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CALCULATED CRITICALITY DATA FOR LMFBR $(U+Pu)O_2$-WATER SYSTEMS

W. R. Cobb

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Reactor Division

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JANUARY 1972

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CALCULATED CRITICALITY DATA FOR LMFBR $(U+Pu)O_2$-WATER SYSTEMS

W. R. Cobb*

Abstract

Calculated criticality data are presented for typical LMFBR mixed-oxide fuel-water systems based on the weight fraction of PuO_2, the degree of heterogeneity of the fuel, and the degree of moderation as variables within the ranges of interest to LMFBR fuel-processing criticality safety. Limited data are also presented to indicate the poisoning effects of nitrate, boron, and stainless steel. The calculational methods employed are discussed, including an improved strategy for critical-dimension searches developed for this investigation, as well as the results and the expected accuracy of the data. Tables of buckling, extrapolation distances, critical dimensions, and masses are presented.

Keywords: LMFBR, criticality, fuel processing.

Introduction

Meager experimental criticality data exist for systems of mixed uranium-plutonium oxide and water with plutonium content in the range of interest for proposed liquid-metal fast-breeder reactor (LMFBR) fuels. Critical approach and exponential experiments on 25.2 wt % PuO_2-UO_2 prototype fast flux test facility (FFTF) fuel pins in water have been reported,[1] and critical experiments with mixed oxide fuel at 15 and 30 wt % plutonium were performed and reported recently.[2] Other experiments on fuel having from 2 to 4 wt % plutonium and various amounts of ^{240}Pu have been reported and are summarized elsewhere.[3]

Such criticality data are of great importance in assessing the out-of-reactor criticality safety problems that could arise during the storage and processing of LMFBR fuel. The proposed use of aqueous fuel processing and the possibility of storing spent fuel elements in water

*Now with Nuclear Fuel Services, Inc., 6000 Executive Blvd., Suite 600, Rockville, Maryland 20852.

prior to processing introduce neutronics problems quite different from those present in-reactor, since large quantities of plutonium must be stored and processed and the minimum critical mass for plutonium under optimum moderation is on the order of a few kilograms or less.

In order to effectively develop equipment to handle these problems of storage and dissolution, the designer must have a feel for the criticality aspects of the expected normal conditions and credible abnormal conditions. Ideally, criticality experiments would be performed on actual mockups of all seriously proposed designs, but this would be economically impractical. In fact, the large variety of conditions that could exist in an aqueous LMFBR fuel reprocessing plant make criticality experiments impractical for all but the final component designs.

It is clear, therefore, that the initial basic criticality data for use in preliminary component design must be obtained from calculations rather than experiment. The calculation of such data over the ranges of interest of fuel types, isotopic composition, moderation, degree of fuel heterogeneity, reflection, poison, and other parameters is alone a formidable task. Nevertheless such data for LMFBR-type fuels are needed and are not presently available in easily accessible tabular and graphical form. To this end this report describes the data generated for typical LMFBR mixed-oxide fuel-water systems based on the weight fraction of PuO_2, the degree of heterogeneity, and the degree of moderation as variables. Limited data are also given to indicate the effects of nitrate, boron, and stainless steel.

Scope and Generality of Data

The basic data presented in this report are intended to give criticality parameters that cover the range of interest in LMFBR mixed-oxide fuel reprocessing with regard to the weight fraction of PuO_2 in the mixed oxide and the degree of heterogeneity in the fuel lumps. Specifically, the fuel mixtures considered were 20.0, 16.0, 12.0, and 8.0 wt % PuO_2-UO_2 at an assumed 90% theoretical density with pin diameters of 0.26, 0.18, 0.10, and 0.0 in. The uranium was assumed to be depleted, and the

plutonium isotopic composition was chosen to be typical of LMFBR core discharge fuel.[4] Calculations were performed for fully reflected, unpoisoned fuel-water mixtures with water-to-fuel volume ratios from 0.1027 to 30.0. The minimum volume ratio of 0.1027 corresponds to the closest packing of cylindrical rods on a hexagonal array.

Calculations were also made to show the effect of the addition of stainless steel, boron, and nitrate to the pure fuel-water systems. Data for these variations are not complete in the sense that they do not cover the entire range of parameters for the fuel-water systems, and hence they are intended to show only the type of effect to be expected.

The effect of the stainless steel cladding on the criticality parameters is indicated by results of calculations at all fuel compositions for a 0.26-in.-diam fuel pin with a cladding thickness of 0.015 in. This corresponds to the addition of steel at a constant cladding-to-fuel volume ratio of 0.244, and the resultant changes should be typical for all pin diameters. The effect of soluble boron poison has been indicated by calculations at all pin diameters for the 20 wt % PuO_2 fuel. In these cases it was assumed that the boron was present in the water at a 0.3 M concentration and that the density of the water was not affected. The effect of the addition of nitrate has been indicated in calculations for the 20 wt % fuel in which the water was replaced by 8 M HNO_3.

While the heterogeneity effects have been investigated by considering the fuel lumps as infinitely long cylindrical fuel pins on a hexagonal array, the data presented should be useful in assessing criticality problems for a much wider variety of heterogeneous situations since, to a good approximation, the data at a particular rod size and average density are applicable to arbitrarily shaped fuel pieces at the same density having the same fuel surface-to-volume ratio. In comparing the results of the heterogeneous and homogeneous (pin diameter = 0.0) calculations at the same average density it should be recalled that the homogeneous calculations represent situations that would occur if the oxide fuel were simply mixed with the water or nitric acid and, in that sense, are not physically realizable. The data presented may also be used to obtain conservative estimates of minimum critical sizes for systems containing fuel

lumps in fissile solution, since a separate, more detailed Monte Carlo analysis[5] has shown that at optimum moderation for a lumped fuel-water system, introduction of dissolved fuel into the moderator causes a reduction in neutron multiplication.

Methods of Calculation

The methods used to calculate the data presented in this report followed the standard approach to reactor neutronics problems and employed the codes developed for that purpose at ORNL. A schematic outline of the calculational process that gives the sources of data and the codes used is shown in Fig. 1.

The basic data source was Version II of the ENDF/B cross-section file. Cross sections for both the fast and thermal energy ranges were obtained through the processing code SUPERTOG[6] for the uranium, plutonium, oxygen, and stainless steel constitutents. The fast and thermal cross sections were then combined with room-temperature free-gas scattering kernels to obtain a 123-group XSDRN[7] library. Cross sections for nitrogen, boron, and hydrogen in water were obtained from existing XSDRN libraries. The resultant XSDRN library contained all the cross sections in the form of smooth data and resonance parameters that were required for the investigation of the various conditions.

