.1600000D 01	0.1441900D 02	0.1650000D 01	0.1558600D 02	0.1700000D 01	0.1351600D 02	0.1750000D 01	0.1556500D 02
0.1800000D 01	0.1236700D 02	0.1850000D 01	0.1231100D 02	0.1900000D 01	0.1311000D 02	0.1950000D 01	0.7755200D 01
0.2000000D 01	0.1169900D 02	0.2050000D 01	0.7046200D 01	0.2100000D 01	0.1208500D 02	0.2150000D 01	0.4994700D 01
0.2200000D 01	0.8156100D 01	0.2250000D 01	0.6058000D 01	0.2300000D 01	0.7185300D 01	0.2350000D 01	0.6772100D 01
0.2400000D 01	0.7734100D 01	0.2450000D 01	0.1483900D 01	0.2500000D 01	0.4552900D 01	0.2550000D 01	0.8422600D 01
0.2600000D 01	0.2945300D 01	0.2650000D 01	0.3671700D 01	0.2700000D 01	0.2192700D 01	0.2750000D 01	0.5682000D 01
0.2800000D 01	0.2636600D 01	0.2850000D 01	0.4174800D 01	0.2900000D 01	0.2602400D 01	0.2950000D 01	0.2774100D 01
0.3000000D 01	0.1426600D 01	0.3050000D 01	0.3862600D 01	0.3100000D 01	0.9837200D 00	0.3150000D 01	0.2454500D 01
0.3200000D 01	0.3286400D 01	0.3250000D 01	0.7896500D 00	0.3300000D 01	0.2326200D 01	0.3350000D 01	0.8208900D 00
0.3400000D 01	0.2141800D 01	0.3450000D 01	-.1726100D 01	0.3500000D 01	0.4645300D 01	0.3550000D 01	0.8282100D-01
0.3600000D 01	0.1953900D 01	0.3650000D 01	0.4835500D 00	0.3700000D 01	0.1845000D 01	0.3750000D 01	0.4097000D 00
0.3800000D 01	0.2978000D 01	0.3850000D 01	0.2064300D 00	0.3900000D 01	0.1768500D 01	0.3950000D 01	-.1957300D 01
0.4000000D 01	0.2032500D 01						

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

TIME (SEC.)	TEMPERATURE (F)	TIME (SEC.)	TEMPERATURE (F)	TIME (SEC.)	TEMPERATURE (F)	TIME (SEC.)	TEMPERATURE (F)
0.0	0.6435900D 03	0.5000000D-01	0.6378000D 03	0.1000000D 00	0.6326700D 03	0.1500000D 00	0.6287100D 03
0.2000000D 00	0.6214700D 03	0.2500000D 00	0.6153400D 03	0.3000000D 00	0.6122500D 03	0.3500000D 00	0.6091400D 03
0.4000000D 00	0.6042300D 03	0.4500000D 00	0.5985400D 03	0.5000000D 00	0.5970100D 03	0.5500000D 00	0.5908600D 03
0.6000000D 00	0.5913300D 03	0.6500000D 00	0.5882700D 03	0.7000000D 00	0.5859800D 03	0.7500000D 00	0.5844100D 03
0.8000000D 00	0.5812500D 03	0.8500000D 00	0.5797300D 03	0.9000000D 00	0.5779100D 03	0.9500000D 00	0.5763400D 03
0.1000000D 01	0.5749100D 03	0.1050000D 01	0.5750300D 03	0.1100000D 01	0.5711100D 03	0.1150000D 01	0.5715100D 03
0.1200000D 01	0.5687100D 03	0.1250000D 01	0.5681300D 03	0.1300000D 01	0.5679600D 03	0.1350000D 01	0.5662200D 03
0.1400000D 01	0.5655800D 03	0.1450000D 01	0.5637100D 03	0.1500000D 01	0.5636100D 03	0.1550000D 01	0.5618600D 03
0.1600000D 01	0.5626300D 03	0.1650000D 01	0.5613500D 03	0.1700000D 01	0.5612100D 03	0.1750000D 01	0.5591800D 03
0.1800000D 01	0.5593100D 03	0.1850000D 01	0.5585500D 03	0.1900000D 01	0.5570900D 03	0.1950000D 01	0.5587700D 03
0.2000000D 01	0.5566500D 03	0.2050000D 01	0.5579200D 03	0.2100000D 01	0.5550400D 03	0.2150000D 01	0.5573400D 03
0.2200000D 01	0.5559900D 03	0.2250000D 01	0.5563400D 03	0.2300000D 01	0.5554500D 03	0.2350000D 01	0.5549500D 03
0.2400000D 01	0.5537700D 03	0.2450000D 01	0.5563800D 03	0.2500000D 01	0.5555000D 03	0.2550000D 01	0.5528800D 03
0.2600000D 01	0.5544700D 03	0.2650000D 01	0.5543300D 03	0.2700000D 01	0.5549900D 03	0.2750000D 01	0.5531600D 03
0.2800000D 01	0.5539100D 03	0.2850000D 01	0.5530600D 03	0.2900000D 01	0.5534100D 03	0.2950000D 01	0.5532500D 03
0.3000000D 01	0.5538200D 03	0.3050000D 01	0.5525700D 03	0.3100000D 01	0.5535500D 03	0.3150000D 01	0.5529700D 03
0.3200000D 01	0.5521200D 03	0.3250000D 01	0.5530400D 03	0.3300000D 01	0.5524200D 03	0.3350000D 01	0.5529500D 03
0.3400000D 01	0.5523400D 03	0.3450000D 01	0.5542200D 03	0.3500000D 01	0.551[illegible]00D 03	0.3550000D 01	0.55276[illegible]0D 03
0.3600000D 01	0.5520500D 03	0.3650000D 01	0.5525500D 03	0.3700000D 01	0.5519000D 03	0.3750000D 01	0.5523900D 03

