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Determination of Excess Reactivity and Control Worth for
the Core Test Reactor

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ABSTRACT

One-dimensional scoping calculations were performed to determine the reactivity and control worth characteristics of several core and reflector configurations for the Core Test Reactor. A comparison was made of three reflector designs: (1) six S8DR drums, 4.5 inches in radius; (2) seven S8DR drums, 4.5 inches in radius; and (3) six new drums, 6.25 inches in radius. Only the third option, six new drums, appears to have sufficient control and reactivity to provide adequate margins to achieve the design lifetime. Parametric studies of the nuclear effects of the internal reflector composition indicated that the Be/BeO area should be maximized in order to increase reactivity, and that the steel/nickel area should be minimized in order to increase reactivity and control.

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DETERMINATION OF EXCESS REACTIVITY AND CONTROL WORTH
FOR THE CORE TEST REACTOR

I. INTRODUCTION

The principal objective of the studies described here was to provide a basis for selection of the internal (inside the core vessel) and external reflectors for the ZrH Core Test Reactor. Three external reflector configurations were analyzed. The first configuration consisted of six S8DR drums, extended in length to 18 inches (see Figure 1). Since the Test Reactor is larger than S8DR, this design requires rather large stationary cusps between drums. The second configuration consists of seven S8DR drums, 18 inches long (see Figure 2). Since six S8DR drums are on hand, this would require the fabrication of a new drum in addition to drum and shim extensions and cusps. It does result in more control than the six S8DR drum configuration, since the cusps are smaller and the movable (drums + shims) part of the reflector is larger. The third configuration consisted of six new drums, made as large as is geometrically possible within the constraint of the allowable clearances between drums, cusps, and core vessel (see Figure 3). This design results in more reactivity and control than the S8DR drum designs, since the new drums can be made 6.25 inches in radius vs 4.5 inches for S8DR drums.

The calculations described herein were performed on two core configurations; a 4-zone core, "C," was used in the early calculations, and a 2-zone core "D3," was used after August 19, 1970. The results presented in Section II (Summary of Results) have been adjusted, where necessary, so that they all apply to the 2-zone core "D3," which is the current reference design. A description is given in Section IV (Details of the Analysis). Section III (Methods Used) describes the one-dimensional calculational technique used and outlines the methods used to normalize the calculations to experiment.

FIGURE 1
SIX S8DR DRUMS

295 E
S8DR
Dr.
Sh.

Figure 2

SEVEN S8DR DRUMS

SECTION A-A

SHEET 3

1/1

Figure 3
 SIX NEW DRUMS

DATE	BY	DESCRIPTION	DATE	APPROVED
10/10/74	DET/AC	1.70		
LAYOUT OF REFLECTOR CROSS SECTION - 6 DRUMS CONCEPT .650 PITCH E 09974				
SCALE 1" = 1'-0"			SHEET 1 OF 1	

II. SUMMARY OF RESULTS

A. External Reflector Comparison

For each of the three reflector configurations studied, the available reactivity and control were determined as a function of drum thickness. (The drum thickness may be varied by changing the number of shims attached to the back of the drum.) A comparison of the three external reflector configurations is given in Table I for a drum thickness-to-radius (T/R) ratio of 1.0, which is the thickness at which drum worth is maximized. The data in Table I apply to a two-zone core of 0.650 in. pitch, 25 mil Incoloy clad, and a solid Be internal reflector region 0.364 in. thick. This implies a vessel ID of 12.577 inches. The reactivity and shutdown margins given in Table I are based on the Flight Reactor poison loading of \$6 Gd-155/\$6 Eu-151 and a cold-to-hot/power swing of \$3.65 (see Reference 1).

TABLE I
Nuclear Comparison of External Reflector Configurations

Drum Type	S8DR	S8DR	New
Number of Drums	6	7	6
Drum Length	18 in.	18 in.	18 in.
Shim Length	15 in.	15 in.	15 in.
Drum Radius	4.5 in.	4.5 in.	6.25 in.
T/R	1.0	1.0	1.0
Total Drum Worth*	\$ 9.70	\$10.90	\$12.80
Normalized Cold, Clean Reactivity	\$17.10	\$17.80	\$20.80
Hot, Poisoned BOL Reactivity	\$ 1.40	\$ 2.10	\$ 5.10
EOL Reactivity Margin	\$ 0.40	\$ 1.10	\$ 4.10
MOL Cold Shutdown Margin	\$ 3.60	\$ 4.10	\$ 3.00

*All reactivity data are based on $\beta = 0.0078$ and $\rho = k_1 - k_2 / k_1 k_2 \beta$

Figures 4 through 7 compare the three configurations as a function of drum thickness. Figure 4 shows reactivity vs drum thickness, Figure 5 shows total control drum worth vs drum thickness, Figure 6 shows reactivity vs control, and Figure 7 shows EOL ρ margin vs MOL shutdown margin.

Figure 4

Figure 5

Figure 6

Figure 7

From Table I and the Figure 7, it appears that only the third configuration, six New drums, can provide sufficient margins for the design goal of five years life. This conclusion becomes stronger when probable changes in the above design are considered, such as increased cladding thickness and the use of steel and NaK in the internal reflector region.

B. Internal Reflector Comparison

A series of calculations were performed to determine reactivity and control as a function of the material composition and average thickness of the internal reflector region. Table II shows the control and reactivity for internal reflector regions comprised of 100% dense Be/BeO, stainless steel, nickel, and NaK. The control and reactivity of various mixtures of these materials may be obtained by linear interpolation between the 100% values. The last row in Table II shows a composite region, the composition of which corresponds to a series of D-pieces similar to those used in S8DR.

In the table, reactivity and control values are given for two average region thicknesses. The larger one, 0.364 in., is the one used in the calculations described above in Section II.A. The smaller one, 0.229 in., represents the minimum average thickness achievable with the 295-element core configuration, since it occurs when the corner fuel element fins coincide with the core vessel ID (minus the insertion clearance of 0.0625 in.).

TABLE II
Nuclear Comparison of Internal Reflector Configurations

Composition of Internal Reflector Region				Average Thickness of Internal Reflector Region			
				0.229 in.		0.364 in.	
Be/BeO	Steel	Ni	NaK	ρ	Control	ρ	Control
100%	0	0	0	\$20.45	$\geq$ \$12.80	\$20.80	\$12.80
0	100%	0	0	\$18.62	$\geq$ \$11.70	\$17.90	\$11.70
0	0	100%	0	\$18.50	$\geq$ \$11.60	\$17.80	\$11.60
0	0	0	100%	\$18.90	$\geq$ \$13.95	\$18.30	\$14.66
34%	57%	0	8%	\$19.08	$\geq$ \$12.19	\$18.74	\$12.19

From the values in Table II, it may be concluded that (1) the use of Be or BeO maximizes reactivity, (2) NaK or void maximizes control, (3) steel and nickel reduce both reactivity and control, and (4) nickel reduces reactivity and control more than steel. Thus, we may conclude that the order of preference of materials is Be/BeO, NaK/void, steel, nickel.

III. METHODS USED

A. Basic Calculational Techniques

The basic analytical tool used for these calculations was the APC-II multigroup, one-dimensional, discrete ordinates transport code (Reference 2). The code was principally used in the leakage (DB^2) iteration mode, in which axial and radial cases are alternately run, the multigroup leakages in the direction of the calculation being used as transverse leakages in the following iteration. DB^2 spreading was used in the non-core regions; that is, the average core DB^2 was used to determine transverse leakage in the non-core region (i.e., reflector, vessel, grids, etc.).

The calculations were made in S_4 , using the standard SNAP cross section library (Reference 3). This library contains P_1 -corrected- P_0 cross sections in 28 energy groups. Seventeen groups of downscatter and 12 groups of upscatter are allowed.

The nuclear models (region dimensions, isotope atom densities, etc.) for these calculations were developed in a manner similar to that described in Reference 4. Cell calculations were not performed because previous analysis has shown that the core may be treated homogeneously without great inaccuracy, particularly for scoping calculations such as these.