The code XSDRN was used to perform spectrum calculations for the equivalent cell for each fuel type, pin diameter, and average fuel density. A slightly modified version of the Nordheim integral treatment, which is included in the XSDRN code, was used to obtain the correctly shielded resonance cross sections for use in the subsequent one-dimensional discrete-ordinates cell calculation. The results of the 123-group S_4P_3 calculation were then used to obtain 16-group cell-weighted cross sections for use in the diffusion theory calculations. The 16-group energy structure (Table 1) is similar to the Hansen-Roach energy structure,[8] except that in the present work, neutron upscattering was allowed from the three lowest groups.

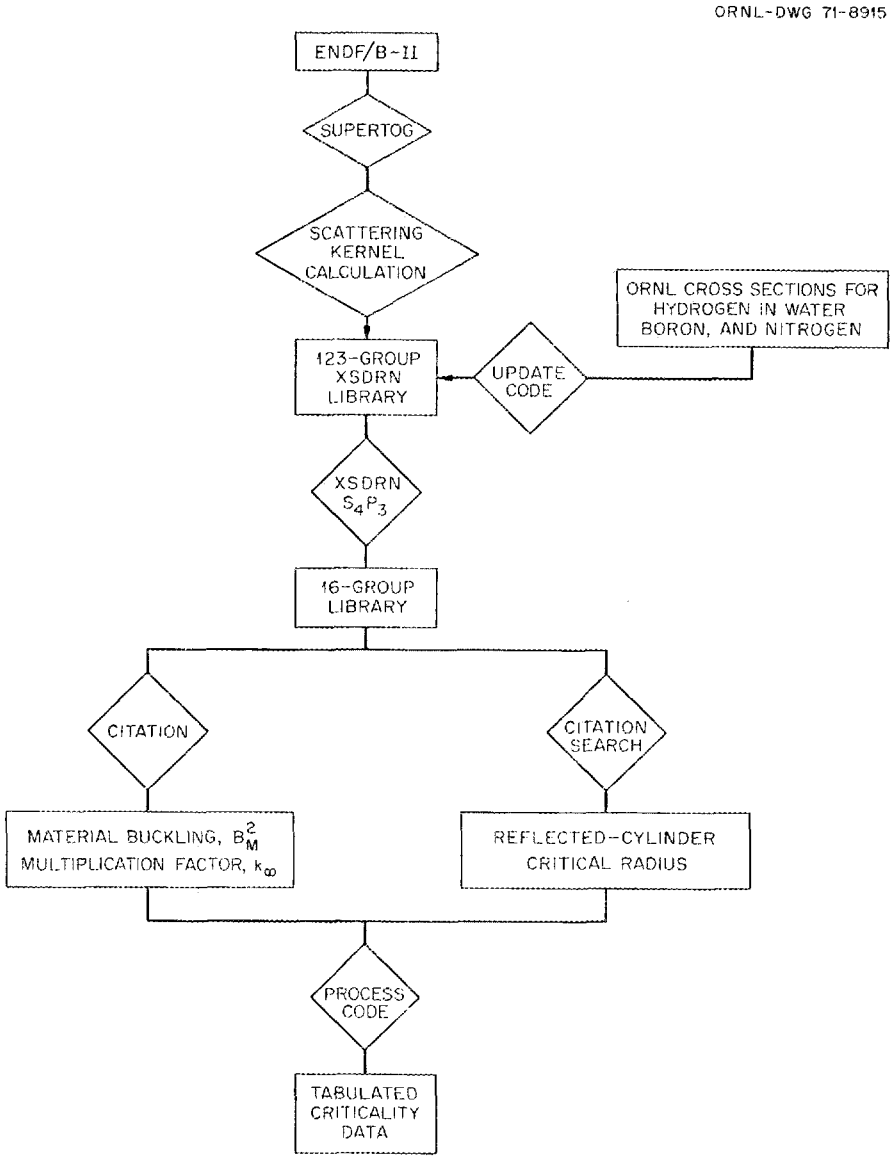

Fig. 1. Schematic Outline of Calculational Process.

The code CITATION[9] was then employed to calculate the material buckling and k_∞ for the homogenized cell and, in a separate calculation, was used to determine the critical radius of a water-reflected infinite cylinder of the homogenized composition. An improved method for critical-dimension searches was developed and incorporated into the code CITATION for this purpose and is described in Appendix A. These three criticality parameters, B_m^2, k_∞, and R_c, which were calculated directly,

Table 1. Sixteen-Group Energy Structure

Group No.	Upper Energy (eV)	Group No.	Upper Energy (eV)
1	1.492×10^{7}	9	5.829×10^{2}
2	3.012×10^{6}	10	1.013×10^{2}
3	1.496×10^{6}	11	2.902×10^{1}
4	9.072×10^{5}	12	1.068×10^{1}
5	4.076×10^{5}	13	3.059×10^{0}
6	1.111×10^{5}	14	1.125×10^{0}
7	1.930×10^{4}	15	4.500×10^{-1}
8	3.355×10^{3}	16	9.999×10^{-2}

were then used to determine the remaining parameters presented in the tables of Appendix B.

In determining the criticality parameters for the systems with boron, nitrate, and stainless steel, the XSDRN cell calculations were not redone. Instead the 16-group cross sections for the appropriate fuel type and pin diameter and hydrogen-to-plutonium ratio were used in the required CITATION calculations. Since the broad-group structure contained 16 energy groups with four thermal groups, this treatment should not introduce significant error.

Calculated Results

Curves of the infinite-reflected-cylinder critical radii are given in Figs. 2 through 5 and curves of the reflected-sphere critical masses in Figs. 6 through 9. The heterogeneity effects on the critical radii are quite striking and are similar for all the fuel types. Most noticeable of these effects are the decreased prominence of the peak in the critical radius and the change in the position of the minimum critical radius for the lumped fuel. The peak in the homogeneous curve is due to the large percentage of parasitic resonance absorptions in the ^{238}U and ^{240}Pu in the intermediate energy range. When the fuel is lumped, even into rods as small as 0.10 in. in diameter, the resonances are strongly

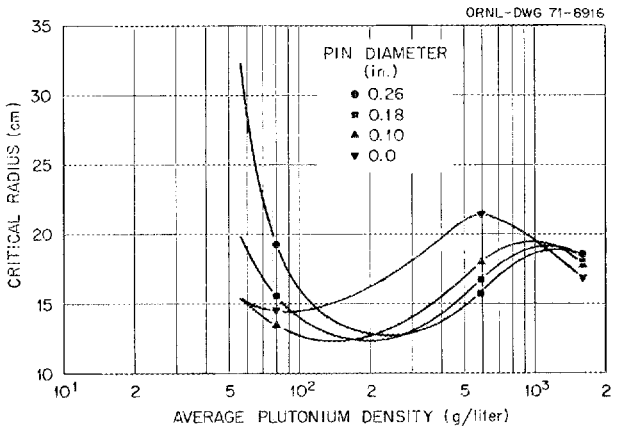

Fig. 2. Reflected-Cylinder Critical Radii for 20 wt % PuO_2–UO_2.