PINSIM: A NUCLEAR FUEL PIN SIMULATOR-TRANSIENT ANALYSIS CODE, 4DD 2 VERSION 002, 06/10/80 NO. 246 (PINMAN) PAGE 0017
PINSIM VERIFICATION STUDY PROBLEM : POWER-DROP TEST SIMULATION 05/13/80

---- [illegible] ATURE TABLE -----

TIME (SEC.)	TEMPERATURE (F)	TIME (SEC.)	TEMPERATURE (F)	TIME (SEC.)	TEMPERATURE (F)	TIME (SEC.)	TEMPERATURE (F)
0.3800000D 01	0.5510400D 03	0.3850000D 01	0.5519400D 03	0.3900000D 01	0.5512900D 03	0.3950000D 01	0.5531000D 03
0.4000000D 01	0.5516300D 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	0.10000 01	1.00	1	4

GAP CALCULATION FLAG	INTERNAL DATA FLAG	HEAT TRANSFER AREA SCALING FACTOR	PIN DEFORMATION FLAG
0	0	0.1000000 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	0.9796550D-01	1.000	1.0330	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	0.1655830D-02	0.2341700D-02	0.1722710D-04	0.0	1
1	2	0.2341700D-02	0.3312770D-02	0.4057740D-02	0.3450010D-04	0.0	1
1	3	0.4057740D-02	0.4685740D-02	0.5238990D-02	0.3450010D-04	0.0	1
1	4	0.5238990D-02	0.5739150D-02	0.6199090D-02	0.3450010D-04	0.0	1
1	5	0.6199090D-02	0.6627190D-02	0.7029260D-02	0.3450010D-04	0.0	1
1	6	0.7029260D-02	0.7409540D-02	0.7771240D-02	0.3450010D-04	0.0	1
1	7	0.7771240D-02	0.8116840D-02	0.8448310D-02	0.3450010D-04	0.0	1
1	8	0.8448310D-02	0.8767260D-02	0.9075000D-02	0.3450010D-04	0.0	1
1	9	0.9075000D-02	0.9375730D-02	0.9667120D-02	0.3436380D-04	0.5000000D 00	3
1	10	0.9667120D-02	0.9949970D-02	0.1022500D-01	0.3436380D-04	0.5500060D 00	3
1	11	0.1022500D-01	0.1059290D-01	0.1094850D-01	0.4812780D-04	0.0	2
1	12	0.1094850D-01	0.1129290D-01	0.1162710D-01	0.4812780D-04	0.0	2
1	13	0.1162710D-01	0.1195200D-01	0.1226820D-01	0.4812780D-04	0.0	2
1	14	0.1226820D-01	0.1257650D-01	0.1287750D-01	0.4812780D-04	0.0	2
1	15	0.1287750D-01	0.1317150D-01	0.1345910D-01	0.4812780D-04	.0	2
1	16	0.1345910D-01	0.1374070D-01	0.1401670D-01	0.4812780D-04	0.0	2
1	17	0.1401670D-01	0.1429130D-01	0.1456060D-01	0.4883420D-04	0.0	4
1	18	0.1456060D-01	0.1482510D-01	0.1508500D-01	0.4883420D-04	0.0	4
1	19	0.1508500D-01	0.1534040D-01	0.1559170D-01	0.4883420D-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.

