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VOLUME V. TEMPRO

A HEAT TRANSFER-LIFETIME CODE

FOR SNAP REACTOR ANALYSIS

AEC Research and Development Report

Atoms International Division
Rockwell International

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Canoga Park, California 91304

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VOLUME V. TEMPRO
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FOR SNAP REACTOR ANALYSIS

L. D. FELTEN
AND
E. MOODY

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ABSTRACT

The TEMPRO computer program does heat transfer and reactivity calculations as a function of time for SNAP-type reactors. It determines hydrogen loss rates and the associated reactivity loss. Fuel swelling, uranium burnup, and fission product buildup are considered.

Figure 1. Three-Dimensional TEMPRO Model

I. INTRODUCTION

The TEMPRO computer program is a combination of heat transfer and reactivity lifetime calculations for a SNAP type reactor core. The program calculates axial temperatures as a function of time and reactor operating conditions. It also calculates the hydrogen loss from the zirconium hydride (ZrH) fuel matrix and the associated reactivity for each time interval. Fuel slug swelling, uranium burnup, fission product buildup worth, and other nuclear parameters are also determined for the operating history input to the code.

The program assumes that the fuel elements are arranged in hexagonal rings and then calculates conditions for an average element in each ring (Figure 1). The fuel element is assumed to consist of a fuel slug inside a cladding tube. The inner surface of the cladding tube is coated with a hydrogen gas diffusion barrier, and a gas gap exists between the fuel slug and the diffusion barrier. The program will, however, handle cases where the gap is closed and contact occurs between the barrier and the fuel slug. The temperature calculations are two dimensional only, radial and axial. The temperature and coolant flow conditions are assumed to be constant in the azimuthal direction.

6531-5431

Figure 2. Typical Radial Temperature Profile

II. DISCUSSION OF EQUATIONS

A. TEMPERATURE DISTRIBUTIONS

The program uses a nodal model of the reactor core with up to 20 rings of fuel elements (Figure 1) each with 11 axial nodes for each fuel element component. The axial temperature distribution is computed by determining first the bulk coolant temperature distribution by numerical integration:

$$T_{n+1} = T_n + \frac{\bar{q}\Delta L}{\omega C_p} . \quad \dots(1)$$

(Nomenclature is given on the foldout at the end of the report.)

The local heat flux, q , is obtained from the product of the average linear power density and the relative radial and axial power densities.

$$q = \left(\frac{3413P}{L_f N_p} \right) \times \varphi_r \times \varphi_a . \quad \dots(2)$$

Flow in a coolant channel can vary from node n to $n + 1$ by change in channel area or by radial pressure gradients. Such a change is implied by variable flow multipliers input to the problem. Cross flow is accounted for in each channel by the equations:

$$\omega_n + \omega_i = \omega_{n+1} + \omega_o \quad \dots(3)$$

and

$$\frac{q\Delta L}{C_p} + \omega_n T_n + \omega_i T_i = \omega_{n+1} T_{n+1} + \omega_o T_o . \quad \dots(4)$$

The energy balance solution between coolant channels is iterative and is solved within a 0.1% tolerance on outlet temperatures.

The radial temperatures computed are shown in Figure 2. The outside cladding temperature is computed by the equation:

$$T_{cl} = T_{cool} + \frac{q}{\pi D_{cl} h} . \quad \dots(5)$$

Temperatures in to the fuel slug surface are computed by:

$$T_2 = T_1 + \frac{qd}{\pi \bar{D}k} . \quad \dots (6)$$

The fuel centerline temperature is obtained from

$$T_o = T_{\text{fuel surface}} + \frac{q}{4\pi k_f} . \quad \dots (7)$$

The axial temperature distribution of each component in the fuel element is obtained by finding the radial temperature increments from the corresponding axial bulk coolant temperature distribution. The thermal conductivity values are input as constants except for the fuel and cladding conductivities. The cladding conductivity is input as a linear function of temperature. The fuel conductivity can be input as a constant, or the program can be instructed to calculate it as a function of temperature and H/Zr (hydrogen to zirconium) ratio.

B. GAS GAP HEAT TRANSFER

The gas gap provided to accommodate fuel swelling is the most complicated heat transfer path in the fuel element since the characteristics of the path vary considerably over the lifetime of the element. At initial reactor startup (low fuel temperature), the hydrogen pressure in the gap, from the ZrH fuel material, is very low. Heat flow approaches the free molecular condition unless the gap has been pre-filled with helium during assembly. At normal reactor operating conditions, the hydrogen pressure increases over that at startup. As hydrogen leaks from the fuel elements during the reactor life, the H/Zr ratio of the fuel material decreases, and thus, the hydrogen pressure in the gap decreases. Also, over the element lifetime, fission gas (assumed to be xenon) is released into the gap. At the same time, the gap is shrinking as the fuel swells from irradiation. For some cases, the fuel comes into intimate contact with the diffusion barrier.

Thus, the method of calculating the temperature across the gap is dependent on the history of reactor operation as well as on the current operating conditions.

The hydrogen pressure in the gas gap is determined by the average fuel temperature and the fuel hydrogen content (H/Zr ratio). The pressure equations are:⁽¹⁾

$$\ln P = a_o + \frac{a_1 \times 10^4}{T_f}, \quad \dots(8)$$

where

$$a_o = -8.8455 + 88.9801(H/Zr) - 78.8961(H/Zr)^2 + 21.3731(H/Zr)^3$$

$$a_1 = -12.972 + 9.7707(H/Zr) - 2.4984(H/Zr)^2$$

(units are atmospheres and °R).

The thermal properties of hydrogen, helium, and xenon were obtained from Touloukian^(2,3) and are calculated by the program as a function of temperature. The thermal conductivity of a hydrogen-helium mixture is calculated from the equation:

$$k_{\text{mix}} = \frac{k_1}{1 + \phi_{12} \frac{x_2}{x_1}} + \frac{k_2}{1 + \phi_{21} \frac{x_1}{x_2}}. \quad \dots(9)$$

When xenon gas is present, Equation 9 is used to determine the conductivity of the mixture of xenon and the hydrogen-helium mixture previously calculated. The correlation coefficients, ϕ_{12} and ϕ_{21} , for the different mixtures were obtained from the work of Saxena.⁽⁴⁾

For heat transfer from a gas to a solid surface, or vice versa, a temperature jump, or slip, occurs at the surface. A simplified form of the temperature jump effect is given by Kennard,⁽⁵⁾ as follows:

$$g = \frac{2 - \alpha}{\alpha} \sqrt{2\pi RT} \frac{\gamma k}{(\gamma + 1) C_p P} \quad \dots(10)$$

with $C_p = \frac{\gamma R}{\gamma - 1}.$

The heat conductance across the gas gap is:

$$\frac{Q}{A\Delta T} = \frac{k}{d + g_1 + g_2} ; \quad \dots(11)$$

where the gas gap width, d , is effectively increased by the temperature jumps at the two walls, g_1 and g_2 . From Equation 10 we see that the temperature jump distance is inversely proportional to gas pressure, P . At high gas pressures, when g becomes small compared to the gap width, d , continuum conduction prevails. At low pressures, g becomes large and d is unimportant (Equation 11). This is the regime of molecular conduction, which is independent of gap width.

For a binary gas mixture, we use the equation:⁽⁶⁾

$$g = x_1 \left(\frac{2 - \alpha_1}{\alpha_1} \right) \frac{\ell_1 m_1 C_{V1}}{m_M C_{VM}} + x_2 \left(\frac{2 - \alpha_2}{\alpha_2} \right) \frac{\ell_2 m_2 C_{V2}}{m_M C_{VM}} , \quad \dots(12)$$

where

$$\begin{aligned} \frac{\ell_1 (2 - \alpha_1)}{\alpha_1} = g_1 (\text{pure component}) \div \left\{ 1 + \frac{x_2}{x_1} \left[8 \left(1 + \frac{m_1}{m_2} \right) \right]^{-1/2} \right. \\ \left. \times \left(1 + \frac{\sigma_2}{\sigma_1} \right)^2 \right\} \end{aligned} \quad \dots(13)$$

and

$$\begin{aligned} \frac{\ell_2 (2 - \alpha_2)}{\alpha_2} = g_2 (\text{pure component}) \div \left\{ 1 + \frac{x_1}{x_2} \left[8 \left(1 + \frac{m_2}{m_1} \right) \right]^{-1/2} \right. \\ \left. \times \left(1 + \frac{\sigma_1}{\sigma_2} \right)^2 \right\} . \end{aligned} \quad \dots(14)$$

Here g_1 and g_2 are determined from Equation 10 with the partial pressure of each gas used. (Note that Subscripts 1 and 2 refer to gas species here, not walls as in Equation 11.)

If the fuel slug swells sufficiently to fill the allowed gap, then the contact conductance must be considered. Contact resistance to heat flow is determined

by the relative smoothness of the two surfaces in contact, the contact pressure, the material hardness, and the gas entrapped in the voids. The thermal contact resistance formulas are from the work of Cetinkale.⁽⁷⁾ The overall coefficient is:

$$U_{OA} = U_G + \frac{C\bar{k}}{r_e \tan^{-1} \left(\frac{1}{C} \sqrt{1 - \frac{U_G}{U_{OA}}} - 1 \right)} . \quad \dots(15)$$

The effective $\bar{k}$ for the fuel and glass barrier, which are in contact, is:

$$\bar{k} = \frac{2k_f k_b}{k_f + k_b} . \quad \dots(16)$$

A measure of the effectiveness of the contact is obtained by a function of contact pressure and Meyer hardness:

$$C = \frac{\sqrt[3]{P_{C_{\max}}^{1/3} P_C^{2/3}}}{M_H} , \quad \dots(17)$$

where $P_{C_{\max}}$ is the maximum contact pressure that has occurred. The Meyer hardness can be approximated as three times the yield strength (of the softer material).

The distance between contacts is a function of surface finish and is represented by:

$$r_e = 0.0048(\lambda_f + \lambda_b)C^{-5/3} . \quad \dots(18)$$

The gas heat transfer contribution is:

$$U_G = \frac{k_g}{\epsilon(\xi_b + \xi_f)} . \quad \dots(19)$$

The program automatically checks the gas gap to determine whether a contact conductance calculation is required.

Figure 3. Offset Swelling Example

C. FUEL SWELLING EFFECTS

The basic equation for fuel swelling involves two terms: one dependent exclusively on metal atom burnup and a second, offset effect, term which involves the fuel temperature. The equation is:

$$\% \frac{\Delta V}{V} = b\beta^r + \max \left\{ a_A \left[\beta (\bar{T}_f + 460) \right]^x, a_B \left(\frac{\beta}{t} \right)^n \times e^{-T_{act}/(\bar{T}_f + 460)} \right\} \left(1 - e^{-t/\tau} \right). \quad \dots(20)$$

In the first term, b and r are input constants and β is the metal atom % burnup

$$\beta = \frac{\bar{P}t \bar{\phi}_r \phi_a}{\pi r_f^2 L_f N_p \rho_{ma}} \times 3.28 \times 10^{13} \frac{\text{fission}}{\text{kw sec}} \times \text{unit conversion} . \quad \dots(21)$$

The metal atom density is:

$$\rho_{ma} = 6.023 \times 10^{23} \rho_f \left[1 - \frac{0.0167}{1.74} \left(H/Zr \right) \right] \times \left[0.01 f_{w\%} \left(\frac{0.9315}{235} + \frac{0.0685}{238.1} \right) + \frac{1 - 0.01 f_{w\%}}{91.22} \right]. \quad \dots(22)$$

Equation 22 assumes the 93.15% U^{235} enrichment used in SNAP reactors. The hydrogen weight correction is assumed to be a linear function of H/Zr ratio.

The offset swelling is dependent on the past history of the reactor as shown in the hypothetical example of Figure 3. At each time period, the saturation offset swelling, as obtained from the second part of Equation 20 with the exponential time term equal to zero, is compared to the existing offset swelling. If it is larger, then the offset swelling is increased by the additional amount that would occur in the time interval.

$$\left(\frac{\Delta V}{V} \right)_{ofs2} = \left(\frac{\Delta V}{V} \right)_{ofs1} + \left[\left(\frac{\Delta V}{V} \right)_s - \left(\frac{\Delta V}{V} \right)_{ofs1} \right] \left(1 - e^{-\Delta t/\tau} \right). \quad \dots(23)$$

If it is smaller, then the offset swelling term is not changed.

If the fuel swelling closes the allowable fuel-to-cladding gap, then the fuel slug will begin to exert a pressure on the cladding. The cladding inside radius will increase by:⁽⁸⁾

$$\delta_{cl} = \frac{r_{ci} P_c}{E_{cl}} \left(\frac{r_{ci}^2 + r_{co}^2}{r_{co}^2 - r_{ci}^2} + \mu_{cl} \right), \quad \dots (24)$$

and the fuel outer radius will decrease by:

$$\delta_f = \frac{r_{ci} P_c}{E_f} (1 - \mu_f). \quad \dots (25)$$

The two dimensional changes must be equal to the difference between the unconstrained fuel radius and the unstretched cladding. Thus, δ_c , δ_f , and contact pressure (P_c) can be determined. The stress in the cladding is then computed by:

$$\sigma_{cl} = P_c \left(\frac{r_{ci}^2 + r_{co}^2}{r_{co}^2 - r_{ci}^2} \right). \quad \dots (26)$$

D. HYDROGEN LEAKAGE

Hydrogen leakage from a fuel element segment is determined from the equation:

$$L_i = A \left(\frac{K_D N_i M}{d_{cl}} \sqrt{P} e^{-Q_{cl}/T_{cl}} + \frac{K_A G_D}{d_g} P e^{-Q_{gl}/T_{gl}} \right). \quad \dots (27)$$

The first term gives the hydrogen leakage through the bare cladding metal. It contains the multipliers, $K_D N_i$, which is the equivalent fraction of the barrier which is defective for that segment. The second term gives the hydrogen leakage through the ceramic barrier coating. The reactivity worth which corresponds to this leakage is:

$$\Delta W_H = N_p \Delta t k_{HW} \phi_H \sum_{i=1}^{10} L_i, \quad \dots (28)$$

and the new ring H/Zr ratio is:

$$(H/Zr)_n = (H/Zr)_{n-1} - k_{HZr} \sum_{i=1}^{10} L_i . \quad \dots (29)$$

E. PREPOISON AND FISSION PRODUCT EFFECTS

Three different prepoison loadings can be accounted for, each of which may have an absorption cross section which varies linearly with time. Prepoison 3 is assumed to have a daughter with its own absorption cross section and natural decay constant. In addition, the program will account for an initial tritium loading in the fuel which decays to the nuclear poison, helium-3, and has been considered as an ultimate shutdown mechanism.

The reactivity worth of xenon is accounted for and a linear buildup worth for other fission products is allowed. The xenon equations are written in such a manner so as to use the source normalized output information from the APC transport code⁽⁹⁾ as input to TEMPRO.

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III. PROGRAM OPTIONS

A. /SNGLN/ DATA BLOCK

	<u>Input Variable</u>	<u>Location</u>
1. Axial flux profile input	APHI	(1)
Cosine shape input	APHI > 0	
Table input at PHIN	APHI < 0	
2. Fuel thermal conductivity	XKF	(14)
Constant Value	XKF > 0	
Computed as a function of temperature and H/Zr	XKF < 0	
3. Fuel thermal expansion	AF	(25)
Computed by $\alpha_f = AF + BF \times T_f$	AF $\geq$ 0	
Computed by cubic lattice dimension	AF < 0	
Note: Use second option for δ phase only		
4. Number of fuel swelling correlations used	ENSWEQ	(34)
Up to three correlations are possible. The correlations are entered in data block /ARRAYN/ along with the axial locations, ZSWL, above which location each is to be used.		
5. Thermal expansion (fuel and cladding)	OPTE	(49)
Included	OPTE $\leq$ 0	
Not considered	OPTE > 0	
6. Fuel swelling	OPTS	(50)
Included	OPTS $\leq$ 0	
Not considered	OPTS > 0	

	<u>Input Variable</u>	<u>Location</u>
7. Contact pressure	OPTG	(51)
Input	OPTG > 0	
Computed	OPTG ≤ 0	
8. Read case title	TTL	(53)
Read title	TTL = 1	
No title	TTL = 0	
Note: The title is read after the second data block (ARRAYN) read		
9. Type of run	FLAG	(54)
Single element, single time	FLAG = 1	
Full core, single time	FLAG = 2	
Lifetime study, full core	FLAG = 3	
Lifetime study for four fuel gap widths to determine optimum (Input four gap widths at TGAPØP)	FLAG = 4	
10. Helium gas in gap	PHE	(58)
Enter helium gas loaded into fuel gap, psia		
11. Uranium fuel loading	PCFUEL	(63)
Constant fuel loading	PCFUEL > 0	
Variable axial fuel loading entered at PCFLV	PCFUEL ≤ 0	
12. Balance cross flow between rings	ADJFLO	(65)
Consider energy balance for cross flow	ADJFLO ≤ 0	
Not considered	ADJFLO > 0	

	<u>Input Variable</u>	<u>Location</u>
13. Fuel temperature - H/Zr relationship	CMPFLG	(74)
Average H/Zr input controlling	CMPFLG $\leq$ 0	
Local H/Zr input controlling	CMPFLG = 1	
Local fuel centerline temperature controlling	CMPFLG = 2	
Note: Use last two only if FLAG = 1 or 2		
14. Output suppression	PRNTFL	(75)
Print detailed data for each ring at each time	PRNTFL $\leq$ 0	
Suppress detailed output for FLAG = 2	PRNTFL > 0	
Prints first, last, and every n'th time for FLAG = 3 or 4	PRNTFL = n	
15. Average temperature and power shape to current time	AVGFLG	(77)
Data input at PHIRBR, TFBRBR	AVGFLG $\leq$ 0	
PHIRBR and TFBRBR set equal to last computed values	AVGFLG > 0	
Note: Use second option for FLAG = 2 only		
16. Intermediate data output	DEBUG	(78)
Prints data on iterative loops	DEBUG > 0	
B. /ARRAYN/ DATA BLOCK		
Normalized axial rod lengths	ZOL	(962-972)
Built in; 0, 0.1, 0.2. . . 0.9, 1.0	May be over- ridden	
C. /L ϕ AFDT/ DATA BLOCK		
1. Number of time steps in lifetime analysis	ENTLIF	(1)

	<u>Input Variable</u>	<u>Location</u>
2. Time plots on CRT	CRTOT	(29)
No CRT plots	CRTOT = 0	
Plot power, flow, inlet temperature, hydrogen loss, xenon worth, redistri- bution worth, prepoison worth, excess reactivity, average metal atom burnup, xenon concentration, integral fission product/burnup loss, and temperature- power defect worth	CRTOT = 1	
Also plot, for each ring, average coolant, cladding, glass, gap, fuel surface, fuel average, and peak fuel temperatures as well as H/Zr	CRTOT = 2	
Note: CRT plots can only be made for options FLAG = 3, or 4		
3. Read in new flow multipliers	WDMRD	(1895-1944)
Use existing flow multipliers	WDMRD = 0	
Read in new flow multipliers (WDM) for this time step	WDMRD > 0	
Note: Use of this option will cause a read of the /ARRAYN/ data block to accept the new flow multipliers		

IV. PROGRAM USAGE

The common block data used by the program is listed in Tables 1 through 4. The first two common blocks, /SINGLN/ and /ARRAYN/, hold the input data for the heat transfer calculations for a single time run. The /LØAFDT/ block is for reactivity and lifetime analysis computations (FLAG = 3 or 4).

