Dr-801

Y-1948

VALIDATION OF THE "KENO" CODE FOR
NUCLEAR CRITICALITY SAFETY CAL-
CULATIONS OF MODERATED,
LOW-ENRICHED URANIUM
SYSTEMS

G. R. Handley
C. M. Hopper
Technical Division

UNION
CARBIDE

OAK RIDGE Y-12 PLANT
OAK RIDGE, TENNESSEE

prepared for the U.S. ATOMIC ENERGY COMMISSION
under U.S. GOVERNMENT Contract W-7405 eng 26

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Reference to a company or product name does not imply approval or recommendation of the product by Union Carbide Corporation or the U.S. Atomic Energy Commission to the exclusion of others that may meet specifications.

Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22151
Price: Printed Copy \$5.45; Microfiche \$1.45

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

**VALIDATION OF THE "KENO" CODE FOR NUCLEAR CRITICALITY SAFETY
CALCULATIONS OF MODERATED, LOW-ENRICHED URANIUM SYSTEMS**

G. R. Handley
C. M. Hopper
Technical Division

Oak Ridge Y-12 Plant

P.O. Box Y, Oak Ridge, Tennessee 37830

Date Issued - June 13, 1974

Prepared for the U.S. Atomic Energy Commission
Under U.S. Government Contract W-7405-eng-26

MASTER

ABSTRACT

The Monte Carlo computer code, KENO, was employed to calculate 40 critical experiments with uranium enrichments in the U-235 isotope of 5% or less. A variety of geometries and materials were considered. The code input parameters and the 16-energy-group cross sections are included. It is concluded that the code and cross sections are adequate and that reliable criticality safety calculations may be made for systems of general interest, provided the limits of validated applicability are not exceeded.

CONTENTS

SUMMARY	4
INTRODUCTION	5
VALIDATION OF THE "KENO" CODE	6
Method of Calculation	6
Results of Calculations	6
Conclusions	12
APPENDIX A	13
Input Parameters Employed in the Calculations	14
APPENDIX B	21
Cross Sections Employed in the Calculations	21
APPENDIX C	53
Leakage, Absorptions, and Fissions from the KENO Code Outputs	53
REFERENCES	64
ACKNOWLEDGEMENTS	66

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

SUMMARY

This report documents validation of the KENO code and 16-energy-group cross sections by calculating the k_{eff} values for 40 experimentally critical assemblies which had uranium enrichments of 5% or less in the U-235 isotope. These assemblies were of different geometries and contained a variety of materials so that a selected specific range of neutron-energy spectra was covered.

From the balance table of fission, absorption, and leakage found in each KENO output, the fissions were used to calculate the average energy group of a neutron causing fission, ie:

$$\frac{\sum_{i=1}^{16} i F(i)}{F \text{ (total)}}$$

A second-degree polynomial was estimated from the 40 pairs of neutron multiplication factors, k_{eff} , and the average energy group of a neutron causing fission, E , where E is the independent variable and k_{eff} the dependent variable. In addition, upper and lower tolerance limits were approximated for the distribution of k_{eff} values around the polynomial for each value of E . The tolerance limits are such that 99.9% of the distribution of k_{eff} values, for a given E level, will lie between the tolerance limits with 99% confidence. Limits were computed under the assumptions that the k_{eff} values are random observations from a normal probability distribution for each value of E and that a second-degree polynomial is the true model relating k_{eff} values to E values.

The estimated polynomial is of the following form:

$$\hat{k}_{eff}(E) = 2.1046556 - 0.1327182 * E + 0.0039172 * E^2 .$$

The standard deviation of the estimated curve is given by:

$$S_{\hat{k}_{eff}}(E) = 0.0072892 .$$

Based on the calculational methods presented in this report, it is concluded that the code and cross sections are adequate; and, for nuclear safety purposes, any $k_{eff} + 2\sigma$ which exceeds the lower tolerance limit (which is a function of E) must be considered critical and all lower values may be considered subcritical provided: (1) the fuel and reflector are not significantly different in constituents or the relative abundance of constituents from the experiments considered, and (2) the average energy group of a neutron causing fission is not outside the range examined (14.1 to 15.6).

INTRODUCTION

In order to analyze nuclear criticality safety without undue conservatism or expense, experimental data are often supplemented by calculations. Each calculational method must be correlated with relevant experimental data in order to establish a bias in the method over a specific area of applicability. The KENO⁽¹⁾ computer code has been employed for several years to supplement criticality experiments. KENO is a multigroup Monte Carlo criticality code which allows analysis of complex three-dimensional systems.

The code was validated⁽²⁾ by the Oak Ridge Y-12 Plant^(a) for application to systems of highly enriched uranium. In order to properly employ the code to analyze the criticality safety of low-enriched systems at the Oak Ridge Gaseous Diffusion Plant (ORGDP),^(a) another validation was needed. The validation for highly enriched uranium had already shown the mechanics of the code to be in good working order and, so, this investigation was designed mainly to determine the bias of computed k_{eff} due to cross sections of uranium enrichments of 5% or less. Changes and improvements are often made to the code which are revalidated to the satisfaction of the programmers; however, an extensive and independent validation after each change is prohibitively expensive. Therefore, a version of the code and cross sections has been obtained which is under Y-12 Criticality Safety's control. The code and cross sections have been independently validated for the intended applications, and updating and revalidation will be accomplished only as required.

A total of 40 low ($\leq 5\%$)-enriched systems, applicable to the ORGDP, were calculated. A listing of calculational mockup input parameters is included in Appendix A; the cross sections are identified and listed in Appendix B. With these input parameters and cross sections, it is possible to examine in detail any mockup of interest.

(a) Operated by the Union Carbide Corporation's Nuclear Division for the US Atomic Energy Commission.

VALIDATION OF THE "KENO" CODE

METHOD OF CALCULATION

The calculations employed the Hansen-Roach⁽³⁾ 16-energy-group cross sections in most experimental cases. Resonance self-shielding corrected, uranium cross sections were used in all cases. Many of the U-238 cross sections were modified by Knight⁽⁴⁾ to depict the large changes in the U-238 resonance region based on Hanford experiments with 2 and 3% enriched uranium in paraffin. The dE/E weighted hydrogen was used for all cases since all the cores had large hydrogen-to-U-235 atomic ratios.⁽⁵⁾

The KENO calculations (submitted one at a time to an IBM 360 Model 91 computer) were for 5.3 batches of 600 neutrons each. The first three batches in each case were skipped. In Cases 1 through 26, the neutrons were started in a flat distribution throughout the fissile material; in Cases 37 through 40 (intersecting pipes), the neutrons were started at the intersection of the radial axes of the pipes. This latter technique prevents underestimation of k_{eff} due to a slow upward convergence.⁽⁶⁾ Instead of tracking complete neutron histories, the reflectors could have employed adjoint biasing⁽⁷⁾ for cases with edge dimensions less than 100 cm and differential current albedos⁽⁸⁾ for larger cases, but this was not done. No effort of any kind was made to force agreement between experiments and calculations.

RESULTS OF CALCULATIONS

The calculated k_{eff} values for the critical experiments considered are presented in Table 1 with short descriptions of the experiments and references⁽⁹⁻¹⁵⁾ to the experimental results. The standard deviation of k_{eff} is based wholly on statistical analysis of the number of neutrons tracked and their histories; and, therefore, does not include any possible uncertainties in such factors as cross sections, dimensions, and densities.

The KENO code output for each case included a balance table containing values for the system leakage, core absorptions, and fissions. These are tabulated in Appendix C. The quantity chosen to establish an acceptable correlation to k_{eff} , thus establishing the bias, was:

$$\frac{\sum_{i=1}^{16} i F(i)}{F(\text{total})},$$

which is the average energy-group of a neutron causing fission. This quantity was calculated for each case and is also presented in Appendix C. As stated by Lever and Johnson:⁽¹⁶⁾

"A second degree polynomial was estimated from forty pairs of neutron multiplication factors, k_{eff} , and the average energy group of a neutron causing fission, E , where E is the independent variable and k_{eff} is the dependent variable. In addition, upper and lower tolerance limits were approximated for the distribution of k_{eff} values around the polynomial for each value of E . The tolerance limits are such that one can say that 99.9 percent of the distribution of k_{eff} values, for a given E level, will lie between the tolerance limits with 99 percent

Table 1
 "KENO" CALCULATED k_{eff} RESULTS FOR EXPERIMENTALLY CRITICAL SYSTEMS

Experiment	Reference	$k_{\text{eff}} \pm \sigma$
1. Two reflected facing rectangular parallelepipeds of homogeneous U(1.4)F ₄ and paraffin with an H/U-235 atomic ratio of 420. Each stack measured 92.1 cm x 92.3 cm x 75.7 cm, with a void gap between stacks of 10.363 cm. The reflector was 20.32 cm of polyethylene on all sides except on the facing areas.	Scott(9)	0.99965 ± 0.00257
2. Reflected split cube of homogeneous U(1.4)F ₄ and paraffin with an H/U-235 atomic ratio of 420. Each half measured 46.25 cm x 92.5 cm x 95.1 cm. The void gap measured 0.681 cm. The top was reflected by 7.62 cm of mild steel. Other sides were reflected by 20.32 cm of polyethylene except on the facing areas.	Scott(9)	0.99886 ± 0.00258
3. Reflected split cube of homogeneous U(1.4)F ₄ and paraffin with an H/U-235 atomic ratio of 420. Each half measured 46.25 cm x 92.5 cm x 95.1 cm. The void gap measured 0.815 cm. The top was reflected by 21.6 cm of concrete. Other sides were reflected by 20.32 cm of polyethylene except on the facing areas.	Scott(9)	1.00585 ± 0.00304
4. An unreflected rectangular parallelepiped of homogeneous U(1.4)F ₄ and paraffin with an H/U-235 atomic ratio of 421.8; 93.1 cm x 93.0 cm x 123.8 cm.	Abbey(10)	1.00192 ± 0.00317
5. An unreflected rectangular parallelepiped of homogeneous U(1.4)F ₄ and paraffin with an H/U-235 atomic ratio of 421.8; 100.0 cm x 99.9 cm x 103.1 cm.	Abbey(10)	0.99752 ± 0.00310
6. An unreflected rectangular parallelepiped of homogeneous U(1.4)F ₄ and paraffin with an H/U-235 atomic ratio of 421.8; 130.7 cm x 130.6 cm x 74.2 cm.	Abbey(10)	0.99328 ± 0.00304
7. Reflected slab-column rectangular parallelepipeds of homogeneous U(1.4)F ₄ and paraffin with an H/U-235 atomic ratio of 425. Slab measured 97.7 cm x 148.7 cm x 56.4 cm. Column measured 84.5 cm x 69.2 cm x 72.0 cm. The reflector was 20.32 cm of polyethylene on all sides.	Scott(9)	0.98926 ± 0.00312
8. Reflected split slab-column rectangular parallelepipeds of homogeneous U(1.4)F ₄ and paraffin with an H/U-235 atomic ratio of 425. Slab measured 97.7 cm x 123.0 cm x 61.5 cm. Column measured 84.5 cm x 76.9 cm x 77.1 cm. Gap measured 3.25 cm. The reflector was 20.32 cm on all sides except on the facing areas.	Scott(9)	0.99582 ± 0.00356
9. A reflected rectangular parallelepiped of homogeneous U(1.4)F ₄ and paraffin with an H/U-235 atomic ratio of 500; 81.9 cm x 98.5 cm x 94.7 cm, reflected with 20.32 cm of polyethylene on all sides.	Scott(9)	0.98911 ± 0.00248
10. A reflected rectangular parallelepiped of homogeneous U(1.4)F ₄ and paraffin with an H/U-235 atomic ratio of 595; 87.4 cm x 98.0 cm x 94.5 cm, reflected with 20.32 cm of polyethylene on all sides.	Scott(9)	0.99033 ± 0.00312

Table 1 (Continued)

Experiment	Reference	$k_{\text{eff}} \pm \sigma$
11. A reflected rectangular parallelepiped of homogeneous U(2)F ₄ and paraffin with an H/U-235 atomic ratio of 195.2; 56.22 cm x 56.22 cm x 112.88 cm, reflected with 15.2 cm of paraffin on top and sides and 15.2 cm of Plexiglas on the bottom.	Raffety ⁽¹¹⁾	0.99648 ± 0.00367
12. An unreflected rectangular parallelepiped of homogeneous U(2)F ₄ and paraffin with an H/U-235 atomic ratio of 195.2; 71.47 cm x 71.47 cm x 94.14 cm.	Raffety ⁽¹¹⁾	0.99902 ± 0.00463
13. A reflected rectangular parallelepiped of homogeneous U(2)F ₄ and paraffin with an H/U-235 atomic ratio of 293.9; 51.11 cm x 51.11 cm x 73.87 cm, reflected with 15.2 cm of paraffin on top and sides and 15.2 cm of Plexiglas on the bottom.	Raffety ⁽¹¹⁾	1.00015 ± 0.00387
14. An unreflected rectangular parallelepiped of homogeneous U(2)F ₄ and paraffin with an H/U-235 atomic ratio of 293.9; 56.22 cm x 56.22 cm x 122.47 cm.	Raffety ⁽¹¹⁾	0.99422 ± 0.00370
15. A reflected rectangular parallelepiped of homogeneous U(2)F ₄ and paraffin with an H/U-235 atomic ratio of 406.3; 53.67 cm x 53.67 cm x 54.29 cm, reflected with 15.2 cm of paraffin on top and sides and 15.2 cm of Plexiglas on the bottom.	Raffety ⁽¹¹⁾	0.99757 ± 0.00307
16. A reflected rectangular parallelepiped of homogeneous U(2)F ₄ and paraffin with an H/U-235 atomic ratio of 495.9; 46.00 cm x 46.00 cm x 96.57 cm, reflected with 15.2 cm of paraffin on top and sides and 15.2 cm of Plexiglas on the bottom.	Raffety ⁽¹¹⁾	0.98136 ± 0.00338
17. A reflected rectangular parallelepiped of homogeneous U(2)F ₄ and paraffin with an H/U-235 atomic ratio of 613.6; 56.32 cm x 61.29 cm x 54.08 cm, reflected with 15.2 cm of polyethylene on top and sides and 15.2 cm of Plexiglas on the bottom.	Raffety ⁽¹¹⁾	0.98918 ± 0.00321
18. An unreflected rectangular parallelepiped of homogeneous U(2)F ₄ and paraffin with an H/U-235 atomic ratio of 613.6; 61.3 cm x 66.54 cm x 66.52 cm.	Raffety ⁽¹¹⁾	0.98201 ± 0.00335
19. A reflected rectangular parallelepiped of homogeneous U(2)F ₄ and paraffin with an H/U-235 atomic ratio of 971.7; 76.61 cm x 76.44 cm x 82.42 cm, reflected with 15.2 cm of polyethylene on top and sides and 15.2 cm of Plexiglas on the bottom.	Raffety ⁽¹¹⁾	0.99637 ± 0.00260
20. An unreflected rectangular parallelepiped of homogeneous U(2)F ₄ and paraffin with an H/U-235 atomic ratio of 971.7; 81.45 cm x 86.70 cm x 88.22 cm.	Raffety ⁽¹¹⁾	0.99962 ± 0.00317

Table 1 (Continued)

Experiment	Reference	$k_{\text{eff}} \pm \sigma$
21. A reflected rectangular parallelepiped of homogeneous $\text{U}(3)\text{F}_4$ and paraffin with an H/U-235 atomic ratio of 133.4; 51.14 cm x 51.14 cm x 51.27 cm, reflected with 15.2 cm of paraffin on top and sides and 15.2 cm of Plexiglas on the bottom.	Raffety ⁽¹¹⁾	1.01677 ± 0.00426
22. A reflected rectangular parallelepiped of homogeneous $\text{U}(3)\text{F}_4$ and paraffin with an H/U-235 atomic ratio of 133.4; 43.47 cm x 43.47 cm x 86.39 cm, reflected with 15.2 cm of paraffin on top and sides and 15.2 cm of Plexiglas on the bottom.	Raffety ⁽¹¹⁾	1.01670 ± 0.00391
23. A reflected rectangular parallelepiped of homogeneous $\text{U}(3)\text{F}_4$ and paraffin with an H/U-235 atomic ratio of 133.4; 46.02 cm x 46.02 cm x 67.57 cm, reflected with 15.2 cm of paraffin on top and sides and 15.2 cm of Plexiglas on the bottom.	Raffety ⁽¹¹⁾	1.01144 ± 0.00426
24. A reflected rectangular parallelepiped of homogeneous $\text{U}(3)\text{F}_4$ and paraffin with an H/U-235 atomic ratio of 133.4; 56.25 cm x 56.25 cm x 43.41 cm, reflected with 15.2 cm of paraffin on top and sides and 15.2 cm of Plexiglas on the bottom.	Raffety ⁽¹¹⁾	1.00589 ± 0.00406
25. A reflected rectangular parallelepiped of homogeneous $\text{U}(3)\text{F}_4$ and paraffin with an H/U-235 atomic ratio of 133.4; 61.36 cm x 61.36 cm x 38.67 cm, reflected with 15.2 cm of paraffin on top and sides and 15.2 cm of Plexiglas on the bottom.	Raffety ⁽¹¹⁾	1.01280 ± 0.00418
26. An unreflected rectangular parallelepiped of homogeneous $\text{U}(3)\text{F}_4$ and paraffin with an H/U-235 atomic ratio of 133.4; 56.47 cm x 56.47 cm x 86.64 cm.	Raffety ⁽¹¹⁾	1.01125 ± 0.00413
27. An unreflected rectangular parallelepiped of homogeneous $\text{U}(3)\text{F}_4$ and paraffin with an H/U-235 atomic ratio of 133.4; 56.25 cm x 61.36 cm x 74.38 cm.	Raffety ⁽¹¹⁾	1.01192 ± 0.00334
28. An unreflected rectangular parallelepiped of homogeneous $\text{U}(3)\text{F}_4$ and paraffin with an H/U-235 atomic ratio of 133.4; 61.4 cm x 61.4 cm x 66.0 cm.	Raffety ⁽¹¹⁾	1.00486 ± 0.00368
29. A reflected rectangular parallelepiped of homogeneous $\text{U}(3)\text{F}_4$ and paraffin with an H/U-235 atomic ratio of 276.9; 40.81 cm x 40.80 cm x 39.49 cm, reflected with 15.2 cm of polyethylene on top and sides and 15.2 cm of Plexiglas on the bottom.	Raffety ⁽¹¹⁾	1.00433 ± 0.00441
30. An unreflected rectangular parallelepiped of homogeneous $\text{U}(3)\text{F}_4$ and paraffin with an H/U-235 atomic ratio of 276.9; 40.90 cm x 40.93 cm x 116.80 cm.	Raffety ⁽¹¹⁾	1.00367 ± 0.00360

Table 1 (Continued)

Experiment	Reference	$k_{\text{eff}} \pm \sigma$
31. An unreflected rectangular parallelepiped of homogeneous $\text{U}(3)\text{F}_4$ and paraffin with an H/U-235 atomic ratio of 276.9; 48.59 cm x 51.14 cm x 48.53 cm.	Raffety ⁽¹¹⁾	0.99975 ± 0.00372
32. An unreflected rectangular parallelepiped of homogeneous $\text{U}(3)\text{F}_4$ and paraffin with an H/U-235 atomic ratio of 276.9; 81.71 cm x 81.66 cm x 31.34 cm.	Raffety ⁽¹¹⁾	1.00049 ± 0.00426
33. A composite cadmium/steel/water side reflected stainless steel cylinder of 0.079 cm wall thickness and 19.545 cm IR filled to a height of 54.45 cm with $\text{U}(4.98)\text{O}_2\text{F}_2$ solution at an H/U-235 atomic ratio of 488.	Johnson ⁽¹²⁾	0.98450 ± 0.00438
34. A composite one-inch steel/water side reflected stainless steel cylinder of 0.079 cm wall thickness and 16.51 cm IR filled to a height of 143 cm with $\text{U}(4.98)\text{O}_2\text{F}_2$ solution at an H/U-235 atomic ratio of 488.	Johnson ⁽¹²⁾	0.98077 ± 0.00417
35. An unreflected sphere of $\text{U}(4.98)\text{O}_2\text{F}_2$ with an H/U-235 atomic ratio of 490. Solution radius of 25.3873 cm and stainless steel container wall thickness of 0.0508 cm.	Johnson ⁽¹³⁾	0.98493 ± 0.00444
36. An unreflected stainless steel cylinder of 0.07874 cm wall thickness and a 19.55 cm IR filled to a height of 101.7 cm with $\text{U}(4.98)\text{O}_2\text{F}_2$ solution at an H/U-235 atomic ratio of 496.	Webster ⁽¹⁴⁾	0.97900 ± 0.00443
37. A water-reflected 90° cylindrical cross of Plexiglas tubing with 13.335 cm IR filled with $\text{U}(5.0)\text{O}_2\text{F}_2$ at an H/U-235 atomic ratio of 498. The solution height above the bottom of the vertical cylinder was 117.2 cm. The water reflector height above the bottom of the vertical cylinder was 117.3 cm.	Johnson ⁽¹⁵⁾	1.00696 ± 0.00418
38. A water-reflected 30° cylindrical "Y" of aluminum tubing with 13.97 cm IR, filled with $\text{U}(5.0)\text{O}_2\text{F}_2$ at an H/U-235 atomic ratio of 512. The solution height above the bottom of the vertical cylinder was 132.1 cm. The water reflector height above the bottom of the vertical cylinder was 209.8 cm.	Johnson ⁽¹⁵⁾	0.99273 ± 0.00403
39. A water-reflected 90° cylindrical cross of Plexiglas tubing with 13.653 cm IR, filled with $\text{U}(5.0)\text{O}_2\text{F}_2$ at an H/U-235 atomic ratio of 524. The solution height above the bottom of the vertical cylinder was 115.6 cm. The water reflector height above the bottom of the vertical cylinder was 210.5 cm.	Johnson ⁽¹⁵⁾	0.98720 ± 0.00430
40. A water-reflected 30° cylindrical "Y" of aluminum tubing with 13.97 cm IR, filled with $\text{U}(5.0)\text{O}_2\text{F}_2$ at an H/U-235 atomic ratio of 573. The solution height above the bottom of the vertical cylinder was 169.1 cm. The water reflector height above the bottom of the vertical cylinder was 209.7 cm.	Johnson ⁽¹⁵⁾	0.98230 ± 0.00399

confidence. The limits were computed under the assumptions that the k_{eff} values are random observations from a normal probability distribution for each value of E and that a second degree polynomial is the true model relating k_{eff} values to E values.