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.[illegible]70264D-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
2330.00	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)
0.135466D 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
HEAT TRANSFER COEFFICIENT (BTU/SEC-FT2-F)	0.0	
SURFACE HEAT FLUX (BTU/SEC-FT2)	0.946960D 02	0.946960D 02
TEMPERATURE (DEG. F)	0.643590D 03	0.643590D 03

BACK CALCULATION

CALCULATED RESULTS

	UNFILTERED	FILTERED
POWER (KW)	0.927694D 01	0.927694D 01
SURFACE HEAT FLUX (BTU/SEC-FT2)	0.946960D 02	
SURFACE TEMPERATURE (DEG. F)	0.643590D 03	

TEMPERATURE DISTRIBUTION
PIN 1 LEVEL 1

NODE

LEVEL NO	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	829.26

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	688.59	665.65	652.02

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)	SURF.HT.TRANS. COEFF(B/S-FT2-F)
1	0.927694D 01	0.927694D 01	0.946960D 02	0.842246D 03	0.829265D 03	0.643590D 03	0.643590D 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

	NODE									
LEVEL NO	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	829.26

	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, PIN 1 = 0.307975D 02 BTU

LEVEL	STORED ENERGY PER LEVEL(BTU)
1	0.307975D 02

TOTAL NODAL STORED ENERGY (BTU)

LEVEL NO	NODE 1	2	3	4	5	6	7	8	9	10
1	0.72470 00	0.14510 01	0.14510 01	0.14510 01	0.14510 01	0.14510 01	0.14510 01	0.14510 01	0.18620 01	0.18300 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	2.38	2.02	1.95

PINSIM: A NUCLEAR FUEL PIN SIMULATOR-TRANSIENT ANALYSIS CODE, MOD 2   VERSION 002, 06/10/80   NO. 206 (PINMAN)   PAGE 0030
PINSIM VERIFICATION STUDY PROBLEM : POWER-DROP TEST SIMULATION   06/13/80

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, LEVEL # 1

CALCULATION LOCATION

PIN	LEVEL	NODE
1	1	0

LEVEL BOUNDARY CONDITIONS

	UNFILTERED	FILTERED
HEAT TRANSFER COEFFICIENT (BTU/SEC-FT2-F)	0.0	
SURFACE HEAT FLUX (BTU/SEC-FT2)	0.3351600 02	0.3351600 02
TEMPERATURE (DEG. F)	0.5749100 03	0.5749100 03

BACK CALCULATION

CALCULATED RESULTS

	UNFILTERED	FILTERED
POWER (KW)	-0.4540800-01	-0.4540800-01
SURFACE HEAT FLUX (BTU/SEC-FT2)	0.3351600 02	
SURFACE TEMPERATURE (DEG. F)	0.5749100 03	

TEMPERATURE DISTRIBUTION
PIN 1 LEVEL 1

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	640.55	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	584.26	577.99

131

SUMMARY OF PIN CONDITIONS, PIN NO. 1

TAU (SEC)	DELT (SEC)
0.100D 01	0.500D-01

	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	-0.454080D-01	0.328341D 01	0.335160D 02	0.666009D 03	0.626427D 03	0.574910D 03	0.574910D 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	1

SUMMARY OF PIN CONDITIONS. PIN NO. 1

PIN TEMPERATURE DISTRIBUTION

					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	640.56	636.45	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, PIN NO. 1

TOTAL STORED ENERGY, PIN 1 = 0.229912D 02 BTU

LEVEL	STORED ENERGY PER LEVEL(BTU)
1	0.229912D 02

TOTAL NODAL STORED ENERGY (BTU)

	NODE									
LEVEL NO	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

	NODE								
LEVEL NO	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	652.02
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	61[illegible].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	59.850	597.01	-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	624.52	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	44.226	581.25	-0.43582E-01	697.45	587.12	681.29	608.64	585.30
0.850000	40.245	579.73	0.33305E-01	688.55	579.23	673.75	605.21	583.42
0.900000	38.130	577.91	-0.35047E-01	680.38	571.74	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	-0.45408E-01	666.01	657.96	653.41	596.17	577.99
1.05000	28.895	575.03	-0.97887E-02	659.17	551.61	647.35	594.01	577.69
1.10000	32.984	571.11	0.43551E-01	652.72	645.66	641.67	591.00	574.15
1.15000	26.395	571.51	-0.19565E-01	646.64	540.03	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	512.31	609.77	576.73	565.66
1.50000	17.846	563.61	0.31268E-01	612.77	608.58	606.21	575.23	565.26
1.55000	18.864	561.86	-0.26748E-01	608.99	505.05	602.82	573.48	563.60
1.60000	14.419	562.63	0.43414E-01	605.43	601.75	599.67	572.42	563.96
1.65000	15.586	561.35	-0.60286E-01	602.08	598.62	596.65	571.10	562.79
1.70000	13.516	561.21	0.39671E-01	598.93	595.70	593.86	570.03	562.46
1.75000	15.565	559.18	0.40619E-02	595.98	592.96	591.24	568.52	560.62
1.80000	12.367	559.31	-0.10950E-01	593.20	590.36	588.75	567.42	560.45
1.85000	12.311	558.55	-0.22501E-01	590.58	587.91	586.39	566.33	559.69
1.90000	13.110	557.09	0.49042E-01	588.12	585.62	584.20	565.04	558.30
1.95000	7.7552	556.77	-0.40807E-01	585.79	583.44	582.11	564.60	559.49