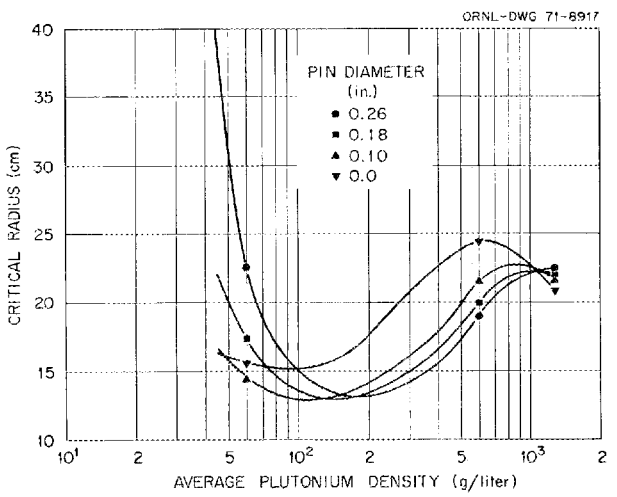

Fig. 3. Reflected-Cylinder Critical Radii for 16 wt % PuO_2–UO_2.

self-shielded, and the percentage of parasitic absorptions is greatly reduced. Thus lumping the fuel causes more neutrons to be available for productive fission reactions and the critical radius becomes smaller.

The minimum critical radius occurs at higher plutonium density for lumped fuel due to two phenomena. The first is resonance self-shielding, which means that for lumped fuel it takes less hydrogen to scatter the neutrons over the nonproductive resonance energy range. Thus as the plutonium density decreases (and the hydrogen density increases) the critical radius drops sooner for larger fuel lumps. The second phenomenon

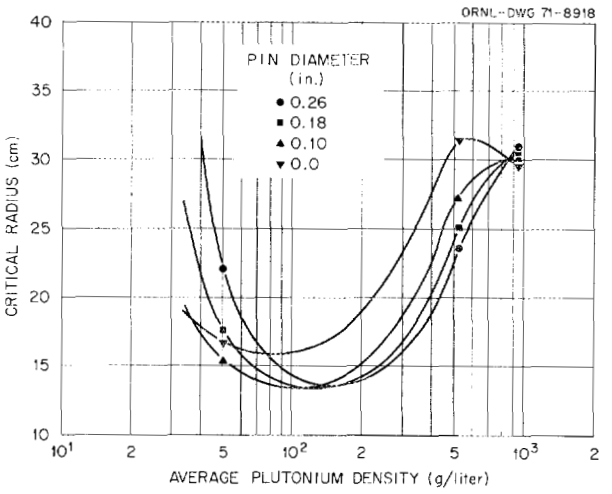

Fig. 4. Reflected-Cylinder Critical Radii for 12 wt % PuO_2–UO_2.

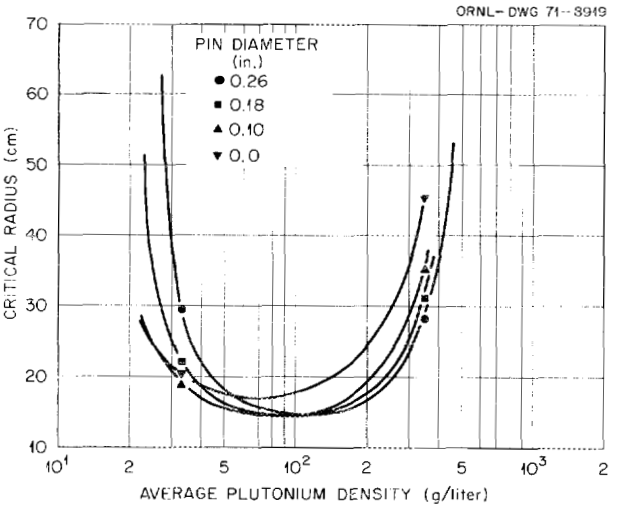

Fig. 5. Reflected-Cylinder Critical Radii for 8 wt % PuO_2–UO_2.

is the thermal energy self-shielding, which reduces the fission as well as capture cross section in the fuel. Hence, as the plutonium density decreases further and the system becomes more thermal, the nonnegligible thermal absorption cross section for parasitic absorptions in hydrogen begins to compete with fuel absorptions. At some point the hydrogen begins to dominate the competition, and then further reduction of plutonium density causes the critical radius to rise. For the larger fuel

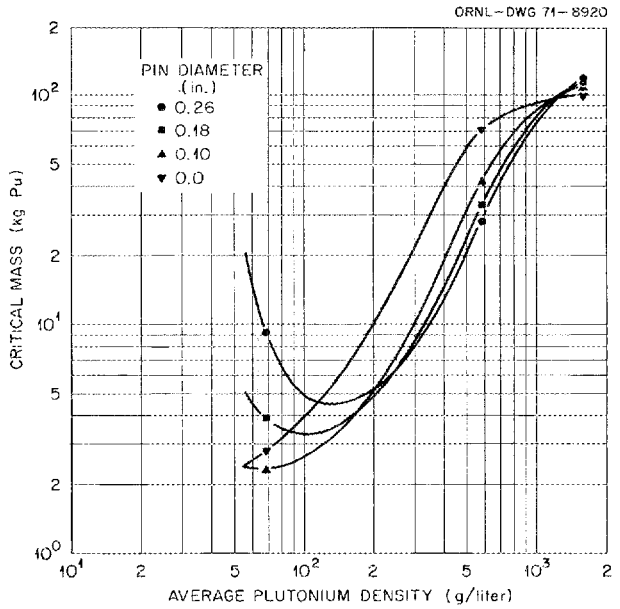

Fig. 6. Reflected-Sphere Critical Masses for 20 wt % PuO_2–UO_2.