The estimated polynomial is of the following form:

$$\hat{k}_{\text{eff}}(E) = 2.1046556 - 0.1327182 \cdot E + 0.0039172 \cdot E^2$$

The standard deviation of the estimated curve is given by:

$$S_{k_{\text{eff}}}(E) = 0.0072892$$

The data, curve fit, and lower tolerance limit, all as a function of E , are presented in Figure 1.

Figure 1. CALCULATED k_{eff} RESULTS, CURVE FIT, AND LOWER TOLERANCE LIMIT.

CONCLUSIONS

Based on the method presented, it is concluded that the code and cross sections are adequate; and, for nuclear safety purposes, any $k_{\text{eff}} + 2\sigma$ which exceeds the lower curve in Figure 1 must be considered critical and all lower values may be considered subcritical provided: (1) the fuel and reflector are not significantly different in constituents or the relative abundance of constituents from the experiments in Table 1, and (2) the average energy group of a neutron causing fission is not outside of the range (14.1 to 15.6) of that for the experiments in Table 1.

However, the safety of a system which cannot be closely tied to an experiment should never be determined entirely by one single calculation (since it could contain any amount of statistical error); but, rather, should be based upon a series of calculations where one parameter may be varied and plotted versus k_{eff} , or the same case could be calculated more than once with a different starting random number. Either method can be used to expose unrealistic values requiring further study.

APPENDIX A

INPUT PARAMETERS EMPLOYED IN THE CALCULATIONS

```

LOW ENRICHED VALIDATION CASE 1
60 0 53 600 3 16 6 6 2 6 6 2 2 1 1 6 0 0 111 00 0 0 0 00 0 0 3 0 0
1 1102 0.0376126
1 6100 0.0180830
1 9100 0.0252264
1 -92512 0.0000895537
1 92824 0.00621705
2 402 1.0
BOX TYPE 1
CUBOID 1 80.8815 5.1815 46.05 -46.05 46.15 -46.15 16R0
CUBOID 2 101.2015 5.1815 66.37 -66.37 66.47 -66.47 16R0
CUBOID 0 101.2015 0.0 66.37 -66.37 66.47 -66.47 16R0
BOX TYPE 2
CUBOID 1 -5.1815 -80.8815 46.05 -46.05 46.15 -46.15 16R0
CUBOID 2 -5.1815 -101.2015 66.37 -66.37 66.47 -66.47 16R0
CUBOID 0 0.0 -101.2015 66.37 -66.37 66.47 -66.47 16R0
1 2 2 1 1 1 1 1 0
2 1 1 1 1 1 1 1 1
END CASE
LOW ENRICHED VALIDATION CASE 2
60 0 53 600 3 16 6 7 3 7 7 2 2 1 1 7 0 0 111 00 0 0 0 00 0 0 3 0 0
1 1102 0.0376126
1 6100 0.0180830
1 9100 0.0252264
1 -92512 0.0000895537
1 92824 0.00621705
2 402 1.0
3 100 0.998723
BOX TYPE 1
CUBOID 1 46.5905 0.3405 46.25 -46.25 47.55 -47.55 16R0
CUBOID 2 66.9105 0.3405 66.57 -66.57 47.55 -47.87 16R0
CUBOID 3 66.9105 0.3405 66.57 -66.57 55.17 -67.87 16R0
CUBOID 0 66.9105 0.0 66.57 -66.57 67.87 -67.87 16R0
BOX TYPE 2
CUBOID 1 -0.3405 -46.5905 46.25 -46.25 47.55 -47.55 16R0
CUBOID 2 -0.3405 -66.9105 66.57 -66.57 57.87 -67.87 16R0
CUBOID 0 0.0 -66.9105 66.57 -66.57 67.87 -67.87 16R0
1 2 2 1 1 1 1 1 0
2 1 1 1 1 1 1 1 1
END CASE
LOW ENRICHED VALIDATION CASE 3
60 0 53 600 3 16 6 7 3 7 7 2 2 1 1 7 0 0 111 00 0 0 0 00 0 0 3 0 0
1 1102 0.0376126
1 6100 0.0180830
1 9100 0.0252264
1 -92512 0.0000895537
1 92824 0.00621705
2 402 1.0
3 301 0.970464
BOX TYPE 1
CUBOID 1 46.6575 0.4075 46.25 -46.25 47.55 -47.55 16R0
CUBOID 2 66.9775 0.4075 66.57 -66.57 47.55 -67.87 16R0
CUBOID 3 66.9775 0.4075 66.57 -66.57 69.15 -67.87 16R0
CUBOID 0 66.9775 0.0 66.57 -66.57 69.15 -67.87 16R0
BOX TYPE 2
CUBOID 1 -0.4075 -46.6575 46.25 -46.25 47.55 -47.55 16R0
CUBOID 2 -0.4075 -66.9775 66.57 -66.57 67.87 -67.87 16R0
CUBOID 0 0.0 -66.9775 66.57 -66.57 69.15 -67.87 16R0
1 2 2 1 1 1 1 1 0
2 1 1 1 1 1 1 1 1
END CASE

```

```

LOW ENRICHED VALIDATION CASE 4
60 53 600 3 16 6 5 1 5 1 0 1 1 1 5 0 0 0 11 00 0 0 0 00 0 0 0 0 0
1 1102 0.0377269
1 6100 0.0181379
1 9100 0.0251952
1 -92512 0.0000894426
1 92824 0.00620935
CUBOID 1 46.55 -46.55 46.50 -46.50 61.90 -61.90 16R0
END CASE
LOW ENRICHED VALIDATION CASE 5
60 53 600 3 16 6 5 1 5 1 0 1 1 1 5 0 0 0 11 00 0 0 0 00 0 0 0 0 0
1 1102 0.0377269
1 6100 0.0181379
1 9100 0.0251952
1 -92512 0.0000894426
1 92824 0.00620935
CUBOID 1 50.00 -50.00 49.95 -49.95 51.55 -51.55 16R0
END CASE
LOW ENRICHED VALIDATION CASE 6
60 53 600 3 16 6 5 1 5 1 0 1 1 1 5 0 0 0 11 00 0 0 0 00 0 0 0 0 0
1 1102 0.0377269
1 6100 0.0181379
1 9100 0.0251952
1 -92512 0.0000894426
1 92824 0.00620935
CUBOID 1 65.35 -65.35 65.30 -65.30 37.10 -37.10 16R0
END CASE
LOW ENRICHED VALIDATION CASE 7
40 53 600 3 16 6 6 2 6 7 3 3 1 1 5 0 0 11 00 0 0 0 00 0 0 3 0 0
1 1102 0.0380559
1 6100 0.0182961
1 9100 0.00252234
1 -92512 0.0000895431
1 92824 0.00621631
2 402 1.0
BOX TYPE 1
CUBOID 1 56.4 0.0 148.7 0.0 17.7 0.0 16R0
CUBOID 2 56.4 -20.32 169.02 -20.32 118.02 -20.32 16R0
BOX TYPE 2
CUBOID 1 20.32 0.0 69.2 0.0 72.0 0.0 16R0
CUBOID 2 20.32 0.0 89.52 -99.82 107.82 -30.52 16R0
BOX TYPE 3
CUBOID 1 64.18 0.0 69.2 0.0 72.0 0.0 16R0
CUBOID 2 84.5 0.0 89.52 -20.32 92.52 -20.32 16R0
CUBOID 0 104.82 0.0 89.52 -99.82 107.82 -30.52 16R0
1 1 3 1 1 1 1 1 0
2 2 3 1 1 1 1 1 0
3 3 3 1 1 1 1 1 1
END CASE
LOW ENRICHED VALIDATION CASE 8
60 53 600 3 16 6 6 2 6 17 9 3 3 1 6 0 0 11 00 0 0 0 00 0 0 3 0 0
1 1102 0.0380559
1 6100 0.0182961
1 9100 0.00252234
1 -92512 0.0000895431
1 92824 0.00621631
2 402 1.0
BOX TYPE 1
CUBOID 1 81.82 20.32 81.66 20.32 118.02 20.32 16R0
CUBOID 2 81.82 0.0 81.66 0.0 138.34 0.0 16R0
BOX TYPE 2
CUBOID 0 81.82 0.0 3.25 4.0 138.34 0.0 16R0
BOX TYPE 3
CUBOID 1 81.82 20.32 81.66 0.0 118.02 20.32 16R0
CUBOID 2 81.82 0.0 81.98 0.0 138.34 0.0 16R0
BOX TYPE 4

```

```

CUBOID 1 20.32 0.0 81.66 66.42 107.62 30.52 16R0
CUBOID 2 20.32 0.0 81.66 0.0 138.34 0.0 16R0
BOX TYPE 5
CUBOID 0 20.32 0.0 3.25 0.0 138.34 0.0 16R0
BOX TYPE 6
CUBOID 1 20.32 0.0 61.66 0.0 107.62 30.52 16R0
CUBOID 2 20.32 0.0 81.98 0.0 138.34 0.0 16R0
BOX TYPE 7
CUBOID 1 64.18 0.0 81.66 66.42 107.62 30.52 16R0
CUBOID 2 84.5 0.0 81.66 0.0 138.34 0.0 16R0
CUBOID 0 84.5 0.0 81.66 0.0 138.34 0.0 16R0
BOX TYPE 8
CUBOID 0 84.5 0.0 3.25 0.0 138.34 0.0 16R0
BOX TYPE 9
CUBOID 1 64.18 0.0 61.66 0.0 107.62 30.52 16R0
CUBOID 2 84.5 0.0 81.98 0.0 127.94 10.2 16R0
CUBOID 0 84.5 0.0 81.98 0.0 138.34 0.0 16R0
1 1 1 1 1 1 1 1 C
2 1 1 1 2 2 1 1 1 0
3 1 1 1 3 3 1 1 1 0
4 2 2 1 1 1 1 1 1 0
5 2 2 1 2 2 1 1 1 0
6 2 2 1 3 3 1 1 1 0
7 3 3 1 1 1 1 1 1 0
8 3 3 1 2 2 1 1 1 0
9 3 3 1 3 3 1 1 1 1
END CASE
LOW ENRICHED VALIDATION CASE 9
60 53 600 3 16 6 6 2 6 2 0 1 1 1 6 0 0 0 11 00 0 0 0 00 0 0 0 0 0
1 1102 0.0405081357
1 6100 0.01947506527
1 9100 0.02282148484
1 -92512 0.00008101627
1 92826 0.005624354964
2 402 1.0
CUBOID 1 47.35 -47.35 49.25 -49.25 40.95 -40.95 16R0
CUBOID 2 67.67 -67.67 69.57 -69.57 61.27 -61.27 16R0
END CASE
LOW ENRICHED VALIDATION CASE 10
60 53 600 3 16 6 6 2 6 2 0 1 1 1 6 0 0 0 11 00 0 0 0 00 0 0 0 0 0
1 1102 0.04427215651
1 6100 0.02128469063
1 9100 0.02095971429
1 -92500 0.00007440698574
1 92827 0.005165521587
2 402 1.0
CUBOID 1 49.00 -49.00 47.25 -47.25 43.70 -43.70 16R0
CUBOID 2 69.32 -69.32 67.57 -67.57 64.02 -64.02 16R0
END CASE
LOW ENRICHED VALIDATION CASE 11
60 53 600 3 16 6 6 3 8 3 0 1 1 1 6 0 0 0 11 00 0 0 0 00 0 0 0 0 0
1 1102 0.0308642
1 6100 0.014839
1 9100 0.0312192
1 -92511 0.000158107
1 92821 0.00764671
2 1102 0.0825824
2 6100 0.0397031
3 602 1.0
CUBOID 1 28.110 -28.110 28.110 -28.110 56.44 -56.44 16R0
CUBOID 2 43.310 -43.310 42.310 -43.310 71.64 -56.44 16R0
CUBOID 3 43.310 -43.310 43.310 -43.310 71.64 -71.64 16R0
END CASE
LOW ENRICHED VALIDATION CASE 12
60 53 600 3 16 6 5 1 5 1 0 1 1 1 5 0 0 0 11 00 0 0 0 00 0 0 0 0 0
1 1102 0.0308642

```

```

1 6100 0.0148390
1 9100 0.0312192
1 -92511 0.000158107
1 92821 0.00764671
CUBOID 1 35.735 -35.735 35.735 -35.735 47.07 -47.07 16R0
END CASE
LOW ENRICHED VALIDATION CASE 13
60 53 600 3 16 6 6 3 8 3 0 1 1 1 6 0 0 0 11 00 0 0 0 00 0 0 0 0 0
1 1102 0.039097
1 6100 0.018797
1 9100 0.026280
1 -92512 0.00013303
1 92824 0.0064370
2 1102 0.0825824
2 6100 0.0397031
3 602 1.0
CUBOID 1 51.11 0.0 51.11 0.0 73.87 0.0 16R0
CUBOID 2 66.31 -15.2 66.31 -15.2 89.07 0.0 16R0
CUBOID 3 66.31 -15.2 66.31 -15.2 89.07 -15.2 16R0
END CASE
LOW ENRICHED VALIDATION CASE 14
60 53 600 3 16 6 5 1 5 1 0 1 1 1 5 0 0 0 11 00 0 0 0 00 0 0 0 0 0
1 1102 0.0390971
1 6100 0.0187967
1 9100 0.0262801
1 -92512 0.000133028
1 92824 0.00643701
CUBOID 1 28.110 -28.110 28.110 -28.110 61.235 -61.235 16R0
END CASE
LOW ENRICHED VALIDATION CASE 15
60 53 600 3 16 6 6 3 8 4 0 1 1 1 6 0 0 0 11 00 3R0 00 5R0
1 -92512 0.000111912
1 92827 0.005415249
1 1102 0.045472123
1 6100 0.021861238
1 9100 0.022109080
2 6100 0.039703
2 1102 0.082582
3 602 1.0
CUBOID 1 26.835 -26.835 26.835 -26.835 27.145 -27.145 16R0
CUBOID 2 42.035 -42.035 42.035 -42.035 42.345 -27.145 16R0
CUBOID 3 42.035 -42.035 42.035 -42.035 42.345 -42.345 16R0
CUBE 0 43.0 -43.0 16R0
END CASE
LOW ENRICHED VALIDATION CASE 16
60 53 600 3 16 6 6 3 8 3 0 1 1 1 6 0 0 0 11 00 0 0 0 00 0 0 0 0 0
1 1102 0.0492124
1 6100 0.0236601
1 9100 0.0195962
1 -92512 0.0000992352
1 92829 0.00479978
2 1102 0.0825824
2 6100 0.0397031
3 602 1.0
CUBOID 1 23.000 -23.000 23.000 -23.000 48.285 -48.285 16R0
CUBOID 2 38.200 -38.200 38.200 -38.200 63.485 -48.285 16R0
CUBOID 3 38.200 -38.200 38.200 -38.200 63.485 -63.485 16R0
END CASE
LOW ENRICHED VALIDATION CASE 17
60 53 600 3 16 6 7 3 7 4 0 3R1 7 0 0 11 00 3R0 00 5R0
1 -92500 0.000086674
1 92832 0.0041941
1 1102 0.0531871
1 6100 0.025570
1 9100 0.017123
2 402 1.0

```

```

3 602 1.000000000
CUBOID 1 28.160 -28.160 30.645 -30.645 27.040 -27.040 16R0
CUBOID 2 43.360 -43.360 45.845 -45.845 42.240 -27.040 16R0
CUBOID 3 43.360 -43.360 45.845 -45.845 42.240 -42.240 16R0
CUBE 0 49.0 -49.0 16R0
END CASE
LOW ENRICHED VALIDATION CASE 18
60 53 600 3 16 6 5 1 5 1 0 1 1 1 5 3 0 0 11 00 0 0 0 0 0 0 0 0
1 1102 0.053187
1 6100 0.025570
1 9100 0.017123
1 -92500 0.000086674
1 92832 0.0041941
CUBOID 1 30.65 -30.65 33.27 -33.27 33.26 -33.26 16R0
END CASE
LOW ENRICHED VALIDATION CASE 19
16.0 53 600 3 16 6 7 3 7 4 0 3R1 7 0 0 11 00 3R0 00 5R0
1 -92500 0.0000623207
1 92861 0.003015046
1 1102 0.0605571
1 6100 0.029114
1 9100 0.012309
2 402 1.0
3 602 1.000000000
CUBOID 1 38.255 -38.255 38.220 -38.220 41.210 -41.210 16R0
CUBOID 2 53.455 -53.455 53.420 -53.420 56.410 -41.210 16R0
CUBOID 3 53.455 -53.455 53.420 -53.420 56.410 -56.410 16R0
CUBE 0 59.0 -59.0 16R0
END CASE
LOW ENRICHED VALIDATION CASE 20
60 53 600 3 16 6 5 1 5 1 0 1 1 1 5 4 0 0 11 00 3R0 00 5R0
1 1102 0.060557
1 6100 0.029114
1 9100 0.012309
1 -92500 0.0000623207
1 92861 0.003015046
CUBOID 1 40.725 -40.725 43.35 -43.35 44.11 -44.11 16R0
END CASE
LOW ENRICHED VALIDATION CASE 21
16.0 53 600 3 16 6 6 3 8 4 0 3R1 6 0 0 11 00 3R0 00 5R0
1 -92510 0.000234940
1 92821 0.007499891
1 1102 0.031341010
1 6100 0.015067188
1 9100 0.030939126
2 6100 0.039703000
2 1102 0.082582000
3 602 1.000000000
CUBOID 1 25.570 -25.570 25.570 -25.570 25.635 -25.635 16R0
CUBOID 2 40.770 -40.770 40.770 -40.770 40.835 -25.635 16R0
CUBOID 3 40.770 -40.770 40.770 -40.770 40.835 -40.835 16R0
CUBE 0 43.0 -43.0 16R0
END CASE
LOW ENRICHED VALIDATION CASE 22
16.0 53 600 3 16 6 6 3 8 4 0 3R1 6 0 0 11 00 3R0 00 5R0
1 -92510 0.000234940
1 92821 0.007499891
1 1102 0.031341010
1 6100 0.015067188
1 9100 0.030939126
2 6100 0.039703000
2 1102 0.082582000
3 602 1.000000000
CUBOID 1 21.735 -21.735 21.735 -21.735 43.195 -43.195 16R0
CUBOID 2 36.935 -36.935 36.935 -36.935 58.395 -43.195 16R0
CUBOID 3 36.935 -36.935 36.935 -36.935 58.395 -58.395 16R0

```

```

CUBE 0 59.0 -59.0 16R0
END CASE
LOW ENRICHED VALIDATION CASE 23
16.0 53 600 3 16 6 6 3 8 4 0 3R1 6 0 0 11 00 3R0 00 5R0
1 -92510 0.000234940
1 92821 0.007499891
1 1102 0.031341010
1 6100 0.015067188
1 9100 0.030939126
2 6100 0.039703000
2 1102 0.082582000
3 602 1.000000000
CUBOID 1 23.010 -23.010 23.010 -23.010 33.785 -33.785 16R0
CUBOID 2 38.210 -38.210 38.210 -38.210 48.985 -33.785 16R0
CUBOID 3 38.210 -38.210 38.210 -38.210 48.985 -48.985 16R0
CUBE 0 49.0 -49.0 16R0
END CASE
LOW ENRICHED VALIDATION CASE 24
16.0 53 600 3 16 6 6 3 8 4 0 3R1 6 0 0 11 00 3R0 00 5R0
1 -92510 0.000234940
1 92821 0.007499891
1 1102 0.031341010
1 6100 0.015067188
1 9100 0.030939126
2 6100 0.039703000
2 1102 0.082582000
3 602 1.000000000
CUBOID 1 28.125 -28.125 28.125 -28.125 21.705 -21.705 16R0
CUBOID 2 33.325 -33.325 33.325 -33.325 36.905 -21.705 16R0
CUBOID 3 33.325 -33.325 33.325 -33.325 36.905 -36.905 16R0
CUBE 0 49.0 -49.0 16R0
END CASE
LOW ENRICHED VALIDATION CASE 25
16.0 53 600 3 16 6 6 3 8 4 0 3R1 6 0 0 11 00 3R0 00 5R0
1 -92510 0.000234940
1 92821 0.007499891
1 1102 0.031341010
1 6100 0.015067188
1 9100 0.030939126
2 6100 0.039703000
2 1102 0.082582000
3 602 1.000000000
CUBOID 1 30.680 -30.680 30.680 -30.680 19.335 -19.335 16R0
CUBOID 2 45.880 -45.880 45.880 -45.880 34.535 -19.335 16R0
CUBOID 3 45.880 -45.880 45.880 -45.880 34.535 -34.535 16R0
CUBE 0 49.0 -49.0 16R0
END CASE
LOW ENRICHED VALIDATION CASE 26
60 53 600 3 16 6 5 1 5 1 0 3R1 5 0 0 11 00 3R0 00 5R0
1 1102 0.031341
1 6100 0.0150672
1 9100 0.0309391
1 -92510 0.00023494
1 92821 0.00749989
CUBOID 1 28.235 -28.235 28.235 -28.235 43.32 -43.32 16R0
END CASE
LOW ENRICHED VALIDATION CASE 27
60 53 600 3 16 6 5 1 5 1 0 3R1 5 0 0 11 00 3R0 00 5R0
1 1102 0.031341
1 6100 0.0150672
1 9100 0.0309391
1 -92510 0.00023494
1 92821 0.00749989
CUBOID 1 28.125 -28.125 30.680 -30.680 37.19 -37.19 16R0
END CASE
LOW ENRICHED VALIDATION CASE 28