Each case must have a minimum of two data block reads (/SINGLN/ and /ARRAYN/). For the local H/Zr or fuel temperature condition option (CMPFLG > 0), the /ARRAYØ/ data block is read. For lifetime runs (FLAG = 3 or 4), the /LØAFDT/ data block is read. Each data block read is ended with a minus sign (-) in Column 2 of the last card. The title card read follows the /ARRAYN/ data read unless /ARRAYØ/ is read, in which case it follows the /ARRAYØ/ read. The /LØAFDT/ data is always read last, when it is required.

For the table input in /LØAFDT/, the form is:

Location 1. Number of sets of points in table

2.

3. n_i (if used as for XNITBL)

4. x_1

5. y_1

6. x_2

7. y_2

etc.

A routine is used which will interpolate and extrapolate. Input of the number of points negative will cause printouts if extrapolation exceeds 10% of the data input range. Bad tabular data will cause a dump of common blocks and an indication of the table location. The program will be terminated.

The fuel weight percent table (PCFLV) in data block /ARRAYN/ is input alternately as PC_1 (wt %), Z/L_1 , PC_2 , Z/L_2 , etc.

The data input format is shown in Figure 4. A full set of input data is printed as part of the output for the sample problem (see Appendix).

Note that for all options, a zero time step must be run to compute some required initial parameters. For option FLAG = 1, it is required to select the proper ring (DTBP) since the data are obtained from the arrays in /ARRAYN/.

The program subroutines are listed in Table 5. The current load module map is shown in Table 6. The load module is stored on the AI disk at the Corporate Computing Center under the program name W50213. The control cards used to call it for use are:

```
//JOB LIB@@@DD@@@DSNAME = WSYS.AILIB, DISP = SHR
```

```
//GO@@@EXEC@@@W50213
```

Data card input .

The program requires 200K of computer memory storage to run. A six-ring, four-time-step case runs just under 5 sec, or about 0.2 sec per ring per time step on the IBM 360-165 computer.

TABLE 1
COMMON BLOCK /SINGLN/
(Sheet 1 of 3)

Symbol	Data	Location
APHI } BPHI }	Coefficients in $\phi_a = a \cos (\pi l / b L)$ (input $a < 0$ for table read of ϕ_A) ^a	1 2
WDX	Total core flow rate (lb/hr)	3
PCOR	Total core power, includes bypass and reflector power (kwt)	4
ENP	Total core elements	5
WFUEL	Core fuel loading (kg)	6
TCLD	Nominal cladding thickness, cold (in.)	7
TGLS	Nominal glass thickness, cold (in.)	8
TGPP	Nominal radial gap, cold (in.)	9
DP	Nominal cladding outside diameter, cold (in.)	10
ALFB	Glass accommodation coefficient	11
ALFF	Fuel accommodation coefficient	12
FFG	Fission gas release fraction	13
XKF	Fuel thermal conductivity, input 0 < to compute (Btu/hr-ft-°F)	14
SKB	Glass thermal conductivity (Btu/hr-ft-°F)	15
HMY	Fuel Meyer hardness (psi)	16
WLF	Surface roughness, fuel and glass combined (μ in.)	17
WLB	Surface wavelength, fuel and glass combined (μ in.)	18
EPS	Contact shape factor	19
	No input	20
	No input	21
AKC	Cladding thermal conductivity constant (Btu/hr-ft-°F)	22
BKC	Cladding thermal conductivity temperature slope	23
BPF	Coolant bypass fraction	24
AF } BF }	Fuel expansion: $\alpha_F = a_F + b_F T$ (input <0 to use cubic lattice size approach)	25
AC } BC }	Cladding expansion: $\alpha_c = a_c + b_c T$	27 28
EF	Fuel elastic modulus (psi x 10 ⁻⁶)	29
EC	Cladding elastic modulus (psi x 10 ⁻⁶)	30

TABLE 1
COMMON BLOCK /SINGLN/
(Sheet 2 of 3)

Symbol	Data	Location
XMUF	Fuel Poisson's ratio	31
XMUC	Cladding Poisson's ratio	32
RHOFL	Fuel-hydride density (gm/cc)	33
ENSWEQ	Number of swelling correlations used	34
PCNT	Contact pressure (psia)	35
PCNTMX	Maximum contact pressure (psia)	36
	Not currently used	37
	Not currently used	38
TIME	Operating time (hr)	39
	No input	40
HZR	Average H/Zr ratio	41
	No input	42
TAU	Time constant for offset swelling, Eq. 23 (hr)	43
	Not currently used	44
PHIRAV	Average radial power fraction to current time	45
TIN	Coolant inlet temperature, to reflector if cooled (°F)	46
PCORBR	Average core power to current time (kwt)	47
TFBR	Average fuel temperature to current time (°F)	48
OPTE	Expansion computing option: 0 - yes; 1 - no	49
OPTS	Swelling computing option: 0 - yes; 1 - no	50
OPTG	Contact pressure computing option: 0 - yes; 1 - no	51
PHITYM	Time to hold BOL radial power distribution (hr)	52
TTL	Title read flag: 0 - no; 1 - yes	53
FLAG	Program flag: 1-single element, 2-all rings, 3-lifetime, 4-optimize	54
ENFR	Number of full element rings	55
ENR1	Number of elements in 1st partial ring	56
ENR2	Number of elements in 2nd partial ring	57
PHE	He loading pressure (psia)	58
TEOL	EOL time, for radial power distribution (hr)	59

TABLE 1
COMMON BLOCK /SINGLN/
(Sheet 3 of 3)

Symbol	Data	Location
TMOL	Time for mid-life power distribution (hr)	60
DTBP	Ring number for single element run	61
CPCL	Coolant specific heat (Btu/lb-°F)	62
PCFUEL	Fuel fraction (wt %)	63
	Not currently used	64
ADJFLO	Cross-flow calculation; 0 - yes; 1 - no	65
FLOFCT	Factor applied to outer ring flow to account for nonheating (built in as 1)	66
PBP	Power absorbed by bypass flow (kwt)	67
PREF	Power generated in reflector (kwt)	68
PSHT	Power shorted to reflector from outer rings (kwt)	69
	Not currently used	70
	Not currently used	71
	Not currently used	72
	Not currently used	73
CMPFLG	Flag to read in either H/Zr or fuel temperature (1 or 2)	74
PRNTFL	Flag to control printout; >0 suppresses detailed data for Option 2, prints every i th time for Options 3 and 4	75
	Not currently used	76
AVGFLG	Flag >0 sets PHIRBR and TRBRBR = current values for next case (Option 2 only)	77
DEBUG	Positive value prints iteration data if problems occur	78
TLOLD	Time of last calculation (hr)	79
DVFLG	Sets old swelling value = 0 if positive	80

TABLE 2
COMMON BLOCK /ARRAYN/

Symbol	Data	Location
BBA(3)	Burnup coefficient; b in Eq. 20	1-3
RSWL(3)	Burnup exponent; r in Eq. 20	4-6
OFFSET(3)	Offset coefficient; a_A in Eq. 20	7-9
ENSWL(3)	Offset exponent; n in Eq. 20	10-12
XSWL(3)	Offset exponent; x in Eq. 20	13-15
ZSWL(3)	Z/L factors for changing correlations	16-18
TACT(3)	Activation temperature; Eq. 20	19-21
TCM(11, 20)	Cladding thickness multipliers, by axial node and by ring	22-241
WDM(11, 20)	Coolant flow multipliers	242-461
DPM(11, 20)	Cladding outside diameter multipliers	462-681
DFM(11, 20)	Fuel diameter multipliers	682-901
PHI(20, 3)	Radial power ratio, by ring and for up to three time intervals	902-961
ZOL(11)	Normalized axial rod length, built in 0-1.0 may be overridden	962-972
TF1(11)	Nominal fuel average temperatures, built in	973-983
HCR(20)	Ring coolant film coefficients (Btu/hr-ft ² -°F)	984-1003
XL(20)	Ring fuel element lengths (ft)	1004-1023
PCL(11)	Axial coolant pressures (psia)	1024-1034
HCM(11, 20)	Coolant film coefficient multipliers	1035-1254
VCAP(20)	End cap volume (in. ³)	1255-1274
BPM(11)	Bypass fraction multipliers	1275-1285
PHIN(11)	Axial power distribution if other than cosine	1286-1296
PHIRBR(20)	Average radial power fraction to current time / ring	1297-1316
TFBRBR(20)	Average fuel temperature to current time / ring	1317-1336
OFFSEX(3)	Offset coefficient; a_B in Eq. 20	1337-1339
PCFLV(20)	Fuel fraction (wt %), axial vs Z/L	1340-1359
PHIRM(20)	Fuel enrichment multipliers, by ring	1360-1379

- NOTES: 1. TCM, WDM, DPM, DFM, HCM, and BPM built in = 1.0.
ZOL built in = 0.0 - 1.0 in 0.1 increments.
TF1 built in = 1170, 1200, 1250, 1300, 1350, 1390, 1410, 1420, 1415, 1395, 1350.
2. To set multipliers equal but other than 1, input desired value in (1, N) and -1. in (2, N) similarly for XL, HCR and VCAP only.

TABLE 3
COMMON BLOCK /ARRAY ϕ /; (OUTPUT)
(Sheet 1 of 2)

Symbol	Data	Location
TBULK(11,20)	Local coolant bulk temperature ($^{\circ}$ F)	1-220
TCLAD(11,20)	Local coolant-cladding interface temperature ($^{\circ}$ F)	221-440
TGLASS(11,20)	Local cladding-glass interface temperature ($^{\circ}$ F)	441-660
TGAP(11,20)	Local glass-gap interface temperature ($^{\circ}$ F)	661-880
TSURF(11,20)	Local fuel surface temperature ($^{\circ}$ F)	881-1100
TCENTL(11,20)	Local fuel centerline temperature ($^{\circ}$ F)	1101-1320
TFAVG(11,20)	Local fuel average temperature ($^{\circ}$ F)	1321-1540
PHIA(11)	Local axial power ratio	1541-1551
QPR(11,20)	Local heat flux (Btu/hr-ft)	1552-1771
HZ(11,20)	Local H/Zr ratio	1772-1991
DFLA(11,20)	Local fuel diameter (in.)	1992-2211
DPA(11,20)	Local cladding outside diameter (in.)	2212-2431
TGPX(11,20)	Local gap thickness (in.)	2432-2651
UA(20)	Average UA (kwt/ $^{\circ}$ F)	2652-2671
UGPO(11,20)	Local gap conductance (Btu/hr-ft ² - $^{\circ}$ F)	2672-2891
WDTX(11,20)	Local coolant flow rate (lb/hr)	2892-3111
TCLDX(11,20)	Local cladding thickness (in.)	3112-3331
UAL(11,20)	Local UA (kwt/ $^{\circ}$ F)	3332-3551
PN(11,20)	Local ZrH phase 1 = $\beta + \delta$, 2 = $\alpha + \delta$, 3 = δ , 4 = $\delta + \epsilon$, 5 = ϵ	3552-3771
XMFPL(11,20)	Local H ₂ mean free path length (in.)	3772-3991
PCON(11,20)	Local contact pressure (psi)	3992-4211
TBLKAV(20)	Average coolant bulk temperature ($^{\circ}$ F)	4212-4231
TCLDAV(20)	Average cladding temperature ($^{\circ}$ F)	4232-4251
TGLSAV(20)	Average glass temperature ($^{\circ}$ F)	4252-4271
TGAPAV(20)	Average gap temperature ($^{\circ}$ F)	4272-4291
TCNTAV(20)	Average fuel centerline temperature ($^{\circ}$ F)	4292-4311

TABLE 3
COMMON BLOCK /ARRAYØ/; (OUTPUT)
(Sheet 2 of 2)

Symbol	Data	Location
PGAS(20)	Gap gas pressure (psia)	4312-4331
HZAV(20)	Average H/Zr ratio	4332-4351
RODLN(20)	Fuel rod length (in.)	4352-4371
XH1(20)	Gap hydrogen fraction	4372-4391
XZ1(20)	Gap xenon fraction	4392-4411
DVSAV(20)	Average fuel swelling (%)	4412-4431
PHIRR(20)	Ring radial power ratio	4432-4451
XNH(20)	Average gap conductance (Btu/hr-ft ² -°F)	4452-4471
ENPR(20)	Number of elements in ring	4472-4491
TSRFAV(20)	Average fuel surface temperature (°F)	4492-4511
TFLAV(20)	Average fuel temperature (°F)	4512-4531
SIG(11,20)	Local cladding stress level (psi)	4532-4751
XHE1(20)	Gap helium fraction	4752-4771
WDAV(20)	Average coolant flow (lb/hr)	4772-4791
PKFTMP(20)	Peak fuel temperature (°F)	4792-4811
PKFAVT(20)	Peak fuel average temperature (°F)	4812-4831

TABLE 4
COMMON BLOCK /LØAFDT/
(Sheet 1 of 3)

Symbol	Data	I/O*	Location
ENTLIF	Number of time steps used	I	1
Q1	Activation temperature for defect H ₂ losses; Eq. 27 (°F)	I	2
Q2	Activation temperature for barrier H ₂ losses; Eq. 27 (°F)	I	3
XKA	Barrier permeation constant; Eq. 27	I	4
TLOPT	Optimum lifetime	O	5
WHNOM	Conversion factor, hydrogen worth (\$/cc H ₂ - element)	I	6
SUMPWR	Power summation to current time	O	7
APP1	a in Prepoison 1 loading	I	8
BPP1	b in Prepoison 1 loading	I	9
PP1LD	Prepoison 1 loading (\$)	I	10
APP2	a in Prepoison 2 loading	I	11
BPP2	b in Prepoison 2 loading	I	12
PP2LD	Prepoison 2 loading (\$)	I	13
APP3	a in Prepoison 3 loading	I	14
BPP3	b in Prepoison 3 loading	I	15
PP3LD	Prepoison 3 loading (\$)	I	16
DTRLP	Prepoison 3 daughter loading (\$)	I	17
ABSDTR	Daughter absorption cross section (barns)	I	18
FRCDTR	Prepoison 3 daughter fraction	I	19
DTRDEC	Daughter natural decay constant (mo ⁻¹)	I	20
HE3LD	Helium 3 loading (\$)	I	21
WHE3UL	Ultimate helium 3 worth (\$)	I	22
ABSHE3	Helium 3 absorption cross section (barns)	I	23
WXENOM	Initial xenon worth (\$)	I	24
WRDNOM	Initial hydrogen redistribution worth (\$)	I	25
U235CS	Uranium fission cross section (barns)	I	26
SWLLMT	Swelling limit, minimum gap (in.)	I	27
REALMT	Reactivity limit, excess reactivity (\$)	I	28

*I denotes input item, O denotes output.

TABLE 4
COMMON BLOCK /LOAFDT/
(Sheet 2 of 3)

Symbol	Data	I/O *	Location
CRTOT	Flag to write time step data on tape for CRT	I	29
XMI	Cladding permeation constant; Eq. 27	I	30
XKHZ	Conversion factor, H/Zr (H/Zr/cc H ₂ -element)	I	31
XECCS	Initial core excess reactivity, hot (\$)	I	32
PREF	Normalizing power for fission products (kwt)	I	33
RADIUS	Core radius (in.)	I	34
HEIGHT	Core height, active fuel (in.)	I	35
HALFLA	Decay constant for iodine (sec ⁻¹)	I	36
HALFLB	Decay constant for xenon (sec ⁻¹)	I	37
SIGMAA	Absorption cross section for iodine (barns)	I	38
SIGMAB	Absorption cross section for xenon (barns)	I	39
GNU	U-235 atom density (atoms x 10 ⁻²⁴ /cc)	I	40
WORTH	Equilibrium xenon worth at reference power (\$)	I	41
FLXINT	Integrated flux value; 17.55 built in	I	42
EIGEN	Eigenvalue; 1.0 built in	I	43
TFPOPT	Optimum gap, radial (in.)	O	44
GNUBAR	Average ν ; 2.43 built in	I	45
GAMMAA	Iodine fission product yield	I	46
GAMMAB	Xenon fission product direct yield	I	47
FPBUCCO	Fission product buildup (\$/kw-month)	I	48
TEMPCO	Temperature coefficient (\$/°F)	I	49
POWCO	Power coefficient (\$/kw)	I	50
TLIF(50)	Times used for LOAFR2 calculations (mo)	I	51-100
TINT(50)	Inlet temperatures corresponding to TLIF (°F)	I	101-150
WDOTI(50)	Core flow rates corresponding to TLIF (lb/hr)	I	151-200
PCORT(50)	Core power levels corresponding to TLIF (kwt)	I	201-250
XKDTBL(53)	Defect constant vs time table; K _D in Eq. 27	I	251-303
XNITBL(53,3)	Defect loss rate vs time and Z/L table (Z/L in Location 3); N ₁ in Eq. 27	I	304-462
PHIIHH(20)	H ₂ worth fraction for each ring	I	463-482

*I denotes input item, O denotes output.