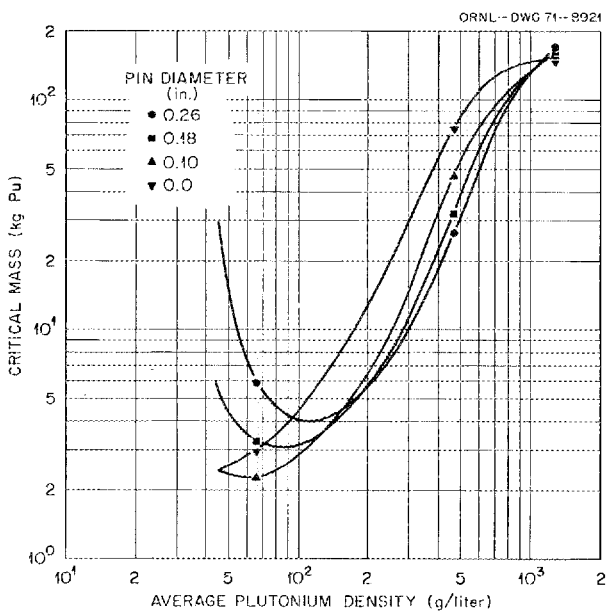

Fig. 7. Reflected-Sphere Critical Masses for 16 wt % PuO_2–UO_2.

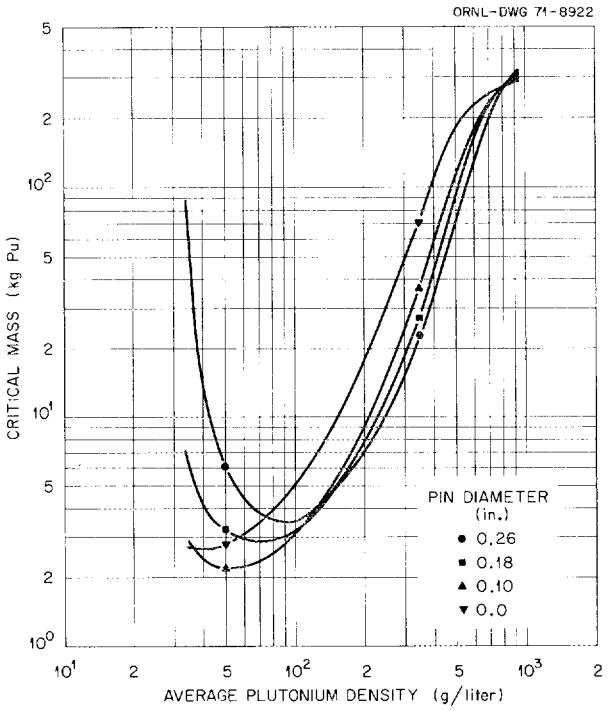

Fig. 8. Reflected-Sphere Critical Masses for 12 wt % PuO_2–UO_2.

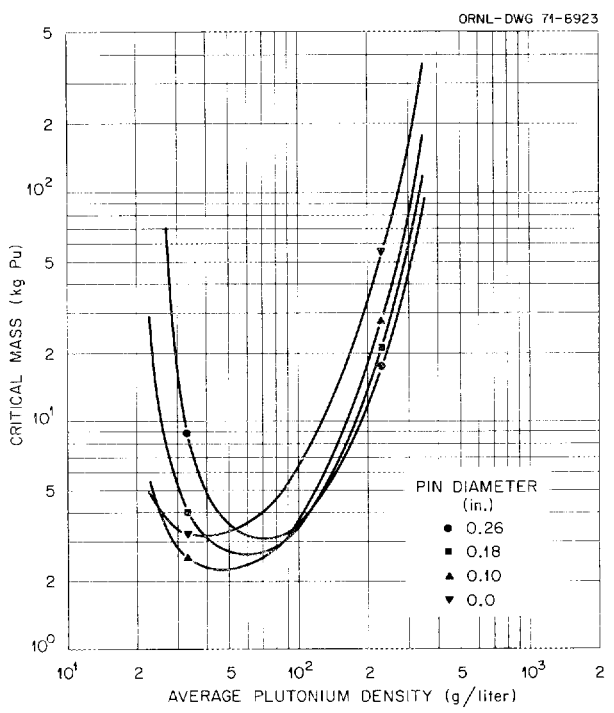

Fig. 9. Reflected-Sphere Critical Masses for 8 wt % PuO_2–UO_2.

lumps, the thermal self-shielding is greater, the hydrogen becomes dominant sooner, and the critical radius rises sooner. Thus the combination of resonance self-shielding, which causes the critical radius to begin to drop sooner when the system is in the resonance energy range, and the thermal self-shielding, which causes the critical radius to rise sooner when the system is in the thermal energy range, causes the minimum critical radius to occur at a higher density for lumped fuel.

Another fact worth noting is that the minimum critical radius, which occurs at different plutonium densities for different fuel mixtures, as well as different lump sizes, is not strongly dependent on the amount (wt %) of PuO_2 in the fuel.

The critical mass curves of Figs. 6 through 9 also display significant heterogeneity effects. In the undermoderated range the lumping of fuel can cause a reduction in the critical mass by as much as a factor of 3. In the overmoderated range the reverse is true due to the earlier competition of parasitic hydrogen absorptions with the thermally self-shielded fuel. It is interesting to note also that for a given fuel mixture, the minimum critical mass of plutonium is strongly dependent on the lump size, but the minimum critical mass is fairly insensitive to the fuel mixture.

The effects of 0.015-in. stainless steel cladding on the critical radii for the 0.26-in.-diam fuel pins are shown in Figs. 10 through 13. The resulting changes in the critical radii are those expected. In the high plutonium density region, the change is largely due to the dilution effect; that is, at the same average plutonium density, the hydrogen density is smaller for the clad fuel. Thus not as many neutrons scatter over the parasitic resonance range, and the critical radius is greater. In the lower plutonium density region, the change is smaller and is due to parasitic absorptions in the stainless steel.

It is obvious in comparison of Figs. 10 through 13 that the increase in critical radius due to the addition of 0.015-in. stainless steel cladding is greatest for the fuel of lowest PuO_2 content. This is true because, although the cladding-to-fuel volume ratio is the same for all the fuels, the relative amounts of stainless steel and plutonium are not.