```

```

60 53 600 3 16 6 5 1 5 1 3 3R1 5 0 0 011 00 3R0 00 5R0
1 1102 0.031341
1 6100 0.0150672
1 9100 0.0309391
1 -92510 0.00023494
1 92821 0.00749989
CUBOID 1 61.4 0.0 61.4 0.0 66.0 0.0 16R0
END CASE
LOW ENRICHED VALIDATION CASE 29
16.0 53 600 3 16 6 7 3 7 4 0 3R1 7 0 0 011 00 3R0 00 5R0
1 -92511 0.000167095
1 92827 0.005335500
1 1102 0.0462621
1 6100 0.0222412
1 9100 0.0220109
2 402 1.0
3 602 1.000000000
CUBOID 1 20.405 -20.405 20.400 -20.400 19.745 -19.745 16R0
CUBOID 2 35.605 -35.605 35.600 -35.600 34.945 -19.745 16R0
CUBOID 3 35.605 -35.605 35.600 -35.600 34.945 -34.945 16R0
CUBE 0 49.0 -49.0 16R0
END CASE
LOW ENRICHED VALIDATION CASE 30
60 53 600 3 16 6 5 1 5 1 4 3R1 5 0 0 011 00 3R0 00 5R0
1 1102 0.0462621
1 6100 0.0222412
1 9100 0.0220109
1 -92511 0.000167095
1 92827 0.00533550
CUBOID 1 20.450 -20.450 20.465 -20.465 58.40 -58.40 16R0
END CASE
LOW ENRICHED VALIDATION CASE 31
60 53 600 3 16 6 5 1 5 1 8 3R1 5 0 0 011 00 3R0 00 5R0
1 1102 0.0462621
1 6100 0.0222412
1 -9100 0.0220109
1 -92511 0.000167095
1 92827 0.00533550
CUBOID 1 24.295 -24.295 25.570 -25.570 24.265 -24.265 16R0
END CASE
LOW ENRICHED VALIDATION CASE 32
60 53 600 3 16 6 5 1 5 1 0 3R1 5 0 0 011 00 3R0 00 5R0
1 1102 0.0462621
1 6100 0.0222412
1 9100 0.0220109
1 -92511 0.000167095
1 92827 0.00533550
CUBOID 1 40.855 -40.855 40.830 -40.830 15.670 -15.670 16R0
END CASE
LOW ENRICHED VALIDATION CASE 33
60 53 600 3 16 6 9 5 9 7 0 1 1 1 9 0 0 011 00 0 0 0 0 0 0 0 0
1 1102 0.0566121
1 8100 0.0329091
1 9100 0.00460306
1 -92512 0.000116008
1 92862 0.00218552
2 200 1.0
3 48100 0.0463070
4 100 1.0
5 502 1.0
CYLINDER 1 19.545 54.525 0.079 16R0
CYLINDER 0 19.545 106.279 0.079 16R0
CYLINDER 2 19.624 106.279 0.0 16R0
CYLINDER 3 19.705 106.279 0.0 16R0
CYLINDER 4 22.245 106.279 0.0 16R0
CYLINDER 5 45.0 106.279 0.0 16R0

```

```

CUBE 0 110.0 -110.0 16R0
END CASE
LOW ENRICHED VALIDATION CASE 34
60 53 600 3 16 6 8 4 8 7 0 3R1 8 0 0 011 00 3R0 00 5R0
1 1102 0.0566121
1 8100 0.0329091
1 9100 0.00460306
1 -92512 0.000116008
1 92862 0.00218552
2 200 1.0
3 100 1.0
4 502 1.0
CYLINDER 2 16.51 0.079 0.0 16R0
CYLINDER 1 16.51 143.079 0.0 16R0
CYLINDER 0 16.51 243.579 0.0 16R0
CYLINDER 2 16.589 243.979 0.0 16R0
CYLINDER 3 19.129 243.979 0.0 16R0
CYLINDER 4 44.529 243.979 0.0 16R0
CUBE 0 250.0 -250.0 16R0
END CASE
LOW ENRICHED VALIDATION CASE 35
60 53 600 3 16 6 11 2 11 3 0 1 1 1 11 0 0 011 00 3R0 00 5R0
1 1102 0.0569086
1 8100 0.0330628
1 9100 0.0046085
1 -92512 0.00011614
1 92862 0.00218811
2 26100 0.060360
2 24100 0.016471
2 28100 0.0064834
2 6100 0.00031691
2 25100 0.0017321
2 14100 0.0016940
SPHERE 1 25.3873 16R0
SPHERE 2 25.4381 16R0
CUBE 0 26.0 -26.0 16R0
END CASE
LOW ENRICHED VALIDATION CASE 36
60 53 600 3 16 6 6 2 6 2 0 3R1 6 0 0 011 00 3R0 00 5R0
1 1102 0.057038
1 8100 0.033082
1 9100 0.0045628
1 -92512 0.00011499
1 92862 0.0021664
2 200 1.0
CYLINDER 1 19.55 101.77874 0.07874 16R0
CYLINDER 2 19.62874 101.77874 0.0 16R0
END CASE
LOW ENRICHED VALIDATION CASE 37
150 53 600 3 16 6 8 4 8 5 0 1 1 1 8 0 0 011 00 3 0 0 0 0 0 0 0 0
1 1102 0.0571821789
1 8100 0.0331283423
1 9100 0.0045372528
1 -92512 0.0001148090
1 92862 0.0021538174
2 502 1.0
3 602 1.0
4 200 1.0
GENERAL 1 6R0 16R0
GENERAL 2 6R0 16R0
GENERAL 3 6R0 16R0
GENERAL 4 6R0 16R0
GENERAL 0 111.76 -111.76 40.64 -40.64 46.18 -118.428 16R0
2 MALE SINGLE
X ZONE -111.76 111.76
Y ZONE -40.64 40.64

```



```

1.0Z -57.316X -5258.594 $
1.0Z -57.316X -5056.756 $
0.99969541ZSQ 0.00030458XSQ 1.0YSQ 0.0343795ZX
-177.82222 $
0.99969541ZSQ 0.00030458XSQ 1.0YSQ 0.0343795ZX
-272.58010 $
1.0Z -119.06 $
1 1 1 0.0 0.0 0.0
END CASE
LOW ENRICHED VALIDATION CASE 40
100 53 600 3 16 6 7 3 7 4 0 1 1 1 7 0 0 11 03 3 0 0 00 5R0
1 1102 0.0584361308
1 8100 0.0332489849
1 9100 0.0043091947
1 -92500 0.0001019969
1 92840 0.0019134628
2 502 1.0
3 13100 0.060245
GENERAL 1 6R0.0 16R0
GENERAL 2 6R0.0 16R0
GENERAL 3 6R0.0 16R0
GENERAL 0 34.29 -34.29 34.29 -115.0 133.754 -96.426 16R0
2 MALE MARRIED
X ZONE -34.29, 34.29
Y ZONE -115.0, 34.29
Z ZONE -96.426, 133.754
ZONE 1 1 1
X BLOCK -34.29, 34.29
Y BLOCK -115.0, 0.0, 34.29
Z BLOCK -96.426, -76.106, 93.154, 133.754
BLOCK 1 1 1
MEDIA 2
BLOCK 1 1 2
MEDIA 1, 2, 3, 3, 3, 1
SURFACES 1, 2, 3, 4, 5
SECTOR -1 -1
SECTOR 1 1
SECTOR 1 1 -1
SECTOR 1 -1 1
SECTOR -1 -1 1
SECTOR -1 1 1
BLOCK 1 1 3
MEDIA 4, 4, 3, 3, 2
SURFACES 1, 2, 3, 4
SECTOR -1
SECTOR -1
SECTOR 1 -1
SECTOR 1 -1
SECTOR 1 1
BLOCK 1 2 1
MEDIA 2
BLOCK 1 2 2
MEDIA 1, 2, 3, 3
SURFACES 3, 4, 5
SECTOR -1 -1
SECTOR 1
SECTOR +1 -1
SECTOR -1 1
BLOCK 1 2 3
MEDIA 4, 3, 2
SURFACES 3, 4
SECTOR -1
SECTOR 1 -1
SECTOR 1
5 LOW ENRICHED VALIDATION CASE 40 QUADRATIC SURFACES
1.0XSQ 0.75YSQ 0.25ZSQ 0.86602540YZ

```

```

-195.1609 $
1.0XSQ 0.75YSQ 0.25ZSQ 0.86602540YZ
-199.6575 $
1.0XSQ 1.0YSQ -195.1609 $
1.0XSQ 1.0YSQ -199.6575 $
-1.0Z -75.946 $
1 1 1 0.0 0.0 0.0
END CASE

```


APPENDIX B

CROSS SECTIONS EMPLOYED IN THE CALCULATIONS

Energy range of the 16 energy groups:

Group	Energy Range	Group	Energy Range
1	3 - ∞ Mev	9	100 - 550 ev
2	1.4 - 3 Mev	10	30 - 100 ev
3	0.9 - 1.4 Mev	11	10 - 30 ev
4	0.4 - 0.9 Mev	12	3 - 10 ev
5	0.1 - 0.4 Mev	13	1 - 3 ev
6	17 - 100 kev	14	0.4 - 1 ev
7	3 - 17 kev	15	0.1 - 0.4 ev
8	0.55 - 3 kev	16	Thermal (0.025 ev)

The choice of U-235 and U-238 cross sections was determined by the nuclear fuel's total scattering cross section in the resonance range, per U-235 or U-238 atom, respectively; ie:

$$\sigma_{pn} = \frac{\sum_{i=1}^j (\sigma_i) (N_i)}{N_n} ,$$

where N_i is the atomic density of each respective element in the fuel; σ_i the individual element's scattering cross section in the resonance range, was taken from the following tabular information: (17)

Element	σ_i	Element	σ_i
Al	1.4	Mn	4.0
B	4.0	Mo	6.0
C	4.6	N	10.0
Cd	5.0	Na	3.1
Cl	6.0	Nb	6.3
Co	7.0	Ni	17.5
Cr	4.3	O	3.7
Cu	7.5	Pu	12.0
F	3.4	Si	2.2
Fe	11.4	Th	12.0
H	21.0	U-235	10.0
K	2.2	U-238	12.0
Li-7	1.0	Zr	6.2

NUCLIDE = 100 CARBON STEEL 7.82G/CC C=.003921, FE=.083491

GP.	ABSORPTION	NU FISSION	TOTAL
1	5.8444E-04	0.0	1.9243E-01
2	4.1745E-04	0.0	1.8925E-01
3	8.3491E-04	0.0	1.7250E-01
4	8.3491E-04	0.0	2.0268E-01
5	8.3491E-04	0.0	2.1779E-01
6	8.3491E-04	0.0	2.0285E-01
7	8.3491E-04	0.0	4.8913E-01
8	9.1840E-04	0.0	6.1097E-01
9	2.2543E-03	0.0	9.3215E-01
10	4.5920E-03	0.0	9.6581E-01
11	8.1021E-03	0.0	9.6581E-01
12	1.4193E-02	0.0	9.6670E-01
13	2.5882E-02	0.0	9.6670E-01
14	4.2580E-02	0.0	9.6670E-01
15	7.5979E-02	0.0	9.8339E-01
16	2.1124E-01	0.0	1.1086E 00

TRANSFER CROSS SECTIONS

FROM	TO	I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.2303E-01	4.3765E-02	1.6698E-02	8.3491E-03	0.0	0.0	
2	1.2916E-01	3.4628E-02	1.6698E-02	8.3491E-03	0.0	0.0	
3	1.2824E-01	2.2559E-02	1.9203E-02	1.6698E-03	0.0	0.0	
4	1.8921E-01	1.2638E-02	8.3491E-10	0.0	0.0	0.0	
5	2.0933E-01	7.6256E-03	0.0	0.0	0.0	0.0	
6	1.9627E-01	5.7469E-03	0.0	0.0	0.0	0.0	
7	4.7660E-01	1.1697E-02	0.0	0.0	0.0	0.0	
8	5.9577E-01	1.4285E-02	0.0	0.0	0.0	0.0	
9	9.0936E-01	2.1132E-02	0.0	0.0	0.0	0.0	
10	9.3113E-01	3.0083E-02	0.0	0.0	0.0	0.0	
11	9.2456E-01	3.3070E-02	0.0	0.0	0.0	0.0	
12	9.2262E-01	2.9884E-02	0.0	0.0	0.0	0.0	
13	9.0827E-01	3.2544E-02	0.0	0.0	0.0	0.0	
14	8.8512E-01	3.9005E-02	0.0	0.0	0.0	0.0	
15	8.8277E-01	2.4644E-02	0.0	0.0	0.0	0.0	
16	8.9739E-01	0.0	0.0	0.0	0.0	0.0	

NUCLIDE = 200 TYPE 304 STAINLESS STEEL 7.9G/CC CONTAINS C,CR,MN,FE,NI,SI

GP.	ABSORPTION	NU FISSION	TOTAL
1	2.4541E-03	0.0	2.0124E-01
2	1.2844E-03	0.0	1.9827E-01
3	1.0047E-03	0.0	1.8220E-01
4	1.0059E-03	0.0	2.1010E-01
5	1.3453E-03	0.0	2.4304E-01
6	2.6103E-03	0.0	2.3948E-01
7	4.2484E-03	0.0	6.8752E-01
8	2.0572E-03	0.0	6.7720E-01
9	9.9427E-03	0.0	1.1688E 00
10	5.5413E-03	0.0	8.7588E-01
11	9.7624E-03	0.0	8.7931E-01
12	1.6972E-02	0.0	8.7980E-01
13	3.0780E-02	0.0	8.8331E-01
14	5.0467E-02	0.0	8.9353E-01
15	9.1197E-02	0.0	9.2527E-01
16	2.5400E-01	0.0	1.0558E 00

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.2187E-01	4.4863E-02	1.8568E-02	1.1549E-02	1.7762E-03	1.6471E-04
2	1.3355E-01	3.3381E-02	2.0275E-02	9.5737E-03	2.1126E-04	0.0
3	1.4195E-01	2.2058E-02	1.5763E-02	1.4211E-03	1.0535E-06	0.0
4	1.9719E-01	1.1833E-02	7.7848E-05	1.6728E-06	8.9754E-08	0.0
5	2.3425E-01	7.4337E-03	2.8516E-06	1.5043E-07	4.6373E-09	0.0
6	2.3192E-01	4.9490E-03	0.0	0.0	0.0	0.0
7	6.6960E-01	1.3672E-02	0.0	0.0	0.0	0.0
8	6.6149E-01	1.3647E-02	0.0	0.0	0.0	0.0
9	1.1407E 00	1.8135E-02	0.0	0.0	0.0	0.0
10	8.4457E-01	2.5766E-02	0.0	0.0	0.0	0.0
11	8.4115E-01	2.8395E-02	0.0	0.0	0.0	0.0
12	8.3731E-01	2.5522E-02	0.0	0.0	0.0	0.0
13	8.2470E-01	2.7835E-02	1.3823E-10	0.0	0.0	0.0
14	8.0960E-01	3.3380E-02	1.1238E-11	0.0	0.0	0.0
15	8.1433E-01	1.9713E-02	0.0	0.0	0.0	0.0
16	8.0139E-01	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 301 ORDINARY CONCRETE

GP.	ABSORPTION	NU FISSION	TOTAL
1	7.6620E-03	0.0	1.2387E-01
2	7.3633E-04	0.0	1.3198E-01
3	4.3313E-05	0.0	2.4376E-01
4	2.6616E-05	0.0	2.6976E-01
5	2.4689E-05	0.0	3.1915E-01
6	3.3592E-05	0.0	3.5204E-01
7	1.1227E-05	0.0	3.9796E-01
8	3.5316E-05	0.0	4.1346E-01
9	1.0590E-04	0.0	4.1154E-01
10	2.4431E-03	0.0	4.1362E-01
11	7.7796E-04	0.0	4.1189E-01
12	9.5359E-04	0.0	4.1226E-01
13	1.4936E-03	0.0	4.1249E-01
14	2.3888E-03	0.0	4.5763E-01
15	4.3191E-03	0.0	5.6240E-01
16	1.0531E-02	0.0	6.6304E-01

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	6.6523E-02	3.7451E-02	4.4339E-03	4.5745E-03	2.4988E-03	7.3047E-04
2	8.7649E-02	2.3429E-02	1.1316E-02	6.6683E-03	1.8099E-03	3.7193E-04
3	1.4960E-01	7.2923E-02	1.5908E-02	4.3822E-03	7.2851E-04	1.6355E-04
4	1.8804E-01	6.8201E-02	1.1192E-02	1.8908E-03	3.2710E-04	7.4343E-05
5	2.4185E-01	6.6966E-02	8.4898E-03	1.4868E-03	2.6763E-04	5.9474E-05
6	2.3183E-01	1.0123E-01	1.5538E-02	2.7803E-03	4.4605E-04	1.7842E-04
7	2.5062E-01	1.2280E-01	2.0058E-02	3.1076E-03	9.0699E-04	4.4605E-04
8	2.5651E-01	1.3082E-01	1.8139E-02	5.3522E-03	1.8139E-03	7.7312E-04
9	2.5497E-01	1.1352E-01	2.8546E-02	1.0110E-02	2.8546E-03	1.4273E-03
10	2.1888E-01	1.3449E-01	4.0426E-02	1.1597E-02	3.4494E-03	2.3194E-03
11	2.0998E-01	1.4734E-01	3.5950E-02	1.0690E-02	5.3525E-03	1.7841E-03
12	2.1606E-01	1.3677E-01	3.5148E-02	1.7574E-02	5.7539E-03	0.0
13	2.0648E-01	1.3127E-01	5.4774E-02	1.8466E-02	0.0	0.0
14	2.3383E-01	1.7233E-01	4.9064E-02	0.0	0.0	0.0
15	4.6684E-01	9.1237E-02	0.0	0.0	0.0	0.0
16	8.5251E-01	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 402 DE/E POLYETHYLENE 0.92G/CC H=.079433, C=.039716

GP.	ABSORPTION	NU FISSION	TOTAL
1	0.0	0.0	1.6403E-01
2	0.0	0.0	2.2916E-01
3	0.0	0.0	3.5189E-01
4	0.0	0.0	4.4403E-01
5	0.0	0.0	6.7875E-01
6	0.0	0.0	1.0982E 00
7	0.0	0.0	1.3083E 00
8	7.9433E-05	0.0	1.3639E 00
9	3.1773E-04	0.0	1.3639E 00
10	6.3546E-04	0.0	1.3639E 00
11	1.1121E-03	0.0	1.3639E 00
12	1.9858E-03	0.0	1.3678E 00
13	3.5745E-03	0.0	1.3678E 00
14	5.5603E-03	0.0	1.6061E 00
15	1.0354E-02	0.0	2.1621E 00
16	2.3155E-02	0.0	3.7508E 00

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	2.9191E-02	8.1538E-02	1.8984E-02	1.8984E-02	1.1438E-02	3.8922E-03
2	6.3307E-02	6.7279E-02	5.4809E-02	3.2965E-02	9.2142E-03	1.5887E-03
3	6.0845E-02	1.7666E-01	8.5470E-02	2.3830E-02	4.1305E-03	9.5319E-04
4	1.2074E-01	2.4854E-01	6.2037E-02	1.0485E-02	1.7475E-03	4.7660E-04
5	2.7480E-01	3.3819E-01	5.4332E-02	9.2936E-03	1.7475E-03	3.9716E-04
6	5.0269E-01	4.9427E-01	8.3007E-02	1.4854E-02	2.3830E-03	9.5319E-04
7	5.7469E-01	6.0258E-01	1.0715E-01	1.6601E-02	4.8454E-03	2.3830E-03
8	5.8153E-01	6.4293E-01	9.6908E-02	2.8596E-02	5.6908E-03	4.1305E-03
9	5.8343E-01	5.5071E-01	1.5251E-01	5.4014E-02	1.5251E-02	7.6256E-03
10	4.1436E-01	6.4011E-01	2.1598E-01	6.1958E-02	1.8428E-02	1.2391E-02
11	3.7444E-01	7.0100E-01	1.9207E-01	5.7112E-02	2.8596E-02	9.5319E-03
12	4.0098E-01	6.5246E-01	1.8778E-01	9.3890E-02	3.0741E-02	0.0
13	3.5757E-01	6.1541E-01	2.9263E-01	9.8656E-02	0.0	0.0
14	5.1977E-01	8.1867E-01	2.6213E-01	0.0	0.0	0.0
15	1.7333E 00	4.1845E-01	0.0	0.0	0.0	0.0
16	3.7276E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 502 DE/E WATER 0.9982G/CC H=.066742, O=.033371

GP.	ABSORPTION	NU FISSION	TOTAL
1	1.3349E-03	0.0	1.4116E-01
2	0.0	0.0	1.8454E-01
3	0.0	0.0	3.2804E-01
4	0.0	0.0	3.9645E-01
5	0.0	0.0	5.7432E-01
6	0.0	0.0	8.8968E-01
7	0.0	0.0	1.0696E 00
8	6.6743E-05	0.0	1.1226E 00
9	2.6697E-04	0.0	1.1226E 00
10	5.3394E-04	0.0	1.1226E 00
11	9.3440E-04	0.0	1.1226E 00
12	1.6686E-03	0.0	1.1226E 00
13	3.0034E-03	0.0	1.1226E 00
14	4.6720E-03	0.0	1.3228E 00
15	8.6766E-03	0.0	1.7900E 00
16	1.9362E-02	0.0	3.1249E 00

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	2.9568E-02	6.5475E-02	1.5952E-02	1.5952E-02	9.6110E-03	3.2704E-03
2	4.9290E-02	5.2427E-02	4.6053E-02	2.7698E-02	7.7422E-03	1.3349E-03
3	8.1961E-02	1.4997E-01	7.1815E-02	2.0023E-02	3.4706E-03	8.0091E-04
4	1.2641E-01	2.0724E-01	5.2126E-02	8.8101E-03	1.4683E-03	4.0046E-04
5	2.3811E-01	2.8095E-01	4.5652E-02	7.8089E-03	1.4683E-03	3.3371E-04
6	3.9502E-01	4.0963E-01	6.9746E-02	1.2481E-02	2.0023E-03	8.0091E-04
7	4.5896E-01	5.0054E-01	9.0036E-02	1.3949E-02	4.0713E-03	2.0023E-03
8	4.7054E-01	5.3494E-01	8.1426E-02	2.4027E-02	8.1426E-03	3.4706E-03
9	4.7214E-01	4.5746E-01	1.2815E-01	4.5385E-02	1.2815E-02	6.4073E-03
10	3.3225E-01	5.3041E-01	1.8147E-01	5.2059E-02	1.5484E-02	1.0412E-02
11	2.9954E-01	5.8073E-01	1.6138E-01	4.7988E-02	2.4027E-02	8.0091E-03
12	3.1810E-01	5.4035E-01	1.5778E-01	7.8890E-02	2.5829E-02	0.0
13	2.8252E-01	5.0831E-01	2.4588E-01	8.2895E-02	0.0	0.0
14	4.2055E-01	6.7737E-01	2.2025E-01	0.0	0.0	0.0
15	1.4366E 00	3.4476E-01	0.0	0.0	0.0	0.0
16	3.1056E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 602 DE/E PLEXIGLAS 1.182G/CC H=.056884, C=.035552, O=.014221

	GP. ABSORPTION	NU FISSION	TOTAL
1	5.6884E-04	0.0	1.4512E-01
2	0.0	0.0	1.9099E-01
3	0.0	0.0	3.1400E-01
4	0.0	0.0	3.9044E-01
5	0.0	0.0	5.6436E-01
6	0.0	0.0	8.6300E-01
7	0.0	0.0	1.0189E 00
8	5.6884E-05	0.0	1.0593E 00
9	2.2754E-04	0.0	1.0593E 00
10	4.5507E-04	0.0	1.0593E 00
11	7.9638E-04	0.0	1.0593E 00
12	1.4221E-03	0.0	1.0629E 00
13	2.5598E-03	0.0	1.0629E 00
14	3.9819E-03	0.0	1.2335E 00
15	7.4198E-03	0.0	1.6317E 00
16	1.6606E-02	0.0	2.7694E 00