Previous calculations have been made using this method to predict the reactivity of a series of critical experiments and operating reactors (Reference 5). The comparison of the method with experiment is shown in Table III, which was taken from Reference 6. This comparison has led to the "standard normalization" of + \$1.00 which is applied to all reactivity values calculated using this method. Thus, the reactivity

TABLE III
Comparison of Calculated and Measured Reactivity

	Calculated			Experiment	Error
	k_{eff}	β_{eff}	ρ (\$)	ρ (\$)	$\Delta \rho$ (\$)
Critical Systems					
S8DR - 164 Elements	1.000	0.0075	0	- 0.20	+ 0.20
SCA-4B - 37 Gd Sleeves	0.994	0.0078	- 0.78	+ 0.02	- 0.80
S8ER - 172 EL's A+B Shims	0.995	0.0075	- 0.67	~ 0.000	- 0.67
S8ER - 185 EL's A Shims	0.993	0.0075	- 0.94	~ 0.000	- 0.94
S8ER - 211 EL's No Shims	0.987	0.0075	- 1.75	- 0.25	- 1.50
Supercritical Systems					
S8DR - 211 Elements	1.092	0.0075	11.23	12.65	- 1.42
SCA-4B No Gd or B	1.079	0.0078	9.41	10.20	- 0.79
SNAPTRAN - No Shims	1.021	0.0075	2.74	3.72	- 0.98
S8ER - 211 EL's Full Shims	1.055	0.0075	6.95	10.59	- 3.64

values quoted herein were obtained using the equation:

$$\rho = \frac{k - 1}{k\beta} + \$1.00$$

where β was determined to be 0.0078 for the test reactor.

B. Drum Worth Determination

Control drum worth is a function of several parameters: neutron leakage from the core; number of drums; drum size (radius and thickness); drum length; etc. The technique used for these studies is based on one-dimensional calculations normalized to experimental results obtained from S8DR and SCA-4A. The sequence used is as follows:

- (1) The total worth of the reflector (drums plus cusps) is determined analytically by calculating reactivity for the core without a reflector and for the core with all drums turned full in. These calculations are performed using APC-II, and should be rather accurate, since the two geometries are reasonably well represented by one-dimensional radial calculations.
- (2) The "movable fraction" of the reflector is determined from drawings of the reflector. This is defined as:

$$\text{Movable Fraction} = \frac{\text{Volume of Drums} + \text{Shims}}{\text{Volume of Drums} + \text{Shims} + \text{Cusps}}$$

Including this parameter allows comparison of reflectors having the same worth but different cusp, drum, and shim volumes. The theoretical maximum worth of the movable fraction is then obtained by multiplying the total reflector worth by the movable fraction.

- (3) Steps (1) and (2), above, were carried out for each of the external reflector configurations to be compared. Each configuration was assumed to have the drums shimmed to a T/R of 1.139, which is the T/R of the fully shimmed S8DR drums. Then, Steps (1) and (2) were carried out for

the S8DR core and its reflector. The total S8DR reflector worth was calculated to be \$38.02, and the movable fraction is 0.891. Multiplying these two together, a maximum theoretical drum worth of \$33.88 is obtained. By comparing this to the experimentally observed (Reference 7) S8DR drum worth of \$18.60 in the vacuum vessel, we obtain a factor to relate the maximum theoretical drum worth to the obtainable drum worth. For S8DR this factor is defined as:

$$\text{Reflector Utilization Factor} = \frac{\$18.60}{\$33.88} = 0.549.$$

- (4) This experimental reflector utilization factor of 0.549 is applied to each of the Test Reactor reflector configurations to be compared, to obtain an estimate of the total drum worth of each. Note that this worth (and reflector utilization factor) applies only to drums having the S8DR T/R of 1.139. Data obtained from Steps (1) through (4) are shown in Table IV for S8DR and the three Test Reactor reflector configurations.
- (5) To obtain drum worth for each candidate reflector configuration for other T/R ratios, experimental data from the SCA-4A (Reference 8) was utilized. Figure 8 shows these data, expressed as relative void-backed drum worth vs drum T/R. This curve was used to obtain drum worth vs shim thickness for each of the reflector configurations compared. As previously described, this comparison as a function of T/R is shown in Figure 5.

Figure 8

TABLE IV
Determination of Drum Worth for T/R = 1.139

Reactor	Drums	Drum Type	Reflector Worth (\$)	Movable Fraction	Worth of Movable Fraction	Estimated Total Drum Worth
Test	6	S8DR	\$21.05	0.801	\$16.86	\$ 9.26
Test	7	S8DR	\$21.55	0.883	\$19.03	\$10.45
Test	6	New	\$24.40	0.918	\$22.40	\$12.30
S8DR	6	S8DR	\$38.02	0.891	\$33.88	\$18.60

IV. DETAILED DESCRIPTION OF CALCULATIONS PERFORMED

Table V compares the two core models used, and Table VI summarizes the results of all cases analyzed. Nuclear model data are given in Tables VII through XXI for the five basically different geometries analyzed. Isotopic neutron balance data are given in Tables XXII through XXV for a fully reflected case and, for comparison, a bare case.

TABLE V
Description of Cores Analyzed

Core Type	"C"	"D3"
Number of Core Zones	4	2
Number of Elements	295	295
Vessel ID	11.82 in.	12.577 in.
Lattice Pitch	0.630 in.	0.650 in.
Radial Gap	0.007 in.	0.006 in.
Glass Thickness	0.002 in.	0.002 in.
Clad Material	Incoloy 800	Incoloy 800
Cladding Thickness	0.015 in.	0.025 in.
Fuel Hydrogen Content ($N_H \times 10^{22}$)	6.3	6.3
Fuel Volume Fractions	0.6418 0.6669 0.6905 0.7168	0.6259 0.6779
Fuel OD	0.53 in. 0.54 in. 0.55 in. 0.56 in.	0.540 in. 0.562 in.
Fuel Length	16.825 in.	18.0 in.
Fuel Composition	ZrH 10.5 w/o U	ZrH 10.5 w/o U
Internal Reflector Region Thickness	0.229 in.	0.364 in.
Internal Reflector Region Materials	NaK 316 SS Be	Be
Reactor Vessel Thickness	0.125 in.	0.125 in.
Reactor Vessel Material	316 SS	316 SS

TABLE VI
Summary of Calculations

Case No.	Core Type	Reflector Type	Drum Length (in.)	Shim Length (in.)	Drum Thickness (in.)	Shim Thickness (in.)	Internal Reflector Composition	k	Normalized ρ (\$)
1	C	6 S8DR	15.3	12.17	2.125	3.0	STD	1.1520	17.91
2	C	7 S8DR	15.3	12.17	2.125	3.0	STD	1.1576	18.45
3	C	6 New	15.3	12.17	3.25	3.0	STD	1.1642	19.08
4	C	6 New	15.3	15.3	3.25	3.0	STD	1.1691	19.54
5	C	Bare	--	---	---	---	STD	0.9595	- 4.41
6	C	6 S8DR	15.3	12.17	2.125	3.0	Be	1.1648	19.14
7	C	6 S8DR	15.3	12.17	2.125	3.0	SS	1.1458	17.31
8	C	6 S8DR	15.3	12.17	2.125	3.0	NaK	1.1485	17.57
9	C	6 S8DR	15.3	12.17	2.125	3.0	Ni	1.1446	17.19
10	C	Bare	--	---	---	---	Be	0.9625	- 3.99
11	C	Bare	--	---	---	---	SS	0.9603	- 4.30
12	C	Bare	--	---	---	---	NaK	0.9335	- 8.13
13	D3	7 S8DR	18.0	18.0	2.125	3.0	Be + NaK	1.1567	18.37
14	D3	7 S8DR	18.0	18.0	2.125	0.0	Be + NaK	1.1119	13.91
15	D3	6 New	18.0	18.0	3.25	3.0	Be + NaK	1.1828	20.80
16	D3	6 New	18.0	18.0	3.25	0.0	Be + NaK	1.1505	17.78
17	D3	Bare	--	---	---	---	Be + NaK	0.9684	- 3.18
18	D3	7 S8DR	18.0	18.0	2.125	3.0	Be*	1.1588	18.56
19	D3	7 S8DR	18.0	18.0	2.125	3.0	None**	1.1491	17.64

*NaK zone eliminated (thickness set to zero)

**Be zone eliminated

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MODEL NO.