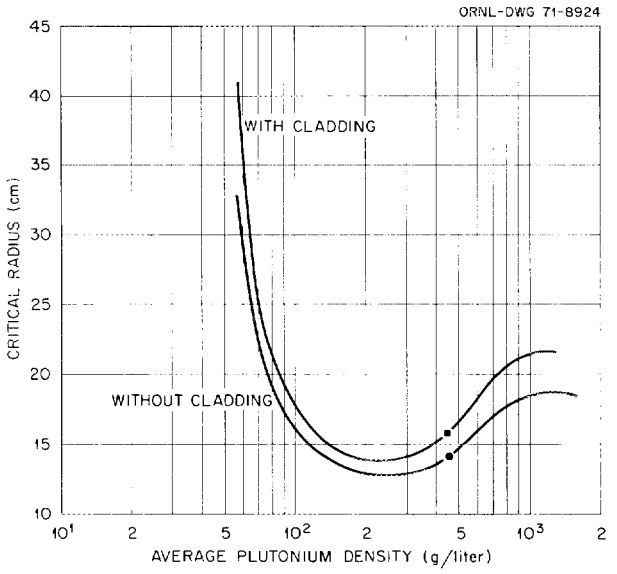

Fig. 10. Comparison of Cylinder Critical Radii for 0.26-in.-diam 20 wt % PuO_2–UO_2 Rods With and Without 0.015-in. Type 316 Stainless Steel Cladding.

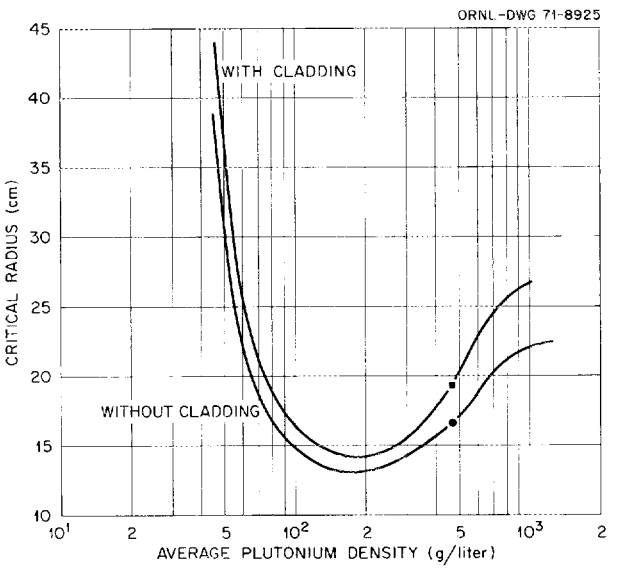

Fig. 11. Comparison of Cylinder Critical Radii for 0.26-in.-diam 16 wt % PuO_2–UO_2 Rods With and Without 0.015-in. Type 316 Stainless Steel Cladding.

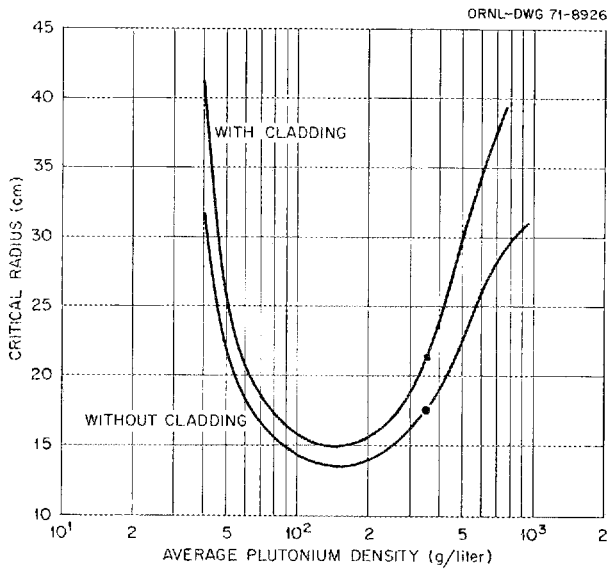

Fig. 12. Comparison of Cylinder Critical Radii for 0.26-in.-diam 12 wt % PuO_2–UO_2 Rods With and Without 0.015-in. Type 316 Stainless Steel Cladding.

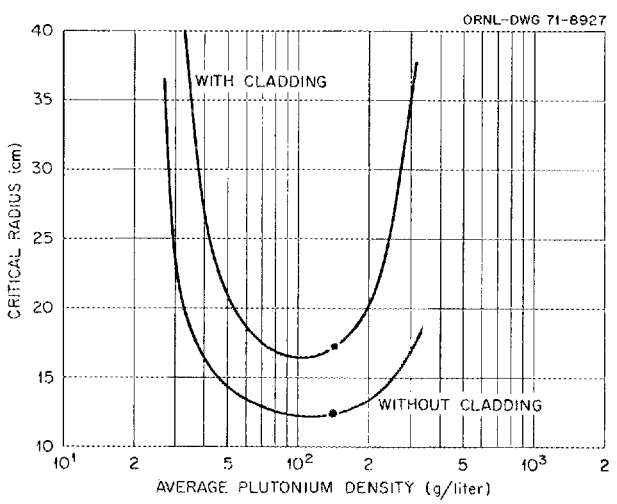

Fig. 13. Comparison of Cylinder Critical Radii for 0.26-in.-diam 8 wt % PuO_2–UO_2 Rods With and Without 0.015-in. Type 316 Stainless Steel Cladding.

Thus for a given average density of plutonium, the average density of stainless steel is largest for the fuel of lowest PuO_2 content, and the effect of the cladding is greatest.

The effects of nitrate and boron on the critical radii for the 20 wt % PuO_2 fuel are shown in Figs. 14 through 17. The effect of adding 0.3 M

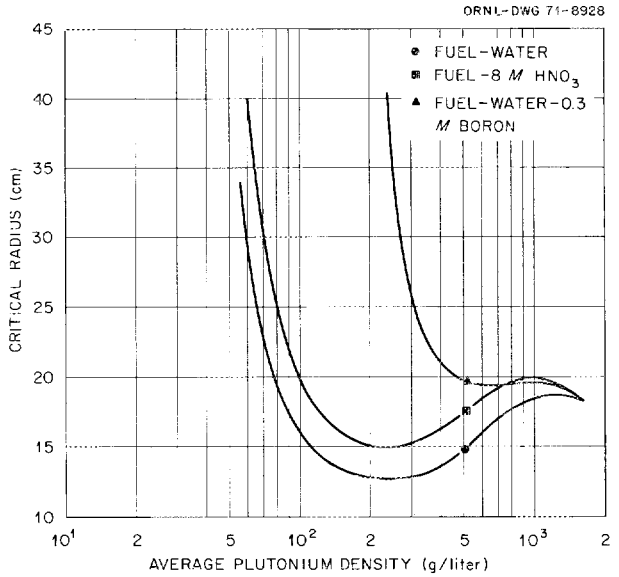

Fig. 14. Comparison of Cylinder Critical Radii for 0.26-in.-diam 20 wt % PuO_2–UO_2 Rods With and Without Nitrate and Boron.