TABLE 4
COMMON BLOCK /LØAFDT/
(Sheet 3 of 3)

Symbol	Data	I/O*	Location
WHA VG(50)	Average core hydrogen worth corresponding to TLIF (\$)	O	483-532
XLI(10,20)	H ₂ loss over a given time increment (cc)	O	533-732
TGAPOP(4)	Gap widths used for optimization (in.)	I	733-736
TSWL(4)	Time to reach swelling limit (mo)	O	737-740
TREAC(4)	Time to reach reactivity limit (mo)	O	741-744
SUMFT(20)	Fuel temperature summation to current time (°F)	O	745-764
SUMPHI(20)	Radial power fraction summation to current time	O	765-784
HDELW(20)	Hydrogen loss worth per ring (\$)	O	785-804
BRNUP(11,20)	Burnup (met. at. %)	O	805-1024
SWLND(11,20)	Swelling at each node (%)	O	1025-1244
W1(50)	Current worth of Prepoison 1 (\$)	O	1245-1294
W2(50)	Current worth of Prepoison 2 (\$)	O	1295-1344
W3(50)	Current worth of Prepoison 3 (\$)	O	1345-1394
WD(50)	Current worth of daughter (\$)	O	1395-1444
WH(50)	Current worth of He-3 (\$)	O	1445-1494
EQXEW(50)	Current equivalent xenon worth (\$)	O	1495-1544
EQRDST(50)	Current equivalent redistribution worth (\$)	O	1545-1594
REACEX(50)	Current excess reactivity (\$)	O	1595-1644
BRNMA(50)	Core average burnup (met. at. %)	O	1645-1694
ACCFP(50)	Fission products accumulation (atoms/cc)	O	1695-1744
PPW(50)	Current total prepoison worth (\$)	O	1745-1794
FPBU(50)	Fission product burnup worth (\$)	O	1795-1844
TMPWDF(50)	Temperature-power defect (\$)	O	1845-1894
WDMRD(50)	Flag to read in new flow multipliers if >0	I	1895-1944
GLPEC	Glass barrier effectiveness; G _D in Eq. 27	I	1945

*I denotes input item, O denotes output.

DECK NO. _____ PROGRAMMER _____ DATE _____ PAGE _____ OF _____ JOB NO. _____

FOR PROGRAM NO. _____ TITLE DATA INPUT FORMAT BY DEPT. _____ GROUP _____

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Figure 4. Data Input Format

FORTRAN WORK SHEET

DECK NO. _____ PROGRAMMER _____ DATE _____ PAGE _____ OF _____ JOB NO. _____

FOR PROGRAM NO. _____ TITLE DATA INPUT FORMAT BY DEPT. _____ GROUP _____

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ERRATA
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Figure 4. Data Input Format

FORTRAN WORK SHEET

DECK NO. _____ PROGRAMMER _____ DATE _____ PAGE _____ OF _____ JOB NO. _____
 FOR PROGRAM NO. _____ TITLE DATA INPUT FORMAT BY DEPT _____ GROUP _____

NOTE: FOR A COMPLETE DATA INPUT - SEE THE SAMPLE PROBLEM.							IDENTIFICATION		
1	10	20	30	40	50	60	70	73	80
LOCATION FOR DATA									
1	1	3	7	1	6	9	9	0	1
6	9	0	4	0	0	2	5	0	0
6	9	1	4	0	0	0	2	5	0
7	6			1					
END OF DATA BLOCK									
1	3	2	1						
2	4	2	1	0					
1	3	3	7	5	7	6			
END OF DATA BLOCK									
TITLE CARD INFORMATION									

Figure 4. Data Input Format

ERRATA
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TABLE 5
TEMPRO DECK SETUP

Name	Function
TEMPRO2	Main direction program
TEMPRO	Heat transfer - performance calculations
LOAFR2	Hydrogen loss - reactivity and bookkeeping calculations
BLOCK	Block data - common initialization (except /LØAFDT/)
BULKT	Compute coolant temperatures with crossflow
DRWR	Input read/write routine
XMULT	Sets arrays = to 1st value for input simplicity
WMADJ	Checks flow multipliers and adjusts to suit mass balance
PHIX	Computes $\phi_R = f(N_{RING}, T)$
PCNTCT	Computes contact pressure and stress
PZH	Computes pressure, temperature, and H/Zr relationship
CUBLAT	Computes cubic lattice dimension of ZrH
PHASE	Computes ZrH phase
CONDF	Computes fuel conductivity = $f(H/Zr, T)$
DYDX	Computes value of variable used for iteration by 2nd order fit
PAR	Computes $y = ax^2 + bx + c$ for three point input
PARFIT	2nd degree polynomial interpolation routine
HYPT	Computes maximum fuel average and centerline temperatures
NLEST	Iteration routine using method of chords
PREPOI	Computes prepoison reactivity gains
BLLOAF	Initializes /LØAFDT/
ENI	Computes Ni in H ₂ leakage equation
OPTMYZ	Computes optimum radial gap
NLTRP	Interpolation routine using up to four points
POLY4	Four point curve fit routine
NLERR	Common dump on table input or NLEST error
HEADO	Prints BOL reactor data for Options 3 and 4
HEAD1	Prints detailed element temperature distributions
HEAD2	Prints element operating conditions for Option 1
HEAD3	Prints ring average data
HEAD4	Prints time step reactivity, flow, power, etc. data
HEAD5	Prints gap optimization data
REDIST	Computes hydrogen redistribution worth (currently a dummy routine)
XENON	Computes equivalent xenon worth and fission product buildup

TABLE 6
LOAD MODULE MAP
(Sheet 1 of 2)

FRR-LEVEL LINKAGE EDITOR OPTIONS SPECIFIED MAP LIST									
DEFAULT OPTION(S) USED - SIZE=(1022376,12284)									
INCLUDE SYSDLD(W50213)									
IEW0000	ENTRY MAIN								
IEW0000	NAME W50213(4)								
IEW0461	SCRIV								
IEW0461	SCRIV								
3/28/73									
TEMPRØ 2									
MODULE MAP									
CONTROL SECTION			ENTRY						
NAME	ORIGIN	LENGTH	NAME	LOCATION	NAME	LOCATION	NAME	LOCATION	NAME
TEMPRO	JJ	3098							
PZH	3078	400							
HEAD1	4258	808							
HEAD3	4E30	1280							
HEAD4	6280	1FA							
MAIN	6880	A02							
BULK1	7688	2208							
NLFRR	9890	4F7							
CUSLAT	9D78	4A0							
PAR	A218	2F2							
PARFIT	A480	480							
PHAS1	A910	672							
ROOT3	AF88	442							
YREAC	B200	410							
YLIM	B7E0	200							
HEAD5	B9F0	280							
XENDV	BC90	480							
COND1	C150	2A2							
ENI	C3F8	1FC							
HEAD2	C5E8	570							
PCF	C868	148							
CRT	CC80	2883							
XMULT	E038	3F6							
PREP1	F420	8C4							
HEAD0	FFFF	826							
ALL0AF	10820	232							
OPTMYZ	10A08	24E							
NAME	ORIGIN	LENGTH	NAME	LOCATION	NAME	LOCATION	NAME	LOCATION	NAME
REDIST	10C88	DE							
PHIX	10D98	364							
WMADJ	11100	970							
SINGLN	11A70	258							
ARRAYN	11CC8	1770							
ARRAY0	12438	4F20							
LOAFR2	18258	1956							
PCNTCT	198B0	4A8							
OYDX	1A058	7A4							
SCRND	1A800	304							
NLEST	1A808	484							
STDCRT	1AF00	F2E							
DRWR	1B8F0	53E							
HYPT	1C420	28F							
POLY4	1C7C0	A1E							
NLTRP	1D1F0	AA6							
IHCSSLOG	1DC88	186	ALOG10	1DC98	ALOG	1DCA0			
IHCSSASN	1DE40	1DF	ARCOS	1DE40	AP SIN	1DE56			
IHC SATN2	1F020	1CB	ATAN2	1F020	ATAN	1F034			
IHCSSCN	1F1F0	109	COS	1F1F0	SIN	1F209			
COSD	1F370	24C	SIND	1F5C8					
IHCSEXP	1E620	192	EXP	1E620					
IHC FRXPR	1F7B8	143	FRXPR#	1F7B8					
IHC ECDM4	1E940	F41	IBCOM#	1E940	FDINCS#	1F9FC	INTSWTCH	1F966	
IHC ECDM2	1F888	65D	SFQNASD	1FC00					
IHCSSQRT	1FEF8	145	SQRT	1FEF8					
CUTRV	20030	130	CUTIV	20000					
DXDYV	20160	72A							
SMRCRT	20890	08							
CTAPFV	20958	4							

TABLE 6
LOAD MODULE MAP
(Sheet 2 of 2)

NAME	ORIGIN	LENGTH	NAME	LOCATION	NAME	LOCATION	NAME	LOCATION	NAME	L
FRAMEV	20960	9F7	RESETV	20978	CAMRAV	20848	IDFRM#	208F8		
GRID1V	21358	918								
LARLV	21C70	5C8								
LINEV	22238	33C								
NXV	22578	37C	IXV	227F8	NYV	2284C	IYV	228A0		
POINTV	228F8	26C								
RITE2V	22868	43C	RITSTV	2287E	RITXYV	228E4				
IHCFCVTH	22F88	119D	ADCON#	22FA8	FCVANOUTP	23052	FCVLJUTP	230F2	FCV7OUTP	
			FCVINOUTP	22FE0	FCVEOUTP	23AE2	FCVCJUTP	23CFC	INT6SWCH	
IHCENFTH	24148	512	ARITH#	24148	ADJSWTC1	244B4				
ATAND	24660	15E								
FIOCS#	247C0	308								
IHCERRM	24898	58C	FRM70N	24838	IHCPRF	24880				
IHCUOPT	25158	310								
PRINTV	25468	F0								
SETCIV	25558	314	SMXYV	2570C	SFTMIV	25764	HJLDIV	257CC	STBLPV	
ACCTV	25970	94	ACCTMSG#	258DA	ACCTSVCS	253F4				
ACCTQ	25908	3C								
COATEV	25948	184								
EXFRMV	25AD0	C4								
IHCFRXPI	25B98	141	FRXPI#	25B98						
LINRV	25CE0	7C4								
TRANSV	264A8	148	TRANSQ	264F0						
X4020V	265F0	2F8	ENDINV	2674C	TRIUNC#	26868				
C4020V	268D8	4A6	T4020V	26930	P4020V	269C4	A4020V	26A78	V4020V	
BRITEV	26D80	150	FAINTV	26F8C						
ERRLV	26E00	362								
ERRNLV	27238	2D8								
NAME	ORIGIN	LENGTH	NAME	LOCATION	NAME	LOCATION	NAME	LOCATION	NAME	L
NONLV	27510	5C8								
SCEPRV	27AD8	C8	SCERV	27A7E	SERKEV	27B34	SFRSAV	27B5F		
STOPTV	27BA0	90								
VXAXV	27C30	284	VYAXV	27F50						
XSCALV	27EB8	2F0	YSCALV	28140						
ARGQ	281A8	50								
BNBCOV	281F8	2C2								
HOLLV	284C0	2E								
INSETO	284F0	15C								
TABLIV#	28650	514	TABLIV	28658						
VCHARV	28868	130	CHSIV	28B7F	PTSIV	28BA8	VCHX	28F14	VCHY	
XMODV	28F98	F2								
YMODV	28FB0	F2								
ERMKV	29068	DE								
IHCFFIOS	29148	1378	FIOCS#	29148	FIOCSBFP	2914F				
IHCUATBL	2A4C0	208	IHSUATHI	2A4C0						
IHCETRC1	2A6C8	28E	IHCETRC1	2A6C8	PORTRA	2A6D0				
IHCNOVER	2A958	50	OVERFL	2A958						
LOAFDT	2A9A8	1F40								
MISC	2C8F8	48								
GAPK	2C930	184								
ENTRY ADDRESS	6880									
TOTAL LENGTH	2CA88									

*****50213 NEW REPLACED IN DATA SET

DIAGNOSTIC MESSAGE DIRECTORY

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APPENDIX
SAMPLE PROBLEM OUTPUT

Note that input data cards are listed at beginning of output.

CARD ORIGIN	LINE 2	LINE 3	LINE 4	LINE 5	LINE 6	CARD ID
1	-1.37	1.182	16990.	99.4	85.	00010001
6	9.04	0.025	0.0025	0.0060	1.005	00010006
11	0.3	0.9	0.00005	-12.0	1.	00010011
16	30000.	65.	10000.	0.538		00010016
21		5.26	0.006107	0.005	7.232 E-06	00010021
26	-0.34 E-09	7.3525 E-06	1.0375 E-09	12.	24.	00010026
31	0.4	0.37	6.11	1.		00010031
41	1.60		500.			00010041
46	1116.8					00010046
51	1.	50000.	1.	3.	5.	00010051
56	24.	0.	3.	50000.	50000.	00010056
61		0.2095	10.5	0.15	1.	00010061
69	1.4					00010069
76			1.			00010076
-1						00010999

CARD ORIGIN	LINE 2	LINE 3	LINE 4	LINE 5	LINE 6	CARD ID
1	3.21			1.		00012001
6		0.				00012006
11			3.0			00012011
16				27000.		00012016
242	1.00	-1.				00012242
253	1.00	-1.				00012253
264	1.00	-1.				00012264
275	1.00	-1.				00012275
286	0.99	-1.				00012286
297	1.01	-1.				00012297
902	1.35	1.29	1.21	1.08	0.96	00012902
907	0.79					00012907
984	3680.	3680.	3680.	3670.	3570.	00012984
989	3280.					00012989
1004	1.3333	-1.				00013004
1024	25.0	24.9	24.8	24.7	24.6	00013024
1029	24.5	24.4	24.3	24.2	24.1	00013029
1034	24.0					00013034
1255	0.15	-1.				00013255
1286	0.33	0.32	1.11	1.29	1.36	00013286
1291	1.32	1.23	1.11	0.90	0.595	00013291
1296	0.20					00013296
1337	5.76 E+06					00013337
-1						00013999

CARD ORIGIN	LINE 2	LINE 3	LINE 4	LINE 5	LINE 6	CARD ID
1	4.	14500.	20800.	38.		00015001
6	3.49 E-06		511.5		3.	00015006
11				359.		00015011
16			180.	0.7	4.44 E-03	00015006
26	19.9	0.	0.5		1500.	00015026
31	0.835 E-05	2.75	600.	4.964	16.	00015031
36	2.87 E-05	2.09 E-05	0.	6.14 E+04	1.14 E-03	00015036
41	1.05					00015041
46	0.061	0.003	0.00014	0.002	0.0004	00015046
51	0.	24.0	48.	60.		00015051
101	1050.	1077.6	1105.	1105.		00015101
151	17030.	17010.	16990.	16990.		00015151
201	91.0	94.7	99.4	99.4		00015201
251	2.			0.	0.0025	00015251
256	60.	0.0025				00015256
304	2. Number of Points		0. Z/L	0.	1.	00015304
309	60.	1.				00015309
357	2.		0.5	0.	1.	00015357
362	60.	1.				00015362
410	2.		1.	0.	1.	00015410
415	60.	1.				00015415
463	2.10	1.99	1.74	1.36	0.96	00015463
468	0.52					00015468
1945	0.0762					00016945
-1						00016999

8- ELEMENT CHECKOUT CASE 4 TIME STEPS

ADJUSTED FLOW MULTIPLIERS TO ATTAIN MASS BALANCE

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
RING											
1	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)
2	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)
3	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)
4	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)	1.0000 (1.0000)
5	0.9900 (0.9900)	0.9900 (0.9900)	0.9900 (0.9900)	0.9900 (0.9900)	0.9900 (0.9900)	0.9900 (0.9900)	0.9900 (0.9900)	0.9900 (0.9900)	0.9900 (0.9900)	0.9900 (0.9900)	0.9900 (0.9900)
6	1.0100 (1.0100)	1.0100 (1.0100)	1.0100 (1.0100)	1.0100 (1.0100)	1.0100 (1.0100)	1.0100 (1.0100)	1.0100 (1.0100)	1.0100 (1.0100)	1.0100 (1.0100)	1.0100 (1.0100)	1.0100 (1.0100)
TEMP	1050.0	1055.0	1062.4	1072.7	1085.4	1097.0	1108.1	1118.3	1127.1	1132.6	1137.0

*** () DENOTES INPUT VALUE ***

BEGINNING OF LIFE REACTOR DATA

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

ELEMENT DATA

THERMAL-HYDRAULIC DATA

CLAD OUTSIDE DIAMETER, IN	1.0050	CORE POWER, KWT	91.
CLAD THICKNESS, IN	0.0250	COOLANT INLET TEMPERATURE, DEG F	1050.
BARRIER THICKNESS, IN	0.0025	COOLANT INLET PRESSURE, PSIA	75.00
RADIAL GAP WIDTH, IN	0.0060	COOLANT OUTLET PRESSURE, PSIA	24.00
FUEL DIAMETER, IN	0.0380	COOLANT FLOW RATE, LB/HR	17030.
FUEL LENGTH, FT	1.222	COOLANT TEMPERATURE RISE, DEG F	87.
H/ZR RATIO	1.6000	BYPASS FRACTION	0.005
URANIUM LOADING, WT %	10.500	POWER TO BYPASS, KWT	0.
		POWER TO REFLECTOR, KWT	0.
NUMBER OF ELEMENTS	85.	POWER SHORTED, KWT	1.4

PREPILSON DATA

GENERAL NUCLEAR DATA

PREPILSON NO	1	2	3	URANIUM LOADING, KG	9.04
WORTH, \$	3.00	0.0	0.0	EQUIVALENT XENON WORTH, \$	0.0
CONSTANT A	11.50	0.0	359.00	EQUIVALENT REDIST WORTH, \$	0.0
CONSTANT B	0.0	0.0	0.0	EXCESS REACTIVITY, \$	2.75
HELIUM 3 WORTH, \$			0.0	FOL DESIGN REACTIVITY MARGIN, \$	0.50
DAUGHTER WORTH, \$			0.0	FOL DESIGN SWELLING MARGIN, IN	0.0
ULTIMATE HELIUM WORTH, \$			0.0	ELEMENT HYDROGEN WORTH, \$	0.00

CORE SUMMARY DATA AT 0. HOURS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