TABLE VIII

NUCLEAR MODEL II - RADIAL

REGION DIMENSIONS & VOLUME FRACTION

CORE TEST REACTOR - MODEL C

4 ZONE CORE - 6 DRUM REFLECTOR

S8DR TYPE DRUMS

REGION #	REGION DESCRIPTION		REGION DIMENSIONS				MATERIAL DESCRIPTION		VOLUME FRACTION OF MATERIAL IN REGION
			Outer Boundary (cm)	Region Thickness (cm)	Diameter or Ht. (inches)	Region Thickness (in)			
1	Core	Part 1	5.110	5.110	4.023	2.012	Incoloy	800	0.07718
							Fuel		0.64185
							Void		0.03437
							NaK		0.23662
2	Core	Part 2	8.014	2.904	6.310	1.143	Incoloy	800	0.07858
							Fuel		0.66685
							Void		0.03502
							NaK		0.20437
3	Core	Part 3	10.726	2.712	8.446	1.068	Incoloy	800	0.07989
							Fuel		0.69049
							Void		0.03557
							NaK		0.18366
4	Core	Part 4	14.430	3.704	11.362	1.458	Incoloy	800	0.08132
							Fuel		0.71683
							Void		0.0363
							NaK		0.15504
5	Interface		15.0114	0.5814	11.820	0.2289	NaK		0.0773
							316 SS		0.567
							Void		--
							Be		0.3558
6	Vessel + NaK		15.4051	0.3937	12.130	0.1550	316 SS		0.8085
							NaK		0.1915
7	Drums + Cusp		22.281	6.8759	17.544	2.707	Be		0.8727
							Void		0.1273
8	Shim	1	24.9349	2.6539	19.6338	1.0449	Be		0.5539
							Void		0.4461
9	Shim	2	27.5882	2.6533	21.7230	1.0446	Be		0.4797
							Void		0.5203
10	Shim	3	30.2410	2.6528	23.8118	1.0444	Be		0.4357
							Void		0.5643

TABLE IX

ATOM DENSITIES ($\times 10^{-24}$)

MODEL C

Core Test Reactor

4 Zone Core - 6 Drum Reflector

S8DR Type Drums

[illegible]

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MODEL NO.

NUCLEAR MODEL II Radial

REGION DIMENSIONS & VOLUME FRACTION

Core Test Reactor - 4 Zone Core-

7 Drum Reflector S8DR Type Drums

MODEL C

REGION #	REGION DESCRIPTION	REGION DIMENSIONS				MATERIAL DESCRIPTION	VOLUME FRACTION OF MATERIAL IN REGION
		Outer Boundary (cm)	Region Thickness (cm)	Diameter or Ht. (inches)	Region Thickness (in)		
1	Core part 1	5.110	5.110	4.023	2.0115	Incoloy 800	.07718
						Fuel	.64185
						Void	.03437
						NaK	.23662
2	Core part 2	8.014	2.904	6.310	1.143	Incoloy 800	.07858
						Fuel	.66685
						Void	.03502
						NaK	.20437
3	Core part 3	10.726	2.712	8.446	1.0680	Incoloy 800	.07989
						Fuel	.69049
						Void	.03557
						NaK	.18366
4	Core part 4	14.430	3.704	11.362	1.4580	Incoloy 800	.08132
						Fuel	.71683
						Void	.0363
						NaK	.15504
5	Interface	15.0114	0.5814	11.820	0.2290	NaK	.0773
						316 SS	.567
						Void	-
						Be	.3558
6	Vessel + NaK	15.4051	0.3937	12.130	0.1550	316SS	0.8085
						NaK	0.1915
7	Drums + Cusps	21.8661	6.4610	17.2174	2.5437	Be	.89709
						Void	.10291
8	Shim 1	24.5473	2.6812	19.3286	1.0556	Be	.68573
						Void	.31427
9	Shim 2	27.2288	2.6815	21.4400	1.0557	Be	.56180
						Void	.43820
10	Shim 3	29.9100	2.6812	23.5512	1.0556	Be	.50903
						Void	.49097

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TABLE XII

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MODEL NO.

NUCLEAR MODEL II - RADIAL

REGION DIMENSIONS & VOLUME FRACTION

CORE TEST REACTOR - MODEL C

4 ZONE CORE - 6 DRUMS

NEW DRUMS

REGIO. #	REGION DESCRIPTION		REGION DIMENSIONS				MATERIAL DESCRIPTION		VOLUME FRACTION OF MATERIAL IN REGION
			Outer Boundary (cm)	Region Thick- ness (cm)	Diameter or Ht. (inches)	Region Thick- ness (in)			
1	Core	Part 1	5.110	5.110	4.023	2.012	Incoloy	800	0.07718
							Fuel		0.64185
							Void		0.03437
							NaK		0.23662
2	Core	Part 2	8.014	2.904	6.310	1.143	Incoloy	800	0.07858
							Fuel		0.66685
							Void		0.03502
							NaK		0.20437
3	Core	Part 3	10.726	2.712	8.446	1.068	Incoloy	800	0.07989
							Fuel		0.69049
							Void		0.03557
							NaK		0.18366
4	Core	Part 4	14.430	3.704	11.362	1.458	Incoloy	800	0.08132
							Fuel		0.71683
							Void		0.03630
							NaK		0.15504
5	Interface		15.0114	0.5814	11.820	0.2289	NaK		0.0773
							316 SS		0.5670
							Void		---
							BeO		0.3558
6	Vessel &	NaK	15.4051	0.3937	12.130	0.1550	316 SS		0.8085
							NaK		0.1915
7	Ref.		24.4963	9.0912	18.2884	3.0792	Be		0.8782
							Void		0.1218
8	Shim	1	27.1719	2.6756	21.3952	1.5534	Be		0.61244
							Void		0.38756
9	Shim	2	29.8554	2.6835	23.5082	1.0565	Be		0.55327
							Void		0.44673
10	Shim	3	31.1965	1.3411	24.5642	0.5280	Be		0.51705
							Void		0.48295

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MODEL NO.

NUCLEAR MODEL III

ATOM DENSITIES ($\times 10^{-24}$)

MODEL C

Core Test Reactor

4 Zone Core - 6 Drum Reflector

15.3" Large Drums - 12.17" Shims

REGION NUMBER

REGION NUMBER	REGION		ISOTOPE								
	NAME		Eu 151	H	O	Al	Na	Zr	U 238	U 235	Na
1	Core	0		4.044-02	4.3-04	1.64-04	8.0-05	2.266-02	7.0-05	9.6-04	1.15-03
2	Core	0		4.202-02	"	"	"	2.354-02	7.3-05	9.97-04	1.02-03
3	"	0		4.35-02	"	"	"	2.438-02	7.5-05	1.033-03	8.9-04
4	"	0		4.516-02	"	"	"	2.531-02	7.8-05	1.072-03	7.5-04
5	Interface	0		0	2.42-02	0	0	0	0	0	3.9-04
6	Vessel + NaK	0		0	0	0	0	0	0	0	9.51-04
7	Drums	0		0	7.78-04	0	0	0	0	0	0
8	Shim 1	0		0	5.42-04	0	0	0	0	0	0
9	2	0		0	4.9-04	0	0	0	0	0	0
10	3	0		0	4.58-04	0	0	0	0	0	0
			K	Cr	Fe	Ni	Mn	316 SS	Be	Ta 181	
1	Core	2.5-03		1.381-03	3.079-03	2.068-03	6.0-05	0	0	0	
2	Core	2.21-03		"	"	"	"	0	0	0	
3	"	1.94-03		"	"	"	"	0	0	0	
4	"	1.62-03		"	"	"	"	0	0	0	
5	Interface	8.1-04		0	0	0	0	5.67-01	2.42-02	0	
6	Vessel	1.982-03		0	0	0	0	8.1-01	0	0	
7	Drums	0		0	0	0	0	0	1.0661-02	0	
8	Shim 1	0		0	0	0	0	0	7.435-02	0	
9	Shim 2	0		0	0	0	0	0	6.717-02	0	
10	Shim 3	0		0	0	0	0	0	6.278-02	0

ATOM DENSITIES ($\times 10^{-24}$)

Core Test Reactor

MODEL C

AXIAL

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DATE _____

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TABLE XVI

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MODEL NO.