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	3.8304E-02	6.8083E-02	1.3595E-02	1.3595E-02	8.1913E-03	2.7873E-03
2	6.7265E-02	5.3129E-02	3.9250E-02	2.3607E-02	6.5985E-03	1.1377E-03
3	8.6662E-02	1.4542E-01	6.1207E-02	1.7065E-02	2.9580E-03	6.8261E-04
4	1.4672E-01	1.9019E-01	4.4426E-02	7.5087E-03	1.2514E-03	3.4130E-04
5	2.6720E-01	2.5005E-01	3.8909E-02	6.6554E-03	1.2514E-03	2.8442E-04
6	4.3043E-01	3.6010E-01	5.9444E-02	1.0637E-02	1.7065E-03	6.8261E-04
7	4.8694E-01	4.3819E-01	7.6736E-02	1.1889E-02	3.4699E-03	1.7065E-03
8	4.9219E-01	4.6730E-01	6.9398E-02	2.0478E-02	6.9398E-03	2.9580E-03
9	4.9355E-01	4.0126E-01	1.0922E-01	3.8681E-02	1.0922E-02	5.4609E-03
10	3.6967E-01	4.6809E-01	1.5467E-01	4.4369E-02	1.3197E-02	8.8739E-03
11	3.4018E-01	5.1259E-01	1.3754E-01	4.0900E-02	2.0478E-02	6.8261E-03
12	3.6070E-01	4.7703E-01	1.3447E-01	6.7237E-02	2.2014E-02	0.0
13	3.2869E-01	4.5141E-01	2.0956E-01	7.0650E-02	0.0	0.0
14	4.4269E-01	5.9914E-01	1.8772E-01	0.0	0.0	0.0
15	1.3161E 00	3.0818E-01	0.0	0.0	0.0	0.0
16	2.7528E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 1102 HYDROGEN DE/E

HANSEN ROACH

GP.	ABSORPTION	NU FISSION	TOTAL
1	0.0	0.0	1.4500E 00
2	0.0	0.0	2.1750E 00
3	0.0	0.0	3.3000E 00
4	0.0	0.0	4.1250E 00
5	0.0	0.0	6.7500E 00
6	0.0	0.0	1.1700E 01
7	0.0	0.0	1.4250E 01
8	1.0000E-03	0.0	1.5000E 01
9	4.0000E-03	0.0	1.5000E 01
10	8.0000E-03	0.0	1.5000E 01
11	1.4000E-02	0.0	1.5000E 01
12	2.5000E-02	0.0	1.5000E 01
13	4.5000E-02	0.0	1.5000E 01
14	7.0000E-02	0.0	1.8000E 01
15	1.3000E-01	0.0	2.5000E 01
16	2.9000E-01	0.0	4.5000E 01

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.0000E-02	7.6900E-01	2.3900E-01	2.3900E-01	1.4400E-01	4.9000E-02
2	2.4400E-01	6.9000E-01	6.9000E-01	4.1500E-01	1.1600E-01	2.0000E-02
3	6.4000E-02	1.7960E 00	1.0760E 00	3.0000E-01	5.2000E-02	1.2000E-02
4	3.5700E-01	2.8270E 00	7.8100E-01	1.3200E-01	2.2000E-02	6.0000E-03
5	1.8810E 00	4.0410E 00	6.8400E-01	1.1700E-01	2.2000E-02	5.0000E-03
6	4.4040E 00	6.0220E 00	1.0450E 00	1.8700E-01	3.0000E-02	1.2000E-02
7	5.2290E 00	7.3720E 00	1.3490E 00	2.0900E-01	6.1000E-02	3.0000E-02
8	5.3650E 00	7.8800E 00	1.2200E 00	3.6000E-01	1.2200E-01	5.2000E-02
9	5.3890E 00	6.7190E 00	1.9200E 00	6.8000E-01	1.9200E-01	9.6000E-02
10	3.3480E 00	7.7570E 00	2.7190E 00	7.8000E-01	2.3200E-01	1.5600E-01
11	2.8750E 00	8.4940E 00	2.4180E 00	7.1900E-01	3.6000E-01	1.2000E-01
12	3.1360E 00	7.9060E 00	2.3640E 00	1.1820E 00	3.8700E-01	0.0
13	2.6200E 00	7.4090E 00	3.6840E 00	1.2420E 00	0.0	0.0
14	4.7300E 00	9.9000E 00	3.3000E 00	0.0	0.0	0.0
15	1.9870E 01	5.0000E 00	0.0	0.0	0.0	0.0
16	4.4710E 01	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 6100 CARBON

HANSEN ROACH

GP.	ABSORPTION	NU FISSI CN	TOTAL
1	0.0	0.0	1.2300E 00
2	0.0	0.0	1.4200E 00
3	0.0	0.0	2.2600E 00
4	0.0	0.0	2.9300E 00
5	0.0	0.0	3.5900E 00
6	0.0	0.0	4.2500E 00
7	0.0	0.0	4.4400E 00
8	0.0	0.0	4.3400E 00
9	0.0	0.0	4.3400E 00
10	0.0	0.0	4.3400E 00
11	0.0	0.0	4.3400E 00
12	0.0	0.0	4.4400E 00
13	0.0	0.0	4.4400E 00
14	0.0	0.0	4.4400E 00
15	7.0000E-04	0.0	4.4387E 00
16	3.0000E-03	0.0	4.4390E 00

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	7.1500E-01	5.1500E-01	0.0	0.0	0.0	0.0
2	1.1060E 00	3.1400E-01	0.0	0.0	0.0	0.0
3	1.4040E 00	8.5600E-01	0.0	0.0	0.0	0.0
4	2.3260E 00	6.0400E-01	0.0	0.0	0.0	0.0
5	3.1570E 00	4.3300E-01	0.0	0.0	0.0	0.0
6	3.8490E 00	4.0100E-01	0.0	0.0	0.0	0.0
7	4.0120E 00	4.2800E-01	0.0	0.0	0.0	0.0
8	3.9120E 00	4.2800E-01	0.0	0.0	0.0	0.0
9	3.9120E 00	4.2800E-01	0.0	0.0	0.0	0.0
10	3.7370E 00	6.0300E-01	0.0	0.0	0.0	0.0
11	3.6780E 00	6.6200E-01	0.0	0.0	0.0	0.0
12	3.8240E 00	6.1600E-01	0.0	0.0	0.0	0.0
13	3.7630E 00	6.7700E-01	0.0	0.0	0.0	0.0
14	3.6270E 00	8.1300E-01	0.0	0.0	0.0	0.0
15	3.9020E 00	5.3600E-01	0.0	0.0	0.0	0.0
16	4.4360E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 8100 OXYGEN

HANSEN ROACH

GP.	ABSORPTION	NU FISSION	TOTAL
1	4.0000E-02	0.0	1.3300E 00
2	0.0	0.0	1.1800E 00
3	0.0	0.0	2.2300E 00
4	0.0	0.0	2.6300E 00
5	0.0	0.0	2.7100E 00
6	0.0	0.0	2.2600E 00
7	0.0	0.0	2.5500E 00
8	0.0	0.0	2.6400E 00
9	0.0	0.0	2.6400E 00
10	0.0	0.0	2.6400E 00
11	0.0	0.0	2.6400E 00
12	0.0	0.0	2.6400E 00
13	0.0	0.0	2.6400E 00
14	0.0	0.0	2.6400E 00
15	0.0	0.0	2.6400E 00
16	2.0000E-04	0.0	2.6412E 00

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	8.6600E-01	4.2400E-01	0.0	0.0	0.0	0.0
2	9.8900E-01	1.9100E-01	0.0	0.0	0.0	0.0
3	2.3280E 00	9.0200E-01	0.0	0.0	0.0	0.0
4	3.0740E 00	5.5600E-01	0.0	0.0	0.0	0.0
5	3.3730E 00	3.3700E-01	0.0	0.0	0.0	0.0
6	3.0290E 00	2.3100E-01	0.0	0.0	0.0	0.0
7	3.2950E 00	2.5500E-01	0.0	0.0	0.0	0.0
8	3.3700E 00	2.7000E-01	0.0	0.0	0.0	0.0
9	3.3700E 00	2.7000E-01	0.0	0.0	0.0	0.0
10	3.2600E 00	3.8000E-01	0.0	0.0	0.0	0.0
11	3.2260E 00	4.1400E-01	0.0	0.0	0.0	0.0
12	3.2600E 00	3.8000E-01	0.0	0.0	0.0	0.0
13	3.2260E 00	4.1400E-01	0.0	0.0	0.0	0.0
14	3.1420E 00	4.9800E-01	0.0	0.0	0.0	0.0
15	3.3090E 00	3.3100E-01	0.0	0.0	0.0	0.0
16	3.6410E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 9100 FLUORINE

HANSEN ROACH

GP.	ABSORPTION	NU FISSION	TOTAL
1	1.0000E-01	0.0	1.4000E 00
2	0.0	0.0	1.9000E 00
3	0.0	0.0	2.0900E 00
4	2.0003E-04	0.0	3.2002E 00
5	2.0003E-04	0.0	4.6102E 00
6	0.0	0.0	3.7800E 00
7	0.0	0.0	3.5700E 00
8	0.0	0.0	3.5700E 00
9	0.0	0.0	3.4700E 00
10	0.0	0.0	3.2800E 00
11	0.0	0.0	2.9900E 00
12	0.0	0.0	3.1800E 00
13	1.0000E-03	0.0	3.2810E 00
14	2.0000E-03	0.0	3.2820E 00
15	4.0000E-03	0.0	3.4740E 00
16	8.0000E-03	0.0	3.4680E 00

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
I						
1	8.8000E-01	4.2000E-01	0.0	0.0	0.0	0.0
2	1.2800E 00	3.2900E-01	2.1000E-01	9.0000E-02	0.0	0.0
3	1.4100E 00	6.8000E-01	8.0000E-08	0.0	0.0	0.0
4	2.1400E 00	1.0600E 00	0.0	0.0	0.0	0.0
5	3.9530E 00	6.5000E-01	7.0000E-03	0.0	0.0	0.0
6	3.5300E 00	2.5000E-01	0.0	0.0	0.0	0.0
7	3.3600E 00	2.1000E-01	0.0	0.0	0.0	0.0
8	3.3500E 00	2.2000E-01	0.0	0.0	0.0	0.0
9	3.2500E 00	2.2000E-01	0.0	0.0	0.0	0.0
10	2.9900E 00	2.9000E-01	0.0	0.0	0.0	0.0
11	2.7100E 00	2.8000E-01	0.0	0.0	0.0	0.0
12	2.9000E 00	2.8000E-01	0.0	0.0	0.0	0.0
13	2.9700E 00	3.1000E-01	0.0	0.0	0.0	0.0
14	2.9100E 00	3.7000E-01	0.0	0.0	0.0	0.0
15	3.2100E 00	2.6000E-01	0.0	0.0	0.0	0.0
16	3.4600E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 13100 ALUMINUM

HANSEN ROACH

GP.	ABSORPTION	NU FISSION	TOTAL
1	1.5900E-02	0.0	1.8059E 00
2	0.0	0.0	2.0223E 00
3	3.8001E-04	0.0	2.1404E 00
4	7.0000E-04	0.0	2.7207E 00
5	2.0000E-03	0.0	2.8320E 00
6	5.0000E-03	0.0	1.4350E 00
7	2.0000E-03	0.0	1.4630E 00
8	1.0000E-03	0.0	1.3650E 00
9	3.0000E-03	0.0	1.3660E 00
10	6.0000E-03	0.0	1.3660E 00
11	1.0000E-02	0.0	1.3660E 00
12	1.7000E-02	0.0	1.3850E 00
13	3.0000E-02	0.0	1.4100E 00
14	5.0000E-02	0.0	1.4600E 00
15	8.0000E-02	0.0	1.4600E 00
16	2.3000E-01	0.0	1.5700E 00

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1						
1	1.1000E 00	5.6000E-01	1.0000E-01	3.0000E-02	0.0	0.0
2	1.6614E 00	2.3000E-01	1.1000E-01	2.0000E-02	9.0000E-04	0.0
3	1.6100E 00	3.8000E-01	1.4000E-01	1.0000E-02	0.0	0.0
4	2.4700E 00	2.5000E-01	1.0000E-08	0.0	0.0	0.0
5	2.6900E 00	1.4000E-01	0.0	0.0	0.0	0.0
6	1.3600E 00	7.0000E-02	0.0	0.0	0.0	0.0
7	1.3980E 00	6.3000E-02	0.0	0.0	0.0	0.0
8	1.3040E 00	6.0000E-02	0.0	0.0	0.0	0.0
9	1.3030E 00	6.0000E-02	0.0	0.0	0.0	0.0
10	1.2760E 00	8.4000E-02	0.0	0.0	0.0	0.0
11	1.2640E 00	9.2000E-02	0.0	0.0	0.0	0.0
12	1.2840E 00	8.4000E-02	0.0	0.0	0.0	0.0
13	1.2860E 00	9.4000E-02	0.0	0.0	0.0	0.0
14	1.2950E 00	1.1500E-01	0.0	0.0	0.0	0.0
15	1.3060E 00	7.4000E-02	0.0	0.0	0.0	0.0
16	1.3400E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 14100 SILICCN

XSDRN

	GP. ABSORPTION	NU FISSCN	TOTAL
1	5.6174E-02	0.0	2.2823E 00
2	3.9050E-04	0.0	2.8555E 00
3	5.5414E-04	0.0	3.1642E 00
4	4.1608E-04	0.0	3.6072E 00
5	1.0146E-04	0.0	4.4521E 00
6	1.2879E-03	0.0	1.5270E 00
7	3.2716E-04	0.0	2.2098E 00
8	8.9856E-04	0.0	2.6154E 00
9	1.6849E-03	0.0	2.2876E 00
10	2.8588E-03	0.0	2.2529E 00
11	5.6232E-03	0.0	2.2631E 00
12	1.0586E-02	0.0	2.27C6E 00
13	2.0232E-02	0.0	1.9634E 00
14	3.1331E-02	0.0	1.7349E 00
15	6.6321E-02	0.0	1.7827E 00
16	1.4112E-01	0.0	1.9229E 00

TRANSFER CROSS SECTIONS

FROM	TO	I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
I							
1	1.5454E 00	4.2350E-01	1.3138E-01	9.3091E-02	3.2728E-02	0.0	
2	2.5099E 00	2.7210E-01	5.2575E-02	1.8661E-02	1.8697E-03	0.0	
3	2.7585E 00	4.0515E-01	0.0	0.0	0.0	0.0	
4	3.4017E 00	2.0511E-01	0.0	0.0	0.0	0.0	
5	4.4224E 00	2.9543E-02	0.0	0.0	0.0	0.0	
6	1.4759E 00	4.9741E-02	0.0	0.0	0.0	0.0	
7	2.1001E 00	1.0930E-01	0.0	0.0	0.0	0.0	
8	2.5200E 00	9.4475E-02	0.0	0.0	0.0	0.0	
9	2.1967E 00	8.9201E-02	0.0	0.0	0.0	0.0	
10	2.1252E 00	1.2477E-01	0.0	0.0	0.0	0.0	
11	2.1005E 00	1.5695E-01	0.0	0.0	0.0	0.0	
12	2.1353E 00	1.2474E-01	0.0	0.0	0.0	0.0	
13	1.8493E 00	9.3888E-02	8.1599E-08	0.0	0.0	0.0	
14	1.5804E 00	1.0019E-01	6.6343E-09	0.0	0.0	0.0	
15	2.2314E 00	-5.2459E-01	0.0	0.0	0.0	0.0	
16	1.6494E 00	0.0	0.0	0.0	0.0	0.0	

NUCLIDE = 24100 CHROMIUM

AEROJET

GP.	ABSORPTION	NU FISSION	TOTAL
1	1.0000E-02	0.0	2.4400E 00
2	2.0000E-02	0.0	2.3600E 00
3	2.0000E-02	0.0	2.1700E 00
4	2.0000E-02	0.0	2.6200E 00
5	4.0000E-02	0.0	3.5500E 00
6	1.1000E-01	0.0	3.1700E 00
7	7.0000E-02	0.0	1.2920E 01
8	2.0000E-02	0.0	4.6700E 00
9	3.0000E-02	0.0	4.7400E 00
10	6.0000E-02	0.0	4.2500E 00
11	1.1000E-01	0.0	4.3000E 00
12	1.9000E-01	0.0	4.3500E 00
13	3.4000E-01	0.0	4.4700E 00
14	5.5000E-01	0.0	4.6400E 00
15	9.9000E-01	0.0	5.2100E 00
16	3.1900E 00	0.0	6.1000E 00

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1						
1	1.2500E 00	5.7000E-01	2.6000E-01	2.5000E-01	9.0000E-02	1.0000E-02
2	1.4700E 00	3.5000E-01	3.6000E-01	1.5000E-01	1.0000E-02	0.0
3	1.7900E 00	2.8000E-01	7.0000E-02	1.0000E-02	0.0	0.0
4	2.4500E 00	1.5000E-01	1.0000E-07	0.0	0.0	0.0
5	3.3800E 00	1.3000E-01	0.0	0.0	0.0	0.0
6	3.0000E 00	6.0000E-02	0.0	0.0	0.0	0.0
7	1.2680E 01	1.7000E-01	0.0	0.0	0.0	0.0
8	4.5600E 00	9.0000E-02	0.0	0.0	0.0	0.0
9	4.1200E 00	9.0000E-02	0.0	0.0	0.0	0.0
10	4.0600E 00	1.3000E-01	0.0	0.0	0.0	0.0
11	4.0500E 00	1.4000E-01	0.0	0.0	0.0	0.0
12	4.0300E 00	1.3000E-01	0.0	0.0	0.0	0.0
13	3.9900E 00	1.4000E-01	0.0	0.0	0.0	0.0
14	3.9200E 00	1.7000E-01	0.0	0.0	0.0	0.0
15	4.1000E 00	1.2000E-01	0.0	0.0	0.0	0.0
16	3.0000E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 25100 MANGANESE

XSDRN

GP.	ABSORPTION	NU	FISSION	TOTAL
1	1.2257E-02	0.0		3.6463E 00
2	2.4046E-03	0.0		3.5511E 00
3	3.4033E-03	0.0		3.2749E 00
4	4.2274E-03	0.0		3.3505E 00
5	1.0296E-02	0.0		3.8640E 00
6	3.6371E-02	0.0		8.7848E 00
7	1.5945E-02	0.0		1.9633E 01
8	4.6360E-01	0.0		3.6610E 01
9	4.3253E 00	0.0		1.8680E 02
10	3.3490E-01	0.0		3.6303E 00
11	4.9580E-01	0.0		2.9929E 00
12	8.9713E-01	0.0		2.5279E 00
13	1.6182E 00	0.0		2.9672E 00
14	2.5848E 00	0.0		4.8873E 00
15	5.4715E 00	0.0		7.7829E 00
16	1.1643E 01	0.0		1.3999E 01

TRANSFER CROSS SECTIONS

FROM	TO	I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	2.0814E 00	6.7663E-01	4.0070E-01	3.4008E-01	1.3760E-01	0.0	
2	2.2297E 00	5.5807E-01	5.1231E-01	2.2352E-01	2.5044E-02	0.0	
3	2.4409E 00	5.6863E-01	2.3296E-01	2.8417E-02	6.0823E-04	0.0	
4	2.8668E 00	4.3351E-01	4.4943E-02	9.6578E-04	5.1818E-05	0.0	
5	3.6782E 00	1.7376E-01	1.6463E-03	8.6850E-05	2.6773E-06	0.0	
6	8.7005E 00	4.7949E-02	0.0	0.0	0.0	0.0	
7	1.8793E 01	8.2422E-01	0.0	0.0	0.0	0.0	
8	3.5754E 01	3.9249E-01	0.0	0.0	0.0	0.0	
9	1.8238E 02	9.3817E-02	0.0	0.0	0.0	0.0	
10	3.2172E 00	7.8199E-02	0.0	0.0	0.0	0.0	
11	2.4127E 00	8.4411E-02	0.0	0.0	0.0	0.0	
12	1.6286E 00	2.1043E-03	0.0	0.0	0.0	0.0	
13	1.2852E 00	6.3819E-02	9.3157E-14	0.0	0.0	0.0	
14	2.2176E 00	6.2617E-02	3.8336E-15	0.0	0.0	0.0	
15	2.6675E 00	-3.6334E-01	0.0	0.0	0.0	0.0	
16	2.2491E 00	0.0	0.0	0.0	0.0	0.0	

NUCLIDE = 26100 IRON

HANSEN ROACH

GP.	ABSORPTION	NU FISSCN	TOTAL
1	7.0000E-03	0.0	2.2470E 00
2	5.0000E-03	0.0	2.2000E 00
3	1.0000E-02	0.0	1.9600E 00
4	1.0000E-02	0.0	2.2900E 00
5	1.0000E-02	0.0	2.4400E 00
6	1.0000E-02	0.0	2.2300E 00
7	1.0000E-02	0.0	5.6500E 00
8	1.1000E-02	0.0	7.1140E 00
9	2.7000E-02	0.0	1.0968E 01
10	5.5000E-02	0.0	1.1364E 01
11	9.8000E-02	0.0	1.1364E 01
12	1.7000E-01	0.0	1.1370E 01
13	3.1000E-01	0.0	1.1370E 01
14	5.1000E-01	0.0	1.1370E 01
15	9.1000E-01	0.0	1.1570E 01
16	2.5300E 00	0.0	1.3070E 01

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.4400E 00	5.0000E-01	2.0000E-01	1.0000E-01	0.0	0.0
2	1.4950E 00	4.0000E-01	2.0000E-01	1.0000E-01	0.0	0.0
3	1.4700E 00	2.3000E-01	2.3000E-01	2.0000E-02	0.0	0.0
4	2.1570E 00	1.2300E-01	1.0000E-08	0.0	0.0	0.0
5	2.3590E 00	7.1000E-02	0.0	0.0	0.0	0.0
6	2.1700E 00	5.0000E-02	0.0	0.0	0.0	0.0
7	5.5200E 00	1.2000E-01	0.0	0.0	0.0	0.0
8	6.9520E 00	1.5100E-01	0.0	0.0	0.0	0.0
9	1.0708E 01	2.3300E-01	0.0	0.0	0.0	0.0
10	1.0977E 01	3.3200E-01	0.0	0.0	0.0	0.0
11	1.0901E 01	3.6500E-01	0.0	0.0	0.0	0.0
12	1.0071E 01	2.2900E-01	0.0	0.0	0.0	0.0
13	1.0702E 01	3.5800E-01	0.0	0.0	0.0	0.0
14	1.0431E 01	4.2900E-01	0.0	0.0	0.0	0.0
15	1.0390E 01	2.7000E-01	0.0	0.0	0.0	0.0
16	1.0540E 01	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 28100 NICKEL