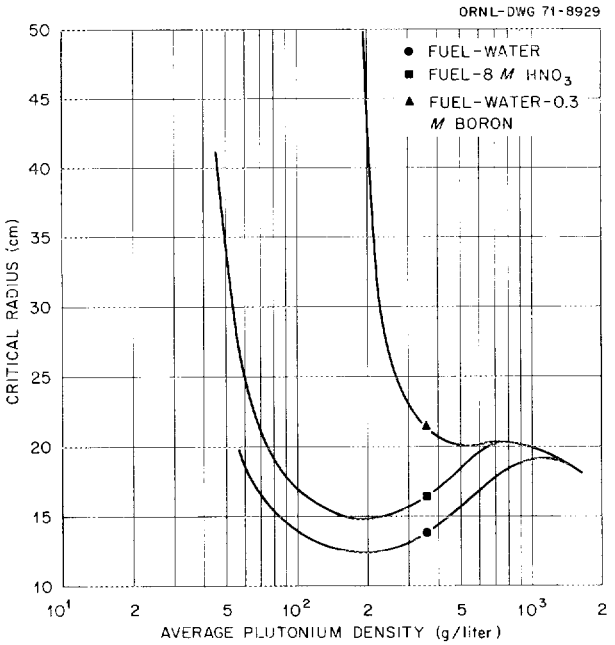

Fig. 15. Comparison of Cylinder Critical Radii for 0.18-in.-diam 20 wt % PuO_2–UO_2 Rods With and Without Nitrate and Boron.

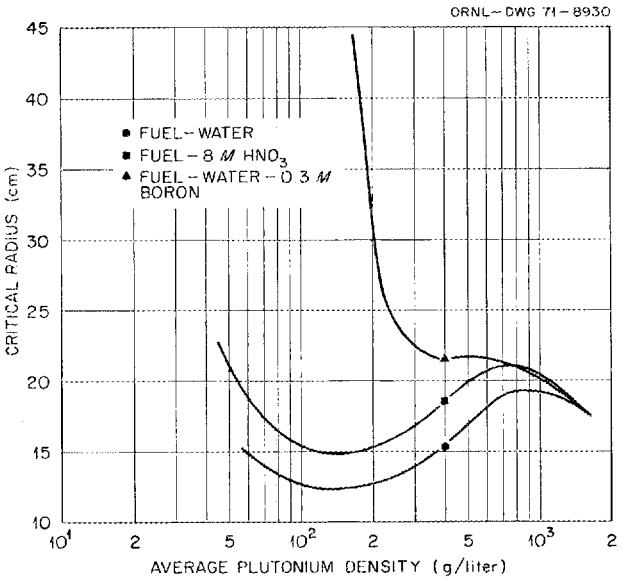

Fig. 16. Comparison of Cylinder Critical Radii for 0.10-in.-diam 20 wt % PuO_2–UO_2 Rods With and Without Nitrate and Boron.

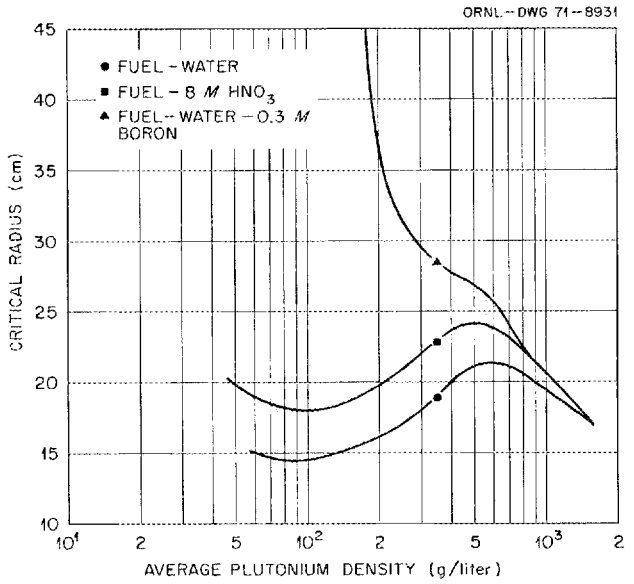

Fig. 17. Comparison of Cylinder Critical Radii for 0.0-in.-diam 20 wt % PuO_2–UO_2 Rods With and Without Nitrate and Boron.

natural boron to the fuel-water system is to make criticality impossible in the highly thermalized system because of the large parasitic thermal absorption cross section of the ^{10}B isotope. At higher plutonium densities, the effect is much less because the absorption cross section of boron is much smaller in the fast and intermediate energy range.

The change in critical radius caused by the replacement of water by 8 M HNO_3 is due to both dilution and absorption effects. For the same average plutonium density, the hydrogen density is smaller for the fuel-8 M HNO_3 system than for the fuel-water system, and the probability of absorption in 8 M HNO_3 is larger than for water due to the added presence of the nitrogen. In the thermalized systems the absorption effect is primarily responsible for the change in critical radius, and in the intermediate energy range both effects are significant.

Comparisons of the curves indicate that the boron and nitrate effects are not strongly dependent on the fuel lump size, although it appears that the nitrate effects are slightly more pronounced for the smaller lumps. A much stronger dependence on the fuel mixture should be observed for the same reasons indicated for stainless steel.

Comments on Accuracy

A detailed comparison of the data presented in this report with experimental data is not possible because only one set of experiments with high PuO_2 content fuel has been reported. A comparison of calculated results with this set of experimental data has been made, however, to assess the accuracy of the calculations. This comparison is presented in Table 2 and Fig. 18. Table 2 gives the multiplication factors calculated by the methods of this report for the experimentally determined critical situations. The comparison shows good agreement between measured and calculated values, except at the final point, which was originally reported to be only approximate. Figure 18 shows the comparison between the calculated reflected-sphere and infinite-cylinder critical radii and those determined by buckling conversion from the experimental data. It may be seen that the results are in good agreement, particularly for the cylinder

Table 2. Experimental Results and Calculated k_{eff} for 25.2 wt % PuO_2–$U(Nat)O_2$ Rods Moderated and Reflected by Water

Lattice Pitch (in.)	Water-to-Fuel Volume Ratio	Average Plutonium Density (g/liter)	Effective Critical Radius (cm)	Material Buckling (m^{-2})	Extrapolation Distance (cm)	Calculated k_{eff}
0.450	4.26	437.3	12.25	153.8 ± 2.7	8.01	1.0002
0.600	8.60	239.6	11.85	172.7 ± 2.2	7.25	1.0113
0.779	15.42	140.1	12.98	160.9 ± 1.0	6.89	1.0121
0.900	21.01	104.5	14.69	138.5 ± 1.0	6.90	1.0143
1.039	28.45	78.1	17.80	111.6 ± 0.3	6.61	1.0094
1.200	38.37	58.4	24.41	77.0 ± 1.0	6.11	1.0004
1.350	48.92	46.1	36.45	~46.8		0.9736