NUCLEAR MODEL II - RADIAL

REGION DIMENSIONS & VOLUME FRACTION

CORE TEST REACTOR - MODEL D3

2 ZONE CORE - 7 DRUM REFLECTOR

S8DR TYPE DRUMS

[illegible]

PREPARED BY	ATOMICS INTERNATIONAL A Division of North American Rockwell Corporation TABLE XVII	PAGE 30 OF
CHECKED BY		REPORT NO. TI-759-240-012
DATE		MODEL NO.

NUCLEAR MODEL III Radial

ATOM DENSITIES ($\times 10^{-24}$)
 Core Test Reactor - Model D3
 2 Zone Core - 7 Drum Reflector
 S8DR Type Drums

REGION NUMBER	REGION	ISOTOPE								
	NAME	1	2	3	4	5	6	7	8	9
		H	Zr	U-235	U-238	$\emptyset$	Al	Na	Cr	Fe
1	Core	.03943	.02209	9.389-04	6.82-05	4.35-04	1.65-04	7.8-05	2.35-03	5.45-03
2	"	"	"	"	"	"	"	"	"	"
3	"	"	"	"	"	"	"	"	"	"
4	Core	.04271	.02393	1.017-03	7.39-05	4.35-04	1.65-04	7.8-05	2.43-03	5.41-03
5	"	"	"	"	"	"	"	"	"	"
6	IF	0	0	0	0	8.86-04	0	0	0	0
7	NaK	0	0	0	0	0	0	0	0	0
8	Vessel	0	0	0	0	0	0	0	0	0
9	Drum	0	0	0	0	7.82-04	0	0	0	0
10	Shim 1	0	0	0	0	6.26-04	0	0	0	0
11	2	0	0	0	0	5.47-04	0	0	0	0
12	3	0	0	0	0	5.2-04	0	0	0	0
		10	11	12	13	14	15	16	17	18
		Ni	Mn	Na	K	316 SS	Be	Ta	Gd	Xe
1	Core	3.66-03	1.08-04	.001	2.083-03	0	0	0	1.0-20	1.0-20
2	"	"	"	"	"	0	0	0	"	"
3	"	"	"	"	"	0	0	0	"	"
4	Core	3.63-03	1.08-04	7.36-04	1.54-03	0	0	0	1.0-20	1.0-20
5	"	"	"	"	"	0	0	0	"	"
6	IF	0	0	0	0	0	.1214	0	0	0
7	NaK	0	0	.005003	.01043	0	0	0	0	0
8	Vessel	0	0	0	0	1.0	0	0	0	0
9	Drum	0	0	0	0	0	.10717	0	0	0
10	Shim 1	0	0	0	0	0	.08579	0	0	0
11	2	0	0	0	0	0	.07499	0	0	0
12	3	0	0	0	0	0	.071189	0	0	0

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MODEL NO.

NUCLEAR MODEL III

ATOM DENSITIES ($\times 10^{-24}$)

Model D3

Core Test Reactor

2 Zone Core - 7 Drum Reflector

S8DR Type Drums

[illegible]

DATE

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TABLE XIX

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MODEL NO.

NUCLEAR MODEL III Radial

ATOM DENSITIES ($\times 10^{-24}$)

Core Test Reactor

2 Zone Core - 6 Drum Reflector

Large Drums

MODEL D3

REGION NUMBER	REGION	ISOTOPE								
	NAME									
	Y	H	Zr	U-235	U-238	O	AL	Na	Cr	Fe
1	Core	.03943	.02209	9.389-04	6.82-05	4.35-04	1.65-04	7.8-05	2.45-03	5.45-03
2	"	"	"	"	"	"	"	"	"	"
3	"	"	"	"	"	"	"	"	"	"
4	Core	.04271	.02393	1.017-03	7.39-05	4.35-04	1.65-04	7.8-05	2.45-03	5.41-03
5	"	"	"	"	"	"	"	"	"	"
6	Interface	0	0	0	0	8.86-04	0	0	0	0
7	NaK	0	0	0	0	0	0	0	0	0
8	Vessel	0	0	0	0	0	0	0	0	0
9	Drums	0	0	0	0	8.27-04	0	0	0	0
10	Shim 1	0	0	0	0	8.19-04	0	0	0	0
11	2	0	0	0	0	7.47-04	0	0	0	0
12	3	0	0	0	0	6.86-04	0	0	0	0
		Ni	Mn	Na	K	316SS	Be	Ta	Gd	Xe
1	Core	3.66-03	1.08-04	.001	2.083-03	0	0	0	1.0-20	1.0-20
2	"	"	"	"	"	0	0	0	"	"
3	"	"	"	"	"	0	0	0	"	"
4	Core	3.63-03	1.08-04	7.36-04	1.54-03	0	0	0	1.0-20	1.0-20
5	"	"	"	"	"	0	0	0	"	"
6	Interface	0	0	0	0	0	.1214	0	0	0
7	NaK	0	0	.005003	.01043	0	0	0	0	0
8	Vessel	0	0	0	0	1.0	0	0	0	0
9	Drum	0	0	0	0	0	.11328	0	0	0
10	Shim 1	0	0	0	0	0	.112271	0	0	0
11	2	0	0	0	0	0	.102316	0	0	0
12	3	0	0	0	0	0	.093976	0	0	0

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NUCLEAR MODEL III Radial

MODEL NO.

ATOM DENSITIES ($\times 10^{-24}$)

Core Test Reactor

2 Zone Core - 6 Drum Reflector

Large Drums

MODEL D3

REGION NUMBER	REGION	ISOTOPE					
	NAME	1	2	3	U-236	Eu	Sm
1	Core	1.0-20	1.0-20	1.0-20	1.0-20	0	0
2	"	"	"	"	"	"	"
3	"	"	"	"	"	"	"
4	Core	"	"	"	"	"	"
5	"	"	"	"	"	"	"
6	Isotope	0	0	0	0	0	0
7	NaK	0	0	0	0	0	0
8	Vessel	0	0	0	0	0	0
9	Drum	0	0	0	0	0	0
10	Shim 1	0	0	0	0	0	0
11	2	0	0	0	0	0	0
13	3	0	0	0	0	0	0

- - - - - SUMMARY BY ZONE, INCLUDING SUMMARY FOR ALL ZONES IN LAST COLUMN* - - - - -

*EXCEPTION - LAST LEFT LEAKAGE IS RT BNDY LEAKAGE

THE REACTION RATES HAVE BEEN DIVIDED BY XNF

	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5	ZONE 6
NO. INTERVALS	5.00000	5.00000	5.00000	5.00000	5.00000	3.00000
ZONE WIDTH	3.28170	3.28170	3.28160	2.52200	2.52200	0.92500
ZONE VOLUME	33.83353	101.50055	169.16150	175.98779	215.95203	89.22192
AVERAGE FLUX	0.03799	0.03647	0.03360	0.03012	0.02634	0.02361
RIGHT RADIUS	3.28170	6.56340	9.84500	12.36700	14.88900	15.81400
RADIAL LEAKAGE	0.01040	0.03007	0.04679	0.05172	0.07016	-0.00295
TRANS LEAKAGE	0.00403	0.01159	0.01776	0.01648	0.01729	0.00653
LEFT LEAKAGE	0.0	0.01040	0.04047	0.08727	0.13899	0.20915
LEFT L+	0.0	0.20444	0.39495	0.55074	0.63561	0.70284
LEFT L-	0.0	0.19404	0.35448	0.46347	0.49662	0.49369
NU FISSION/ABSN	1.61951	1.61967	1.62025	1.63392	1.65647	0.0
NU FISSION	0.06327	0.18266	0.28277	0.29216	0.36162	0.0
ABSORPTION	0.03906	0.11278	0.17452	0.17881	0.21831	-0.00356
FISSION	0.02596	0.07495	0.11603	0.11989	0.14846	0.0