HANSEN ROACH

GP.	ABSORPTION	NU FISSIEN	TOTAL
1	2.7000E-01	0.0	2.2900E 00
2	1.0000E-01	0.0	2.3400E 00
3	1.0000E-02	0.0	2.5300E 00
4	1.0000E-02	0.0	2.4500E 00
5	1.0000E-02	0.0	2.3800E 00
6	2.0000E-02	0.0	5.1700E 00
7	3.8000E-01	0.0	1.4580E 01
8	4.0000E-02	0.0	1.5680E 01
9	5.0000E-02	0.0	1.6680E 01
10	1.0000E-01	0.0	1.6730E 01
11	1.8000E-01	0.0	1.7300E 01
12	3.1000E-01	0.0	1.7310E 01
13	5.6000E-01	0.0	1.7510E 01
14	9.4000E-01	0.0	1.8200E 01
15	1.6000E 00	0.0	1.9000E 01
16	4.6000E 00	0.0	2.1210E 01

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.2200E 00	5.0000E-01	2.0000E-01	1.0000E-01	0.0	0.0
2	1.6400E 00	3.0000E-01	2.0000E-01	1.0000E-01	0.0	0.0
3	2.2200E 00	2.5000E-01	5.0000E-02	0.0	0.0	0.0
4	2.3400E 00	1.0000E-01	0.0	0.0	0.0	0.0
5	3.2900E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	5.0500E 00	1.0000E-01	0.0	0.0	0.0	0.0
7	1.3910E 01	2.9000E-01	0.0	0.0	0.0	0.0
8	1.5320E 01	3.2000E-01	0.0	0.0	0.0	0.0
9	1.6300E 01	3.3000E-01	0.0	0.0	0.0	0.0
10	1.6160E 01	4.7000E-01	0.0	0.0	0.0	0.0
11	1.6590E 01	5.3000E-01	0.0	0.0	0.0	0.0
12	1.6520E 01	4.8000E-01	0.0	0.0	0.0	0.0
13	1.6420E 01	5.3000E-01	0.0	0.0	0.0	0.0
14	1.6620E 01	6.4000E-01	0.0	0.0	0.0	0.0
15	1.6970E 01	4.3000E-01	0.0	0.0	0.0	0.0
16	1.6610E 01	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 48100 CADMIUM

GAM-2

GP.	ABSORPTION	NU FISSION	TOTAL
1	1.6140E-02	0.0	3.0237E 00
2	2.9271E-02	0.0	3.8702E 00
3	5.5117E-02	0.0	4.3887E 00
4	9.2146E-02	0.0	4.9335E 00
5	1.1743E-01	0.0	5.5426E 00
6	3.4910E-01	0.0	6.9149E 00
7	1.8583E 00	0.0	6.5292E 00
8	2.5000E 00	0.0	6.3237E 00
9	3.4714E 00	0.0	1.1245E 01
10	5.9200E 00	0.0	1.0048E 01
11	3.1000E 00	0.0	7.1571E 00
12	1.1400E 00	0.0	5.1163E 00
13	4.8500E 00	0.0	9.3299E 00
14	7.4300E 01	0.0	8.2031E 01
15	3.0000E 03	0.0	3.0234E 03
16	3.0000E 03	0.0	3.0069E 03

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	9.9348E-01	7.0794E-01	4.3157E-01	5.8678E-01	2.5866E-01	2.9166E-02
2	2.4256E 00	3.9814E-01	6.2911E-01	3.6103E-01	4.5997E-02	9.9879E-04
3	3.2626E 00	6.3377E-01	3.7953E-01	5.6406E-02	1.2215E-03	6.5599E-05
4	4.3250E 00	4.5144E-01	6.3282E-02	1.4687E-03	7.7199E-05	2.3999E-06
5	5.7128E 00	1.1169E-01	6.2449E-04	3.3399E-05	9.9999E-07	0.0
6	6.5091E 00	5.6708E-02	9.9999E-08	9.9999E-08	0.0	0.0
7	4.6164E 00	5.4472E-02	9.9999E-08	0.0	0.0	0.0
8	3.7882E 00	3.5525E-02	0.0	0.0	0.0	0.0
9	7.5792E 00	1.9488E-01	0.0	0.0	0.0	0.0
10	4.4846E 00	7.2471E-02	0.0	0.0	0.0	0.0
11	3.9861E 00	7.1051E-02	0.0	0.0	0.0	0.0
12	3.9195E 00	5.6840E-02	0.0	0.0	0.0	0.0
13	4.3902E 00	8.9700E-02	0.0	0.0	0.0	0.0
14	7.5717E 00	1.5986E-01	0.0	0.0	0.0	0.0
15	2.3000E 01	4.0680E-01	0.0	0.0	0.0	0.0
16	6.5000E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 92500 U-235 YR

HANSEN ROACH

	GP. ABSORPTION	NU FISSION	TOTAL
1	1.2600E 00	3.5570E 00	4.2500E 00
2	1.3000E 00	3.1960E 00	4.5000E 00
3	1.3300E 00	3.0870E 00	4.6500E 00
4	1.3500E 00	2.9880E 00	5.2000E 00
5	1.6600E 00	3.5180E 00	7.9000E 00
6	3.1500E 00	6.1250E 00	1.2400E 01
7	5.5000E 00	1.0290E 01	1.5100E 01
8	1.1100E 01	1.9360E 01	2.1100E 01
9	2.7200E 01	4.5815E 01	3.7200E 01
10	5.8000E 01	9.3100E 01	6.8000E 01
11	7.9000E 01	1.0690E 02	8.9000E 01
12	7.4000E 01	8.2600E 01	8.4000E 01
13	3.9000E 01	7.3500E 01	4.9000E 01
14	8.0000E 01	1.7150E 02	9.0000E 01
15	2.2400E 02	4.5325E 02	2.3400E 02
16	6.1100E 02	1.2642E 03	6.2100E 02

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
I						
1	1.2000E 00	2.7000E-01	3.7000E-01	6.5000E-01	4.4000E-01	6.0000E-02
2	1.7700E 00	2.4000E-01	6.7000E-01	4.5000E-01	7.0000E-02	0.0
3	2.3000E 00	5.5000E-01	4.0000E-01	7.0000E-02	0.0	0.0
4	3.4200E 00	3.5000E-01	8.0000E-02	0.0	0.0	0.0
5	6.1600E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	9.2000E 00	5.0000E-02	0.0	0.0	0.0	0.0
7	9.5500E 00	5.0000E-02	0.0	0.0	0.0	0.0
8	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
I = 9 THRU I= 14	SAME AS ABOVE					
15	9.9600E 00	4.0000E-02	0.0	0.0	0.0	0.0
16	1.0000E 01	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 92510 U-235-10R SIG P = 4000 HANSEN ROACH

GP.	ABSORPTION	NU	FISSION	TOTAL
1	1.2600E 00	3.5570E 00	4.2500E 00	
2	1.3000E 00	3.1960E 00	4.5000E 00	
3	1.3300E 00	3.0870E 00	4.6500E 00	
4	1.3500E 00	2.9880E 00	5.2000E 00	
5	1.6600E 00	3.5180E 00	7.9000E 00	
6	3.1500E 00	6.1250E 00	1.2400E 01	
7	5.5000E 00	1.0290E 01	1.5100E 01	
8	1.1100E 01	1.9360E 01	2.1100E 01	
9	2.7200E 01	4.5815E 01	3.7200E 01	
10	5.8000E 01	9.3100E 01	6.8000E 01	
11	7.1100E 01	9.9600E 01	8.1100E 01	
12	6.9900E 01	7.7800E 01	7.9900E 01	
13	3.9000E 01	7.3500E 01	4.9000E 01	
14	8.0000E 01	1.7150E 02	9.0000E 01	
15	2.2400E 02	4.5325E 02	2.3400E 02	
16	6.1100E 02	1.2642E 03	6.2100E 02	

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
I						
1	1.2000E 00	2.7000E-01	3.7000E-01	6.5000E-01	4.4000E-01	6.0000E-02
2	1.7700E 00	2.4000E-01	6.7000E-01	4.5000E-01	7.0000E-02	0.0
3	2.3000E 00	5.5000E-01	4.0000E-01	7.0000E-02	0.0	0.0
4	3.4200E 00	3.5000E-01	8.0000E-02	0.0	0.0	0.0
5	6.1600E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	9.2000E 00	5.0000E-02	0.0	0.0	0.0	0.0
7	9.5500E 00	5.0000E-02	0.0	0.0	0.0	0.0
8	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
I = 9 THRU I= 14	SAME AS ABOVE					
15	9.9600E 00	4.0000E-02	0.0	0.0	0.0	0.0
16	1.0000E 01	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 92511 U-235-11R SIG P = 6000

HANSEN ROACH

GP.	ABSORPTION	NU FISSIEN	TOTAL
1	1.2600E 00	3.5570E 00	4.2500E 00
2	1.3000E 00	3.1960E 00	4.5000E 00
3	1.3300E 00	3.0870E 00	4.6500E 00
4	1.3500E 00	2.9880E 00	5.2000E 00
5	1.6600E 00	3.5180E 00	7.9000E 00
6	3.1500E 00	6.1250E 00	1.2400E 01
7	5.5000E 00	1.0290E 01	1.5100E 01
8	1.1100E 01	1.9360E 01	2.1100E 01
9	2.7200E 01	4.5815E 01	2.7200E 01
10	5.8000E 01	9.3100E 01	6.8000E 01
11	7.3700E 01	1.0180E 02	8.3700E 01
12	7.1300E 01	7.9200E 01	8.1300E 01
13	3.9000E 01	7.3500E 01	4.9000E 01
14	8.0000E 01	1.7150E 02	9.0000E 01
15	2.2400E 02	4.5325E 02	2.3400E 02
16	6.1100E 02	1.2642E 03	6.2100E 02

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
I						
1	1.2000E 00	2.7000E-01	3.7000E-01	6.5000E-01	4.4000E-01	6.0000E-02
2	1.7700E 00	2.4000E-01	6.7000E-01	4.5000E-01	7.0000E-02	0.0
3	2.3000E 00	5.5000E-01	4.0000E-01	7.0000E-02	0.0	0.0
4	3.4200E 00	3.5000E-01	8.0000E-02	0.0	0.0	0.0
5	6.1600E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	9.2000E 00	5.0000E-02	0.0	0.0	0.0	0.0
7	9.5500E 00	5.0000E-02	0.0	0.0	0.0	0.0
8	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
I = 9 THRU I= 14	SAME AS ABOVE					
15	9.9600E 00	4.0000E-02	0.0	0.0	0.0	0.0
16	1.0000E 01	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 92512 U-235-12R SIG P = 10000 HANSEN ROACH

GP.	ABSORPTION	NU FISSION	TOTAL
1	1.2600E 00	3.5570E 00	4.2500E 00
2	1.3000E 00	3.1960E 00	4.5000E 00
3	1.3300E 00	3.0870E 00	4.6500E 00
4	1.3500E 00	2.9880E 00	5.2000E 00
5	1.6600E 00	3.5100E 00	7.9000E 00
6	3.1500E 00	6.1250E 00	1.2400E 01
7	5.5000E 00	1.0290E 01	1.5100E 01
8	1.1100E 01	1.9360E 01	2.1100E 01
9	2.7200E 01	4.5015E 01	3.7200E 01
10	5.8000E 01	9.3100E 01	6.8000E 01
11	7.5200E 01	1.0380E 02	8.5200E 01
12	7.2200E 01	8.0700E 01	8.2200E 01
13	3.9000E 01	7.3500E 01	4.9000E 01
14	8.0000E 01	1.7150E 02	9.0000E 01
15	2.2400E 02	4.5325E 02	2.3400E 02
16	6.1100E 02	1.2642E 03	6.2100E 02

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
I						
1	1.2000E 00	2.7000E-01	3.7000E-01	6.5000E-01	4.4000E-01	6.0000E-02
2	1.7700E 00	2.4000E-01	6.7000E-01	4.5000E-01	7.0000E-02	0.0
3	2.3000E 00	5.5000E-01	4.0000E-01	1.0000E-02	0.0	0.0
4	3.4200E 00	3.5000E-01	8.0000E-02	0.0	0.0	0.0
5	6.1600E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	9.2000E 00	5.0000E-02	0.0	0.0	0.0	0.0
7	9.5500E 00	5.0000E-02	0.0	0.0	0.0	0.0
8	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
I = 9 THRU I= 14	SAME AS ABOVE					
15	9.9600E 00	4.0000E-02	0.0	0.0	0.0	0.0
16	1.0000E 01	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 92821 U-238 SIG P = 120

HANSEN ROACH JRK MOD

GP.	ABSORPTION	NU FISSION	TOTAL
1	5.6600E-01	1.7250E 00	4.0000E 00
2	5.3500E-01	1.2130E 00	4.4000E 00
3	1.4400E-01	1.0800E-01	4.5000E 00
4	1.4000E-01	0.0	5.2500E 00
5	1.6000E-01	0.0	8.2000E 00
6	4.5000E-01	0.0	1.2000E 01
7	7.0000E-01	0.0	1.4000E C1
8	9.9900E-01	0.0	1.3999E 01
9	2.3310E 00	0.0	1.3331E 01
10	5.6240E 00	0.0	1.4624E 01
11	3.6260E 00	0.0	1.2626E C1
12	6.5120E 00	0.0	1.5512E 01
13	4.0000E-01	0.0	9.4000E 00
14	5.5000E-01	0.0	9.5500E 00
15	1.0000E 00	0.0	1.0000E 01
16	2.4400E 00	0.0	1.1440E 01

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.2540E 00	3.3000E-01	4.6000E-01	7.9000E-01	5.3000E-01	7.0000E-02
2	1.8250E 00	3.5000E-01	9.6000E-01	6.4000E-01	9.0000E-02	0.0
3	2.9060E 00	8.0000E-01	5.5000E-C1	1.0000E-01	0.0	0.0
4	4.5300E 00	5.0000E-01	8.0000E-02	0.0	0.0	0.0
5	7.9600E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	1.1450E 01	1.0000E-01	0.0	0.0	0.0	0.0
7	1.3240E 01	6.0000E-02	0.0	0.0	0.0	0.0
8	1.2940E 01	6.0000E-02	0.0	0.0	0.0	0.0
9	1.0950E 01	5.0000E-02	0.0	0.0	0.0	0.0
10	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0
I = 11 THRU I= 14	SAME AS ABOVE					
15	8.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
16	9.0000E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 92824 U-238 SIG P = 160

HANSEN ROACH JRK MCD

GP.	ABSORPTION	NU FISSION	TOTAL
1	5.6600E-01	1.7250E 00	4.0000E 00
2	5.3500E-01	1.2130E 00	4.4000E 00
3	1.4400E-01	1.0800E-01	4.5000E 00
4	1.4000E-01	0.0	5.2500E 00
5	1.8000E-01	0.0	8.2000E 00
6	4.5000E-01	0.0	1.2000E 01
7	7.0000E-01	0.0	1.4000E 01
8	1.1700E 00	0.0	1.4170E 01
9	2.8080E 00	0.0	1.3000E 01
10	6.4740E 00	0.0	1.5474E 01
11	4.2900E 00	0.0	1.3290E 01
12	7.8780E 00	0.0	1.6878E 01
13	4.0000E-01	0.0	9.4000E 00
14	5.5000E-01	0.0	5.5500E 00
15	1.0000E 00	0.0	1.0000E 01
16	2.4400E 00	0.0	1.1440E 01

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
I						
1	1.2540E 00	3.3000E-01	4.6000E-01	7.9000E-01	5.3000E-01	7.0000E-02
2	1.8250E 00	3.5000E-01	9.6000E-01	6.4000E-01	9.0000E-02	0.0
3	2.9060E 00	8.0000E-01	5.5000E-01	1.0000E-01	0.0	0.0
4	4.5300E 00	5.0000E-01	8.0000E-02	0.0	0.0	0.0
5	7.9600E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	1.1450E 01	1.0000E-01	0.0	0.0	0.0	0.0
7	1.3240E 01	6.0000E-02	0.0	0.0	0.0	0.0
8	1.2940E 01	6.0000E-02	0.0	0.0	0.0	0.0
9	1.0950E 01	5.0000E-02	0.0	0.0	0.0	0.0
10	8.9400E 00	8.0000E-02	0.0	0.0	0.0	0.0
I = 11 THRU I = 14	SAME AS ABOVE					
15	8.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
16	9.0000E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 92826 U-238 SIG P = 200

HANSEN ROACH JRK MOD

GP.	ABSORPTION	NU FISSION	TOTAL
1	5.6600E-01	1.7250E 00	4.0000E 00
2	5.3500E-01	1.2130E 00	4.4000E 00
3	1.4400E-01	1.0800E-01	4.5000E 00
4	1.4000E-01	0.0	5.2500E 00
5	1.6000E-01	0.0	8.2000E 00
6	4.5000E-01	0.0	1.2000E 01
7	7.0000E-01	0.0	1.4000E 01
8	1.2300E 00	0.0	1.4230E 01
9	3.1980E 00	0.0	1.4198E 01
10	7.2160E 00	0.0	1.6216E 01
11	4.9200E 00	0.0	1.3920E 01
12	9.1840E 00	0.0	1.8184E 01
13	4.0000E-01	0.0	9.4000E 00
14	5.5000E-01	0.0	9.5500E 00
15	1.0000E 00	0.0	1.0000E 01
16	2.4400E 00	0.0	1.1440E 01

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
I						
1	1.2540E 00	3.3000E-01	4.6000E-01	7.9000E-01	5.3000E-01	7.0000E-02
2	1.8250E 00	3.5000E-01	9.6000E-01	6.4000E-01	9.0000E-02	0.0
3	2.9060E 00	8.0000E-01	5.5000E-01	1.0000E-01	0.0	0.0
4	4.5300E 00	5.0000E-01	8.0000E-02	0.0	0.0	0.0
5	7.9600E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	1.1450E 01	1.0000E-01	0.0	0.0	0.0	0.0
7	1.3240E 01	6.0000E-02	0.0	0.0	0.0	0.0
8	1.2940E 01	6.0000E-02	0.0	0.0	0.0	0.0
9	1.0950E 01	5.0000E-02	0.0	0.0	0.0	0.0
10	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0
I = 11 THRU I= 14	SAME AS ABOVE					
15	8.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
16	9.0000E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 92827 U-238 SIG P = 220

HANSEN ROACH JRK MOD

GP.	ABSORPTION	NU FISSION	TOTAL
1	5.6600E-01	1.7250E 00	4.0000E 00
2	5.3500E-01	1.2130E 00	4.4000E 00
3	1.4400E-01	1.0800E-01	4.5000E 00
4	1.4000E-01	0.0	5.2500E 00
5	1.6000E-01	0.0	8.2000E 00
6	4.5000E-01	0.0	1.2000E 01
7	7.0000E-01	0.0	1.4000E 01
8	1.2865E 00	0.0	1.4286E 01
9	2.4020E 00	0.0	1.4403E 01
10	7.5530E 00	0.0	1.6553E 01
11	5.1875E 00	0.0	1.4188E 01
12	9.7940E 00	0.0	1.8794E 01
13	4.0000E-01	0.0	5.4000E 00
14	5.5000E-01	0.0	9.5500E 00
15	1.0000E 00	0.0	1.0000E 01
16	2.4400E 00	0.0	1.1440E 01

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.2540E 00	3.3000E-01	4.6000E-01	7.9000E-01	5.3000E-01	7.0000E-02
2	1.8250E 00	3.5000E-01	9.6000E-01	6.4000E-01	9.0000E-02	0.0
3	2.9060E 00	8.0000E-01	5.5000E-01	1.0000E-01	0.0	0.0
4	4.5300E 00	5.0000E-01	8.0000E-02	0.0	0.0	0.0
5	7.9600E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	1.1450E 01	1.0000E-01	0.0	0.0	0.0	0.0
7	1.3240E 01	6.0000E-02	0.0	0.0	0.0	0.0
8	1.2940E 01	6.0000E-02	0.0	0.0	0.0	0.0
9	1.0950E 01	5.0000E-02	0.0	0.0	0.0	0.0
10	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0
I = 11 THRU I= 14 SAME AS ABOVE						
15	8.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
16	9.0000E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 92829 U-238 SIG P = 260

HANSEN ROACH JRK MOD

GP.	ABSORPTION	NU FISSION	TOTAL
1	5.6600E-01	1.7250E 00	4.0000E 00
2	5.3500E-01	1.2130E 00	4.4000E 00
3	1.4400E-01	1.0800E-01	4.5000E 00
4	1.4000E-01	0.0	5.2500E 00
5	1.6000E-01	0.0	8.2000E 00
6	4.5000E-01	0.0	1.2000E 01
7	7.0000E-01	0.0	1.4000E 01
8	1.3920E 00	0.0	1.4392E 01
9	3.8280E 00	0.0	1.4828E 01
10	8.3520E 00	0.0	1.7352E 01
11	5.7420E 00	0.0	1.4742E 01
12	1.1049E 01	0.0	2.0049E 01
13	4.0000E-01	0.0	9.4000E 00
14	5.5000E-01	0.0	9.5500E 00
15	1.0000E 00	0.0	1.0000E 01
16	2.4400E 00	0.0	1.1440E 01

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
I						
1	1.2540E 00	3.3000E-01	4.6000E-01	7.9000E-01	5.3000E-01	7.0000E-02
2	1.8250E 00	3.5000E-01	9.6000E-01	6.4000E-01	9.0000E-02	0.0
3	2.9060E 00	8.0000E-01	5.5000E-01	1.0000E-01	0.0	0.0
4	4.5300E 00	5.0000E-01	8.0000E-02	0.0	0.0	0.0
5	7.9600E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	1.1450E 01	1.0000E-01	0.0	0.0	0.0	0.0
7	1.3240E 01	6.0000E-02	0.0	0.0	0.0	0.0
8	1.2940E 01	6.0000E-02	0.0	0.0	0.0	0.0
9	1.0950E 01	5.0000E-02	0.0	0.0	0.0	0.0
10	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0
I = 11 THRU I= 14	SAME AS ABOVE					
15	8.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
16	9.0000E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 92832 U-238 SIG P = 330