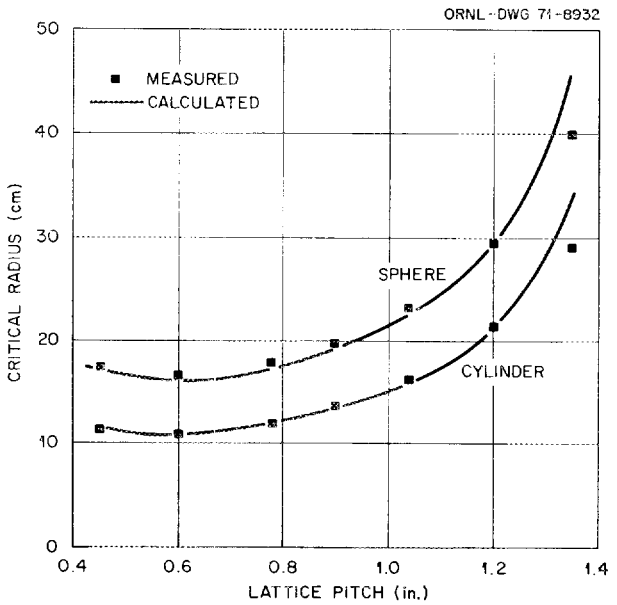

Fig. 18. Comparison of Measured and Calculated Critical Radii for 25.2 wt % PuO_2–UO_2 Fuel Rods in Water.

radii. For the sphere radii the calculated results are low by a few percent and are therefore conservative.

From these comparisons it is inferred that the calculated results for the critical dimensions are accurate below approximately 450 g Pu/liter. The calculated material bucklings were low compared with the measured values, and since the reflected-cylinder critical radii were in good agreement, the extrapolation distances were also low. Based on this observation, it is advisable to use the bucklings and extrapolation distances of this report only simultaneously and not in conjunction with values obtained experimentally or by other calculational methods.

For systems with higher plutonium density than approximately 450 g/liter, there are no experimental data for verification of the calculated results. There is some indication, however, that the results are a few percent in error due to the use of the ENDF/B Version II cross sections for ^{239}Pu. It was discovered during the ENDF/B data testing that these ^{239}Pu cross sections gave consistently low values of k_{eff} for several fast reactor critical experiments.[10] Since systems in the range above 450 g Pu/liter are primarily fast systems, it is expected that the

calculated results in this range are also in error and that this error is not conservative. In addition it is generally accepted that multigroup diffusion theory does not do as well in this range as it does in the well-thermalized range and that multigroup transport theory should be used.[11] For these reasons it is advised that the safe values of the criticality parameters for $k_{eff} = 0.95$ be used when in the concentration range above 450 g Pu/liter.

APPENDICES

Appendix A

IMPROVED STRATEGY FOR CRITICAL-DIMENSION SEARCHES

In order to remove the possibility for input errors in the calculation of the criticality data, the computer codes used in this analysis were linked so that the entire computational process was automated; that is, having specified the fuel composition, pin diameter, and cladding thickness, a single job submission caused the required XSDRN and CITATION cases at the ten moderator-to-fuel volume ratios to be run. For the job step that determined the cylinder critical radii it was found that the usual method of determining the critical radius was not adequate, since the convergence or nonconvergence of the iterative process was very sensitive to the initial guess of the critical radius. Clearly, in an automated calculational process covering such a wide range of possible critical radii, incorporation of a procedure for determining a priori a good estimate for the critical radius for every case would be very difficult.

An improved strategy was therefore developed to perform the critical-dimension searches that was not sensitive to the initial guess and which could be used effectively in the automated computational process. The approach taken used the relatively recent direct iteration technique[12] for determining the critical buckling of an assembly in conjunction with the historical buckling conversion technique for geometry transformations. As an added bonus from this approach, the new strategy was found to be very rapidly convergent and therefore faster than the usual approach.

The success of this new approach hinges on two facts. The first is that the direct iteration technique allows the determination of the critical buckling of an assembly with the same ease and speed as determining the multiplication factors. This is accomplished by recasting the neutronics equations into an alternate eigenvalue problem, where the eigenvalue is the critical buckling, and then applying the EQUIPOISE[13] method to obtain its solution. The details of the direct iteration method are discussed by Vondy in Ref. 12.

The second fact is that the buckling conversion technique, while approximate in the sense that the extrapolation distance λ is not the

same for all geometries, is actually very accurate. This is to say that the extrapolation distance is a slowly varying function of geometry and size of the assembly.

The improved strategy is best explained by example. Consider the problem of finding the critical radius, R_c, of an infinitely long, fully reflected cylinder. Suppose that in a one-dimensional calculation, an initial guess of the critical radius, R_1, is made and then the direct iteration technique is employed to determine the buckling, B_1^2, that makes the assembly critical at the chosen radius R_1. If the calculated buckling, B_1^2, is considered to be the axial buckling, the system criticality may be expressed by equating the material buckling, B_M^2, and the geometric buckling:

$$B_M^2 = \left(\frac{2.405}{R_1 + \lambda}\right)^2 + B_1^2 \ . \tag{A.1}$$

For an infinitely long cylinder, the axial buckling is zero and the criticality equation becomes

$$B_M^2 = \left(\frac{2.405}{R_c + \lambda}\right)^2 \ , \tag{A.2}$$

where R_c is the critical radius being sought.

Equation (A.1) contains two unknowns; the material buckling, B_M^2, and the extrapolation distance, λ. If the material buckling were known, the extrapolation distance could be determined and used in Eq. (A.2) to determine R_c. Thus solving Eq. (A.1) for λ,

$$\lambda = \frac{2.405}{\sqrt{B_M^2 - B_1^2}} - R_1 \ , \tag{A.3}$$

and solving Eq. (A.2) for R_c,

$$R_c = \frac{2.405}{\sqrt{B_M^2}} - \lambda \ , \tag{A.4}$$

provides, by substitution, an equation for the critical radius R_c in terms

of B_M^2, B_1^2, and R_1:

$$R_c = 2.405\left(\frac{1}{\sqrt{B_M^2}} - \frac{1}{\sqrt{B_M^2 - B_1^2}}\right) + R_1 \ . \tag{A.5}$$

If it were precisely true that the extrapolation distance λ was the same at the guessed radius R_1 and the critical radius R_c, and also if the material buckling were known, Eq. (A.5) would give the exact value for the critical radius R_c. Since λ is not exactly the same for the two different radii, Eq. (A.5) is not exact; but since λ is nearly the same, Eq. (A.5) gives a means of obtaining a good next estimate of the critical radius. Hence an iterative procedure based on Eq. (A.5) is indicated,

$$R_{i+1} = 2.405\left(\frac{1}{\sqrt{B_M^2}} - \frac{1}{\sqrt{B_M^2 - B_i^2}}\right) + R_i \ , \tag{A.6}$$

where R_i is the ith iteration estimate of the critical radius, B_i^2 is the axial buckling that makes the assembly of radius R_i critical, and R_{i+1} is the next iteration estimate of the infinite cylinder critical radius based on the assumption that λ is independent of radius. The iteration procedure is to be terminated when B_i^2 is sufficiently near zero that $B_i^2/B_M^2 < \epsilon$, where ϵ is some acceptable level of accuracy.