MATL ABSN

1	HZR	20C	0.00065	0.00187	0.00289	0.00299	0.00372	0.0
2	ZR	20C	0.00084	0.00243	0.00374	0.00382	0.00431	0.0
3	U235	20C	0.03447	0.09952	0.15403	0.15901	0.19473	0.0
4	U238	20C	0.00060	0.00172	0.00266	0.00272	0.00304	0.0
5	O	20C	0.00000	0.00000	0.00001	0.00000	0.00000	0.00000
6	AL	20C	0.00000	0.00001	0.00001	0.00001	0.00001	0.0
7	NA	20C	0.00000	0.00001	0.00001	0.00001	0.00001	0.0
8	CR	20C	0.00039	0.00113	0.00175	0.00165	0.00205	0.0
9	FE	20C	0.00073	0.00210	0.00325	0.00308	0.00380	0.0
10	NI	20C	0.00097	0.00279	0.00431	0.00406	0.00491	0.0
11	MN	20C	0.00012	0.00034	0.00052	0.00050	0.00059	0.0
12	NA	20C	0.00003	0.00009	0.00014	0.00010	0.00012	0.0
13	K	20C	0.00027	0.00079	0.00122	0.00085	0.00101	0.0
14	316SS	20C	0.0	0.0	0.0	0.0	0.0	0.0
15	BF	20C	0.0	0.0	0.0	0.0	0.0	-0.00357
16	TA191	20C	0.0	0.0	0.0	0.0	0.0	0.0
17	GO-155	20C	0.00000	0.00000	0.00000	0.00000	0.00000	0.0
18	XE135	20C	0.00000	0.00000	0.00000	0.00000	0.00000	0.0
19	LEP1	FISS	0.00000	0.00000	0.00000	0.00000	0.00000	0.0

Table XXII
Isotopic Neutron Balance Tables
Core D3
Radial - 6 New Drums

20	LFP2	FISS	0.00000	0.00000	0.00000	0.00000	0.00000	0.0
21	LFP3	FISS	0.00000	0.00000	0.00000	0.00000	0.00000	0.0
22	U236	20C	0.00000	0.00000	0.00000	0.00000	0.00000	0.0
23	EU151	20C	0.0	0.0	0.0	0.0	0.0	0.0
24	SM149	20C	0.0	0.0	0.0	0.0	0.0	0.0

MATL FISS

1	HZR	20C	0.0	0.0	0.0	0.0	0.0	0.0
2	ZR	20C	0.0	0.0	0.0	0.0	0.0	0.0
3	U235	20C	0.02595	0.07492	0.11599	0.11985	0.14842	0.0
4	U238	20C	0.00001	0.00003	0.00004	0.00004	0.00004	0.0
5	O	20C	0.0	0.0	0.0	0.0	0.0	0.0
6	AL	20C	0.0	0.0	0.0	0.0	0.0	0.0
7	NA	20C	0.0	0.0	0.0	0.0	0.0	0.0
8	CR	20C	0.0	0.0	0.0	0.0	0.0	0.0
9	FE	20C	0.0	0.0	0.0	0.0	0.0	0.0
10	NI	20C	0.0	0.0	0.0	0.0	0.0	0.0
11	MN	20C	0.0	0.0	0.0	0.0	0.0	0.0
12	NA	20C	0.0	0.0	0.0	0.0	0.0	0.0
13	K	20C	0.0	0.0	0.0	0.0	0.0	0.0
14	316SS	20C	0.0	0.0	0.0	0.0	0.0	0.0
15	BE	20C	0.0	0.0	0.0	0.0	0.0	0.0
16	TA181	20C	0.0	0.0	0.0	0.0	0.0	0.0
17	GD-155	20C	0.0	0.0	0.0	0.0	0.0	0.0
18	XE135	20C	0.0	0.0	0.0	0.0	0.0	0.0
19	LFP1	FISS	0.0	0.0	0.0	0.0	0.0	0.0
20	LFP2	FISS	0.0	0.0	0.0	0.0	0.0	0.0
21	LFP3	FISS	0.0	0.0	0.0	0.0	0.0	0.0
22	U236	20C	0.00000	0.00000	0.00000	0.00000	0.00000	0.0
23	EU151	20C	0.0	0.0	0.0	0.0	0.0	0.0
24	SM149	20C	0.0	0.0	0.0	0.0	0.0	0.0

Table XXII(cont.)

--- SUMMARY BY ZONE, INCLUDING SUMMARY FOR ALL ZONES IN LAST COLUMN* ---

*EXCEPTION - LAST LEFT LEAKAGE IS RT BNDY LEAKAGE

THE REACTION RATES HAVE BEEN DIVIDED BY XNF

	ZONE 7	ZONE 8	ZONE 9	ZONE 10	ZONE 11	ZONE 12
NO. INTERVALS	3.00000	4.00000	10.00000	6.00000	6.00000	6.00000
ZONE WIDTH	0.15900	0.31699	9.76500	2.66699	2.66701	2.66701
ZONE VOLUME	15.87805	32.12964	1299.04370	458.95508	503.64844	548.33984
AVERAGE FLUX	0.02247	0.02217	0.01444	0.00694	0.00426	0.00198
RIGHT RADIUS	15.97300	16.28999	26.05499	28.72198	31.38899	34.05600
RADIAL LEAKAGE	-0.00191	-0.02079	-0.05135	-0.01013	-0.00686	-0.00341
TRANS LEAKAGE	0.00111	0.00221	0.05815	0.00987	0.00664	0.00337
LEFT LEAKAGE	0.20620	0.20429	0.18350	0.13216	0.12203	0.11517
LEFT L+	0.68847	0.69161	0.68127	0.42926	0.32170	0.21739
LEFT L-	0.48227	0.48732	0.49778	0.29711	0.19967	0.10222
NU FISSION/ABSN	0.0	0.0	0.0	0.0	0.0	0.0
NU FISSION	0.0	0.0	0.0	0.0	0.0	0.0
ABSORPTION	0.00080	0.01860	-0.00677	0.00017	0.00015	0.00001
FISSION	0.0	0.0	0.0	0.0	0.0	0.0

MATL	ABSN						
1	HZR	20C	0.0	0.0	0.0	0.0	0.0
2	ZR	20C	0.0	0.0	0.0	0.0	0.0
3	U235	20C	0.0	0.0	0.0	0.0	0.0
4	U238	20C	0.0	0.0	0.0	0.0	0.0
5	O	20C	0.0	0.0	0.00001	0.00000	0.00000
6	AL	20C	0.0	0.0	0.0	0.0	0.0
7	NA	20C	0.0	0.0	0.0	0.0	0.0
8	CP	20C	0.0	0.0	0.0	0.0	0.0
9	FE	20C	0.0	0.0	0.0	0.0	0.0
10	NI	20C	0.0	0.0	0.0	0.0	0.0
11	MN	20C	0.0	0.0	0.0	0.0	0.0
12	NA	20C	0.00009	0.0	0.0	0.0	0.0
13	K	20C	0.00071	0.0	0.0	0.0	0.0
14	316SS	20C	0.0	0.01860	0.0	0.0	0.0
15	BE	20C	0.0	0.0	-0.00678	0.00017	0.00015
16	TA181	20C	0.0	0.0	0.0	0.0	0.0
17	GO-155	20C	0.0	0.0	0.0	0.0	0.0
18	XE135	20C	0.0	0.0	0.0	0.0	0.0
19	LEPI	FISS	0.0	0.0	0.0	0.0	0.0

Table XII(cont.)