HANSEN ROACH JRK MOD

GP.	ABSORPTION	NU FISSION	TOTAL
1	5.6600E-01	1.7250E 00	4.0000E 00
2	5.3500E-01	1.2130E 00	4.4000E 00
3	1.4400E-01	1.0800E-01	4.5000E 00
4	1.4000E-01	0.0	5.2500E 00
5	1.6000E-01	0.0	8.2000E 00
6	4.5000E-01	0.0	1.2000E 01
7	7.0000E-01	0.0	1.4000E 01
8	1.5345E 00	0.0	1.4534E 01
9	4.2710E 00	0.0	1.5371E 01
10	9.5790E 00	0.0	1.8579E 01
11	6.7890E 00	0.0	1.5789E 01
12	1.3299E 01	0.0	2.2299E 01
13	4.0000E-01	0.0	9.4000E 00
14	5.5000E-01	0.0	9.5500E 00
15	1.0000E 00	0.0	1.0000E 01
16	2.4400E 00	0.0	1.1440E 01

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.2540E 00	3.3000E-01	4.6000E-01	7.9000E-01	5.3000E-01	7.0000E-02
2	1.8250E 00	3.5000E-01	9.6000E-01	6.4000E-01	9.0000E-02	0.0
3	2.9060E 00	8.0000E-01	5.5000E-01	1.0000E-01	0.0	0.0
4	4.5300E 00	5.0000E-01	8.0000E-02	0.0	0.0	0.0
5	7.9600E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	1.1450E 01	1.0000E-01	0.0	0.0	0.0	0.0
7	1.3240E 01	6.0000E-02	0.0	0.0	0.0	0.0
8	1.2940E 01	6.0000E-02	0.0	0.0	0.0	0.0
9	1.0950E 01	5.0000E-02	0.0	0.0	0.0	0.0
10	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0
I = 11 THRU I = 14 SAME AS ABOVE						
15	8.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
16	9.0000E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 92839 U-238 SIG P = 650

HANSEN ROACH

GP.	ABSORPTION	NU FISSION	TOTAL
1	5.6600E-01	1.7250E 00	4.0000E 00
2	5.3500E-01	1.2130E 00	4.4000E 00
3	1.4400E-01	1.0800E-01	4.5000E 00
4	1.4000E-01	0.0	5.2500E 00
5	1.6000E-01	0.0	8.2000E 00
6	4.5000E-01	0.0	1.2000E 01
7	7.0000E-01	0.0	1.4000E 01
8	1.8000E 00	0.0	1.4800E 01
9	6.0000E 00	0.0	1.7000E 01
10	1.3000E 01	0.0	2.2000E 01
11	9.6000E 00	0.0	1.8600E 01
12	1.9500E 01	0.0	2.8500E 01
13	4.0000E-01	0.0	9.4000E 00
14	5.5000E-01	0.0	9.5500E 00
15	1.0000E 00	0.0	1.0000E 01
16	2.4400E 00	0.0	1.1440E 01

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.2540E 00	3.3000E-01	4.6000E-01	7.9000E-01	5.3000E-01	7.0000E-02
2	1.8250E 00	3.5000E-01	9.6000E-01	6.4000E-01	9.0000E-02	0.0
3	2.9060E 00	8.0000E-01	5.5000E-01	1.0000E-01	0.0	0.0
4	4.5300E 00	5.0000E-01	8.0000E-02	0.0	0.0	0.0
5	7.9600E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	1.1450E 01	1.0000E-01	0.0	0.0	0.0	0.0
7	1.3240E 01	6.0000E-02	0.0	0.0	0.0	0.0
8	1.2940E 01	6.0000E-02	0.0	0.0	0.0	0.0
9	1.0950E 01	5.0000E-02	0.0	0.0	0.0	0.0
10	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0
I = 11 THRU I= 14	SAME AS ABOVE					
15	8.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
16	9.0000E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 92840 U-238 SIG P = 700

HANSEN ROACH

GP.	ABSORPTION	NU FISSION	TOTAL
1	5.6600E-01	1.7250E 00	4.0000E 00
2	5.3500E-01	1.2130E 00	4.4000E 00
3	1.4400E-01	1.0800E-01	4.5000E 00
4	1.4000E-01	0.0	5.2500E 00
5	1.6000E-01	0.0	8.2000E 00
6	4.5000E-01	0.0	1.2000E 01
7	7.0000E-01	0.0	1.4000E 01
8	1.8500E 00	0.0	1.4850E 01
9	6.1000E 00	0.0	1.7100E 01
10	1.3300E 01	0.0	2.2300E 01
11	9.9000E 00	0.0	1.8900E 01
12	2.0200E 01	0.0	2.9200E 01
13	4.0000E-01	0.0	9.4000E 00
14	5.5000E-01	0.0	9.5500E 00
15	1.0000E 00	0.0	1.0000E 01
16	2.4400E 00	0.0	1.1440E 01

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.2540E 00	3.3000E-01	4.6000E-01	7.9000E-01	5.3000E-01	7.0000E-02
2	1.8250E 00	3.5000E-01	9.6000E-01	6.4000E-01	9.0000E-02	0.0
3	2.9060E 00	8.0000E-01	5.5000E-01	1.0000E-01	0.0	0.0
4	4.5300E 00	5.0000E-01	8.0000E-02	0.0	0.0	0.0
5	7.9600E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	1.1450E 01	1.0000E-01	0.0	0.0	0.0	0.0
7	1.3240E 01	6.0000E-02	0.0	0.0	0.0	0.0
8	1.2940E 01	6.0000E-02	0.0	0.0	0.0	0.0
9	1.0950E 01	5.0000E-02	0.0	0.0	0.0	0.0
10	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0
I = 11 THRU I= 14	SAME AS ABOVE					
15	8.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
16	9.0000E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 92861 U-238-6R SIG P = 400 HANSEN ROACH

GP.	ABSORPTION	NU FISSION	TOTAL
1	5.6600E-01	1.7250E 00	4.0000E 00
2	5.3500E-01	1.2130E 00	4.4000E 00
3	1.4400E-01	1.0800E-01	4.5000E 00
4	1.4000E-01	0.0	5.2500E 00
5	1.6000E-01	0.0	8.2000E 00
6	4.5000E-01	0.0	1.2000E 01
7	7.0000E-01	0.0	1.4000E 01
8	8.4000E-01	0.0	1.4700E 01
9	5.1000E 00	0.0	1.6100E 01
10	9.5000E 00	0.0	1.8500E 01
11	7.8000E 00	0.0	1.6800E 01
12	1.5600E 01	0.0	2.4600E 01
13	4.0000E-01	0.0	9.4000E 00
14	5.5000E-01	0.0	9.5500E 00
15	1.0000E 00	0.0	1.0000E 01
16	2.4400E 00	0.0	1.1440E 01

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
I						
1	1.2540E 00	3.3000E-01	4.6000E-01	7.9000E-01	5.3000E-01	7.0000E-02
2	1.8250E 00	3.5000E-01	9.6000E-01	6.4000E-01	9.0000E-02	0.0
3	2.9060E 00	8.0000E-01	5.5000E-01	1.0000E-01	0.0	0.0
4	4.5300E 00	5.0000E-01	8.0000E-02	0.0	0.0	0.0
5	7.9600E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	1.1450E 01	1.0000E-01	0.0	0.0	0.0	0.0
7	1.3240E 01	6.0000E-02	0.0	0.0	0.0	0.0
8	1.3800E 01	6.0000E-02	0.0	0.0	0.0	0.0
9	1.0950E 01	5.0000E-02	0.0	0.0	0.0	0.0
10	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0
I = 11 THRU I = 14	SAME AS ABOVE					
15	8.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
16	9.0000E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE = 92862 U-238-7R SIG P = 600 HANSEN ROACH

GP.	ABSORPTION	NU FISSION	TOTAL
1	5.6500E-01	1.7250E 00	4.0000E 00
2	5.3500E-01	1.2130E 00	4.4000E 00
3	1.4400E-01	1.0800E-01	4.5000E 00
4	1.4000E-01	0.0	5.2500E 00
5	1.6000E-01	0.0	8.2000E 00
6	4.5000E-01	0.0	1.2000E 01
7	7.0000E-01	0.0	1.4000E 01
8	1.8000E 00	0.0	1.4800E 01
9	5.8000E 00	0.0	1.6800E 01
10	1.1700E 01	0.0	2.0900E 01
11	9.2000E 00	0.0	1.8200E 01
12	1.8000E 01	0.0	2.7800E 01
13	4.0000E-01	0.0	5.4000E 00
14	5.5000E-01	0.0	5.5500E 00
15	1.0000E 00	0.0	1.0000E 01
16	2.4400E 00	0.0	1.1440E 01

TRANSFER CROSS SECTIONS

FROM	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
I						
1	1.2540E 00	3.3000E-01	4.6000E-01	7.9000E-01	5.3000E-01	7.0000E-02
2	1.8250E 00	3.5000E-01	9.6000E-01	6.4000E-01	5.0000E-02	0.0
3	2.9060E 00	8.0000E-01	5.5000E-01	1.0000E-01	0.0	0.0
4	4.5300E 00	5.0000E-01	8.0000E-02	0.0	0.0	0.0
5	7.9600E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	1.1450E 01	1.0000E-01	0.0	0.0	0.0	0.0
7	1.3240E 01	6.0000E-02	0.0	0.0	0.0	0.0
8	1.2940E 01	6.0000E-02	0.0	0.0	0.0	0.0
9	1.0950E 01	5.0000E-02	0.0	0.0	0.0	0.0
10	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0
I = 11 THRU I= 14	SAME AS ABOVE					
15	8.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
16	9.0000E 00	0.0	0.0	0.0	0.0	0.0

APPENDIX C

LEAKAGE, ABSORPTIONS, AND FISSIONS FROM THE "KENO" CODE OUTPUTS

FOR THE 40 CALCULATED EXPERIMENTS
(GROUP 17 REPRESENTS THE TOTALS)

CASE	ENERGY GROUP	SYSTEM LEAKAGE	CORE ABSORPTIONS	FISSIONS	SLM CF (I*F(I)) F(TOTAL)	K-EFF
1	1	0.5881180-03	C.123747C-C1	0.2220450-C1		
1	2	0.1357680-02	C.125850C-C1	0.2952460-C1		
1	3	0.6470250-03	C.204280C-C2	0.1908940-02		
1	4	0.7115360-03	C.253827C-C2	0.789137C-C3		
1	5	0.6103630-03	C.386857C-C2	0.1061370-02		
1	6	0.6183330-03	C.783082C-C2	0.1394690-02		
1	7	0.6101890-03	C.565547C-C2	0.1836650-02		
1	8	0.4499410-03	C.145273C-C1	0.3116010-02		
1	9	0.6263100-03	C.341588C-C1	0.6952200-C2		
1	10	0.3067150-03	C.504222C-C1	0.9190080-02		
1	11	0.3173800-03	C.331482C-C1	0.9080910-02		
1	12	0.3431710-03	C.538871C-C1	0.6906950-02		
1	13	0.1980750-03	C.688821C-C2	0.5890390-C2		
1	14	0.1707730-03	C.571962C-C2	0.1125190-01		
1	15	0.4908680-03	C.625343C-C1	0.8114640-01		
1	16	0.3691630-02	C.580452C-C0	0.8107920-C0		
1	17	0.1173810-01	C.846138C-C0	0.1003090-C1	0.148573C 02	0.999650C 00
2	1	0.6459980-03	C.122884C-C1	0.2204940-C1		
2	2	0.1102160-02	C.131184C-C1	0.2982790-C1		
2	3	0.8947490-03	C.205908C-C2	0.1924160-02		
2	4	0.5111290-03	C.294025C-C2	0.7896700-C3		
2	5	0.8011950-03	C.382749C-C2	0.1050000-02		
2	6	0.6041960-03	C.768857C-C2	0.1369360-C2		
2	7	0.2180540-03	C.562105C-C2	0.1830100-02		
2	8	0.1787600-03	C.147312C-C1	0.3075080-C2		
2	9	0.1455200-03	C.342782C-C1	0.7016630-02		
2	10	0.8549900-04	C.504815C-C1	0.9200890-C2		
2	11	0.1779900-03	C.330766C-C1	0.5061300-02		
2	12	0.5886760-04	C.533159C-C1	0.6833730-02		
2	13	0.7517290-04	C.678089C-C2	0.5758610-C2		
2	14	0.5088570-04	C.565857C-C2	0.1122790-C1		
2	15	0.1502680-03	C.625967C-C1	0.8122730-C1		
2	16	0.9679190-03	C.579460C-C0	0.8094060-C0		
2	17	0.6668360-02	C.895563C-C0	0.1001690-C1	0.148547C 02	0.998660C 00
3	1	0.5056160-03	C.122144C-C1	0.2191670-C1		
3	2	0.3818170-03	C.130370C-C1	0.2964300-C1		
3	3	0.2217270-03	C.203939C-C2	0.1905750-02		
3	4	0.1940710-03	C.255979C-C2	0.7949160-03		
3	5	0.2190960-03	C.386743C-C2	0.1060950-02		
3	6	0.1621640-03	C.783039C-C2	0.1394640-02		
3	7	0.9694710-04	C.566982C-C2	0.1839380-02		
3	8	0.5526690-04	C.149220C-C1	0.3114910-02		
3	9	0.9018130-04	C.342218C-C1	0.7005110-02		
3	10	0.9566570-04	C.505745C-C1	0.9250730-C2		
3	11	0.3067260-04	C.328877C-C1	0.9005560-C2		
3	12	0.3179300-04	C.535671C-C1	0.6865930-02		

3	13	0.2940480-04	C.6EC582C-C2	0.5819930-02		
3	14	0.0	C.977400C-C2	0.1131480-01		
3	15	0.6361740-04	C.632553C-C1	0.820872C-C1		
3	16	0.1713660-02	C.5E4212C-C0	0.8160440-00		
3	17	0.3895700-02	C.9C2242C-C0	0.1009110-01	0.148657C-02	0.100585C-01
4	1	0.8494650-02	C.126246C-C1	0.2265280-01		
4	2	0.1632170-01	C.136585C-C1	0.3114710-01		
4	3	0.7718410-02	C.213C99C-C2	0.1991350-02		
4	4	0.9226130-02	C.3C7423C-C2	0.8256520-C3		
4	5	0.1053340-01	C.255180C-C2	0.1055070-02		
4	6	0.6441780-02	C.8138C0C-C2	0.1449400-02		
4	7	0.5217000-02	C.1C0355C-C1	0.19C8930-02		
4	8	0.4093190-02	C.154232C-C1	0.2219470-02		
4	9	0.3484540-02	C.254588C-C1	0.7258070-02		
4	10	0.2357460-02	C.528579C-C1	0.5641020-02		
4	11	0.2126130-02	C.342210C-C1	0.9374160-02		
4	12	0.2234700-02	C.558217C-C1	0.7154390-02		
4	13	0.2096390-02	C.7C5740C-C2	0.6063560-02		
4	14	0.1412850-02	C.1C0436C-C1	0.1161700-01		
4	15	0.3930580-02	C.651077C-C1	0.8442900-01		
4	16	0.6327100-02	C.576847C-C0	0.8C52900-00		
4	17	0.9201600-01	C.5C6612C-C0	0.1005120-01	0.143149C-02	0.100192C-01
5	1	0.1019950-01	C.125563C-C1	0.2331980-01		
5	2	0.1687210-01	C.134814C-C1	0.3065330-C1		
5	3	0.7421860-02	C.213175C-C2	0.1992070-02		
5	4	0.1053510-01	C.3C5821C-C2	0.8213480-03		
5	5	0.1022410-01	C.402452C-C2	0.1104160-02		
5	6	0.6920240-02	C.8C4467C-C2	0.1432780-02		
5	7	0.4804040-02	C.557380C-C2	0.1897200-02		
5	8	0.4044260-02	C.153755C-C1	0.3209490-02		
5	9	0.4327850-02	C.358443C-C1	0.7336960-02		
5	10	0.2575C90-02	C.526776C-C1	0.9600870-02		
5	11	0.1795860-02	C.340724C-C1	0.9333460-02		
5	12	0.2718400-02	C.555783C-C1	0.7123190-02		
5	13	0.2016200-02	C.705670C-C2	0.8028790-02		
5	14	0.1663590-02	C.553788C-C2	0.1149470-01		
5	15	0.4186530-02	C.646859C-C1	0.8388710-01		
5	16	0.7367450-02	C.575031C-C0	0.8027540-00		
5	17	0.9767210-01	C.9C39740-C0	0.1001990-01	0.148093C-02	0.997520C-00
6	1	0.1017C70-01	C.126352C-C1	0.2267170-01		
6	2	0.1724290-01	C.133067C-C1	0.3025620-C1		
6	3	0.7185C90-02	C.212486C-C2	0.1585620-02		
6	4	0.1273960-01	C.304484C-C2	0.8177590-03		
6	5	0.1005490-01	C.4C0753C-C2	0.1059380-C2		
6	6	0.6982640-02	C.8C1452C-C2	0.1427480-02		
6	7	0.5293080-02	C.1C0088C-C1	0.1903860-C2		
6	8	0.4204300-02	C.153912C-C1	0.3212770-C2		
6	9	0.4178910-02	C.356528C-C1	0.7305960-02		
6	10	0.2725000-02	C.523C00C-C1	0.9533650-02		
6	11	0.2640830-02	C.345448C-C1	0.9462860-C2		
6	12	0.2279660-02	C.554178C-C1	0.7102630-02		
6	13	0.2399810-02	C.7C1566C-C2	0.5953720-C2		
6	14	0.1937940-02	C.1C03C4C-C1	0.1160180-01		
6	15	0.3728460-02	C.645972C-C1	0.8376690-01		
6	16	0.7636770-02	C.571255C-C0	0.7574840-00		
6	17	0.1014010-00	C.899397C-C0	0.9556260-C0	0.148173C-02	0.9932800-00
7	1	0.3595030-03	C.834150C-C2	0.2371680-01		
7	2	0.3308980-03	C.1412C9C-C1	0.3210750-C1		
7	3	0.2000000-03	C.211761C-C2	0.1578850-C2		
7	4	0.9878420-04	C.314470C-C2	0.8484460-C3		
7	5	0.6551800-04	C.386287C-C2	0.1063910-02		
7	6	0.6666650-04	C.7495C6C-C2	0.1334900-02		
7	7	0.3333320-04	C.5259C4C-C2	0.1768850-02		
7	8	0.6427650-04	C.145368C-C1	0.3034340-02		
7	9	0.0	C.220325C-C1	0.6761030-02		
7	10	0.3330950-04	C.485147C-C1	0.6841720-C2		

7	11	0.3329020-04	C.322321C-01	0.8828310-02		
7	12	0.1655310-03	C.5220C7C-01	0.6689470-02		
7	13	0.0	0.659434C-02	0.5640960-02		
7	14	0.6615640-04	C.551573C-02	0.1102750-01		
7	15	0.9492870-04	C.613793C-01	0.7573030-01		
7	16	0.8920910-03	C.572379C-00	0.8000200-00		
7	17	0.2504290-02	C.878767C-00	0.9933930-00	0.147956C-02	C.989260C-00
8	1	0.5571150-03	C.860478C-02	0.2446530-01		
8	2	0.4936070-03	0.142166C-01	0.3232500-01		
8	3	0.3296860-03	0.2162C7C-02	0.2020400-02		
8	4	0.2970110-03	C.315621C-02	0.8623450-03		
8	5	0.4544700-03	C.3524200-02	0.1080800-02		
8	6	0.9828830-04	C.755380C-02	0.1345360-02		
8	7	0.6588210-04	C.5380550-02	0.1784350-02		
8	8	0.6425090-04	0.144758C-01	0.3021600-02		
8	9	0.6074900-04	C.322502C-01	0.6805610-02		
8	10	0.2533310-04	0.487294C-01	0.8880830-02		
8	11	0.0	C.3226C8C-01	0.8836160-02		
8	12	0.9131120-04	C.519794C-01	0.6661100-02		
8	13	0.0	C.662472C-02	0.5666960-02		
8	14	0.1476300-03	C.546810C-02	0.1097230-01		
8	15	0.2323380-03	C.614904C-01	0.7987470-01		
8	16	0.1611200-02	C.5755950-00	0.8045140-00		
8	17	0.4528870-02	C.8829120-00	0.9991170-00	C.147866C-02	0.995820C-00
9	1	0.1306340-03	C.106054C-01	0.1902970-01		
9	2	0.3614290-03	C.117303C-01	0.2667180-01		
9	3	0.1925650-03	0.175652C-02	0.1678800-02		
9	4	0.0	C.2550930-02	0.6851090-03		
9	5	0.6531650-04	C.224976C-02	0.8915070-03		
9	6	0.9592780-04	C.6526C9C-02	0.1162320-02		
9	7	0.6531600-04	C.815212C-02	0.1550680-02		
9	8	0.0	C.133624C-01	0.2667250-02		
9	9	0.9940780-04	C.231306C-01	0.6042190-02		
9	10	0.9722110-04	C.4828C6C-01	0.7584550-02		
9	11	0.0	C.319238C-01	0.7819760-02		
9	12	0.0	C.532197C-01	0.5946240-02		
9	13	0.9536170-04	C.615951C-02	0.5055510-02		
9	14	0.3287530-04	0.876949C-02	0.5782180-02		
9	15	0.6318840-04	C.574013C-01	0.7232650-01		
9	16	0.8565860-03	C.603415C-00	0.8217000-00		
9	17	0.2155830-02	C.900274C-00	0.9909940-00	C.145851C-02	0.989119C-00
10	1	0.1940310-03	C.557370C-02	0.1717850-01		
10	2	0.4946560-03	C.102047C-01	0.2320290-01		
10	3	0.0	C.154966C-02	0.1448120-02		
10	4	0.9828510-04	C.218919C-02	0.5879550-03		
10	5	0.9899270-04	C.275754C-02	0.7674500-03		
10	6	0.6616320-04	C.560676C-02	0.5905830-03		
10	7	0.6565920-04	C.703271C-02	0.1337750-02		
10	8	0.9999280-04	C.118672C-01	0.2274590-02		
10	9	0.0	C.200380C-01	0.5177050-02		
10	10	0.6661140-04	C.434348C-01	0.6887620-02		
10	11	0.3092350-04	C.292316C-01	0.6583550-02		
10	12	0.6503390-04	C.455929C-01	0.5328270-02		
10	13	0.0	C.569017C-02	0.4457500-02		
10	14	0.6636540-04	C.808125C-02	0.8640720-02		
10	15	0.9330970-04	C.529122C-01	0.6566980-01		
10	16	0.8886290-03	C.638290C-00	0.8440190-00		
10	17	0.2328690-02	C.9090920-00	0.9549590-00	C.151293C-02	C.990530C-00
11	1	0.1518270-02	C.150360C-01	0.2703420-01		
11	2	0.2042630-02	C.156425C-01	0.3560910-01		
11	3	0.6811890-03	C.267268C-02	0.2677800-02		
11	4	0.8158940-03	C.385752C-02	0.1427100-02		
11	5	0.6589650-03	C.528389C-02	0.1565610-02		
11	6	0.3585610-03	C.104577C-01	0.2571000-02		
11	7	0.3640610-03	C.1290C7C-01	0.3373120-02		
11	8	0.4236900-03	C.175066C-01	0.5685660-02		