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TIME(SEC)	SRF HT FLUX B/S-F 2 (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, 2)	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	583.51	581.40	580.15	563.51	557.72
2.05000	7.0462	557.92	0.22904E-02	581.56	579.50	578.33	563.08	558.57
2.10000	12.085	555.04	-0.14672E-01	579.53	577.70	576.60	561.76	556.16
2.15000	4.9947	557.34	0.30206E-01	577.93	575.03	575.00	561.56	557.80
2.20000	8.1561	555.99	-0.35709E-01	576.14	574.44	573.48	560.89	556.75
2.25000	6.0580	556.34	0.30787E-01	574.36	572.99	572.10	560.47	556.90
2.30000	7.1853	555.45	-0.18220E-01	573.38	571.62	570.78	559.82	556.12
2.35000	6.7721	554.95	-0.22526E-02	571.70	570.33	569.55	559.15	555.58
2.40000	7.7341	553.77	0.35168E-01	570.42	569.14	568.41	558.30	554.49
2.45000	1.4839	556.38	-0.31738E-01	569.20	568.00	567.32	558.51	556.52
2.50000	4.5529	555.50	-0.12156E-01	568.37	566.94	566.30	558.28	555.92
2.55000	8.4226	552.88	0.36789E-01	567.31	565.97	565.39	557.21	553.65
2.60000	2.9453	554.47	-0.27023E-01	566.32	565.05	564.49	556.99	554.74
2.65000	3.6717	554.33	0.21774E-01	565.10	564.19	563.67	556.78	554.67
2.70000	2.1927	554.99	-0.15066E-01	564.23	563.38	562.90	556.77	555.19
2.75000	5.6820	553.16	0.13977E-02	563.43	562.64	562.18	556.12	553.69
2.80000	2.6366	553.91	0.15606E-02	562.57	561.94	561.52	555.90	554.15
2.85000	4.1748	553.06	-0.81652E-02	561.97	561.27	560.88	555.46	553.45
2.90000	2.6024	553.41	0.12859E-01	561.30	560.66	560.29	555.25	553.65
2.95000	2.7741	553.25	-0.42815E-02	560.68	560.07	559.72	555.03	553.51
3.00000	1.4266	553.82	0.61344E-02	560.10	559.53	559.21	555.04	553.95
3.05000	3.8626	552.57	-0.24370E-01	559.55	559.01	558.71	554.58	552.93
3.10000	0.98372	553.55	0.30144E-01	559.05	558.55	558.27	554.59	553.64
3.15000	2.4545	552.97	-0.16619E-01	558.57	558.11	557.85	554.38	553.20
3.20000	3.3864	552.12	-0.39528E-02	558.13	557.69	557.44	553.94	552.43
3.25000	0.78965	553.04	-0.71054E-03	557.71	557.30	557.06	553.93	553.11
3.30000	2.3262	552.42	0.22964E-01	557.32	556.94	556.72	553.73	552.64
3.35000	0.82089	552.95	-0.30357E-01	556.95	556.59	556.38	553.72	553.03
3.40000	2.1418	552.34	0.38546E-01	556.61	556.23	556.09	553.51	552.54
3.45000	-1.7261	554.22	-0.45223E-01	556.29	555.98	555.80	553.43	554.06
3.50000	4.6453	551.41	0.40585E-01	556.00	555.72	555.57	553.30	551.84
3.55000	0.83821E-01	552.76	-0.41424E-01	555.73	555.46	555.30	553.28	552.77
3.60000	1.9539	552.05	0.30678E-01	555.47	555.23	555.09	553.07	552.23
3.65000	0.48355	552.55	-0.78483E-02	555.24	555.00	554.87	553.07	552.59
3.70000	1.3450	551.90	-0.12174E-01	555.01	554.78	554.65	552.84	552.07
3.75000	0.40970	552.39	0.31879E-01	554.80	554.59	554.48	552.86	552.43
3.80000	2.9780	551.04	-0.48263E-01	554.58	554.38	554.25	552.40	551.32
3.85000	0.20643	551.94	0.45409E-01	554.39	554.19	554.09	552.41	551.96
3.90000	1.7686	551.29	-0.26095E-01	554.19	554.00	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

R E S T A R T	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	0.14696E-01	553.34	553.67	553.58	552.41	551.82

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