20	LFP2	FISS	0.0	0.0	0.0	0.0	0.0	0.0
21	LFP3	FISS	0.0	0.0	0.0	0.0	0.0	0.0
22	U236	20C	0.0	0.0	0.0	0.0	0.0	0.0
23	EU151	20C	0.0	0.0	0.0	0.0	0.0	0.0
24	SM149	20C	0.0	0.0	0.0	0.0	0.0	0.0

MATL

FISN

1	HZR	20C	0.0	0.0	0.0	0.0	0.0	0.0
2	ZR	20C	0.0	0.0	0.0	0.0	0.0	0.0
3	U235	20C	0.0	0.0	0.0	0.0	0.0	0.0
4	U238	20C	0.0	0.0	0.0	0.0	0.0	0.0
5	O	20C	0.0	0.0	0.0	0.0	0.0	0.0
6	AL	20C	0.0	0.0	0.0	0.0	0.0	0.0
7	NA	20C	0.0	0.0	0.0	0.0	0.0	0.0
8	CR	20C	0.0	0.0	0.0	0.0	0.0	0.0
9	FE	20C	0.0	0.0	0.0	0.0	0.0	0.0
10	NI	20C	0.0	0.0	0.0	0.0	0.0	0.0
11	MN	20C	0.0	0.0	0.0	0.0	0.0	0.0
12	NA	20C	0.0	0.0	0.0	0.0	0.0	0.0
13	K	20C	0.0	0.0	0.0	0.0	0.0	0.0
14	316SS	20C	0.0	0.0	0.0	0.0	0.0	0.0
15	BE	20C	0.0	0.0	0.0	0.0	0.0	0.0
16	TA181	20C	0.0	0.0	0.0	0.0	0.0	0.0
17	GD-155	20C	0.0	0.0	0.0	0.0	0.0	0.0
18	XF135	20C	0.0	0.0	0.0	0.0	0.0	0.0
19	LFP1	FISS	0.0	0.0	0.0	0.0	0.0	0.0
20	LFP2	FISS	0.0	0.0	0.0	0.0	0.0	0.0
21	LFP3	FISS	0.0	0.0	0.0	0.0	0.0	0.0
22	U236	20C	0.0	0.0	0.0	0.0	0.0	0.0
23	EU151	20C	0.0	0.0	0.0	0.0	0.0	0.0
24	SM149	20C	0.0	0.0	0.0	0.0	0.0	0.0

Table XXII(cont.)

- - - - - SUMMARY BY ZONE, INCLUDING SUMMARY FOR ALL ZONES IN LAST COLUMN* - - - - -
 *EXCEPTION - LAST LEFT LEAKAGE IS RT BNDY LEAKAGE

THE REACTION RATES HAVE BEEN DIVIDED BY XNF

	ZONE 13
NO. INTERVALS	63.00000
ZONE WIDTH	34.05600
ZONE VOLUME	3643.65015
AVERAGE FLUX	0.01372
RIGHT RADIUS	34.05600
RADIAL LEAKAGE	0.11176
TRANS LEAKAGE	0.15502
LEFT LEAKAGE	0.11176
LEFT L+	0.11176
LEFT L-	0.0
NU FISSION/ABSN	1.61349
NU FISSION	1.18247
ABSORPTION	0.73286
FISSION	0.48528

MATL	ABSN	
1 HZR	20C	0.01211
2 ZR	20C	0.01513
3 U235	20C	0.64175
4 U238	20C	0.01074
5 O	20C	0.00003
6 AL	20C	0.00004
7 NA	20C	0.00004
8 CR	20C	0.00696
9 FE	20C	0.01296
10 NI	20C	0.01704
11 MN	20C	0.00206
12 VA	20C	0.00056
13 K	20C	0.00495
14 B16SS	20C	0.01860
15 BE	20C	-0.01002
16 TA181	20C	0.0
17 GD-155	20C	0.00000
18 XF135	20C	0.00000
19 LEF1	FISS	0.00000
20 LEF2	FISS	0.00000

Table XII(cont.)

21	LFP3	FISS	0.00000
22	U236	20C	0.00000
23	EU151	20C	0.0
24	SM149	20C	0.0

MATL	FISN
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1	HZR	20C	0.0
2	ZR	20C	0.0
3	U235	20C	0.48512
4	U238	20C	0.00016
5	Q	20C	0.0
6	AL	20C	0.0
7	NA	20C	0.0
8	CR	20C	0.0
9	FE	20C	0.0
10	NI	20C	0.0
11	MN	20C	0.0
12	NA	20C	0.0
13	K	20C	0.0
14	316SS	20C	0.0
15	BE	20C	0.0
16	TA181	20C	0.0
17	GD-155	20C	0.0
18	XE135	20C	0.0
19	LFP1	FISS	0.0
20	LFP2	FISS	0.0
21	LFP3	FISS	0.0
22	U236	20C	0.00000
23	EU151	20C	0.0
24	SM149	20C	0.0

Table XXII(cont.)

--- SUMMARY BY ZONE, INCLUDING SUMMARY FOR ALL ZONES IN LAST COLUMN* ---
 *EXCEPTION - LAST LEFT LEAKAGE IS RT. BNDY LEAKAGE

THE REACTION RATES HAVE BEEN DIVIDED BY XNF

	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5
NO. INTERVALS	26.00000	6.00000	6.00000	4.00000	42.00000
ZONE WIDTH	22.85999	2.22301	3.81000	1.27000	30.16299
ZONE VOLUME	22.85999	2.22301	3.81000	1.27000	30.16299
AVERAGE FLUX	0.94806	0.24133	0.15253	0.11010	0.76020
RIGHT RADIUS	22.85999	25.08299	28.89299	30.16299	30.16299
RADIAL LEAKAGE	0.06714	-0.00887	-0.00599	-0.00180	0.05048
TRANS LEAKAGE	0.20892	0.00517	0.00560	0.00135	0.22105
LEFT LEAKAGE	0.00000	0.06714	0.05827	0.05228	0.05048
LEFT L+	0.32995	0.11636	0.07563	0.06358	0.05048
LEFT L-	0.32995	0.04922	0.01736	0.01130	0.0
NU FISSION/ABSN	1.63438	0.0	0.0	0.0	1.62422
NU FISSION	1.18315	0.0	0.0	0.0	1.18315
ABSORPTION	0.72391	0.00369	0.00038	0.00045	0.72844
FISSION	0.48556	0.0	0.0	0.0	0.48556

MATL	ABSN					
1	HZR	20C	0.01209	0.0	0.0	0.01209
2	ZR	20C	0.01513	0.0	0.0	0.01513
3	U235	20C	0.64090	0.0	0.0	0.64090
4	U238	20C	0.01074	0.0	0.0	0.01074
5	O	20C	0.00002	0.0	0.0	0.00002
6	AL	20C	0.00004	0.0	0.0	0.00004
7	NA	20C	0.00004	0.0	0.0	0.00004
8	CR	20C	0.00697	0.0	0.0	0.00697
9	FE	20C	0.01297	0.0	0.0	0.01297
10	NI	20C	0.01705	0.0	0.0	0.01705
11	MN	20C	0.00206	0.0	0.0	0.00206
12	NA	20C	0.00048	0.00002	0.00004	0.00053
13	K	20C	0.00416	0.00016	0.00035	0.00472
14	316SS	20C	0.0	0.00250	0.0	0.00290
15	BE	20C	0.0	0.0	0.0	0.0
16	TA181	20C	0.0	0.0	0.0	0.0
17	GO-155	20C	0.00000	0.0	0.0	0.00000
18	XE135	20C	0.00000	0.0	0.0	0.00000
19	LFP1	FISS	0.00000	0.0	0.0	0.00000
20	LFP2	FISS	0.00000	0.0	0.0	0.00000

Table XXIII
 Isotopic Neutron Balance Tables
 Core D3
 Axial - 6 New Drums

21	LFP3	FISS	0.00000	0.0	0.0	0.0	0.00000
22	U236	20C	0.00000	0.0	0.0	0.0	0.00000
23	EU151	20C	0.0	0.0	0.0	0.0	0.0
24	SM149	20C	0.0	0.0	0.0	0.0	0.0
25	HASTN	20C	0.0	0.00102	0.0	0.0	0.00102