DATA	RING -	1	2	3	4	5	6
AVG COOLANT TEMP, F		1113.1	1110.3	1106.7	1100.7	1095.7	1085.5
AVG CLAD TEMP, F		1118.0	1115.1	1111.1	1104.7	1099.3	1088.7
AVG GLASS TEMP, F		1120.8	1117.7	1113.6	1106.9	1101.3	1090.3
AVG GAP TEMP, F		1144.7	1140.6	1135.2	1126.3	1118.6	1104.7
AVG FUEL SURF TEMP, F		1167.2	1162.1	1155.4	1144.5	1134.8	1118.2
AVG FUEL TEMP, F		1192.0	1175.2	1167.6	1155.4	1144.5	1126.2
AVG FUEL CENTL TEMP, F		1196.8	1188.3	1179.9	1166.3	1154.2	1134.2
PEAK FUEL CENTL TEMP, F		1242.6	1226.0	1215.3	1198.0	1182.7	1156.7
PEAK FUEL AVG TEMP, F		1223.2	1211.7	1201.9	1186.0	1172.0	1147.7
AVG UA, KW/DEG		1.782	1.809	1.805	1.797	1.788	1.768
RADIAL POWER RATIO		1.3492	1.2892	1.2093	1.0794	0.9594	0.7895
GAP PRESSURE, PSIA		0.376	0.343	0.312	0.263	0.225	0.172
AVG H/ZP RATIO		1.6000	1.6000	1.6000	1.6000	1.6000	1.6000
HYDROGEN FRACTION		0.0291	0.0268	0.0245	0.0208	0.0181	0.0139
HELIUM FRACTION		0.9709	0.9732	0.9755	0.9792	0.9819	0.9861
XENON FRACTION		-0.0000	-0.0000	0.0000	0.0	-0.0000	-0.0000
FUEL ROD LENGTH, INCHES		16.210	16.231	16.241	16.239	16.237	16.234
NO. OF ELEMENTS		1.	6.	12.	18.	24.	24.
AVG COOLANT FLOW, LB/HR		199.351	199.351	199.351	199.351	197.357	201.344
AVG GAP CONDUCTANCE		325.0	323.9	322.8	320.9	319.3	316.7
AVG. VOLUME SWELLING, %		0.0	0.0	0.0	0.0	0.0	0.0

REACTIVITY DATA

POWER, KWT	91.0
INTEGRAL HYDROGEN LOSS, %	0.0
CURRENT XENON WORTH, %	0.0
CURRENT REDISTRIBUTION WORTH, %	0.0
CURRENT PREPOISON WORTH, %	3.000
CURRENT EXCESS REACTIVITY, %	0.807
PREPOISON 1 WORTH CHANGE, %	0.0
PREPOISON 2 WORTH CHANGE, %	0.0
PREPOISON 3 WORTH CHANGE, %	0.0
DAUGHTER WORTH CHANGE, %	0.0
HELIUM 3 WORTH CHANGE, %	0.0
INTEGRAL FBH LOSS, %	0.0
TEMP & POWER DEFECT WORTH, %	1.943

BURNUP & COOLANT DATA

AVG COOLANT OUTLET TEMP, DEG F	1137.0
AVG COOLANT TEMP RISE, DEG F	87.0
COOLANT INLET TEMP, DEG F	1050.0
COOLANT BYPASS TEMP RISE, DEG F	0.0
COOLANT FLOW RATE, LB/HR	17230.
MAXIMUM M/A BURNUP, %	0.0
RING & Z/L	1 & 0.0
MAX. VOL. SWEL, %	0.0
M/A BURNUP NORM BY MAX. SWEL.	0.0
RING & Z/L	1 & 0.0
CORE AVG M/A BURNUP, %	0.0
XENON CONC., ATOMS/CC	0.0
FUEL INVENTORY, KG	2.040

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS
85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1051.3	1058.1	1059.5	1083.7	1090.3	1115.1	1130.2	1144.0	1155.9	1164.7	1169.4
CLAD OUTER TEMP	1052.6	1061.2	1073.7	1088.5	1104.4	1120.1	1134.8	1148.1	1159.2	1166.9	1170.1
CLAD/GLASS TEMP	1053.4	1063.3	1076.4	1091.7	1107.8	1123.3	1137.8	1150.8	1161.4	1168.3	1170.6
GLASS/GAP TEMP	1054.4	1065.7	1079.8	1095.6	1111.9	1127.3	1141.5	1154.2	1164.1	1170.1	1171.2
FUEL SURFACE TEMP	1069.9	1103.4	1130.1	1153.4	1172.6	1186.0	1196.2	1203.6	1204.4	1197.0	1180.4
AVERAGE FUEL TEMP	1074.1	1113.8	1144.2	1170.5	1191.5	1205.7	1216.3	1223.1	1219.9	1206.3	1183.1
FUEL CENTER TEMP	1078.2	1124.1	1158.3	1187.5	1210.4	1225.4	1236.5	1242.6	1235.4	1215.5	1185.9
AXIAL POWER RATIO	0.330	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0133	1.0134	1.0136	1.0137	1.0138	1.0140	1.0141	1.0143	1.0144	1.0144	1.0145
FUEL SLUG DIAM.	0.9445	0.9447	0.9449	0.9451	0.9452	0.9453	0.9453	0.9454	0.9454	0.9453	0.9451
TEMP. JUMP, MILS	0.3666	0.3733	0.3795	0.3858	0.3907	0.3954	0.3988	0.4019	0.4035	0.4032	0.4009
GAP CONDUCTANCE	311.9	318.7	323.2	326.8	328.1	329.1	327.3	328.9	327.2	323.7	318.8
LOCAL HEAT FLUX	1204.	2993.	4051.	4708.	4963.	4817.	4489.	4051.	3284.	2171.	730.
COOLANT FLOW, LB/HR	199.35	199.35	199.35	199.35	199.35	199.35	199.35	199.35	199.35	199.35	199.35
LOCAL UA, KW/DFG	1.783	1.809	1.824	1.825	1.811	1.789	1.753	1.723	1.726	1.757	1.786
LOCAL H/ZR RATIO	1.719	1.678	1.644	1.612	1.591	1.573	1.557	1.547	1.549	1.566	1.597
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-256.0	-254.0	-252.0	-250.0	-248.0	-246.0	-243.9	-241.9	-239.9	-237.9	-235.9
RADIAL GAP, MILS	6.7314	6.6519	6.6169	6.6025	6.6241	6.6500	6.6782	6.7165	6.7713	6.8451	6.9329

THE ABOVE DATA IS FOR RING NO 1 CONTAINING 1 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS
85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1051.3	1057.8	1068.7	1082.2	1097.2	1112.3	1126.7	1139.9	1151.2	1159.6	1164.1
CLAD OUTER TEMP	1052.5	1060.7	1072.7	1086.8	1102.0	1117.0	1131.1	1143.8	1154.4	1161.8	1164.8
CLAD/GLASS TEMP	1053.3	1062.7	1075.3	1089.9	1105.2	1120.1	1133.9	1146.4	1156.5	1163.1	1165.3
GLASS/GAP TEMP	1054.3	1065.1	1078.5	1093.6	1109.2	1123.9	1137.5	1149.6	1159.1	1164.8	1165.9
FUEL SURFACE TEMP	1069.1	1101.1	1126.7	1149.0	1167.2	1180.2	1189.9	1197.0	1197.7	1190.6	1174.7
AVERAGE FUEL TEMP	1073.4	1111.8	1141.2	1165.9	1185.0	1197.4	1206.0	1211.5	1209.5	1198.4	1177.3
FUEL CENTER TEMP	1077.7	1122.6	1155.7	1182.7	1202.7	1214.6	1222.0	1226.0	1221.2	1206.7	1179.9
AXIAL POWER RATIO	0.330	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0133	1.0134	1.0135	1.0137	1.0138	1.0140	1.0141	1.0142	1.0143	1.0144	1.0144
FUEL SLUG DIAM.	0.9445	0.9447	0.9449	0.9450	0.9451	0.9452	0.9453	0.9453	0.9453	0.9452	0.9451
TEMP. JUMP, MILS	0.3705	0.3770	0.3830	0.3887	0.3942	0.3981	0.4017	0.4046	0.4061	0.4059	0.4037
GAP CONDUCTANCE	311.6	318.1	322.5	325.6	327.6	328.0	327.8	327.2	325.4	322.3	318.1
LOCAL HEAT FLUX	1149.	2856.	3866.	4493.	4736.	4597.	4284.	3866.	3134.	2072.	697.
COOLANT FLOW, LB/HR	199.35	199.35	199.35	199.35	199.35	199.35	199.35	199.35	199.35	199.35	199.35
LOCAL UA, KW/DFG	1.756	1.781	1.798	1.810	1.818	1.820	1.818	1.812	1.812	1.801	1.785
LOCAL H/ZR RATIO	1.714	1.673	1.640	1.611	1.588	1.572	1.561	1.554	1.557	1.571	1.597
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-257.5	-255.5	-253.5	-251.5	-249.5	-247.5	-245.5	-243.5	-241.5	-239.4	-237.4
RADIAL GAP, MILS	6.7327	6.6559	6.6217	6.6118	6.6235	6.6538	6.6923	6.7346	6.7884	6.8546	6.9295

THE ABOVE DATA IS FOR RING NO 2 CONTAINING 6 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1051.3	1057.4	1067.6	1080.3	1094.3	1109.5	1122.0	1134.4	1145.0	1152.9	1157.1
CLAD OUTER TEMP	1052.4	1060.2	1071.3	1084.6	1098.9	1112.9	1126.1	1138.1	1148.0	1154.9	1157.8
CLAD/GLASS TEMP	1053.2	1062.0	1073.8	1087.5	1101.0	1115.8	1128.8	1140.5	1150.0	1156.2	1158.2
GLASS/GAP TEMP	1054.1	1064.2	1074.8	1091.0	1105.6	1119.4	1132.1	1143.5	1152.4	1157.8	1158.8
FUEL SURFACE TEMP	1068.0	1098.1	1122.1	1143.1	1160.2	1172.4	1181.5	1188.1	1188.8	1182.1	1167.0
AVERAGE FUEL TEMP	1072.0	1108.2	1135.7	1158.9	1176.9	1188.5	1196.6	1201.7	1199.8	1189.3	1169.5
FUEL CENTER TEMP	1076.1	1118.2	1149.3	1174.7	1193.5	1204.7	1211.6	1215.3	1210.8	1196.6	1171.9
AXIAL POWER RATIO	0.330	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0133	1.0134	1.0135	1.0137	1.0138	1.0139	1.0141	1.0142	1.0143	1.0143	1.0144
FUEL SLUG DIAM.	0.9445	0.9447	0.9448	0.9450	0.9451	0.9452	0.9452	0.9452	0.9452	0.9452	0.9450
TEMP. JUMP, MILS	0.2744	0.3805	0.3862	0.3917	0.3966	0.4006	0.4339	0.4067	0.4082	0.4080	0.4058
GAP CONDUCTANCE	311.2	317.3	321.4	324.3	326.1	326.5	326.4	325.9	324.2	321.3	317.3
LOCAL HEAT FLUX	1077.	2677.	3624.	4211.	4440.	4309.	4016.	3624.	2938.	1943.	653.
COOLANT FLOW, LB/HR	199.35	199.35	199.35	199.35	199.35	199.35	199.35	199.35	199.35	199.35	199.35
LOCAL UA, KW/DEG	1.755	1.779	1.795	1.806	1.813	1.816	1.816	1.814	1.809	1.798	1.783
LOCAL H/ZR RATIO	1.709	1.670	1.639	1.611	1.589	1.575	1.565	1.558	1.561	1.574	1.599
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-259.1	-257.1	-255.1	-253.0	-251.0	-249.0	-247.0	-245.0	-243.0	-241.0	-239.0
RADIAL GAP, MILS	6.7368	6.6643	6.6319	6.6224	6.6326	6.6621	6.6982	6.7369	6.7880	6.8497	6.9201

THE ABOVE DATA IS FOR RING NO 3 CONTAINING 12 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1051.3	1056.8	1065.9	1077.2	1089.7	1102.4	1114.4	1125.5	1135.0	1142.0	1145.8
CLAD OUTER TEMP	1052.3	1059.2	1069.2	1081.1	1093.8	1106.3	1118.1	1128.8	1137.6	1143.8	1146.4
CLAD/GLASS TEMP	1053.0	1060.0	1071.4	1083.6	1096.5	1108.9	1120.5	1130.9	1139.4	1144.9	1146.8
GLASS/GAP TEMP	1053.8	1062.9	1074.1	1086.8	1099.8	1112.1	1123.5	1133.6	1141.6	1146.4	1147.2
FUEL SURFACE TEMP	1066.2	1093.2	1114.7	1133.6	1148.9	1159.7	1167.8	1173.7	1174.2	1168.1	1154.6
AVERAGE FUEL TEMP	1069.9	1102.2	1126.9	1147.7	1163.8	1174.1	1181.3	1185.9	1184.1	1174.6	1156.8
FUEL CENTER TEMP	1073.4	1111.1	1139.0	1161.8	1178.6	1188.5	1194.7	1198.0	1193.9	1181.2	1159.0
AXIAL POWER RATIO	0.330	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0133	1.0134	1.0135	1.0136	1.0137	1.0139	1.0140	1.0141	1.0142	1.0142	1.0142
FUEL SLUG DIAM.	0.9444	0.9446	0.9448	0.9449	0.9450	0.9451	0.9451	0.9451	0.9451	0.9451	0.9450
TEMP. JUMP, MILS	0.3805	0.3861	0.3913	0.3963	0.4007	0.4044	0.4074	0.4100	0.4113	0.4111	0.4091
GAP CONDUCTANCE	310.6	316.0	319.6	322.3	323.8	324.3	324.2	323.7	322.2	319.7	316.1
LOCAL HEAT FLUX	962.	2390.	3235.	3759.	3963.	3847.	3585.	3235.	2623.	1734.	583.
COOLANT FLOW, LB/HR	199.35	199.35	199.35	199.35	199.35	199.35	199.35	199.35	199.35	199.35	199.35
LOCAL UA, KW/DEG	1.753	1.773	1.787	1.798	1.804	1.806	1.807	1.805	1.800	1.791	1.777
LOCAL H/ZR RATIO	1.699	1.664	1.635	1.611	1.591	1.578	1.569	1.563	1.565	1.577	1.599
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-261.4	-259.4	-257.4	-255.4	-253.4	-251.4	-249.4	-247.4	-245.4	-243.3	-241.3
RADIAL GAP, MILS	6.7426	6.6777	6.6492	6.6401	6.6493	6.6751	6.7067	6.7422	6.7870	6.8428	6.9060

THE ABOVE DATA IS FOR RING NO 4 CONTAINING 18 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1051.3	1056.2	1064.4	1074.6	1085.8	1097.2	1108.0	1117.9	1126.4	1132.8	1136.1
CLAD OUTER TEMP	1052.2	1058.5	1067.4	1078.1	1089.5	1100.8	1111.3	1120.9	1128.9	1134.4	1136.7
CLAD/GLASS TEMP	1052.8	1059.9	1069.4	1080.4	1091.9	1103.1	1113.5	1122.2	1129.4	1135.4	1137.0
GLASS/GAP TEMP	1053.5	1061.7	1071.8	1083.2	1094.8	1105.9	1116.1	1125.2	1132.4	1136.7	1137.4
FUEL SURFACE TEMP	1064.6	1088.8	1108.1	1125.0	1138.8	1148.5	1155.8	1161.1	1161.6	1156.1	1144.0
AVERAGE FUEL TEMP	1067.8	1096.8	1118.9	1137.6	1152.0	1161.3	1167.8	1171.9	1170.3	1161.9	1146.0
FUEL CENTER TEMP	1071.0	1104.7	1129.7	1150.1	1165.2	1174.2	1179.7	1182.7	1179.1	1167.7	1147.9
AXIAL POWER RATIO	0.330	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.970	0.595	0.200
CLAD DIAMETER, IN	1.0133	1.0134	1.0135	1.0136	1.0137	1.0138	1.0139	1.0140	1.0141	1.0141	1.0141
FUEL SLUG DIAM.	0.9444	0.9446	0.9447	0.9449	0.9449	0.9450	0.9450	0.9451	0.9450	0.9450	0.9449
TEMP. JUMP, MILS	0.3855	0.3906	0.3953	0.3998	0.4039	0.4072	0.4100	0.4123	0.4135	0.4134	0.4116
GAP CONDUCTANCE	310.0	314.8	318.1	320.4	321.8	322.3	322.2	321.8	320.5	318.2	315.0
LOCAL HEAT FLUX	855.	2124.	2876.	3342.	3523.	3420.	3137.	2876.	2332.	1542.	518.
COOLANT FLOW, LB/HR	197.36	197.36	197.36	197.36	197.36	197.36	197.36	197.36	197.36	197.36	197.36
LOCAL UA, KW/DEG	1.748	1.766	1.779	1.788	1.794	1.796	1.796	1.795	1.790	1.782	1.770
LOCAL H/ZR RATIO	1.691	1.659	1.633	1.610	1.592	1.581	1.573	1.567	1.569	1.580	1.600
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-263.4	-261.4	-259.4	-257.3	-255.3	-253.3	-251.3	-249.3	-247.3	-245.3	-243.3
RADIAL GAP, MILS	6.7484	6.6906	6.6652	6.6569	6.6652	6.6882	6.7165	6.7475	6.7883	6.8373	6.8938

THE ABOVE DATA IS FOR RING NO 5 CONTAINING 24 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1051.3	1055.2	1061.7	1069.7	1078.4	1087.1	1095.3	1102.7	1108.9	1113.2	1115.0
CLAD OUTER TEMP	1052.1	1057.2	1064.4	1072.8	1081.7	1090.4	1098.3	1105.4	1111.1	1114.6	1115.5
CLAD/GLASS TEMP	1052.6	1058.4	1066.0	1074.7	1083.7	1092.3	1100.1	1107.0	1112.4	1115.5	1115.8
GLASS/GAP TEMP	1053.2	1059.9	1068.0	1077.0	1086.1	1094.6	1102.3	1109.0	1114.0	1116.5	1116.1
FUEL SURFACE TEMP	1062.4	1082.3	1098.1	1111.7	1122.6	1130.0	1135.3	1138.8	1138.2	1132.7	1121.6
AVERAGE FUEL TEMP	1065.0	1088.9	1107.0	1122.1	1133.5	1140.6	1145.1	1147.7	1145.4	1137.4	1123.2
FUEL CENTER TEMP	1067.6	1095.4	1115.8	1132.4	1144.4	1151.1	1155.0	1156.6	1152.6	1142.2	1124.8
AXIAL POWER RATIO	0.330	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0133	1.0134	1.0135	1.0135	1.0136	1.0137	1.0138	1.0139	1.0139	1.0139	1.0139
FUEL SLUG DIAM.	0.9444	0.9446	0.9447	0.9448	0.9448	0.9449	0.9449	0.9449	0.9449	0.9448	0.9448
TEMP. JUMP, MILS	0.3937	0.3980	0.4019	0.4056	0.4089	0.4114	0.4136	0.4152	0.4160	0.4155	0.4137
GAP CONDUCTANCE	309.2	313.2	315.8	317.7	318.9	319.2	319.1	318.7	317.6	315.7	312.9
LOCAL HEAT FLUX	704.	1749.	2367.	2751.	2900.	2815.	2623.	2367.	1919.	1269.	426.
COOLANT FLOW, LB/HR	201.34	201.34	201.34	201.34	201.34	201.34	201.34	201.34	201.34	201.34	201.34
LOCAL UA, KW/DEG	1.736	1.751	1.761	1.769	1.773	1.775	1.775	1.773	1.770	1.763	1.753
LOCAL H/ZR RATIO	1.674	1.647	1.625	1.606	1.592	1.583	1.577	1.574	1.577	1.587	1.605
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-266.5	-264.5	-262.5	-260.5	-258.5	-256.5	-254.5	-252.5	-250.5	-248.5	-246.5
RADIAL GAP, MILS	6.7550	6.7180	6.6970	6.6734	6.6848	6.7028	6.7252	6.7497	6.7814	6.8209	6.8657