11	9	0.1979400-03	C.3E62C8C-C1	0.1257420-01	
11	10	0.2452980-03	C.565847C-C1	0.16C009D-01	
11	11	0.1948510-03	C.370292C-C1	0.1497040-01	
11	12	0.2276750-03	C.553692C-C1	0.1121180-C1	
11	13	0.1307160-03	C.8E2586C-C2	0.5634990-02	
11	14	0.9669470-04	0.129C560-C1	0.1834910-01	
11	15	0.5036380-03	C.7E3663C-C1	0.1189550 00	
11	16	0.4718980-02	C.446752C CC	0.7172030 00	
11	17	0.1317900-01	C.8182550 C0	C.9552470 00	C.144313C 02 0.996480C 00
12	1	0.1526450-01	C.16C8C9C-C1	0.2891300-01	
12	2	0.2606000-01	C.17C929C-C1	0.389109C-01	
12	3	0.1333340-01	C.258488C-C2	0.2990600-02	
12	4	0.1818590-01	C.436155C-C2	0.1597000-02	
12	5	0.1870270-01	C.5E6323C-C2	0.2185570-02	
12	6	0.1249190-01	C.117134C-C1	0.2879720-02	
12	7	0.1043710-01	C.143193C-C1	0.374403C-02	
12	8	0.8365480-02	C.153244C-C1	0.627603C-02	
12	9	0.6348720-02	C.425518C-C1	0.1385410-C1	
12	10	0.4563120-02	C.623150C-C1	0.1751440-01	
12	11	0.4148950-02	C.414142C-C1	0.1674320-01	
12	12	0.319C830-02	C.613285C-C1	0.1241850-01	
12	13	0.3539000-02	0.565730C-C2	0.1058630-01	
12	14	0.2506910-02	C.142691C-01	0.2028140-C1	
12	15	0.5752100-02	C.8E3466C-C1	0.1310680 00	
12	16	0.7049830-02	C.421021C CC	0.6519500 00	
12	17	0.1599400 00	C.840745C CC	0.10C1910 C1	0.142912C 02 0.999020C 00
13	1	0.1835210-02	C.112703C-01	0.2026360-01	
13	2	0.2118270-02	C.119912C-C1	0.2725720-C1	
13	3	0.6266850-03	C.155670C-C2	0.1560250-02	
13	4	0.1137700-02	0.275753C-C2	0.1023910-02	
13	5	0.1214560-02	C.361649C-C2	0.1347540-02	
13	6	0.3259340-03	C.7C7856C-C2	0.1739510-02	
13	7	0.2603700-03	C.881930C-C2	0.2305000-C2	
13	8	0.1959680-03	C.127381C-C1	0.3910880-C2	
13	9	0.3909360-03	C.312551C-C1	0.8718220-02	
13	10	0.2648320-03	C.457865C-C1	0.1140950-01	
13	11	0.1955230-03	C.206721C-C1	0.11C9760-01	
13	12	0.1647090-03	C.474689C-C1	0.8314240-C2	
13	13	0.2862270-03	C.657433C-C2	0.7141660-02	
13	14	0.1611550-03	C.16C266C-C1	0.1347810-01	
13	15	0.3180110-03	C.654484C-C1	0.9523630-01	
13	16	0.5445460-02	C.5C89E50 CC	0.78E2640 00	
13	17	0.1494150-01	C.8C78860 CC	0.10C3510 C1	C.148341C 02 0.100015C 01
14	1	0.1784480-01	C.121855C-C1	0.2191630-01	
14	2	0.3198950-01	C.1319C60-C1	0.3002750-C1	
14	3	0.1424450-01	C.218769C-C2	0.2191650-C2	
14	4	0.1921470-01	C.202323C-C2	0.1106510-02	
14	5	0.1855800-01	C.4C1558C-C2	0.1496220-02	
14	6	0.1324500-01	C.776580C-C2	0.1909350-02	
14	7	0.9880040-02	C.975141C-C2	0.2559030-02	
14	8	0.8785680-02	C.151294C-C1	0.4306910-02	
14	9	0.7266810-02	0.349267C-C1	0.9742250-02	
14	10	0.4523340-02	C.5C8345C-C1	0.1266720-01	
14	11	0.4475160-02	C.337750C-C1	0.1222110-01	
14	12	0.3829950-02	C.529713C-C1	0.9277860-C2	
14	13	0.3415780-02	C.767203C-C2	0.7E56040-02	
14	14	0.3112400-02	C.1C9217C-01	0.1468130-C1	
14	15	0.65C0420-02	C.713844C-C1	0.1038730 C0	
14	16	0.1031960-01	C.491518C CC	0.7618280 C0	
14	17	0.1772060 00	C.821705C CC	C.9576610 00	0.147138C 02 0.994220C 00
15	1	0.1648930-02	C.880659C-C2	0.158345C-01	
15	2	0.1711620-02	C.553312C-C2	0.2170150-C1	
15	3	0.5508150-03	C.151290C-C2	0.1515640-02	
15	4	0.4915040-03	C.214756C-C2	0.7E61590-C3	
15	5	0.9879810-03	C.269566C-C2	0.100590C-02	
15	6	0.5554640-03	C.53E399C-C2	0.131814C-02	

15	7	0.4568530-03	C.669513C-C2	0.1749800-C2	
15	8	0.4589260-03	C.112083C-C1	0.2941950-C2	
15	9	0.4580130-03	C.281421C-C1	0.6663750-C2	
15	10	0.1317840-03	C.357070C-C1	0.8662920-C2	
15	11	0.1923910-03	C.276153C-C1	0.8636440-C2	
15	12	0.2275380-03	C.456977C-C1	0.6629470-C2	
15	13	0.2939950-03	C.582797C-C2	0.5574850-C2	
15	14	0.2888960-03	C.647550C-C2	0.1073120-01	
15	15	0.3191100-03	C.563367C-C1	0.7829690-C1	
15	16	0.5790840-02	C.5560050-C0	0.8278530-C0	
15	17	0.1456470-01	C.8157780-C0	0.9999020-C0	C.150811C 02 0.997570C 00
16	1	0.1743650-02	C.7675650-C2	0.1390770-01	
16	2	0.2108410-02	C.8226600-C2	0.1872730-C1	
16	3	0.2601660-03	C.128917C-C2	0.1291620-02	
16	4	0.9570200-03	C.180241C-C2	0.6599220-03	
16	5	0.9892250-03	C.224214C-C2	0.8357240-03	
16	6	0.6899550-03	C.425637C-C2	0.1070930-02	
16	7	0.2910280-03	C.546347C-C2	0.1428430-C2	
16	8	0.1951350-03	C.5886020-C2	0.2425040-02	
16	9	0.2639030-03	C.258131C-C1	0.5517640-02	
16	10	0.1979170-03	C.367302C-C1	0.7339190-02	
16	11	0.1952740-03	C.252952C-C1	0.7296070-C2	
16	12	0.2302890-03	C.427197C-C1	0.5569310-02	
16	13	0.1619530-03	C.515618C-C2	0.4723170-02	
16	14	0.1295290-03	C.761384C-C2	0.9214330-02	
16	15	0.4796120-03	C.505296C-C1	0.6780040-01	
16	16	0.4833370-02	C.579139C-C0	0.8366190-C0	
16	17	0.1372640-01	C.813583C-C0	0.9843250-C0	C.151955C 02 0.981360C 00
17	1	0.1457380-02	C.6680010-C2	0.1201040-01	
17	2	0.2201090-02	C.704679C-C2	0.1604150-01	
17	3	0.5940820-03	C.1110820-C2	0.1112830-02	
17	4	0.8556670-03	C.1542920-C2	0.5647000-C3	
17	5	0.5606870-03	C.1508640-C2	0.7111550-03	
17	6	0.4619140-03	C.3713320-C2	0.9124930-03	
17	7	0.2318310-03	C.463783C-C2	0.1212100-02	
17	8	0.3929000-03	C.925961C-C2	0.2085290-02	
17	9	0.3308930-03	C.247900C-C1	0.4709460-02	
17	10	0.2963110-03	C.361579C-C1	0.6394570-02	
17	11	0.3282650-03	C.254966C-C1	0.6550200-02	
17	12	0.2307320-03	C.438220C-C1	0.4939070-C2	
17	13	0.9887170-04	C.484353C-C2	0.4131490-02	
17	14	0.6516230-04	C.650722C-C2	0.7899250-02	
17	15	0.3846260-03	C.476827C-C1	0.6115660-01	
17	16	0.5074710-02	C.6214690-C0	0.8638460-C0	
17	17	0.1356510-01	C.6470690-C0	0.9943170-C0	C.153123C 02 0.989180C 00
18	1	0.1556730-01	C.719223C-C2	0.1293140-C1	
18	2	0.2662250-01	C.767382C-C2	0.1746890-01	
18	3	0.1301520-01	C.118115C-C2	0.1183290-02	
18	4	0.1642110-01	C.163721C-C2	0.5992130-03	
18	5	0.1613350-01	C.202611C-C2	0.7549230-C3	
18	6	0.1068390-01	C.356374C-C2	0.9740290-03	
18	7	0.6890400-02	C.458172C-C2	0.1301970-02	
18	8	0.6062000-02	C.65150C-C2	0.2218670-02	
18	9	0.5648690-02	C.265200C-C1	0.5038120-02	
18	10	0.3756880-02	C.381534C-C1	0.6747480-02	
18	11	0.3826340-02	C.267313C-C1	0.6867420-02	
18	12	0.3310800-02	C.465156C-C1	0.5243100-02	
18	13	0.2790980-02	C.505926C-C2	0.4315510-02	
18	14	0.2584970-02	C.727831C-C2	0.8437880-02	
18	15	0.5690800-02	C.495534C-C1	0.6359750-01	
18	16	0.1430020-01	C.610567C-C0	0.8486920-C0	
18	17	0.1533060-C0	C.6489900-C0	0.5863710-C0	C.152568C 02 0.982010C 00
19	1	0.9283490-03	C.485477C-C2	0.8728820-02	
19	2	0.1052580-02	C.512556C-C2	0.1166800-01	
19	3	0.5293990-03	C.768756C-C3	0.7702170-03	
19	4	0.5601020-03	C.107361C-C2	0.3930030-C3	

19	5	0.4965370-03	C.122598C-C2	0.4941400-03	
19	6	0.3989420-03	C.260694C-C2	0.6407300-03	
19	7	0.2283300-03	C.223631C-C2	0.8459550-03	
19	8	0.1653290-03	C.356825C-C2	0.1457490-02	
19	9	0.1955580-03	C.204049C-C1	0.3364910-02	
19	10	0.1326250-03	C.260895C-C1	0.4623190-02	
19	11	0.1646460-03	C.209551C-C1	0.4766530-02	
19	12	0.9786690-04	C.365780C-C1	0.3735630-02	
19	13	0.9977820-04	C.424773C-C2	0.3052610-02	
19	14	0.1301910-03	C.601644C-C2	0.5855340-02	
19	15	0.2219470-03	C.413385C-C1	0.4666300-01	
19	16	0.2768330-02	C.727324C-C0	0.5069480-C0	
19	17	0.8170510-02	C.907914C-C0	0.1004250-01	C.155041C 02 0.996370C 00
20	1	0.8681740-02	C.493415C-C2	0.8871540-02	
20	2	0.1593840-01	C.530882C-C2	0.1208520-C1	
20	3	0.6942090-02	C.750736C-C3	0.7921970-03	
20	4	0.9444830-02	C.111149C-C2	0.4068700-C3	
20	5	0.8242220-02	C.136461C-C2	0.5085370-03	
20	6	0.5047790-02	C.765541C-C2	0.6526440-03	
20	7	0.3929300-02	C.233556C-C2	0.8719000-03	
20	8	0.3225040-02	C.415821C-C2	0.1527270-02	
20	9	0.3807500-02	C.211755C-C1	0.3491990-02	
20	10	0.2154130-02	C.2699050-C1	0.4782850-02	
20	11	0.1777080-02	C.214421C-C1	0.4877320-02	
20	12	0.1778410-02	C.357893C-C1	0.3852920-C2	
20	13	0.1710120-02	C.438476C-C2	0.3151080-02	
20	14	0.1381290-02	C.627412C-C2	0.6147850-C2	
20	15	0.3497820-02	C.422677C-C1	0.4791640-01	
20	16	0.1141950-01	C.726765C-C0	0.9062520-C0	
20	17	0.8883230-01	C.912748C-C0	0.1006190-01	C.154909C 02 C.999620C 00
21	1	0.2087020-02	C.123868C-C1	0.2414920-C1	
21	2	0.2976050-02	C.145536C-C1	0.3319400-01	
21	3	0.9469150-03	C.264629C-C2	0.2917660-02	
21	4	0.9721460-03	C.383841C-C2	0.1962050-02	
21	5	0.9436720-03	C.504657C-C2	0.2613180-02	
21	6	0.6231200-03	C.980021C-C2	0.3427110-02	
21	7	0.4243250-03	C.121649C-C1	0.4495340-02	
21	8	0.5599820-03	C.165705C-C1	0.7439100-02	
21	9	0.5167670-03	C.361480C-C1	0.1621340-01	
21	10	0.1979420-03	C.525888C-C1	0.2051980-01	
21	11	0.2808760-03	C.359142C-C1	0.1895440-C1	
21	12	0.4215810-03	C.513461C-C1	0.1421030-C1	
21	13	0.2529330-03	C.564150C-C2	0.1223840-01	
21	14	0.1285190-03	C.144304C-C1	0.2309480-01	
21	15	0.4372590-03	C.860911C-C1	0.1424970-C0	
21	16	0.8961210-02	C.357582C-C0	0.6896360-C0	
21	17	0.2073030-01	C.761749C-C0	0.1017560-01	C.143637C 02 0.101677C 01
22	1	0.1921660-02	C.126206C-C1	0.2457100-01	
22	2	0.3207500-02	C.148289C-C1	0.3382200-01	
22	3	0.1012710-02	C.268491C-C2	0.2560240-02	
22	4	0.1676330-02	C.763733C-C2	0.1561500-02	
22	5	0.9094840-03	C.512274C-C2	0.2652630-02	
22	6	0.6208910-03	C.573901C-C2	0.3405710-C2	
22	7	0.4520980-03	C.121786C-C1	0.4500420-02	
22	8	0.5273560-03	C.168816C-C1	0.7578780-C2	
22	9	0.4895110-03	C.366680C-C1	0.1644660-01	
22	10	0.6305030-04	C.524436C-C1	0.2046310-01	
22	11	0.1926710-03	C.261212C-C1	0.1906370-01	
22	12	0.2622720-03	C.507422C-C1	0.1404320-01	
22	13	0.1951060-03	C.555279C-C2	0.1212580-01	
22	14	0.1619830-03	C.144121C-C1	0.2306560-01	
22	15	0.4671630-03	C.555910C-C1	0.1416690-C0	
22	16	0.7355020-02	C.257221C-C0	0.6890290-C0	
22	17	0.1951480-01	C.761656C-C0	0.1017360-01	C.143466C 02 0.101670C 01
23	1	0.1938830-02	C.129971C-C1	0.2344610-01	
23	2	0.2760050-02	C.146864C-C1	0.3349700-01	

23	3	0.7783230-03	C.261418C-C2	0.2882260-C2	
23	4	0.1290600-02	C.374137C-C2	0.1912450-02	
23	5	0.9044630-03	C.507505C-C2	0.2627930-02	
23	6	0.4776760-03	C.576689C-C2	0.3415460-02	
23	7	0.4217590-03	C.119932C-C1	0.4431930-02	
23	8	0.5563310-03	C.167488C-C1	0.7519140-02	
23	9	0.4224190-03	C.360016C-C1	0.1614780-C1	
23	10	0.2878250-03	C.523228C-C1	0.2041600-01	
23	11	0.1624670-03	C.358560C-C1	0.1892370-01	
23	12	0.3596440-03	C.503461C-C1	0.1393360-C1	
23	13	0.2208040-03	C.557380C-C2	0.1215250-01	
23	14	0.1619050-03	C.143663C-C1	0.2299230-C1	
23	15	0.5616530-03	C.852615C-C1	0.1411240 00	
23	16	0.7033350-02	C.356761C C0	0.6882120 00	
23	17	0.1833810-01	C.758112C C0	0.1013630 01	C.143687C 02 0.101144C 01
24	1	0.9289980-02	C.135708C-C1	0.2448120-C1	
24	2	0.1549000-01	C.146046C-C1	0.3331020-01	
24	3	0.6301030-02	C.265719C-C2	0.2929680-C2	
24	4	0.7624160-02	C.378139C-C2	0.1932900-02	
24	5	0.6812150-02	C.503255C-C2	0.2605920-02	
24	6	0.5477620-02	C.552523C-C2	0.3470830-C2	
24	7	0.2962760-02	C.115772C-C1	0.4426000-02	
24	8	0.312880C-02	C.163716C-C1	0.7349830-C2	
24	9	0.2781250-02	C.364148C-C1	0.1633310-C1	
24	10	0.2095360-02	C.528115C-C1	0.2060670-01	
24	11	0.2207760-02	C.360232C-C1	0.1901190-01	
24	12	0.1961590-02	C.509360C-C1	0.1409680-01	
24	13	0.2628670-02	C.571254C-C2	0.1232860-01	
24	14	0.1465660-02	C.143865C-C1	0.2302460-01	
24	15	0.4091220-02	C.648046C-C1	0.1403670 00	
24	16	0.3287460-01	C.351810C C0	0.6756250 00	
24	17	0.1071930 00	C.754820C C0	0.1005900 01	0.143401C 02 0.1005890 01
25	1	0.2038630-02	C.135157C-C1	0.2438180-01	
25	2	0.3135270-02	C.148374C-C1	0.3384130-01	
25	3	0.9806230-03	C.263487C-C2	0.2905080-02	
25	4	0.1396210-02	C.376674C-C2	0.1935640-02	
25	5	0.1293390-02	C.507599C-C2	0.2628420-02	
25	6	0.5787790-03	C.570118C-C2	0.3392480-02	
25	7	0.5595010-03	C.120235C-C1	0.4443120-02	
25	8	0.3890360-03	C.164141C-C1	0.7368880-C2	
25	9	0.2773220-03	C.3624980-C1	0.1625910-01	
25	10	0.2589520-03	C.522282C-C1	0.2041810-01	
25	11	0.3547350-03	C.351799C-C1	0.1856690-01	
25	12	0.3931390-03	C.508814C-C1	0.1408170-01	
25	13	0.1303960-03	C.550389C-C2	0.1206370-01	
25	14	0.2944640-03	C.142218C-C1	0.2276100-01	
25	15	0.9110300-03	C.451980C-C1	0.1410190 00	
25	16	0.9475610-02	C.3971680 C0	0.6889190 00	
25	17	0.2246710-01	C.758720C C0	0.1014980 01	0.143542C 02 0.101280C 01
26	1	0.2212200-01	C.152712C-C1	0.2754870-C1	
26	2	0.3833440-01	C.167312C-C1	0.3816070-01	
26	3	0.2004630-01	C.306023C-C2	0.3374060-C2	
26	4	0.2449610-01	C.431748C-C2	0.2206930-02	
26	5	0.2606600-01	C.585829C-C2	0.3033500-02	
26	6	0.1636250-01	C.114679C-C1	0.4010280-02	
26	7	0.1090290-01	C.140816C-C1	0.5203660-02	
26	8	0.9357040-02	C.154771C-C1	0.8744000-02	
26	9	0.1032630-01	C.426307C-C1	0.1912110-01	
26	10	0.7308240-02	C.618709C-C1	0.2414160-01	
26	11	0.5481340-02	C.413086C-C1	0.218014C-01	
26	12	0.4392820-02	C.585558C-C1	0.1628870-01	
26	13	0.5062490-02	C.110024C-C1	0.1396580-01	
26	14	0.3309740-02	C.166157C-C1	0.2659230-C1	
26	15	0.6579380-02	C.561094C-C1	0.1590790 00	
26	16	0.5706980-02	C.267741C C0	0.6378750 C0	
26	17	0.2158550 00	C.766399C C0	0.1011150 01	C.141060C 02 0.101125C 01