MATL	FISN
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1	HZR	20C	0.0	0.0	0.0	0.0	0.0
2	ZR	20C	0.0	0.0	0.0	0.0	0.0
3	U235	20C	0.48439	0.0	0.0	0.0	0.48439
4	U238	20C	0.00016	0.0	0.0	0.0	0.00016
5	O	20C	0.0	0.0	0.0	0.0	0.0
6	AL	20C	0.0	0.0	0.0	0.0	0.0
7	NA	20C	0.0	0.0	0.0	0.0	0.0
8	CR	20C	0.0	0.0	0.0	0.0	0.0
9	FE	20C	0.0	0.0	0.0	0.0	0.0
10	NI	20C	0.0	0.0	0.0	0.0	0.0
11	MN	20C	0.0	0.0	0.0	0.0	0.0
12	NA	20C	0.0	0.0	0.0	0.0	0.0
13	K	20C	0.0	0.0	0.0	0.0	0.0
14	316SS	20C	0.0	0.0	0.0	0.0	0.0
15	BE	20C	0.0	0.0	0.0	0.0	0.0
16	TA181	20C	0.0	0.0	0.0	0.0	0.0
17	GD-155	20C	0.0	0.0	0.0	0.0	0.0
18	XE135	20C	0.0	0.0	0.0	0.0	0.0
19	LFP1	FISS	0.0	0.0	0.0	0.0	0.0
20	LFP2	FISS	0.0	0.0	0.0	0.0	0.0
21	LFP3	FISS	0.0	0.0	0.0	0.0	0.0
22	U236	20C	0.00000	0.0	0.0	0.0	0.00000
23	EU151	20C	0.0	0.0	0.0	0.0	0.0
24	SM149	20C	0.0	0.0	0.0	0.0	0.0
25	HASTN	20C	0.0	0.0	0.0	0.0	0.0

Table XIII (cont.)

--- SUMMARY BY ZONE, INCLUDING SUMMARY FOR ALL ZONES IN LAST COLUMN* ---
 *EXCEPTION - LAST LEFT LEAKAGE IS RT. BNDY LEAKAGE

THE REACTION RATES HAVE BEEN DIVIDED BY XNF

	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5	ZONE 6
NO. INTERVALS	5.00000	5.00000	5.00000	5.00000	5.00000	3.00000
ZONE WIDTH	3.28170	3.28170	3.28160	2.52200	2.52200	0.92500
ZONE VOLUME	33.83353	101.50055	169.16150	175.98779	215.95203	89.22192
AVERAGE FLUX	0.04741	0.04334	0.03580	0.02680	0.01706	0.00961
RIGHT RADIUS	3.28170	6.56340	9.84500	12.36700	14.88900	15.81400
RADIAL LEAKAGE	0.02581	0.07074	0.09703	0.03313	0.05953	-0.00000
TRANS LEAKAGE	0.00516	0.01416	0.01950	0.01522	0.01198	0.00277
LEFT LEAKAGE	0.0	0.02581	0.09654	0.19357	0.27669	0.33622
LEFT L+	0.0	0.25783	0.47588	0.59686	0.58853	0.46866
LEFT L-	0.0	0.23202	0.37934	0.40329	0.31184	0.13244
NU FISSION/ABSN	1.61660	1.61656	1.61644	1.62804	1.62095	0.0
NU FISSION	0.07479	0.20504	0.28148	0.23505	0.17200	0.0
ABSORPTION	0.04627	0.12684	0.17414	0.14437	0.10611	-0.00276
FISSION	0.03068	0.08411	0.11547	0.09642	0.07054	0.0

ATL ABSN

1	HZR	20C	0.00076	0.00208	0.00286	0.00238	0.00173	0.0
2	ZR	20C	0.00102	0.00281	0.00386	0.00324	0.00248	0.0
3	U235	20C	0.04079	0.11183	0.15352	0.12819	0.09411	0.0
4	U238	20C	0.00071	0.00195	0.00268	0.00224	0.00169	0.0
5	O	20C	0.00000	0.00000	0.00001	0.00000	0.00000	0.00000
6	AL	20C	0.00000	0.00001	0.00001	0.00001	0.00001	0.0
7	NA	20C	0.00000	0.00001	0.00001	0.00001	0.00001	0.0
8	CR	20C	0.00046	0.00126	0.00173	0.00132	0.00096	0.0
9	FE	20C	0.00086	0.00235	0.00322	0.00247	0.00180	0.0
10	NI	20C	0.00115	0.00316	0.00434	0.00332	0.00244	0.0
11	MN	20C	0.00014	0.00038	0.00052	0.00040	0.00030	0.0
12	NA	20C	0.00004	0.00010	0.00014	0.00008	0.00006	0.0
13	K	20C	0.00033	0.00090	0.00124	0.00071	0.00053	0.0
14	RI6SS	20C	0.0	0.0	0.0	0.0	0.0	0.0
15	RE	20C	0.0	0.0	0.0	0.0	0.0	-0.00277
16	TA181	20C	0.0	0.0	0.0	0.0	0.0	0.0
17	GD-155	20C	0.00000	0.00000	0.00000	0.00000	0.00000	0.0
18	XE135	20C	0.00000	0.00000	0.00000	0.00000	0.00000	0.0
19	LFP1	FISS	0.00000	0.00000	0.00000	0.00000	0.00000	0.0

Table XXIV
Isotopic Neutron Balance Tables
Core D3
Radial - Bare

20	LFP2	FISS	0.00000	0.00000	0.00000	0.00000	0.00000	0.0
21	LFP3	FISS	0.00000	0.00000	0.00000	0.00000	0.00000	0.0
22	U236	20C	0.00000	0.00000	0.00000	0.00000	0.00000	0.0
23	EU151	20C	0.0	0.0	0.0	0.0	0.0	0.0
24	SM149	20C	0.0	0.0	0.0	0.0	0.0	0.0

ATL FISS

1	HZR	20C	0.0	0.0	0.0	0.0	0.0	0.0
2	ZR	20C	0.0	0.0	0.0	0.0	0.0	0.0
3	U235	20C	0.03067	0.08408	0.11542	0.09638	0.07051	0.0
4	U238	20C	0.00001	0.00003	0.00005	0.00004	0.00003	0.0
5	O	20C	0.0	0.0	0.0	0.0	0.0	0.0
6	AL	20C	0.0	0.0	0.0	0.0	0.0	0.0
7	NA	20C	0.0	0.0	0.0	0.0	0.0	0.0
8	CR	20C	0.0	0.0	0.0	0.0	0.0	0.0
9	FE	20C	0.0	0.0	0.0	0.0	0.0	0.0
10	NI	20C	0.0	0.0	0.0	0.0	0.0	0.0
11	MN	20C	0.0	0.0	0.0	0.0	0.0	0.0
12	NA	20C	0.0	0.0	0.0	0.0	0.0	0.0
13	K	20C	0.0	0.0	0.0	0.0	0.0	0.0
14	316SS	20C	0.0	0.0	0.0	0.0	0.0	0.0
15	BE	20C	0.0	0.0	0.0	0.0	0.0	0.0
16	TA1R1	20C	0.0	0.0	0.0	0.0	0.0	0.0
17	GD-155	20C	0.0	0.0	0.0	0.0	0.0	0.0
18	XE135	20C	0.0	0.0	0.0	0.0	0.0	0.0
19	LFP1	FISS	0.0	0.0	0.0	0.0	0.0	0.0
20	LFP2	FISS	0.0	0.0	0.0	0.0	0.0	0.0
21	LFP3	FISS	0.0	0.0	0.0	0.0	0.0	0.0
22	U236	20C	0.00000	0.00000	0.00000	0.00000	0.00000	0.0
23	EU151	20C	0.0	0.0	0.0	0.0	0.0	0.0
24	SM149	20C	0.0	0.0	0.0	0.0	0.0	0.0

Table XXIV(cont.)