THE ABOVE DATA IS FOR RING NO 6 CONTAINING 24 ELEMENTS

CORE SUMMARY DATA AT 17520. HOURS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

DATA	RING -	1	2	3	4	5	6
AVG COOLANT TEMP, F		1143.3	1140.5	1136.7	1130.5	1125.2	1114.6
AVG CLAD TEMP, F		1148.5	1145.4	1141.3	1134.6	1129.9	1117.9
AVG GLASS TEMP, F		1151.2	1148.1	1143.8	1136.8	1131.0	1119.6
AVG GAP TEMP, F		1172.8	1169.9	1163.6	1154.9	1147.3	1133.4
AVG FUEL SURF TEMP, F		1192.7	1188.2	1182.0	1171.7	1162.5	1146.3
AVG FUEL TEMP, F		1206.9	1201.7	1194.7	1183.0	1172.6	1154.6
AVG FUEL CENTL TEMP, F		1221.1	1215.3	1207.4	1194.4	1182.7	1162.9
PEAK FUEL CENTL TEMP, F		1259.8	1252.7	1242.7	1226.2	1211.4	1195.7
PEAK FUEL AVG TEMP, F		1245.2	1238.3	1229.2	1214.0	1200.5	1176.5
AVG UA, KW/DEG		2.010	1.992	1.974	1.945	1.918	1.872
RADIAL POWER RATIO		1.3492	1.2892	1.2093	1.0794	0.9594	0.7895
GAP PRESSURE, PSIA		0.501	0.469	0.435	0.373	0.325	0.252
AVG H/ZP RATIO		1.5954	1.5957	1.5960	1.5965	1.5968	1.5974
HYDROGEN FRACTION		0.0329	0.0313	0.0295	0.0259	0.0231	0.0193
HELIUM FRACTION		0.9661	0.9678	0.9697	0.9733	0.9762	0.9802
XENON FRACTION		0.0009	0.0009	0.0008	0.0007	0.0007	0.0006
FUEL ROD LENGTH, INCHES		16.279	16.276	16.273	16.268	16.263	16.256
NO. OF ELEMENTS		1.	4.	12.	18.	24.	24.
AVG COOLANT FLOW, LB/HR		199.117	199.117	199.117	199.117	197.126	201.108
AVG GAP CONDUCTANCE		376.6	371.8	366.7	359.0	352.8	343.1
AVG. VOLUME SWELLING, %		0.553	0.516	0.478	0.420	0.374	0.335

REACTIVITY DATA

POWER, KWT	94.7
INTEGRAL HYDROGEN LOSS, \$	0.141
CURRENT XENON WORTH, \$	0.175
CURRENT REDISTRIBUTION WORTH, \$	0.0
CURRENT PREPOISON WORTH, \$	2.414
CURRENT EXCESS REACTIVITY, \$	0.569
PREPOISON 1 WORTH CHANGE, \$	-0.586
PREPOISON 2 WORTH CHANGE, \$	0.0
PREPOISON 3 WORTH CHANGE, \$	0.0
DAUGHTER WORTH CHANGE, \$	0.0
HELIUM 3 WORTH CHANGE, \$	0.0
INTEGRAL FPBU LOSS, \$	0.306
TEMP & POWER DEFECT WORTH, \$	2.144

BURNUP & COOLANT DATA

AVG COOLANT OUTLET TEMP, DEG F	1168.3
AVG COOLANT TEMP RISE, DEG F	90.7
COOLANT INLET TEMP, DEG F	1077.6
COOLANT BYPASS TEMP RISE, DEG F	0.0
COOLANT FLOW RATE, LB/HR	17010.
MAXIMUM M/A BURNUP, %	0.056
RING & Z/L	1 & 0.40
MAX. VOL. SWEL. %	0.768
M/A BURNUP NORM BY MAX. SWEL.	0.046
RING & Z/L	1 & 0.70
CORE AVG M/A BURNUP, %	0.032
XENON CONC., ATOMS/CC	0.42651E 15
FUEL INVENTORY, KG	3.036

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS
85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1079.0	1086.1	1097.9	1112.7	1129.0	1145.5	1161.1	1175.5	1187.9	1197.1	1202.0
CLAD OUTER TEMP	1080.3	1089.2	1102.2	1117.7	1134.3	1153.6	1165.9	1179.8	1191.4	1199.4	1202.7
CLAD/GLASS TEMP	1091.1	1091.4	1105.1	1121.0	1137.7	1153.9	1169.0	1182.6	1193.6	1200.8	1203.2
GLASS/GAP TEMP	1082.2	1093.9	1108.6	1125.0	1141.9	1158.0	1172.8	1186.0	1196.4	1202.7	1203.9
FUEL SURFACE TEMP	1097.4	1129.8	1155.1	1177.1	1195.3	1203.9	1219.8	1228.3	1231.3	1226.7	1212.4
AVERAGE FUEL TEMP	1102.1	1141.5	1172.9	1195.4	1214.6	1227.7	1237.2	1244.0	1244.0	1235.1	1215.2
FUEL CENTER TEMP	1106.8	1153.1	1186.6	1213.7	1233.9	1246.4	1254.7	1259.8	1256.8	1243.6	1218.0
AXIAL POWER RATIO	0.330	0.220	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0136	1.0137	1.0138	1.0140	1.0141	1.0143	1.0144	1.0146	1.0147	1.0148	1.0148
FUEL SLUG DIAM.	0.9452	0.9459	0.9464	0.9469	0.9473	0.9476	0.9478	0.9479	0.9478	0.9474	0.9467
TEMP. JUMP, MILS	0.3159	0.3214	0.3265	0.3314	0.3359	0.3397	0.3429	0.3457	0.3474	0.3476	0.3460
GAP CONDUCTANCE	328.4	366.6	361.4	375.1	386.2	392.8	396.8	398.1	390.8	375.9	356.6
LOCAL HEAT FLUX	1248.	3101.	4198.	4878.	5143.	4992.	4651.	4198.	3404.	2250.	756.
COOLANT FLOW, LB/HR	199.12	199.12	199.12	199.12	199.12	199.12	199.12	199.12	199.12	199.12	199.12
LOCAL UA, KW/DEG	1.825	1.892	1.944	1.992	2.030	2.052	2.066	2.071	2.049	1.999	1.932
LOCAL H/ZR RATIO	1.710	1.669	1.637	1.608	1.585	1.569	1.558	1.549	1.549	1.560	1.595
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-212.1	-210.1	-208.1	-206.1	-204.1	-202.1	-200.1	-198.1	-196.1	-194.0	-192.0
M/A BURNUP, %	0.014	0.034	0.046	0.054	0.056	0.055	0.051	0.046	0.037	0.025	0.008
LOC. VOL. SWFL., %	0.174	0.313	0.430	0.541	0.637	0.700	0.745	0.768	0.721	0.606	0.446
RADIAL GAP, MILS	6.4969	6.2036	5.7909	5.8114	5.6788	5.6149	5.5871	5.5342	5.7233	5.7433	6.2885

THE ABOVE DATA IS FOR RING NO 1 CONTAINING 1 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS
85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1079.0	1085.8	1097.1	1111.2	1126.8	1142.5	1157.5	1171.2	1182.1	1191.8	1196.5
CLAD OUTER TEMP	1080.2	1089.8	1101.2	1116.0	1131.8	1147.4	1162.0	1175.3	1186.4	1194.0	1197.2
CLAD/GLASS TEMP	1081.0	1090.8	1103.9	1119.1	1135.1	1150.6	1165.0	1178.0	1188.5	1195.4	1197.7
GLASS/GAP TEMP	1082.0	1093.3	1107.2	1123.0	1139.1	1154.5	1169.6	1181.3	1191.2	1197.2	1198.3
FUEL SURFACE TEMP	1096.6	1127.7	1152.1	1173.2	1190.8	1204.0	1214.4	1222.5	1225.2	1220.4	1206.5
AVERAGE FUEL TEMP	1101.1	1138.8	1167.1	1190.8	1209.2	1221.8	1231.1	1237.6	1237.4	1228.5	1209.2
FUEL CENTER TEMP	1105.6	1150.0	1182.1	1208.2	1227.7	1239.7	1247.8	1252.6	1249.6	1236.6	1211.9
AXIAL POWER RATIO	0.330	0.320	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0136	1.0137	1.0138	1.0140	1.0141	1.0143	1.0144	1.0145	1.0146	1.0147	1.0147
FUEL SLUG DIAM.	0.9452	0.9458	0.9463	0.9468	0.9472	0.9474	0.9476	0.9476	0.9475	0.9472	0.9466
TEMP. JUMP, MILS	0.3213	0.3267	0.3317	0.3365	0.3400	0.3446	0.3478	0.3504	0.3521	0.3522	0.3506
GAP CONDUCTANCE	327.8	345.1	353.1	371.6	381.4	386.6	389.2	389.6	383.6	371.1	353.8
LOCAL HEAT FLUX	1193.	2964.	4012.	4662.	4915.	4771.	4445.	4012.	3253.	2150.	723.
COOLANT FLOW, LB/HR	199.12	199.12	199.12	199.12	199.12	199.12	199.12	199.12	199.12	199.12	199.12
LOCAL UA, KW/DEG	1.823	1.886	1.936	1.980	2.013	2.031	2.040	2.043	2.023	1.982	1.922
LOCAL H/ZR RATIO	1.707	1.667	1.636	1.608	1.586	1.571	1.559	1.551	1.551	1.563	1.586
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-216.2	-214.2	-212.2	-210.2	-208.2	-206.2	-204.2	-202.2	-200.2	-198.2	-196.1
M/A BURNUP, %	0.013	0.032	0.044	0.051	0.054	0.052	0.049	0.044	0.036	0.024	0.008
LOC. VOL. SWFL., %	0.171	0.307	0.414	0.517	0.600	0.651	0.682	0.696	0.658	0.564	0.421
RADIAL GAP, MILS	6.5039	6.2238	6.0214	5.8564	5.7413	5.6950	5.6660	5.7054	5.8156	6.0257	6.3202

THE ABOVE DATA IS FOR RING NO 2 CONTAINING 6 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS
85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1079.0	1085.3	1076.0	1109.2	1123.8	1158.6	1152.6	1165.5	1176.6	1184.8	1189.2
CLAD OUTER TEMP	1080.1	1088.2	1079.8	1113.7	1128.5	1143.2	1156.9	1169.4	1179.7	1186.9	1189.9
CLAD/GLASS TEMP	1080.7	1080.1	1102.4	1116.6	1131.6	1146.1	1152.6	1171.8	1181.7	1188.2	1190.4
GLASS/GAP TEMP	1061.8	1092.4	1106.5	1120.2	1135.4	1149.8	1164.1	1175.0	1184.2	1189.9	1190.9
FUEL SURFACE TEMP	1025.6	1124.9	1147.9	1169.0	1184.7	1197.0	1204.3	1214.4	1216.7	1217.0	1198.7
AVERAGE FUEL TEMP	1099.8	1135.3	1162.1	1184.4	1201.9	1213.8	1222.5	1228.5	1228.1	1219.6	1201.2
FUEL CENTER TEMP	1114.0	1145.8	1176.2	1200.9	1219.2	1230.6	1238.1	1242.7	1239.6	1227.1	1203.8
AXIAL POWER RATIO	0.320	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0136	1.0137	1.0139	1.0139	1.0141	1.0142	1.0144	1.0145	1.0146	1.0146	1.0147
FUEL SLU, DIAM.	0.9451	0.9457	0.9462	0.9467	0.9470	0.9472	0.9473	0.9474	0.9473	0.9470	0.9465
TEMP. JUMP, MILS	0.3277	0.330	0.3373	0.3424	0.3464	0.3501	0.3532	0.3558	0.3573	0.3574	0.3558
GAP CONDUCTANCE	226.9	342.6	355.7	362.0	375.5	380.0	382.1	382.2	376.8	365.7	350.3
LOCAL HEAT FLUX	1119.	2782.	3764.	4376.	4611.	4476.	4171.	3764.	3052.	2018.	678.
COOLANT FLOW, LB/HR	194.12	199.12	199.12	199.12	199.12	199.12	199.12	199.12	199.12	199.12	199.12
LOCAL H/A, KW/DEG	1.919	1.974	1.94	1.963	1.952	2.009	2.016	2.017	2.007	1.962	1.909
LOCAL H/ZR RATIO	1.702	1.665	1.635	1.610	1.586	1.574	1.557	1.555	1.556	1.567	1.589
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HUMP STEPS	-221.0	-219.0	-217.0	-215.0	-213.0	-210.9	-203.9	-206.9	-204.9	-202.9	-200.9
M/A BURNUP, %	0.012	0.021	0.041	0.048	0.051	0.049	0.046	0.041	0.033	0.022	0.007
LOC. VOL. SWELL, %	0.167	0.289	0.320	0.482	0.556	0.600	0.624	0.627	0.632	0.517	0.389
RADIAL GAP, MILS	6.5151	6.2539	6.0682	5.9189	5.8177	5.7795	5.7755	5.7984	5.7225	5.0925	6.3600

THE ABOVE DATA IS FOR RING NO 1 CONTAINING 16 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS
85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1079.0	1084.7	1094.1	1106.0	1119.0	1132.7	1144.7	1156.2	1165.1	1173.5	1177.4
CLAD OUTER TEMP	1080.0	1087.2	1097.6	1110.0	1124.2	1136.2	1148.5	1159.7	1169.9	1175.3	1178.0
CLAD/GLASS TEMP	1080.7	1088.9	1099.9	1112.6	1126.0	1138.7	1151.0	1161.9	1170.7	1176.5	1178.4
GLASS/GAP TEMP	1081.5	1091.0	1102.7	1116.5	1124.4	1142.2	1154.1	1164.7	1172.9	1178.0	1178.9
FUEL SURFACE TEMP	1093.9	1120.2	1141.1	1159.4	1174.4	1185.5	1194.2	1200.9	1202.7	1198.2	1185.9
AVERAGE FUEL TEMP	1097.6	1129.6	1152.7	1172.0	1189.6	1200.6	1208.2	1213.5	1217.9	1204.9	1188.2
FUEL CENTER TEMP	1101.3	1138.9	1166.2	1188.7	1205.2	1215.5	1222.2	1226.1	1223.2	1211.7	1190.5
AXIAL POWER RATIO	0.320	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0136	1.0137	1.0138	1.0139	1.0140	1.0142	1.0143	1.0144	1.0145	1.0145	1.0145
FUEL SLU, DIAM.	0.9451	0.9456	0.9461	0.9464	0.9467	0.9469	0.9470	0.9470	0.9469	0.9467	0.9462
TEMP. JUMP, MILS	0.3384	0.3437	0.3477	0.3520	0.3554	0.3592	0.3620	0.3644	0.3657	0.3658	0.3643
GAP CONDUCTANCE	225.6	322.6	350.5	355.8	366.9	370.2	371.6	371.5	366.9	357.8	345.0
LOCAL HEAT FLUX	994.	2482.	2360.	2925.	4117.	3996.	3724.	3260.	2725.	1801.	605.
COOLANT FLOW, LB/HR	199.12	199.12	199.12	199.12	199.12	199.12	199.12	199.12	199.12	199.12	199.12
LOCAL H/A, KW/DEG	1.812	1.865	1.924	1.932	1.962	1.974	1.980	1.980	1.965	1.924	1.889
LOCAL H/ZR RATIO	1.604	1.660	1.632	1.610	1.589	1.576	1.567	1.560	1.561	1.571	1.591
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HUMP STEPS	-224.1	-224.1	-224.1	-222.1	-220.0	-218.0	-216.0	-214.0	-212.0	-210.0	-208.0
M/A BURNUP, %	0.011	0.027	0.037	0.042	0.045	0.044	0.041	0.037	0.033	0.020	0.007
LOC. VOL. SWELL, %	0.159	0.266	0.282	0.430	0.490	0.524	0.542	0.549	0.519	0.449	0.342
RADIAL GAP, MILS	6.5227	6.1304	6.1418	6.0164	5.8241	5.8010	5.9111	5.8354	6.0206	6.1903	6.4181