27	1	0.2140100-01	0.151243C-C1	0.272835D-C1	
27	2	0.388431D-01	C.165209C-C1	0.376811D-01	
27	3	0.201597D-01	C.305690C-C2	0.337038D-C2	
27	4	0.248525D-01	C.432200C-C2	0.220924D-02	
27	5	0.232795D-01	C.595211D-C2	0.3C6208D-02	
27	6	0.163905D-01	0.115610C-01	0.404285D-02	
27	7	0.122970D-01	C.142266C-C1	0.525723D-02	
27	8	0.104240D-01	C.194004C-C1	0.870958D-02	
27	9	0.950296D-02	0.422876C-C1	0.189672D-01	
27	10	0.505280D-02	0.615573C-C1	0.240193D-01	
27	11	0.477809D-02	0.415700C-C1	0.219393D-01	
27	12	0.471970D-02	C.5E6657C-C1	0.162372D-01	
27	13	0.406775D-02	C.112482C-C1	0.142779D-01	
27	14	0.351298D-02	C.165189C-C1	0.264373D-01	
27	15	0.639289D-02	C.573569C-C1	0.161144D 00	
27	16	0.584620D-02	C.36E755C 00	0.639635D 00	
27	17	0.211521D 00	C.788128C 00	0.101429D 01	C.141201C 02 0.101192C 01
28	1	0.226743D-01	0.153305C-C1	0.276555D-C1	
28	2	0.390814D-01	0.166672C-C1	0.380148D-01	
28	3	0.179458D-01	C.306651C-C2	0.338C97D-02	
28	4	0.255140D-01	C.421801C-C2	0.220721D-C2	
28	5	0.250649D-01	C.59C790C-C2	0.305919D-02	
28	6	0.164122D-01	C.115166C-C1	0.402732D-02	
28	7	0.123844D-01	0.141475C-C1	0.522799D-02	
28	8	0.113907D-01	0.192904C-C1	0.666020D-02	
28	9	0.974417D-02	C.425753C-C1	0.190563D-01	
28	10	0.548672D-02	C.611756C-C1	0.238703D-01	
28	11	0.460601D-02	C.417952C-C1	0.220582D-01	
28	12	0.496072D-02	C.5E56C8C-C1	0.162070D-C1	
28	13	0.419733D-02	C.11C915C-C1	0.140790D-01	
28	14	0.375381D-02	0.164586C-C1	0.263409D-C1	
28	15	0.601200D-02	C.572947C-C1	0.161041D 00	
28	16	0.598049D-02	C.364518D 00	0.632285D 00	
28	17	0.2152C9D 00	C.7E3714C 00	0.100721D 01	C.14C980C 02 0.100486C 01
29	1	0.240727D-02	0.818544C-C2	0.147734D-01	
29	2	0.340939D-02	C.659225C-C2	0.195973D-01	
29	3	0.956843D-03	C.145702C-C2	0.160633D-02	
29	4	0.162897D-02	C.2C6664C-C2	0.105618D-02	
29	5	0.115354D-02	0.256470C-C2	0.132777D-02	
29	6	0.104980D-02	C.4E2813C-C2	0.168802D-02	
29	7	0.616077D-03	0.559519C-C2	0.221497D-C2	
29	8	0.265306D-03	C.103173C-C1	0.380780D-02	
29	9	0.427859D-03	C.255563C-C1	0.854841D-02	
29	10	0.362816D-03	C.363727C-C1	0.112356D-C1	
29	11	0.229181D-03	0.254276C-C1	0.106428D-01	
29	12	0.618887D-03	C.4C8385C-C1	0.827314D-C2	
29	13	0.295022D-03	C.620367C-C2	0.70E437D-02	
29	14	0.328739D-03	C.911351C-C2	0.133352D-01	
29	15	0.728413D-03	0.613522C-C1	0.950557D-01	
29	16	0.963125D-02	C.492004C 00	0.8C7096D 00	
29	17	0.241094D-01	C.740879C 00	0.1C0734D 01	C.150352C 02 C.100433C 01
30	1	0.25545C0-01	C.5138C5C-C2	0.164844D-01	
30	2	0.427830D-01	C.584066C-C2	0.224447D-01	
30	3	0.209647D-01	0.167424C-C2	0.1E4581D-02	
30	4	0.284300D-01	C.224261C-C2	0.119722D-02	
30	5	0.260500D-01	C.297435C-C2	0.153986D-02	
30	6	0.178271D-01	C.568473C-C2	0.198751D-02	
30	7	0.114676D-01	C.7C3819C-C2	0.260032D-C2	
30	8	0.112780D-01	C.119059C-C1	0.439560D-02	
30	9	0.944725D-02	C.292289C-C1	0.977685D-02	
30	10	0.704906D-02	C.418126C-C1	0.129160D-01	
30	11	0.506779D-02	0.201427C-C1	0.126164D-01	
30	12	0.482584D-02	0.459818C-C1	0.931508D-02	
30	13	0.481165D-02	C.7C27C9C-C2	0.802469D-02	
30	14	0.405594D-02	C.1C4059C-C1	0.152321D-C1	
30	15	0.848794D-02	C.657284C-C1	0.1C8033D 00	

30	16	0.1169250-01	C.4745C00 C0	0.7783810 C0		
30	17	0.2397830 00	C.759434C C0	0.1006790 C1	0.149034C 02	0.100367C 01
31	1	0.2521200-01	C.9C5464C-C2	0.164C610-01		
31	2	0.4637920-01	C.5E9088C-C2	0.2255920-01		
31	3	0.2217180-01	C.163343C-C2	0.18C0820-02		
31	4	0.2723970-01	C.236234C-C2	0.1207300-02		
31	5	0.2734650-01	C.297125C-C2	0.1538250-02		
31	6	0.1827050-01	C.56C9C00-C2	0.1561030-C2		
31	7	0.1245100-01	C.7C2425C-C2	0.2555160-02		
31	8	0.1021790-01	C.118795C-C1	0.4384370-02		
31	9	0.9742950-02	C.253125C-C1	0.9804830-02		
31	10	0.6130820-02	C.417965C-C1	0.1291110-01		
31	11	0.5516770-02	C.2935390-C1	0.1228620-01		
31	12	0.5053420-02	C.458257C-C1	0.9283450-02		
31	13	0.4526090-02	C.655029C-C2	0.7936990-C2		
31	14	0.3658890-02	C.1C4554C-C1	0.1529880-01		
31	15	0.9053900-02	C.691338C-C1	0.1071120 00		
31	16	0.1222070-01	C.4729020 C0	C.7757590 C0		
31	17	0.2451920 00	C.7561950 C0	0.1002840 01	C.149022C 02	C.999750C 00
32	1	0.2574120-01	C.914771C-C2	0.1650180-01		
32	2	0.4333440-01	C.569421C-C2	0.2211060-01		
32	3	0.2166420-01	C.167199C-C2	0.1843320-02		
32	4	0.2968590-01	C.234142C-C2	0.1196600-02		
32	5	0.2547060-01	C.297075C-C2	0.1537990-02		
32	6	0.1866640-01	C.563528C-C2	0.1970220-02		
32	7	0.1273140-01	C.7C26C4C-C2	0.2555820-02		
32	8	0.1028640-01	C.119640C-C1	0.4415560-02		
32	9	0.9207400-02	C.2527050-C1	0.979C780-02		
32	10	0.6728090-02	C.417497C-C1	0.1289660-01		
32	11	0.5839240-02	C.2548550-C1	0.1234300-C1		
32	12	0.4578630-02	C.45E768C-C1	0.9293800-02		
32	13	0.4384600-02	C.7C7055C-C2	0.8074310-02		
32	14	0.4015100-02	C.1C4970C-C1	0.1535960-01		
32	15	0.9392830-02	C.6E8558C-C1	0.1066810 00		
32	16	0.1187190-01	C.4725140 C0	0.7752220 00		
32	17	0.2435980 00	C.7558350 00	0.1001830 01	0.149049C 02	0.100049C 01
33	1	0.5529190-02	C.514870C-C2	0.6815300-02		
33	2	0.1089370-01	C.358972C-C2	0.9133000-02		
33	3	0.3679800-02	C.673815C-C3	0.8536130-03		
33	4	0.5556760-02	C.5740C6C-C3	0.7284110-03		
33	5	0.5265900-02	C.119921C-C2	0.9010280-03		
33	6	0.4479760-02	C.212053C-C2	0.1117010-02		
33	7	0.2384370-02	C.26E868C-C2	0.1480480-02		
33	8	0.2555790-02	C.610470C-C2	0.2557580-02		
33	9	0.2291130-02	C.175892C-C1	0.5821750-02		
33	10	0.1175860-02	C.245491C-C1	0.75E8750-02		
33	11	0.1618080-02	C.155325C-C1	0.7539860-02		
33	12	0.1131210-02	C.239426C-C1	0.6245540-02		
33	13	0.9589260-03	C.45C711C-C2	0.5262570-02		
33	14	0.7809230-03	C.725362C-C2	0.5583830-02		
33	15	0.1819330-02	C.5C0165C-C1	0.7397890-01		
33	16	0.6418050-02	C.5358C60 C0	0.8479140 C0		
33	17	0.5653880-01	C.716496C C0	0.5887620 C0	0.154253C 02	0.984500C 00
34	1	0.1252320-02	C.483426C-C2	0.6399080-02		
34	2	0.1615540-02	C.355202C-C2	0.9046690-02		
34	3	0.8482210-03	C.662366C-C3	0.8391090-03		
34	4	0.8908200-03	C.552786C-C3	0.7125420-C3		
34	5	0.6926230-03	C.116558C-C2	0.6760560-C3		
34	6	0.7237160-03	C.210374C-C2	0.1108160-02		
34	7	0.2603410-03	C.269224C-C2	0.1462440-02		
34	8	0.4237700-03	C.5E5E650-C2	0.25C9910-02		
34	9	0.2243310-03	C.175582C-C1	0.5811470-02		
34	10	0.2929000-04	C.242127C-C1	0.7879270-02		
34	11	0.2234290-03	C.153019C-C1	0.7E46C9C-C2		
34	12	0.1522680-03	C.335582C-C1	0.6174800-C2		
34	13	0.9053450-04	C.480102C-C2	0.5148800-02		

34	14	0.7930940-04	C.718268C-C2	C.588619C-02	
34	15	0.3134110-03	C.503125C-C1	0.7441680-C1	
34	16	0.246385C-02	C.5338E4C CC	0.8448720 C0	
34	17	0.1028380-01	C.713073C C0	0.5850090 C0	0.154338C 02 0.980770C 00
35	1	0.3145120-01	C.507878C-C2	0.671299C-02	
35	2	0.6072960-01	C.402123C-C2	0.920511C-02	
35	3	0.2425070-01	C.668253C-C3	0.846555C-C3	
35	4	0.3050270-01	C.557346C-C3	0.715929C-C3	
35	5	0.2778260-01	C.116578C-C2	0.875881C-03	
35	6	0.1811070-01	C.212226C-C2	0.1117880-C2	
35	7	0.1310290-01	C.266525C-C2	0.1467530-C2	
35	8	0.1084890-01	0.585804C-C2	0.249243C-02	
35	9	0.9986220-02	C.172244C-C1	0.5700470-02	
35	10	0.6340560-02	C.238476C-C1	0.7759740-C2	
35	11	0.5252080-02	C.190236C-C1	0.7731890-C2	
35	12	0.5733580-02	C.227566C-C1	0.6026380-C2	
35	13	0.6170540-02	C.466441C-C2	0.499771C-C2	
35	14	0.4216880-02	C.654623C-C2	0.9549980-02	
35	15	0.9983030-02	C.450850C-C1	0.7253940-01	
35	16	0.2086080-01	C.538440C C0	0.8514610 C0	
35	17	0.2853230 C0	C.714525C C0	0.5891980 C0	C.154349C 02 C.984930C 00
36	1	0.3241000-01	C.515975C-C2	0.6789950-02	
36	2	0.5944690-01	C.401546C-C2	0.9191910-02	
36	3	0.2209020-01	C.662644C-C3	0.8354550-C3	
36	4	0.2430180-01	C.552846C-C3	0.7125740-C3	
36	5	0.2786750-01	C.1160C7C-C2	0.8716020-C3	
36	6	0.1888220-01	C.207491C-C2	0.1092960-02	
36	7	0.1309270-01	C.265103C-C2	0.1459720-C2	
36	8	0.1174400-01	C.577737C-C2	0.2457820-02	
36	9	0.1160670-01	C.170943C-C1	0.5656520-C2	
36	10	0.6294320-02	C.237912C-C1	0.7740200-C2	
36	11	0.6574070-02	0.187301C-C1	0.7610190-02	
36	12	0.6140490-02	C.322960C-C1	0.5939710-C2	
36	13	0.5589500-02	C.461959C-C2	0.4928250-02	
36	14	0.4451280-02	C.654438C-C2	0.9515280-C2	
36	15	0.1147010-01	0.485957C-C1	0.7163940-01	
36	16	0.2073770-01	C.536613C C0	0.8467220 C0	
36	17	0.2876990 C0	C.711142C C0	C.9831670 C0	C.154339C 02 C.979000C 00
37	1	0.2451730-02	C.440592C-C2	0.5781470-02	
37	2	0.3339190-02	0.362448C-C2	0.8257190-02	
37	3	0.1192510-02	C.558426C-C3	0.7589850-C3	
37	4	0.1611920-02	C.852578C-C3	0.6393850-C3	
37	5	0.1643590-02	C.103050C-C2	0.7763780-C3	
37	6	0.1056590-02	C.187883C-C2	0.5927380-03	
37	7	0.7263780-03	C.233410C-C2	0.1289070-02	
37	8	0.7216470-03	C.524232C-C2	0.2237160-02	
37	9	0.1048220-02	C.152648C-C1	0.5067780-C2	
37	10	0.4497870-03	C.213064C-C1	0.6954520-C2	
37	11	0.4254690-03	C.188567C-C1	0.688801C-02	
37	12	0.4834090-03	C.251640C-C1	0.5381490-C2	
37	13	0.5930100-03	C.423737C-C2	0.4516580-C2	
37	14	0.3526420-03	C.630550C-C2	0.8633090-C2	
37	15	0.1039020-02	C.447779C-C1	0.6596630-01	
37	16	0.7703520-02	C.562497C C0	0.8871270 C0	
37	17	0.2483920-01	C.7203770 C0	C.1011290 C1	C.155073C 02 C.100695C 01
38	1	0.1488160-02	C.450811C-C2	C.585744C-C2	
38	2	0.1909250-02	C.349507C-C2	0.8000950-C2	
38	3	0.4596000-03	C.573603C-C3	0.7275010-03	
38	4	0.6266070-03	C.837325C-C3	0.6279460-03	
38	5	0.6913140-03	C.100515C-C2	0.757281C-C3	
38	6	0.4938960-03	C.179713C-C2	0.9495690-C3	
38	7	0.2304120-03	0.228610C-C2	0.1262560-02	
38	8	0.3275160-03	C.506776C-C2	0.2162030-02	
38	9	0.2279330-03	C.147738C-C1	0.4902850-C2	
38	10	0.2591860-03	C.206599C-C1	0.674092C-02	
38	11	0.6540880-04	C.160442C-C1	0.6532070-02	

38	12	0.1981820-03	C.2829840-C1	0.5217710-02		
38	13	0.2295860-03	C.4123080-C2	0.4356150-02		
38	14	0.1600530-03	C.6233900-C2	0.8470760-02		
38	15	0.3418380-03	0.4357560-C1	0.6383460-01		
38	16	0.3890610-02	C.5586080-C0	0.8766850-00		
38	17	0.1159950-01	0.7118920-C0	0.5570850-C0	C.1551310-02	0.9927300-00
39	1	0.2655050-03	C.4378220-C2	0.5636570-02		
39	2	0.2942400-03	C.3382280-C2	0.7742750-02		
39	3	0.6564080-04	C.5565660-C3	0.7058920-C3		
39	4	0.6594220-04	C.8049560-C3	0.6036700-03		
39	5	0.2298920-03	C.5821770-C3	0.7359700-03		
39	6	0.1309110-03	C.1738400-C2	0.9185360-03		
39	7	0.9877810-04	C.2192670-C2	0.1210960-02		
39	8	0.9817470-04	C.4842560-C2	0.2065360-02		
39	9	0.9775640-04	C.1470720-C1	0.4749880-02		
39	10	0.3306090-04	C.2108300-C1	0.6412880-02		
39	11	0.0	C.1648030-C1	0.6513360-02		
39	12	0.0	C.2812560-C1	0.5031210-02		
39	13	0.1488300-03	C.3577850-C2	0.4168260-02		
39	14	0.9523020-04	C.6028180-C2	0.8133590-02		
39	15	0.1488440-03	C.4223210-C1	0.6258740-01		
39	16	0.1415460-02	C.5594410-C0	0.8739710-00		
39	17	0.3188300-02	C.7114530-C0	0.9915910-00	C.1552570-02	0.9872000-00
40	1	0.1058590-02	C.4337690-C2	0.5346230-02		
40	2	0.1677520-02	0.3175100-C2	0.7268490-02		
40	3	0.4293430-03	C.5340200-C3	0.6772980-C3		
40	4	0.4246540-03	C.7551090-C3	0.5662110-03		
40	5	0.6910470-03	C.5072860-C3	0.6834680-03		
40	6	0.3950800-03	0.1641940-C2	0.8675710-03		
40	7	0.1311790-03	C.2047610-C2	0.1130840-02		
40	8	0.2640200-03	0.4678790-C2	0.1553070-02		
40	9	0.2304010-03	C.1406160-C1	0.4476080-02		
40	10	0.6665400-04	C.2047010-C1	0.6106440-02		
40	11	0.2930190-03	C.1585080-C1	0.6212580-02		
40	12	0.9790820-04	C.2790870-C1	0.4933410-02		
40	13	0.1652300-03	C.3576410-C2	0.4040870-02		
40	14	0.1302620-03	C.5854760-C2	0.7746350-02		
40	15	0.1953900-03	C.4193630-C1	0.5988380-01		
40	16	0.3182740-02	C.5727670-C0	0.8754730-00		
40	17	0.9433040-02	C.7209430-C0	0.5913660-C0	C.1555030-02	0.9823000-00

REFERENCES

- (1) Whitesides, G. E. and Cross, N. F.; *KENO - A Multigroup Monte Carlo Criticality Program*, CTC-5; Union Carbide Corporation-Nuclear Division, Oak Ridge Gaseous Diffusion Plant, Oak Ridge, Tennessee (1969).
- (2) Handley, G. R. and Hopper, C. M.; *Validation Checks of the ANISN and KENO Codes by Correlation with Experimental Data*, Y-1858; Union Carbide Corporation-Nuclear Division, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee (1972).
- (3) Hansen, G. E. and Roach, W. H.; *Six and Sixteen Group Cross Sections for Fast and Intermediate Critical Assemblies*, LAMS-2543; Los Alamos Scientific Laboratory, Los Alamos, New Mexico (1961).
- (4) Knight, J. R.; Appendix I of K-1663 (1966).
- (5) Whitesides, G. E. and Cross, N. F.; "On the Treatment of Hydrogen Scattering in Multigroup Monte Carlo Criticality Calculations", *Trans Am Nucl Soc*, 10, p 239 (1967).
- (6) Whitesides, G. E.; "A Difficulty in Computing the k-effective of the World", *Trans Am Nucl Soc*, 14, p 680 (1971).
- (7) Whitesides, G. E. "Adjoint Biasing in Monte Carlo Criticality Calculations", *Trans Am Nucl Soc*, 11, p 159 (1968).
- (8) Whitesides, G. E. and Thomas, J. T.; "The Use of Differential Current Albedos in Monte Carlo Criticality Calculations", *Trans Am Nucl Soc*, 12, p 889 (1969).
- (9) Scott, J. M., UKAEA, Dounreay Experimental Reactor Establishment, Dounreay; *Personal Communication* (1963).
- (10) Abbey F. (Comp), *Handbook of Experimental Criticality Data*, AHSB(S) Handbook 5 (1968).
- (11) Raffety, S. J. and Mihalcz, J. T.; *Homogeneous Critical Assemblies of 2 and 3% Enriched Uranium in Paraffin*, Y-DR-14; Union Carbide Corporation-Nuclear Division, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee (1969).
- (12) Johnson, E. B.; "Effect of Steel-Water Reflectors on the Criticality of Low-Enriched Uranyl Fluoride Solution", *Neutron Physics Division Annual Progress Report*, ORNL-4280, p 47; Union Carbide Corporation-Nuclear Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee (1968).
- (13) Johnson, E. B.; *Criticality of a Sphere of $U(4.98)O_2F_2$ Solution*, ORNL-3973, p 14; Union Carbide Corporation-Nuclear Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee (1966).

- (14) Webster, J. W. and Johnson, E. B.; *Criticality of a Single Unit of Aqueous Uranyl Fluoride Solution Enriched to 5% in U-235*, ORNL-TM-1195; Union Carbide Corporation-Nuclear Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee (1965).
- (15) Johnson, E. B.; "The Nuclear Criticality of Intersecting Cylinders of $U(5)O_2F_2$ Aqueous Solution", *Trans Am Nucl Soc*, **14**, p 678 (1971).
- (16) Lever, W. E. and Johnson, E. E.; *Personal Communication*, May 2, 1974.
- (17) Knight, J. R.; *Personal Communications*.

ACKNOWLEDGEMENTS

The authors are grateful to the following for their help in preparing this report: E. B. Johnson and L. M. Petries who assisted in choosing the experiments; G. E. Whitesides for his many consultations on every aspect of this report, and W. E. Lever and E. E. Johnson for their advice and statistical calculations.

DISTRIBUTION

Aerojet Nuclear - Idaho Falls

Morfitt, J. W.
Morrison, W. G.

Atomic Energy Commission - Oak Ridge

Hickman, H. D.
Pryor, W. A.
Travis, W. H.
Zachry, D. S., Jr

Atomic Energy Commission - Washington

Stevenson, R. L.

Battelle Pacific Northwest

Brown, C. L.

Dairyland Power Cooperative

Raffety, S. J.

DePauw University

Henry, H. F.

Dow - Rocky Flats

Schuske, C. L.

Goodyear Atomic - Portsmouth

Feuerbacher, J. L.
Thompson, W. B.

Lawrence Livermore Laboratory

Koponen, B. L.

Los Alamos Scientific Laboratory

Paxton, H. C.
Hansen, G. E.

Oak Ridge Gaseous Diffusion Plant

Arendt, J. W.
Barton, J. C.

Davis, W. A.
Dykstra, J.
Evans, E. C.
Ferguson, J. B.
Hartman, W. C.
Lang, D. M.
Legeay, A. J.
Newlon, C. E.
Stief, S. S.
Sommerfeld, K. W.
Trammell, H. E.
Wilcox, W. J., Jr
Winkel, R. A.

Oak Ridge National Laboratory

Cross, N. F.
Crume, E. C., Jr
Knight, J. R.
Lever, W. E.
Mihalczo, J. T.
Petrie, L. M.
Whitesides, G. E.

Oak Ridge Y-12 Plant

Alvey, H. E.
Burditt, R. B.
Briscoe, O. W.
Burkhart, L. E.
Butturini, W. G.
Denny, A.
Ebert, J. W.
Ellingson, R. D.
Fraser, R. J.
Gritzner, V. B.
Handley, G. R. (10)
Hensley, C. E.
Hopper, C. M. (10)
Johnson, C. E.
Johnson, E. B.
Johnson, E. E.
Kahl, K. G.
Keith, A.
Kite, H. T.
Lundin, M. I.

McLendon, J. D.
Mee, W. T.
Oliphant, G. W.
Perry, A. E.
Phillips, L. R.
Smith, H. F. Jr
Smith, R. D.
Snyder, H. G. P.
Strohecker, J. W.
Thomas, J. T.
Weathersby, W. E.
Whitson, W. K.
Wilkinson, P. E.
Yaggi, W. J./Googin, J. M.
Y-12 Central Files (5)
Y-12 Central Files (master copy)
Y-12 Central Files (route copy)
Y-12 Central Files (Y-12RC)

Paducah Gaseous Diffusion Plant

Baker, R. C.
Edwards, A. K.
Hopkins, C. C.
Hull, G. T.
Merriman, J. R.
Phipps, J. K.

United Kingdom

Aubrey, A. F. (5)
Chalmers, J. H. (5)
Scott, J. M.

University of California - Berkeley

Pigford, T. H.

In addition, this report is distributed in accordance with the category UC-46, **Criticality Studies**, as given in the *USAEC Standard Distribution Lists for Unclassified Scientific and Technical Reports*, TID-4500.