- - - - SUMMARY BY ZONE, INCLUDING SUMMARY FOR ALL ZONES IN LAST COLUMN* - - - -
 *EXCEPTION - LAST LEFT LEAKAGE IS RT BNDY LEAKAGE

THE REACTION RATES HAVE BEEN DIVIDED BY XNF

	ZONE 7	ZONE 8	ZONE 9
NO. INTERVALS	3.00000	4.00000	35.00000
ZONE WIDTH	0.15900	0.31699	16.28999
ZONE VOLUME	15.87805	32.12964	833.66333
AVERAGE FLUX	0.00718	0.00624	0.02595
RIGHT RADIUS	15.97300	16.28999	16.28999
RADIAL LEAKAGE	-0.00048	-0.00228	0.33346
TRANS LEAKAGE	0.00037	0.00065	0.06981
LEFT LEAKAGE	0.33623	0.33575	0.33346
LEFT L+	0.37397	0.37233	0.33346
LEFT L-	0.03774	0.03658	0.00000
NU FISSION/ABSN	0.0	0.0	1.62285
NU FISSION	0.0	0.0	0.96837
ABSORPTION	0.00011	0.00163	0.59671
FISSION	0.0	0.0	0.39722

IATL		ABSN		
1	HZR	20C	0.0	0.00981
2	ZR	20C	0.0	0.01341
3	U235	20C	0.0	0.52843
4	U238	20C	0.0	0.00929
5	O	20C	0.0	0.00002
6	AL	20C	0.0	0.00004
7	NA	20C	0.0	0.00004
8	CP	20C	0.0	0.00573
9	FE	20C	0.0	0.01070
10	NI	20C	0.0	0.01441
11	MN	20C	0.0	0.00175
12	NA	20C	0.00001	0.00042
13	K	20C	0.00010	0.00281
14	316SS	20C	0.0	0.00163
15	RF	20C	0.0	-0.00277
16	TA181	20C	0.0	0.0
17	GO-155	20C	0.0	0.00000
18	XF135	20C	0.0	0.00000
19	LFP1	FISS	0.0	0.00000
20	LFP2	FISS	0.0	0.00000

Table XXIV(cont.)

21	LFP3	FISS	0.0	0.0	0.00000
22	U236	20C	0.0	0.0	0.00000
23	EU151	20C	0.0	0.0	0.0
24	SM149	20C	0.0	0.0	0.0

IATL	FISN
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1	HZR	20C	0.0	0.0	0.0
2	ZR	20C	0.0	0.0	0.0
3	U235	20C	0.0	0.0	0.39705
4	U238	20C	0.0	0.0	0.00016
5	Q	20C	0.0	0.0	0.0
6	AL	20C	0.0	0.0	0.0
7	NA	20C	0.0	0.0	0.0
8	CR	20C	0.0	0.0	0.0
9	FE	20C	0.0	0.0	0.0
10	NI	20C	0.0	0.0	0.0
11	MN	20C	0.0	0.0	0.0
12	NA	20C	0.0	0.0	0.0
13	K	20C	0.0	0.0	0.0
14	316SS	20C	0.0	0.0	0.0
15	BE	20C	0.0	0.0	0.0
16	TA181	20C	0.0	0.0	0.0
17	GD-155	20C	0.0	0.0	0.0
18	XF135	20C	0.0	0.0	0.0
19	LFP1	FISS	0.0	0.0	0.0
20	LFP2	FISS	0.0	0.0	0.0
21	LFP3	FISS	0.0	0.0	0.0
22	U236	20C	0.0	0.0	0.00000
23	EU151	20C	0.0	0.0	0.0
24	SM149	20C	0.0	0.0	0.0

Table XXIV(cont.)

- - - - SUMMARY BY ZONE, INCLUDING SUMMARY FOR ALL ZONES IN LAST COLUMN* - - - -
 *EXCEPTION - LAST LEFT LEAKAGE IS PL-BNDY LEAKAGE

THE REACTION RATES HAVE BEEN DIVIDED BY YNE

	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5
NO. INTERVALS	26.00000	6.00000	6.00000	4.00000	42.00000
ZONE WIDTH	22.85999	2.22301	3.81000	1.27000	30.16299
ZONE VOLUME	22.85999	2.22301	3.81000	1.27000	30.16299
AVERAGE FLUX	0.89505	0.21740	0.13242	0.09421	0.71506
RIGHT RADIUS	22.85999	25.08299	28.89299	30.16299	30.16299
RADIAL LEAKAGE	0.06602	-0.01092	-0.00861	-0.00231	0.04419
TRANS LEAKAGE	0.33620	0.00794	0.00829	0.00197	0.35440
LEFT LEAKAGE	0.0	0.06602	0.05510	0.04650	0.04419
LEFT L+	0.31270	0.10892	0.06918	0.05573	0.04419
LEFT L-	0.31270	0.04289	0.01408	0.00923	0.0
NU FISSION/ABSN	1.62008	0.0	0.0	0.0	1.61026
NU FISSION	0.96839	0.0	0.0	0.0	0.96839
ABSORPTION	0.59774	0.00299	0.00032	0.00034	0.60138
FISSION	0.39722	0.0	0.0	0.0	0.39722

IATL ABSN

1	HZR	20C	0.00981	0.0	0.0	0.0	0.00981
2	ZR	20C	0.01341	0.0	0.0	0.0	0.01341
3	U235	20C	0.52883	0.0	0.0	0.0	0.52883
4	U238	20C	0.00929	0.0	0.0	0.0	0.00929
5	D	20C	0.00002	0.0	0.0	0.0	0.00002
6	AL	20C	0.00004	0.0	0.0	0.0	0.00004
7	NA	20C	0.00004	0.0	0.0	0.0	0.00004
8	CR	20C	0.00573	0.0	0.0	0.0	0.00573
9	FF	20C	0.01069	0.0	0.0	0.0	0.01069
10	NI	20C	0.01441	0.0	0.0	0.0	0.01441
11	MN	20C	0.00175	0.0	0.0	0.0	0.00175
12	NA	20C	0.00041	0.00001	0.00002	0.00003	0.00045
13	K	20C	0.00370	0.00014	0.00029	0.00023	0.00417
14	316SS	20C	0.0	0.00200	0.0	0.00031	0.00230
15	BE	20C	0.0	0.0	0.0	0.0	0.0
16	TA131	20C	0.0	0.0	0.0	0.0	0.0
17	GD-155	20C	0.00000	0.0	0.0	0.0	0.00000
18	XF135	20C	0.00000	0.0	0.0	0.0	0.00000
19	LEP1	FISS	0.00000	0.0	0.0	0.0	0.00000
20	LEP2	FISS	0.00000	0.0	0.0	0.0	0.00000

Table XXV
 Isotopic Neutron Balance Tables
 Core D3
 Axial - Bare

21	LFP3	FISS	0.00000	0.0	0.0	0.0	0.00000
22	U236	20C	0.00000	0.0	0.0	0.0	0.00000
23	EU151	20C	0.0	0.0	0.0	0.0	0.0
24	SM149	20C	0.0	0.0	0.0	0.0	0.0
25	HASTN	20C	0.0	0.00084	0.0	0.0	0.00084

ATL FISSN

1	HZR	20C	0.0	0.0	0.0	0.0	0.0
2	ZR	20C	0.0	0.0	0.0	0.0	0.0
3	U235	20C	0.39736	0.0	0.0	0.0	0.39736
4	U238	20C	0.00016	0.0	0.0	0.0	0.00016
5	O	20C	0.0	0.0	0.0	0.0	0.0
6	AL	20C	0.0	0.0	0.0	0.0	0.0
7	NA	20C	0.0	0.0	0.0	0.0	0.0
8	CP	20C	0.0	0.0	0.0	0.0	0.0
9	FE	20C	0.0	0.0	0.0	0.0	0.0
10	NT	20C	0.0	0.0	0.0	0.0	0.0
11	MN	20C	0.0	0.0	0.0	0.0	0.0
12	NA	20C	0.0	0.0	0.0	0.0	0.0
13	K	20C	0.0	0.0	0.0	0.0	0.0
14	316SS	20C	0.0	0.0	0.0	0.0	0.0
15	BE	20C	0.0	0.0	0.0	0.0	0.0
16	TA181	20C	0.0	0.0	0.0	0.0	0.0
17	GD-155	20C	0.0	0.0	0.0	0.0	0.0
18	XE135	20C	0.0	0.0	0.0	0.0	0.0
19	LFP1	FISS	0.0	0.0	0.0	0.0	0.0
20	LFP2	FISS	0.0	0.0	0.0	0.0	0.0
21	LFP3	FISS	0.0	0.0	0.0	0.0	0.0
22	U236	20C	0.00000	0.0	0.0	0.0	0.00000
23	EU151	20C	0.0	0.0	0.0	0.0	0.0
24	SM149	20C	0.0	0.0	0.0	0.0	0.0
25	HASTN	20C	0.0	0.0	0.0	0.0	0.0

Table XXV(cont.)

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