THE ABOVE DATA IS FOR RING NO 4 CONTAINING 16 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS
85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1079.0	1084.1	1092.6	1103.2	1114.9	1126.7	1138.0	1148.3	1157.2	1163.8	1167.3
CLAD OUTER TEMP	1079.2	1086.4	1095.8	1106.9	1118.8	1130.5	1141.5	1151.5	1159.8	1165.5	1167.9
CLAD/GLASS TEMP	1080.5	1087.9	1097.8	1109.2	1121.2	1132.9	1143.7	1152.5	1161.4	1166.6	1168.3
GLASS/GAP TEMP	1081.3	1089.7	1100.3	1112.1	1124.3	1135.8	1146.4	1155.9	1163.4	1167.9	1168.7
FUEL SURFACE TEMP	1092.3	1116.1	1134.9	1151.4	1165.1	1175.1	1183.0	1188.9	1190.4	1186.1	1175.0
AVERAGE FUEL TEMP	1095.6	1124.3	1146.1	1164.5	1178.8	1188.5	1195.4	1200.1	1199.5	1192.2	1177.0
FUEL CENTER TEMP	1098.9	1132.6	1157.3	1177.5	1192.6	1201.8	1207.8	1211.4	1208.6	1198.2	1179.1
AXIAL POWER RATIO	0.330	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0136	1.0137	1.0138	1.0139	1.0140	1.0141	1.0142	1.0143	1.0144	1.0144	1.0145
FUEL SLUG DIAM.	0.9451	0.9455	0.9459	0.9462	0.9465	0.9466	0.9467	0.9467	0.9467	0.9464	0.9461
TEMP. JUMP, MILS	0.3473	0.3518	0.3559	0.3599	0.3635	0.3665	0.3691	0.3713	0.3726	0.3726	0.3712
GAP CONDUCTANCE	324.4	326.6	325.9	323.8	329.5	322.2	323.2	323.0	329.2	351.6	340.9
LOCAL HEAT FLUX	888.	2207.	2988.	3472.	3661.	3553.	3311.	2998.	2423.	1602.	538.
COOLANT FLOW, LB/HR	197.13	197.13	197.13	197.13	197.13	197.14	197.13	197.13	197.13	197.13	197.13
LOCAL UA, KW/DEG	1.806	1.851	1.885	1.913	1.933	1.943	1.947	1.947	1.934	1.908	1.870
LOCAL H/ZR RATIO	1.686	1.655	1.620	1.608	1.591	1.579	1.570	1.564	1.565	1.574	1.593
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-233.9	-231.8	-229.8	-227.8	-225.7	-223.7	-221.7	-219.7	-217.7	-215.7	-213.7
M/A BURNUP, %	0.010	0.024	0.033	0.038	0.040	0.039	0.036	0.033	0.027	0.018	0.006
LOC. VOL. SWFL., %	0.152	0.246	0.220	0.205	0.242	0.261	0.276	0.280	0.254	0.205	0.306
RADIAL GAP, MILS	6.5484	6.3265	6.2274	6.1013	6.0328	6.0158	6.0025	6.0046	6.0276	6.2682	6.4627

THE ABOVE DATA IS FOR RING NO 5 CONTAINING 24 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS
85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1079.0	1083.0	1083.8	1098.1	1107.2	1116.3	1124.8	1132.5	1138.9	1143.4	1145.3
CLAD OUTER TEMP	1079.8	1085.1	1092.6	1101.4	1110.6	1119.6	1128.0	1135.3	1141.2	1144.9	1145.8
CLAD/GLASS TEMP	1080.3	1086.4	1094.3	1103.3	1112.7	1121.6	1129.8	1137.0	1142.6	1145.8	1146.1
GLASS/GAP TEMP	1080.9	1087.9	1096.3	1105.7	1115.2	1124.0	1132.0	1139.0	1144.2	1146.9	1146.5
FUEL SURFACE TEMP	1090.1	1109.9	1125.4	1138.9	1149.8	1157.5	1163.2	1167.2	1167.3	1162.4	1151.8
AVERAGE FUEL TEMP	1092.8	1116.7	1134.7	1149.6	1161.1	1168.5	1173.4	1176.4	1174.7	1167.4	1153.5
FUEL CENTER TEMP	1095.5	1123.5	1143.9	1160.4	1172.4	1179.5	1183.7	1185.6	1182.2	1172.3	1155.2
AXIAL POWER RATIO	0.330	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0136	1.0137	1.0137	1.0138	1.0139	1.0140	1.0141	1.0141	1.0142	1.0142	1.0142
FUEL SLUG DIAM.	0.9450	0.9454	0.9457	0.9458	0.9461	0.9462	0.9463	0.9463	0.9462	0.9460	0.9457
TEMP. JUMP, MILS	0.3757	0.3797	0.3833	0.3868	0.3899	0.3924	0.3945	0.3962	0.3970	0.3967	0.3951
GAP CONDUCTANCE	322.0	321.7	329.0	344.8	348.7	350.4	350.7	350.1	346.9	341.0	332.8
LOCAL HEAT FLUX	731.	1817.	2460.	2850.	3014.	2925.	2776.	2460.	1994.	1319.	443.
COOLANT FLOW, LB/HR	201.11	201.11	201.11	201.11	201.11	201.11	201.11	201.11	201.11	201.11	201.11
LOCAL UA, KW/DEG	1.787	1.823	1.849	1.870	1.885	1.891	1.892	1.890	1.880	1.859	1.830
LOCAL H/ZR RATIO	1.671	1.644	1.623	1.605	1.591	1.581	1.575	1.571	1.573	1.583	1.600
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-252.3	-250.3	-248.3	-246.3	-244.3	-242.3	-240.3	-238.3	-236.3	-234.3	-232.3
M/A BURNUP, %	0.008	0.020	0.027	0.031	0.032	0.032	0.030	0.027	0.022	0.014	0.005
LOC. VOL. SWFL., %	0.142	0.218	0.275	0.223	0.257	0.374	0.380	0.379	0.355	0.309	0.241
RADIAL GAP, MILS	6.5713	6.4075	6.2972	6.2171	6.1707	6.1639	6.1772	6.2031	6.2713	6.3935	6.5342

THE ABOVE DATA IS FOR RING NO 6 CONTAINING 24 ELEMENTS

CORE SUMMARY DATA AT 35040. HOURS

95 ELEMENT CHECKOUT CASE 4 TIME STEPS

DATA	RING -	1	2	3	4	5	6
AVG COOLANT TEMP, F		1174.1	1171.1	1167.1	1163.6	1155.0	1143.0
AVG CLAD TEMP, F		1179.4	1176.2	1171.9	1164.8	1158.9	1147.2
AVG GLASS TEMP, F		1192.4	1179.0	1174.5	1167.2	1161.0	1149.1
AVG GAP TEMP, F		1203.3	1190.3	1193.9	1185.0	1177.2	1162.9
AVG FUEL SURF TEMP, F		1222.6	1214.0	1211.8	1201.4	1192.2	1175.7
AVG FUEL TEMP, F		1237.5	1232.2	1225.1	1213.4	1202.8	1184.5
AVG FUEL CENTL TEMP, F		1252.3	1246.4	1238.4	1225.2	1212.4	1193.2
PEAK FUEL CENTL TEMP, F		1292.7	1285.2	1275.0	1258.2	1243.2	1215.9
PEAK FUEL AVG TEMP, F		1277.6	1270.7	1261.3	1245.9	1232.0	1207.3
AVG UA, KW/DEG		2.115	2.096	2.071	2.032	1.996	1.935
RADIAL POWER RATIO		1.2492	1.2832	1.2093	1.0794	0.9594	0.7835
GAP PRESSURE, PSIA		0.697	0.660	0.615	0.531	0.468	0.368
AVG H/ZR RATIO		1.5889	1.5896	1.5903	1.5914	1.5923	1.5937
HYDROGEN FRACTION		0.0416	0.0400	0.0381	0.0341	0.0308	0.0269
HELIUM FRACTION		0.9565	0.9582	0.9602	0.9644	0.9678	0.9720
XENON FRACTION		0.0019	0.0018	0.0017	0.0015	0.0014	0.0011
FUEL ROD LENGTH, INCHES		16.249	16.236	16.222	16.285	16.280	16.271
NO. OF ELEMENTS		1.	6.	12.	18.	24.	24.
AVG COOLANT FLOW, LB/HR		198.883	198.882	198.883	198.883	196.824	200.872
AVG GAP CONDUCTANCE		406.5	400.7	393.4	382.4	373.5	359.5
AVG. VOLUME SWELLING, %		0.930	0.760	0.708	0.629	0.561	0.462

REACTIVITY DATA

POWER, KWT	39.4
INTEGRAL HYDROGEN LOSS, %	0.342
CURRENT XENON WORTH, %	0.182
CURRENT REDISTRIBUTION WORTH, %	0.0
CURRENT PRECISION WORTH, %	1.322
CURRENT EXCESS REACTIVITY, %	0.474
PRECISION 1 WORTH CHANGE, %	-0.402
PRECISION 2 WORTH CHANGE, %	0.0
PRECISION 3 WORTH CHANGE, %	0.0
DAUGHTER WORTH CHANGE, %	0.0
HELIUM 3 WORTH CHANGE, %	0.0
INTEGRAL FUEL LOSS, %	0.624
TEMP & POWER EFFECT WORTH, %	2.205

BURNUP & COOLANT DATA

AVG COOLANT OUTLET TEMP, DEG F	1200.3
AVG COOLANT TEMP RISE, DEG F	95.3
COOLANT INLET TEMP, DEG F	1105.0
COOLANT BYPASS TEMP RISE, DEG F	0.0
COOLANT FLOW RATE, LB/HR	16990.
MAXIMUM M/A BURNUP, %	0.115
RING 5 Z/L	1 & 0.40
MAX. VOL. SWEL, %	1.057
M/A BURNUP NORM BY MAX. SWEL.	0.094
RING 5 Z/L	1 & 0.70
CORE AV. M/A BURNUP, %	0.065
XENON CONC., ATOMS/CC	0.4425E 15
FUEL INVENTORY, KG	9.032

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS

R5 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1106.5	1113.0	1126.4	1141.0	1150.0	1176.3	1192.8	1207.9	1220.9	1230.6	1235.7
CLAD OUTER TEMP	1107.8	1117.2	1130.9	1147.1	1164.5	1181.7	1197.8	1212.4	1224.6	1233.0	1236.5
CLAD/GLASS TEMP	1108.7	1119.4	1133.8	1150.5	1168.1	1185.1	1200.9	1215.2	1226.8	1234.5	1237.0
GLASS/GAP TEMP	1109.8	1122.1	1137.5	1154.7	1172.5	1189.4	1205.0	1218.9	1229.8	1236.4	1237.7
FUEL SURFACE TEMP	1125.3	1157.8	1183.0	1205.0	1223.7	1238.1	1250.0	1259.5	1263.5	1259.8	1246.1
AVERAGE FUEL TEMP	1130.2	1170.0	1199.5	1224.7	1243.9	1257.8	1268.3	1276.0	1276.8	1268.7	1249.1
FUEL CENTER TEMP	1135.1	1182.1	1216.0	1243.4	1264.1	1277.4	1286.6	1292.5	1290.2	1277.5	1252.1
AXIAL POWER RATIO	0.330	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0139	1.0140	1.0141	1.0143	1.0144	1.0146	1.0148	1.0149	1.0150	1.0151	1.0151
FUEL SLUG DIAM.	0.9457	0.9466	0.9473	0.9480	0.9485	0.9487	0.9489	0.9490	0.9488	0.9483	0.9475
TEMP. JUMP, MILS	0.2980	0.2920	0.2976	0.3021	0.3067	0.3098	0.3129	0.3155	0.3177	0.3176	0.3162
GAP CONDUCTANCE	338.5	365.6	387.6	407.2	422.3	430.0	433.6	433.8	424.1	403.8	375.6
LOCAL HEAT FLUX	1308.	3251.	4401.	5114.	5392.	5233.	4876.	4401.	3568.	2359.	793.
COOLANT FLOW, LB/HR	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88
LOCAL UA, KW/DEG	1.866	1.962	2.036	2.101	2.149	2.173	2.185	2.187	2.158	2.094	2.002
LOCAL H/ZR RATIO	1.705	1.664	1.632	1.604	1.580	1.563	1.550	1.541	1.540	1.550	1.574
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-182.4	-183.4	-178.4	-176.4	-174.4	-172.4	-170.4	-168.3	-166.3	-164.3	-162.3
M/A BURNUP, %	0.028	0.069	0.094	0.109	0.115	0.112	0.104	0.094	0.076	0.050	0.017
LOC. VOL. SWEL., %	0.269	0.496	0.673	0.825	0.941	1.006	1.043	1.057	1.070	0.856	0.629
RADIAL GAP, MILS	6.3890	5.9552	5.6528	5.4133	5.2517	5.1869	5.1721	5.1946	5.3379	5.6261	6.0564

THE ABOVE DATA IS FOR RING NO 1 CONTAINING 1 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS

R5 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1106.5	1113.6	1125.5	1140.2	1156.7	1173.2	1189.0	1203.4	1215.8	1225.0	1230.0
CLAD OUTER TEMP	1107.7	1116.7	1129.8	1145.3	1161.9	1178.3	1193.7	1207.7	1219.3	1227.4	1230.7
CLAD/GLASS TEMP	1108.6	1118.8	1132.6	1148.5	1165.3	1181.6	1196.7	1210.4	1221.5	1228.8	1231.2
GLASS/GAP TEMP	1109.6	1121.4	1136.1	1152.6	1169.6	1185.7	1200.6	1213.9	1224.3	1230.7	1231.8
FUEL SURFACE TEMP	1124.5	1155.7	1180.0	1201.3	1219.2	1233.1	1244.4	1253.5	1257.1	1253.4	1240.0
AVERAGE FUEL TEMP	1129.2	1167.4	1195.8	1219.7	1238.6	1251.9	1261.9	1269.2	1269.9	1261.8	1242.8
FUEL CENTER TEMP	1133.9	1173.0	1211.6	1238.0	1257.9	1270.6	1279.4	1285.0	1282.7	1270.3	1245.7
AXIAL POWER RATIO	0.330	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0139	1.0140	1.0141	1.0142	1.0144	1.0146	1.0147	1.0149	1.0150	1.0150	1.0151
FUEL SLUG DIAM.	0.9456	0.9465	0.9472	0.9479	0.9483	0.9485	0.9487	0.9488	0.9486	0.9481	0.9474
TEMP. JUMP, MILS	0.2935	0.2984	0.3030	0.3073	0.3114	0.3149	0.3179	0.3205	0.3221	0.3224	0.3210
GAP CONDUCTANCE	337.6	363.2	383.8	401.9	415.7	422.6	425.7	425.6	416.5	397.7	371.7
LOCAL HEAT FLUX	1250.	3107.	4206.	4898.	5153.	5002.	4661.	4206.	3410.	2255.	758.
COOLANT FLOW, LB/HR	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88
LOCAL UA, KW/DEG	1.862	1.953	2.023	2.083	2.129	2.157	2.161	2.161	2.134	2.074	1.988
LOCAL H/ZR RATIO	1.702	1.663	1.632	1.604	1.582	1.566	1.553	1.544	1.543	1.553	1.576
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-187.6	-185.6	-183.6	-181.6	-179.6	-177.6	-175.6	-173.6	-171.5	-169.5	-167.5
M/A BURNUP, %	0.027	0.066	0.090	0.104	0.110	0.107	0.100	0.090	0.073	0.048	0.016
LOC. VOL. SWEL., %	0.263	0.479	0.645	0.798	0.896	0.955	0.988	0.999	0.943	0.807	0.594
RADIAL GAP, MILS	6.4012	5.9984	5.7017	5.4772	5.3268	5.2683	5.2575	5.2837	5.4228	5.6980	6.1026

THE ABOVE DATA IS FOR RING NO 2 CONTAINING 6 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1106.5	1113.1	1124.3	1139.2	1152.6	1169.1	1183.8	1197.4	1209.0	1217.7	1222.2
CLAD OUTER TEMP	1107.7	1116.1	1128.3	1142.3	1158.5	1173.9	1188.2	1201.4	1212.3	1219.9	1223.0
CLAD/GLASS TEMP	1108.5	1118.1	1131.0	1145.9	1161.7	1176.4	1191.2	1204.0	1214.4	1221.2	1223.5
GLASS/GAP TEMP	1109.4	1120.5	1134.2	1149.7	1165.7	1180.4	1194.8	1207.2	1217.0	1223.0	1224.1
FUEL SURFACE TEMP	1123.4	1132.9	1146.3	1162.2	1179.2	1196.3	1213.6	1230.3	1245.3	1248.5	1244.7
AVERAGE FUEL TEMP	1127.8	1132.9	1143.8	1157.4	1173.4	1190.9	1208.3	1226.1	1240.5	1252.6	1234.5
FUEL CENTER TEMP	1132.2	1144.8	1160.6	1179.6	1200.5	1221.5	1242.7	1263.9	1272.5	1260.5	1237.2
AXIAL POWER RATIO	0.330	0.920	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0139	1.0140	1.0141	1.0142	1.0144	1.0145	1.0147	1.0148	1.0149	1.0150	1.0150
FUEL SLUG DIAM.	0.9456	0.9464	0.9471	0.9476	0.9481	0.9483	0.9484	0.9485	0.9483	0.9479	0.9472
TEMP. JUMP, MILS	0.3006	0.3054	0.3097	0.3140	0.3179	0.3212	0.3241	0.3266	0.3282	0.3284	0.3271
GAP CONDUCTANCE	336.5	363.2	378.9	395.2	407.3	413.2	415.6	415.2	406.9	390.1	366.9
LOCAL HEAT FLUX	1173.	2015.	3946.	4586.	4935.	4693.	4373.	3946.	3199.	2115.	711.
COOLANT FLOW, LB/HR	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88
LOCAL UA, KW/DEG	1.858	1.742	2.007	2.061	2.101	2.120	2.128	2.128	2.102	2.049	1.971
LOCAL H/ZR RATIO	1.693	1.661	1.632	1.605	1.584	1.569	1.557	1.549	1.548	1.558	1.580
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-194.0	-192.0	-190.0	-188.0	-186.0	-184.0	-182.0	-180.0	-178.0	-176.0	-173.9
M/A BURNUP, %	0.025	0.062	0.094	0.098	0.103	0.100	0.093	0.084	0.068	0.045	0.015
LOC. VOL. SWELL., %	0.255	0.456	0.609	0.739	0.837	0.889	0.916	0.923	0.870	0.744	0.551
RADIAL GAP, MILS	6.4169	6.0317	5.7573	5.5609	5.4254	5.3768	5.3723	5.4016	5.5344	5.7887	6.1604

THE ABOVE DATA IS FOR RING NO 3 CONTAINING 12 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1106.5	1117.4	1122.4	1134.9	1148.5	1162.3	1175.5	1187.6	1198.0	1205.7	1209.9
CLAD OUTER TEMP	1107.5	1115.1	1126.0	1139.0	1152.9	1166.6	1179.5	1191.2	1200.9	1207.7	1210.5
CLAD/GLASS TEMP	1108.2	1116.8	1128.4	1141.7	1155.8	1169.4	1182.1	1193.5	1202.8	1208.9	1210.9
GLASS/GAP TEMP	1109.1	1119.0	1131.3	1145.1	1159.3	1172.9	1185.3	1196.4	1205.2	1210.5	1211.4
FUEL SURFACE TEMP	1121.7	1148.4	1169.3	1187.8	1203.2	1214.9	1224.4	1231.7	1234.3	1230.4	1218.5
AVERAGE FUEL TEMP	1125.6	1158.1	1187.5	1203.1	1219.4	1230.6	1239.0	1244.9	1245.0	1237.5	1220.9
FUEL CENTER TEMP	1129.5	1167.9	1195.8	1218.5	1235.6	1246.4	1253.6	1258.2	1255.7	1244.6	1223.3
AXIAL POWER RATIO	0.330	0.920	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0139	1.0139	1.0141	1.0142	1.0143	1.0144	1.0146	1.0147	1.0148	1.0148	1.0149
FUEL SLUG DIAM.	0.9455	0.9463	0.9469	0.9473	0.9477	0.9479	0.9480	0.9480	0.9479	0.9475	0.9469
TEMP. JUMP, MILS	0.3133	0.3178	0.3219	0.3259	0.3296	0.3327	0.3355	0.3377	0.3391	0.3393	0.3380
GAP CONDUCTANCE	334.6	355.3	371.2	384.8	394.6	399.0	400.6	399.9	392.7	378.9	359.7
LOCAL HEAT FLUX	1048.	2603.	3523.	4095.	4317.	4190.	3904.	3523.	2857.	1889.	635.
COOLANT FLOW, LB/HR	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88
LOCAL UA, KW/DEG	1.850	1.924	1.980	2.026	2.058	2.074	2.079	2.078	2.055	2.009	1.944
LOCAL H/ZR RATIO	1.690	1.656	1.629	1.605	1.585	1.572	1.561	1.554	1.554	1.563	1.583
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-204.4	-202.4	-200.4	-198.4	-196.4	-194.4	-192.4	-190.4	-188.4	-186.4	-184.4
M/A BURNUP, %	0.072	0.056	0.075	0.087	0.092	0.089	0.083	0.075	0.061	0.040	0.014
LOC. VOL. SWELL., %	0.242	0.420	0.552	0.663	0.744	0.785	0.805	0.807	0.758	0.650	0.485
RADIAL GAP, MILS	6.4430	6.1018	5.8705	5.6931	5.5810	5.5455	5.5495	5.5819	5.7034	5.9265	6.2464

THE ABOVE DATA IS FOR RING NO 4 CONTAINING 18 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1106.5	1111.8	1120.8	1131.9	1144.2	1156.6	1168.5	1179.3	1188.7	1195.6	1199.3
CLAD OUTER TEMP	1107.4	1114.2	1124.1	1135.7	1148.2	1160.6	1172.1	1182.6	1191.3	1197.4	1199.9
CLAD/GLASS TEMP	1108.1	1115.8	1126.2	1138.2	1150.8	1163.0	1174.4	1184.7	1193.0	1198.5	1200.3
GLASS/GAP TEMP	1108.8	1117.7	1128.8	1141.2	1154.0	1166.1	1177.2	1187.3	1195.1	1199.8	1200.7
FUEL SURFACE TEMP	1120.1	1144.2	1163.2	1180.0	1194.0	1204.6	1212.1	1215.6	1221.8	1218.0	1207.1
AVERAGE FUEL TEMP	1123.6	1152.9	1175.0	1193.7	1208.4	1218.6	1226.1	1231.4	1231.2	1224.3	1209.2
FUEL CENTER TEMP	1127.1	1161.5	1186.7	1207.3	1222.8	1232.6	1239.1	1243.1	1243.8	1229.6	1211.3
AXIAL POWER RATIO	0.330	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0139	1.0139	1.0143	1.0141	1.0143	1.0144	1.0145	1.0146	1.0147	1.0147	1.0148
FUEL SLUG DIAM.	0.9455	0.9462	0.9467	0.9471	0.9474	0.9475	0.9476	0.9477	0.9475	0.9472	0.9467
TEMP. JUMP, MILS	0.3241	0.3283	0.3321	0.3359	0.3393	0.3422	0.3447	0.3469	0.3482	0.3483	0.3470
GAP CONDUCTANCE	323.0	351.0	364.7	376.0	384.0	387.5	388.5	387.7	381.7	370.2	354.1
LOCAL HEAT FLUX	931.	2314.	3133.	3641.	3939.	3726.	3472.	3133.	2540.	1679.	565.
COOLANT FLOW, LB/HR	196.89	196.89	196.89	196.89	196.89	196.89	196.89	196.89	196.89	196.89	196.89
LOCAL UA, KW/DFG	1.841	1.905	1.953	1.992	2.019	2.032	2.035	2.032	2.014	1.976	1.920
LOCAL H/ZR RATIO	1.683	1.652	1.627	1.605	1.587	1.575	1.565	1.559	1.559	1.567	1.586
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-212.7	-210.7	-209.7	-206.7	-204.6	-202.6	-200.6	-198.6	-196.6	-194.6	-192.6
M/A BURNUP, %	0.020	0.049	0.067	0.078	0.082	0.080	0.074	0.067	0.054	0.036	0.012
LDC. VOL. SWEL., %	0.230	0.397	0.502	0.597	0.665	0.698	0.712	0.711	0.667	0.574	0.433
RADIAL GAP, MILS	6.4668	6.1657	5.9631	5.8109	5.7178	5.6912	5.7302	5.7334	5.8422	6.0361	6.3126

THE ABOVE DATA IS FOR RING NO 5 CONTAINING 24 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1106.5	1110.7	1117.8	1126.5	1136.1	1145.6	1154.6	1162.7	1169.5	1174.2	1176.2
CLAD OUTER TEMP	1107.3	1112.9	1120.8	1130.0	1139.7	1149.2	1157.9	1165.7	1171.9	1175.8	1176.7
CLAD/GLASS TEMP	1107.9	1114.2	1122.5	1132.0	1141.8	1151.2	1159.8	1167.4	1173.2	1176.7	1177.0
GLASS/GAP TEMP	1108.5	1115.8	1124.6	1134.4	1144.4	1153.7	1162.2	1169.5	1175.0	1177.8	1177.4
FUEL SURFACE TEMP	1117.8	1138.0	1153.8	1167.6	1178.8	1186.9	1193.1	1197.5	1198.0	1193.4	1182.8
AVERAGE FUEL TEMP	1120.7	1145.1	1163.5	1178.8	1190.7	1198.4	1203.8	1207.2	1205.8	1198.6	1184.6
FUEL CENTER TEMP	1123.6	1152.3	1173.2	1190.1	1202.5	1210.0	1214.5	1216.9	1213.7	1203.8	1186.3
AXIAL POWER RATIO	0.330	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0139	1.0139	1.0140	1.0141	1.0142	1.0142	1.0144	1.0144	1.0145	1.0145	1.0145
FUEL SLUG DIAM.	0.9454	0.9460	0.9464	0.9467	0.9469	0.9470	0.9471	0.9471	0.9469	0.9466	0.9462
TEMP. JUMP, MILS	0.3621	0.3660	0.3695	0.3729	0.3759	0.3784	0.3805	0.3822	0.3831	0.3828	0.3813
GAP CONDUCTANCE	329.6	343.9	354.4	362.8	368.3	370.3	370.5	369.2	364.2	355.3	343.1
LOCAL HEAT FLUX	767.	1906.	2580.	2998.	3161.	3068.	2858.	2580.	2092.	1383.	465.
COOLANT FLOW, LB/HR	200.87	200.87	200.87	200.87	200.87	200.87	200.87	200.87	200.87	200.87	200.87
LOCAL UA, KW/DFG	1.818	1.869	1.906	1.936	1.955	1.962	1.963	1.959	1.942	1.912	1.870
LOCAL H/ZR RATIO	1.668	1.641	1.620	1.602	1.587	1.578	1.571	1.567	1.569	1.577	1.594
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-241.3	-239.3	-237.3	-235.3	-233.2	-231.2	-229.2	-227.2	-225.2	-223.2	-221.2
M/A BURNUP, %	0.016	0.041	0.055	0.064	0.067	0.065	0.061	0.055	0.045	0.029	0.010
LDC. VOL. SWEL., %	0.214	0.340	0.431	0.503	0.552	0.577	0.576	0.569	0.529	0.452	0.342
RADIAL GAP, MILS	6.5006	6.2547	6.0930	5.9759	5.9083	5.8970	5.9135	5.9507	6.0455	6.2046	6.4229

THE ABOVE DATA IS FOR RING NO 6 CONTAINING 24 ELEMENTS

CORE SUMMARY DATA AT 43800. HOURS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

DATA	RING -	1	2	3	4	5	6
AVG COOLANT TEMP, F		1174.1	1171.1	1167.1	1160.6	1155.0	1143.9
AVG CLAD TEMP, F		1179.4	1176.2	1171.9	1164.8	1158.9	1147.3
AVG GLASS TEMP, F		1182.3	1179.0	1174.6	1167.2	1161.0	1149.1
AVG GAP TEMP, F		1201.8	1197.9	1193.3	1184.0	1176.4	1162.4
AVG FUEL SURF TEMP, F		1219.7	1215.3	1210.4	1199.5	1190.7	1174.7
AVG FUEL TEMP, F		1234.5	1229.5	1224.0	1211.4	1201.3	1183.4
AVG FUEL CFNTL TEMP, F		1249.4	1243.7	1237.6	1223.3	1211.8	1192.1
PEAK FUEL CFNTL TEMP, F		1288.9	1281.7	1273.6	1255.8	1241.3	1215.5
PEAK FUEL AVG TEMP, F		1274.1	1267.5	1259.8	1243.7	1230.4	1206.0
AVG H/A, KW/DFG		2.218	2.193	2.111	2.108	2.063	1.986
RADIAL POWER RATIO		1.3492	1.2892	1.2093	1.0794	0.9594	0.7895
GAP PRESSURE, PSIA		0.641	0.607	0.582	0.498	0.442	0.352
AVG H/ZR RATIO		1.5944	1.5852	1.5862	1.5878	1.5890	1.5910
HYDROGEN FRACTION		0.0355	0.0343	0.0384	0.0302	0.0277	0.0253
HELIUM FRACTION		0.9621	0.9634	0.9594	0.9679	0.9706	0.9733
XENON FRACTION		0.0024	0.0023	0.0021	0.0019	0.0017	0.0014
FUEL ROD LENGTH, INCHES		16.312	16.308	16.304	16.296	16.289	16.279
NO. OF ELEMENTS		1.	6.	12.	18.	24.	24.
AVG COOLANT FLOW, LB/HR		198.883	198.883	198.883	198.883	196.894	200.872
AVG GAP CONDUCTANCE		439.0	430.7	417.7	404.9	392.7	373.8
AVG. VOLUME SWELLING, %		1.053	1.002	0.935	0.821	0.744	0.613

REACTIVITY DATA

POWER, KWT	99.4
INTEGRAL HYDROGEN LOSS, %	0.485
CURRENT XENON WORTH, %	0.191
CURRENT REDISTRIBUTION WORTH, %	0.0
CURRENT PREPOISON WORTH, %	1.715
CURRENT EXCESS REACTIVITY, %	0.362
PREPOISON 1 WORTH CHANGE, %	-0.207
PREPOISON 2 WORTH CHANGE, %	0.0
PREPOISON 3 WORTH CHANGE, %	0.0
DAUGHTER WORTH CHANGE, %	0.0
HELIUM 3 WORTH CHANGE, %	0.0
INTEGRAL FBRU LOSS, %	0.791
TEMP & POWER DEFECT WORTH, %	2.205

BURNUP & COOLANT DATA

AVG COOLANT OUTLET TEMP, DEG F	1200.3
AVG COOLANT TEMP RISE, DEG F	95.3
COOLANT INLET TEMP, DEG F	1105.0
COOLANT BYPASS TEMP RISE, DEG F	0.0
COOLANT FLOW RATE, LB/HR	16990.
MAXIMUM M/A BURNUP, %	0.146
RING & Z/L	1 & 0.40
MAX. VOL. SWEL. %	1.393
M/A BURNUP NORM BY MAX. SWEL.	0.119
RING & Z/L	1 & 0.70
CORE AVG M/A BURNUP, %	0.083
XENON CONC., ATOMS/CC	0.46510E 15
FUEL INVENTORY, KG	9.030

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1106.5	1113.9	1126.4	1141.0	1159.0	1176.3	1192.8	1207.9	1220.9	1230.6	1235.7
CLAD OUTER TEMP	1107.8	1117.2	1129.9	1147.1	1164.5	1181.7	1197.9	1212.4	1224.5	1232.0	1236.5
CLAD/GLASS TEMP	1108.7	1119.4	1133.8	1150.5	1168.0	1185.1	1200.9	1215.2	1227.8	1234.5	1237.0
GLASS/GAP TEMP	1109.8	1122.1	1137.4	1154.7	1172.5	1189.4	1205.0	1218.9	1229.8	1236.4	1237.7
FUEL SURFACE TEMP	1124.9	1156.3	1190.5	1201.6	1219.6	1233.9	1245.8	1255.6	1260.3	1257.9	1245.6
AVERAGE FUEL TEMP	1129.8	1168.5	1197.0	1220.9	1239.8	1253.5	1264.1	1272.0	1273.7	1266.9	1248.6
FUEL CENTER TEMP	1134.7	1180.7	1213.4	1239.9	1260.0	1272.1	1282.3	1288.5	1287.1	1275.6	1251.6
AXIAL POWER RATIO	0.330	0.820	1.110	1.299	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0139	1.0140	1.0141	1.0143	1.0144	1.0146	1.0148	1.0149	1.0150	1.0151	1.0151
FUEL SLUG DIAM.	0.9459	0.9471	0.9480	0.9487	0.9493	0.9497	0.9499	0.9501	0.9499	0.9493	0.9482
TEMP. JUMP, MILS	0.2734	0.2750	0.2793	0.2834	0.2872	0.2905	0.2935	0.2960	0.2977	0.2981	0.2970
GAP CONDUCTANCE	346.0	380.5	409.5	436.5	458.3	470.7	477.6	479.6	466.8	438.3	398.9
LOCAL HEAT FLUX	1307.	3248.	4737.	5110.	5387.	5229.	4872.	4397.	3565.	2357.	792.
COOLANT FLOW, LB/HR	198.88	198.38	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88
LOCAL UA, KW/DEG	1.934	2.014	2.109	2.193	2.269	2.295	2.215	2.021	2.296	2.203	2.091
LOCAL H/ZR RATIO	1.770	1.659	1.628	1.600	1.578	1.561	1.548	1.538	1.535	1.544	1.567
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-157.6	-155.6	-153.6	-151.6	-149.6	-147.6	-145.6	-143.6	-141.6	-139.5	-137.5
M/A BURNUP, %	0.035	0.098	0.119	0.139	0.146	0.142	0.132	0.119	0.097	0.064	0.021
LOC. VOL. SWFL., %	0.356	0.650	0.876	1.071	1.223	1.312	1.367	1.393	1.329	1.151	0.860
RADIAL GAP, MILS	6.2521	5.7181	5.3404	5.0359	4.8211	4.7184	4.6742	4.6769	4.8291	5.1670	5.6934

THE ABOVE DATA IS FOR RING NO 1 CONTAINING 1 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1106.5	1113.6	1125.5	1140.2	1156.7	1172.2	1187.0	1203.4	1215.8	1225.0	1230.0
CLAD OUTER TEMP	1107.7	1116.7	1129.8	1145.3	1161.0	1178.3	1193.7	1207.7	1219.3	1227.4	1230.7
CLAD/GLASS TEMP	1108.6	1118.8	1132.6	1148.5	1165.2	1181.6	1196.7	1210.4	1221.5	1228.8	1231.2
GLASS/GAP TEMP	1109.6	1121.4	1136.1	1152.6	1169.6	1185.7	1200.6	1213.9	1224.3	1230.6	1231.8
FUEL SURFACE TEMP	1124.2	1156.4	1177.7	1198.1	1215.5	1229.2	1240.6	1249.9	1254.3	1251.7	1239.5
AVERAGE FUEL TEMP	1128.8	1166.0	1193.5	1216.5	1234.8	1248.0	1259.1	1265.7	1267.0	1260.1	1242.4
FUEL CENTER TEMP	1133.5	1177.7	1209.2	1234.8	1254.1	1266.7	1275.5	1281.4	1279.8	1268.6	1245.2
AXIAL POWER RATIO	0.330	0.920	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0139	1.0140	1.0141	1.0142	1.0144	1.0146	1.0147	1.0149	1.0150	1.0150	1.0151
FUEL SLUG DIAM.	0.9459	0.9470	0.9478	0.9486	0.9491	0.9494	0.9497	0.9498	0.9496	0.9490	0.9480
TEMP. JUMP, MILS	0.2765	0.2811	0.2852	0.2893	0.2930	0.2963	0.2992	0.3016	0.3033	0.3037	0.3025
GAP CONDUCTANCE	345.0	377.5	404.6	429.4	449.1	460.0	465.7	467.1	455.2	429.2	393.3
LOCAL HEAT FLUX	1249.	3105.	4703.	4884.	5149.	4998.	4657.	4203.	3407.	2253.	757.
COOLANT FLOW, LB/HR	198.88	198.38	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88
LOCAL UA, KW/DEG	1.890	2.003	2.093	2.171	2.231	2.267	2.281	2.285	2.252	2.175	2.062
LOCAL H/ZR RATIO	1.697	1.658	1.627	1.601	1.579	1.563	1.550	1.540	1.539	1.547	1.569
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-164.6	-162.6	-160.5	-158.5	-156.5	-154.5	-152.5	-150.5	-148.5	-146.5	-144.5
M/A BURNUP, %	0.034	0.084	0.114	0.132	0.140	0.135	0.126	0.114	0.092	0.061	0.021
LOC. VOL. SWFL., %	0.349	0.628	0.841	1.025	1.165	1.247	1.295	1.317	1.253	1.085	0.813
RADIAL GAP, MILS	6.2660	5.7582	5.4002	5.1138	4.9128	4.8215	4.7863	4.7944	4.9430	5.2646	5.7599

THE ABOVE DATA IS FOR RING NO 2 CONTAINING 6 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1106.5	1113.1	1124.3	1138.2	1153.6	1169.1	1183.8	1197.4	1209.0	1217.7	1222.3
CLAD OUTER TEMP	1107.7	1116.2	1128.4	1143.0	1158.6	1174.0	1188.4	1201.5	1212.4	1219.9	1223.0
CLAD/GLASS TEMP	1108.5	1118.2	1131.1	1146.1	1161.8	1177.1	1191.3	1204.1	1214.5	1221.3	1223.5
GLASS/GAP TEMP	1109.5	1120.6	1134.4	1149.9	1165.9	1181.0	1195.0	1207.4	1217.2	1223.1	1224.1
FUEL SURFACE TEMP	1123.5	1152.6	1175.1	1194.7	1211.2	1224.1	1234.7	1243.3	1246.9	1243.8	1231.7
AVERAGE FUEL TEMP	1128.0	1163.8	1190.2	1212.2	1229.7	1242.1	1251.4	1258.3	1259.1	1251.9	1234.4
FUEL CENTER TEMP	1132.5	1174.9	1205.2	1229.7	1248.2	1260.0	1268.1	1273.4	1271.4	1260.0	1237.1
AXIAL POWER RATIO	0.330	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0139	1.0140	1.0141	1.0142	1.0144	1.0145	1.0147	1.0148	1.0149	1.0150	1.0150
FUEL SLUG DIAM.	0.9459	0.9469	0.9477	0.9483	0.9488	0.9491	0.9493	0.9494	0.9492	0.9487	0.9478
TEMP. JUMP, MILS	0.3202	0.3252	0.3298	0.3342	0.3383	0.3419	0.3450	0.3476	0.3493	0.3497	0.3483
GAP CONDUCTANCE	341.9	371.6	396.0	417.8	434.8	443.8	448.2	448.8	438.0	415.4	383.9
LOCAL HEAT FLUX	1195.8	2968.8	4018.8	4670.8	4923.8	4778.8	4452.8	4018.8	3258.8	2154.8	724.8
COOLANT FLOW, LB/HR	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88
LOCAL UA, KW/DEG	1.843	1.946	2.026	2.095	2.147	2.174	2.187	2.190	2.159	2.091	1.992
LOCAL H/ZR RATIO	1.694	1.657	1.628	1.602	1.581	1.566	1.554	1.546	1.545	1.554	1.575
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-213.1	-211.0	-209.0	-207.0	-205.0	-203.0	-201.0	-199.0	-197.0	-195.0	-193.0
M/A BURNUP, %	0.032	0.079	0.107	0.124	0.131	0.127	0.118	0.107	0.097	0.057	0.019
LOC. VOL. SWELL., %	0.339	0.599	0.796	0.964	1.091	1.162	1.203	1.218	1.157	1.001	0.752
RADIAL GAP, MILS	6.2844	5.8081	5.4754	5.2124	5.0313	4.9525	4.9268	4.9425	5.0866	5.3861	5.8435

THE ABOVE DATA IS FOR RING NO 3 CONTAINING 12 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1106.5	1112.4	1122.4	1134.8	1148.5	1162.3	1175.5	1187.6	1198.0	1205.7	1209.9
CLAD OUTER TEMP	1107.5	1115.1	1126.0	1139.0	1152.9	1166.6	1179.5	1191.2	1200.9	1207.7	1210.5
CLAD/GLASS TEMP	1108.2	1116.8	1128.4	1141.7	1155.8	1169.4	1182.1	1193.5	1202.9	1208.9	1210.9
GLASS/GAP TEMP	1109.1	1119.0	1131.3	1145.1	1159.3	1172.9	1185.3	1196.4	1205.1	1210.5	1211.4
FUEL SURFACE TEMP	1121.4	1147.4	1167.6	1185.4	1200.5	1212.1	1221.7	1229.2	1232.3	1229.3	1218.2
AVERAGE FUEL TEMP	1125.3	1157.1	1180.8	1200.8	1216.7	1227.8	1236.3	1242.5	1243.0	1236.3	1220.6
FUEL CENTER TEMP	1129.3	1165.9	1194.0	1216.1	1232.8	1243.6	1250.9	1255.7	1253.7	1243.4	1223.0
AXIAL POWER RATIO	0.330	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0139	1.0139	1.0141	1.0142	1.0143	1.0144	1.0146	1.0147	1.0148	1.0148	1.0149
FUEL SLUG DIAM.	0.9459	0.9469	0.9474	0.9480	0.9484	0.9486	0.9488	0.9488	0.9487	0.9482	0.9474
TEMP. JUMP, MILS	0.2983	0.3025	0.3064	0.3101	0.3136	0.3165	0.3191	0.3214	0.3228	0.3230	0.3219
GAP CONDUCTANCE	341.3	367.4	388.2	406.4	420.0	426.8	429.8	429.6	420.5	401.9	376.1
LOCAL HEAT FLUX	1047.8	2501.8	2521.8	4092.8	4314.8	4187.8	3902.8	3521.8	2855.8	1987.8	634.8
COOLANT FLOW, LB/HR	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88	198.88
LOCAL UA, KW/DEG	1.875	1.967	2.037	2.097	2.140	2.162	2.172	2.172	2.145	2.086	2.002
LOCAL H/ZR RATIO	1.686	1.652	1.625	1.602	1.583	1.569	1.558	1.551	1.550	1.558	1.578
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-187.1	-185.0	-183.0	-181.0	-179.0	-177.0	-175.0	-172.0	-171.0	-169.0	-167.0
M/A BURNUP, %	0.028	0.070	0.095	0.111	0.117	0.113	0.106	0.095	0.077	0.051	0.017
LOC. VOL. SWELL., %	0.322	0.552	0.723	0.867	0.973	1.030	1.059	1.067	1.010	0.874	0.662
RADIAL GAP, MILS	6.3177	5.8972	5.6063	5.3798	5.2289	5.1690	5.1559	5.1788	5.3120	5.5758	5.9678

THE ABOVE DATA IS FOR RING NO 4 CONTAINING 18 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1106.5	1111.8	1120.8	1131.9	1144.2	1156.6	1168.5	1179.3	1188.7	1195.6	1199.3
CLAD OUTER TEMP	1107.4	1114.2	1122.1	1132.7	1144.2	1156.6	1168.5	1177.1	1182.6	1191.3	1197.4
CLAD/GLASS TEMP	1108.1	1115.8	1126.2	1138.2	1150.8	1163.0	1174.4	1184.7	1193.0	1199.5	1200.3
GLASS/GAP TEMP	1108.8	1117.7	1128.8	1141.2	1154.0	1166.1	1177.2	1187.3	1195.1	1199.8	1200.7
FUEL SURFACE TEMP	1119.9	1143.3	1151.8	1178.1	1191.8	1202.4	1210.4	1217.7	1220.2	1217.1	1206.9
AVERAGE FUEL TEMP	1123.3	1152.0	1177.6	1191.8	1206.2	1216.4	1223.9	1229.4	1229.7	1221.4	1209.0
FUEL CENTER TEMP	1126.8	1160.7	1195.2	1208.4	1220.6	1231.3	1237.0	1241.2	1239.3	1229.7	1211.1
AXIAL POWER RATIO	0.230	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0139	1.0139	1.0140	1.0141	1.0141	1.0144	1.0144	1.0146	1.0147	1.0147	1.0148
FUEL SLUG DIAM.	0.9457	0.9465	0.9471	0.9476	0.9480	0.9482	0.9484	0.9484	0.9487	0.9478	0.9471
TEMP. JUMP, MILS	0.2101	0.3141	0.3177	0.3212	0.3245	0.3272	0.3297	0.3317	0.3330	0.3332	0.3321
GAP CONDUCTANCE	339.3	362.0	379.6	394.8	405.8	411.0	413.0	412.5	404.8	389.6	368.2
LOCAL HEAT FLUX	931.	2313.	3131.	3639.	3836.	3724.	3470.	3131.	2539.	1678.	564.
COOLANT FLOW, LB/HR	196.89	196.89	196.89	196.89	196.89	196.89	196.89	196.89	196.89	196.89	196.89
LOCAL UA, KW/DEG	1.865	1.945	2.005	2.055	2.091	2.108	2.115	2.114	2.090	2.041	1.970
LOCAL H/ZR RATIO	1.679	1.648	1.624	1.607	1.585	1.572	1.563	1.556	1.555	1.563	1.581
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-197.8	-195.8	-193.7	-191.7	-189.7	-187.7	-185.7	-183.7	-181.7	-179.7	-177.7
M/A BURNUP, %	0.025	0.062	0.185	0.098	0.104	0.101	0.194	0.085	0.069	0.045	0.015
LOC. VOL. SWFL., %	0.307	0.509	0.659	0.782	0.872	0.917	0.929	0.943	0.891	0.773	0.592
RADIAL GAP, MILS	6.2470	5.9751	5.7211	5.5252	5.3986	5.3521	5.3480	5.3750	5.4955	5.7255	6.0642

THE ABOVE DATA IS FOR RING NO 5 CONTAINING 24 ELEMENTS

AXIAL FUEL ELEMENT TEMPERATURE DISTRIBUTIONS

85 ELEMENT CHECKOUT CASE 4 TIME STEPS

Z/L =	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
BULK COOLANT TEMP	1106.5	1110.7	1117.8	1126.5	1136.1	1145.6	1154.6	1162.7	1169.5	1174.2	1176.2
CLAD OUTER TEMP	1107.2	1112.9	1120.8	1130.0	1139.7	1149.2	1157.9	1165.7	1171.9	1175.8	1176.7
CLAD/GLASS TEMP	1107.9	1114.2	1122.5	1132.0	1141.8	1151.2	1159.8	1167.4	1173.2	1176.7	1177.0
GLASS/GAP TEMP	1108.5	1115.8	1124.6	1134.4	1144.4	1153.7	1162.1	1169.5	1175.0	1177.8	1177.4
FUEL SURFACE TEMP	1117.7	1137.4	1157.8	1166.3	1177.2	1185.4	1191.6	1196.2	1197.0	1192.8	1182.7
AVERAGE FUEL TEMP	1120.6	1144.6	1162.5	1177.5	1187.2	1196.9	1202.4	1205.9	1204.8	1198.0	1184.4
FUEL CENTER TEMP	1123.4	1151.7	1172.7	1188.8	1201.0	1208.4	1213.1	1215.5	1212.7	1203.2	1186.2
AXIAL POWER RATIO	0.230	0.820	1.110	1.290	1.360	1.320	1.230	1.110	0.900	0.595	0.200
CLAD DIAMETER, IN	1.0139	1.0139	1.0140	1.0141	1.0142	1.0142	1.0144	1.0144	1.0145	1.0145	1.0145
FUEL SLUG DIAM.	0.9456	0.9462	0.9468	0.9472	0.9475	0.9476	0.9476	0.9476	0.9475	0.9471	0.9466
TEMP. JUMP, MILS	0.3568	0.3606	0.3640	0.3673	0.3702	0.3727	0.3748	0.3765	0.3774	0.3772	0.3757
GAP CONDUCTANCE	335.1	352.9	365.3	377.3	384.8	387.7	388.2	386.8	380.5	369.0	352.2
LOCAL HEAT FLUX	767.	1905.	2578.	2996.	3159.	3066.	2857.	2573.	2091.	1382.	465.
COOLANT FLOW, LB/HR	200.87	200.87	200.87	200.87	200.87	200.87	200.87	200.87	200.87	200.87	200.87
LOCAL UA, KW/DEG	1.839	1.902	1.948	1.985	2.010	2.020	2.022	2.018	1.998	1.960	1.906
LOCAL H/ZR RATIO	1.665	1.638	1.618	1.600	1.585	1.576	1.569	1.564	1.566	1.574	1.591
LOCAL H/ZR PHASE	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
CLAD HOOP STRESS	-236.5	-234.5	-232.5	-230.5	-228.5	-226.5	-224.5	-222.5	-220.5	-218.5	-216.4
M/A BURNUP, %	0.021	0.052	0.070	0.081	0.085	0.093	0.077	0.070	0.057	0.037	0.013
LOC. VOL. SWFL., %	0.286	0.450	0.568	0.662	0.727	0.755	0.763	0.756	0.706	0.609	0.466
RADIAL GAP, MILS	6.3879	6.0844	5.8812	5.7302	5.6279	5.6139	5.6246	5.6634	5.7692	5.9598	6.2282

THE ABOVE DATA IS FOR RING NO 6 CONTAINING 24 ELEMENTS

*** NORMALIZATION FACTOR 4.0 =1398.334 MONTHS ***

*** THE EFFECTIVITY LIMIT WAS REACHED AT 44.750 MONTHS ***

BS ELEMENT CHECKOUT CASE 4 TIME STEPS

END OF LIFE NORMALIZATION FACTORS

ING	NF	Z/L	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	NF 1.3
1	1.0		5.4432	4.9842	4.6339	4.3754	4.0899	3.8492	3.634	3.4223	3.229	3.050	2.8855	16.056
	1.1		0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	
	1.2		0.9391	0.9400	0.9407	0.9413	0.9418	0.9421	0.9423	0.9423	0.9424	0.9424	0.9424	
2	1.0		5.4548	5.0187	4.6350	4.2933	4.0178	3.8011	3.6157	3.4521	3.3014	3.1640	3.0398	16.053
	1.1		0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	
	1.2		0.9391	0.9400	0.9406	0.9412	0.9416	0.9419	0.9420	0.9421	0.9421	0.9421	0.9421	
3	1.0		5.4700	5.0443	4.7562	4.4341	4.2955	4.1837	4.1201	4.0755	4.0421	4.0191	4.0000	16.049
	1.1		0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	
	1.2		0.9391	0.9400	0.9405	0.9410	0.9414	0.9416	0.9418	0.9418	0.9418	0.9418	0.9418	
4	1.0		5.4965	5.1321	4.8698	4.6452	4.4782	4.3903	4.3438	4.3313	4.3211	4.3132	4.3050	16.044
	1.1		0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	
	1.2		0.9390	0.9397	0.9402	0.9407	0.9410	0.9412	0.9413	0.9413	0.9413	0.9413	0.9413	
5	1.0		5.5206	5.2142	4.9708	4.7776	4.6376	4.5461	4.5316	4.5257	4.5281	4.5299	4.5319	16.039
	1.1		0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	
	1.2		0.9390	0.9396	0.9401	0.9404	0.9407	0.9409	0.9409	0.9409	0.9408	0.9404	0.9398	
6	1.0		5.5527	5.2974	5.1126	4.9655	4.8644	4.8206	4.8020	4.8121	4.8262	5.0482	5.2719	16.032
	1.1		0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	0.9530	
	1.2		0.9389	0.9394	0.9398	0.9401	0.9402	0.9404	0.9404	0.9404	0.9402	0.9399	0.9395	

Key to Normalization Factors

NF	1.0	Gap width - mils
NF	1.1	Gap OD - in.
NF	1.2	Fuel slug OD - in.
NF	1.3	Fuel rod length - in.
ING		Fuel lattice ring
NF	4.0	Time to reach swelling limit - months

NOMENCLATURE

Symbol	Description	Units	Symbol	Description	Units
a_o, a_1	Parameters in ZrH dissociation pressure equations	-	r_e	Surface wavelength parameter for contact conductance	in.
A	Area	in. ²	R	Gas constant	ft-lb/lb-°R
a_A, a_B	Constants in fuel offset swelling equation	-	t	Time	hr
b	Burnup coefficient in fuel swelling equation	-	$T, T_{cl}, T_{cool}, T_f, T_{gl}$	Temperature, of cladding, of coolant, of fuel, of glass	°F
C	Contact pressure parameter for heat conductance	-	T_{ACT}	Activation temperature in swelling equation	°R
C_p, C_v, C_{VM}	Specific heat, at constant pressure, at constant volume, and at constant volume of mixture	Btu/lb-°F	U, U_{OA}, U_G	Heat transfer coefficient, overall, of gas	Btu/hr-ft ² -°F
d, d_{cl}, d_f, d_g	Thickness, of cladding, of fuel, of glass	in., mm in Eq. 27	$\frac{\Delta V}{V}$	Fractional volume change (fuel swelling)	-
D, D_{cl}	Diameter, of cladding	in	x	Swelling equation exponent	-
E, E_{cl}, E_f	Modulus of elasticity, of cladding, of fuel	psi	x_1, x_2	Mole fractions	-
$f_w\%$	Fuel fraction	wt %	α	Thermal accommodation coefficient	-
g	Equivalent temperature jump length at surface	in.	β	Fuel burnup	met. at. %
G_D	Glass effectiveness	-	γ	C_p/C_v , heat capacity ratio of gas	-
h	Convection film coefficient	Btu/hr-ft ² -°F	$\delta, \delta_{cl}, \delta_f$	Small radius change, of cladding, of fuel	in.
H/Zr	Hydrogen/zirconium atom ratio	-	ϵ	Contact coefficient shape factor	in.
$k, k_f, k_b, k_g, k_{mix}$	Thermal conductivity, of fuel, of barrier, of gas, of mixture	Btu/hr-ft-°F	$\lambda, \lambda_f, \lambda_b$	Surface finish wavelength, of fuel, of barrier	in.
k_{HW}	Conversion constant for hydrogen worth	\$/cc element	μ, μ_{cl}, μ_f	Poisson's ratio, of cladding, of fuel	-
k_{HZr}	Conversion constant for H/Zr	H/Zr/cc element	ξ, ξ_b, ξ_f	Surface roughness, rms, of barrier, of fuel	in.
K_A	Glass permeation constant	$\frac{cc-mm}{hr-cm^2-atm}$	ρ_f	Fuel slug density	gm/cc
K_D	Defect fraction for H ₂ leakage	-	ρ_{ma}	Fuel metal atom density	atoms/cc
l	Intermediate parameter in gas gap conduction calculation	in.	σ	Molecular cross sections	cm
L, L_f	Length, of fuel	in.	σ_{cl}	Cladding hoop stress	psi
L_i	Hydrogen leakage rate	cc/hr	τ	Time constant for offset fuel swelling	hr
m	Molecular weights	-	φ_r, φ_a	Radial, axial power ratio	-
M	Metal permeation constant for H ₂ leakage	$\frac{cc-mm}{hr-cm^2 \sqrt{atm}}$	φ_H	Relative hydrogen worth (ratio)	-
M_H	Meyer hardness	psi	$\varphi_{12}, \varphi_{21}$	Constants in gas mixture conductivity equations	-
n	Swelling equation exponent	-	$\omega, \omega_i, \omega_o$	Coolant flow, cross flow in, cross flow out	lb/hr
N_i	Defect fraction multiplier	-			
N_p	Number of elements	-			
P	Reactor power	kw			
P, P_c	Pressure, contact pressure	atm, psi			
q	Heat flux	Btu/hr-ft			
Q, Q_{cl}, Q_{gl}	Activation temperature in swelling equation, of cladding, of glass	°R			
r	Swelling equation exponent	-			
r_{cl}, r_{co}, r_f	Radius, cladding inside, cladding outside, fuel	in.			