As previously mentioned, the material buckling, B_M^2, for the assembly being considered is not generally known in advance. In fact, it is possible that the method might be applied to situations having several regions where the material buckling is not precisely defined. It may therefore be necessary to have an initial value of B_M^2 to begin the iterative process and to update this value during the iterations so that the process converges to the correct value. If the initial value of B_M^2 chosen is smaller than the value B_1^2 calculated on the first iteration, the entire process will fail, as is evident from the term $\sqrt{B_M^2 - B_1^2}$ in Eq. (A.5). This conceptual difficulty may be avoided by using as the initial estimate of B_M^2 its maximum possible value, as determined after the first iteration by letting $\lambda = 0$ in Eq. (A.1). At each iteration after the first, the value of the material buckling B_M^2 must then be recalculated, based on the two most current iteration values of B_i^2 and R_i;

that is, since

$$B_M^2 = \left(\frac{2.405}{R_i + \lambda}\right)^2 + B_i^2 \tag{A.7}$$

and

$$B_M^2 = \left(\frac{2.405}{R_{i-1} + \lambda}\right) + B_{i-1}^2 , \tag{A.8}$$

B_M^2 may be determined under the consistent assumption that λ is independent of the radius.

The new strategy may be summarized as follows:

(1) pick an initial estimate of the critical radius R_1,

(2) calculate the buckling B_1^2 to make the assembly critical at the chosen radius,

(3) obtain the initial estimate of B_M^2 from Eq. (A.1) with $\lambda = 0$,

(4) obtain the next estimate of the critical radius R_2 from Eq. (A.6),

(5) calculate next axial buckling B_2^2,

(6) obtain next estimate of B_M^2 by solving Eqs. (A.7) and (A.8),

(7) repeat steps 4 through 6 until, after the ith iteration, $B_i^2/B_M^2 < \epsilon$.

The critical radius of a sphere can be obtained by the same procedure by replacing the factor 2.405 in all the equations by π, and the critical slab half-thickness can be obtained by taking the factor as $\pi/2$.

This procedure has been used successfully in several hundred calculations to determine critical dimensions in several geometries. Most calculations involved "pure" geometries (i.e., one-region slab, cylinder, or spheres), although problems in more complicated geometries have been considered. Also, the behavior of the iteration process as a function of the first guess at the critical dimension and as a function of the method used to obtain B_M^2 has been studied. Figures A.1 through A.5 present the results of applying the process to several sample problems. The first is a reflected-cylinder problem with B_M^2 obtained from an auxiliary calculation, and the second is an annulus problem with the same fissile mixture. In both problems the process was essentially converged to the critical dimension in two iterations over a very wide range of initial guesses. If the material buckling, B_M^2, had been determined during the iterative procedure, only one additional iteration would have been

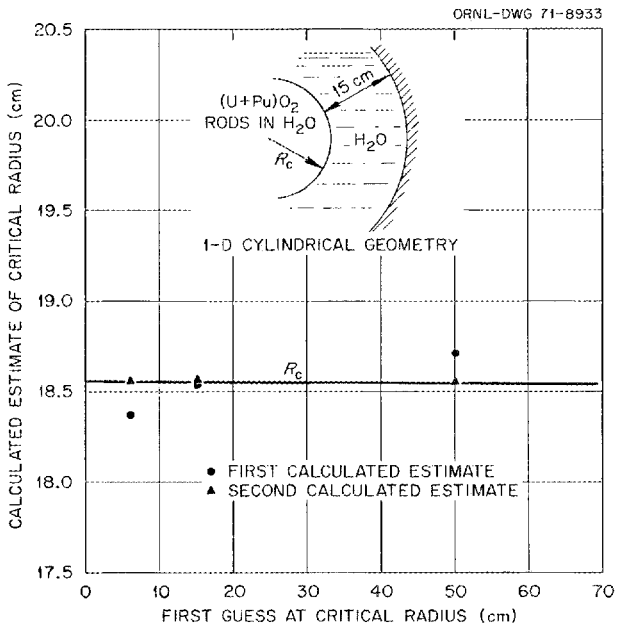

Fig. A.1. Critical Cylinder Radius Sample Problem 1.

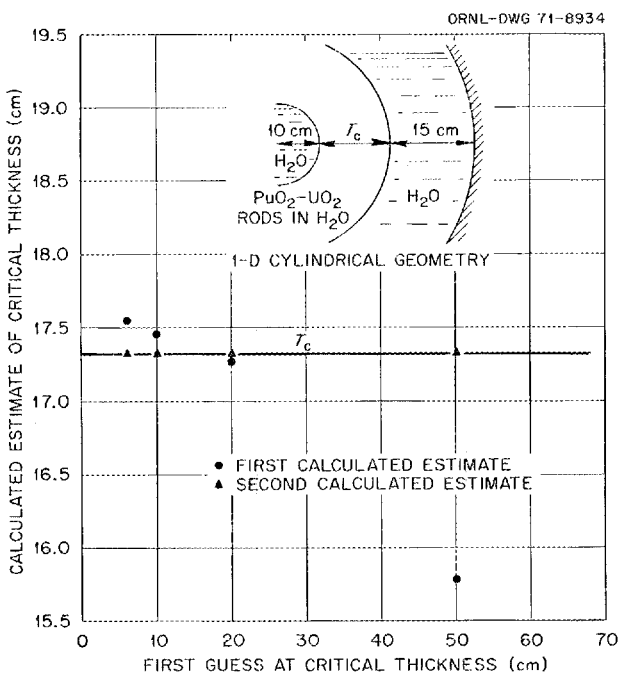

Fig. A.2. Critical Annulus Thickness for Sample Problem 2.

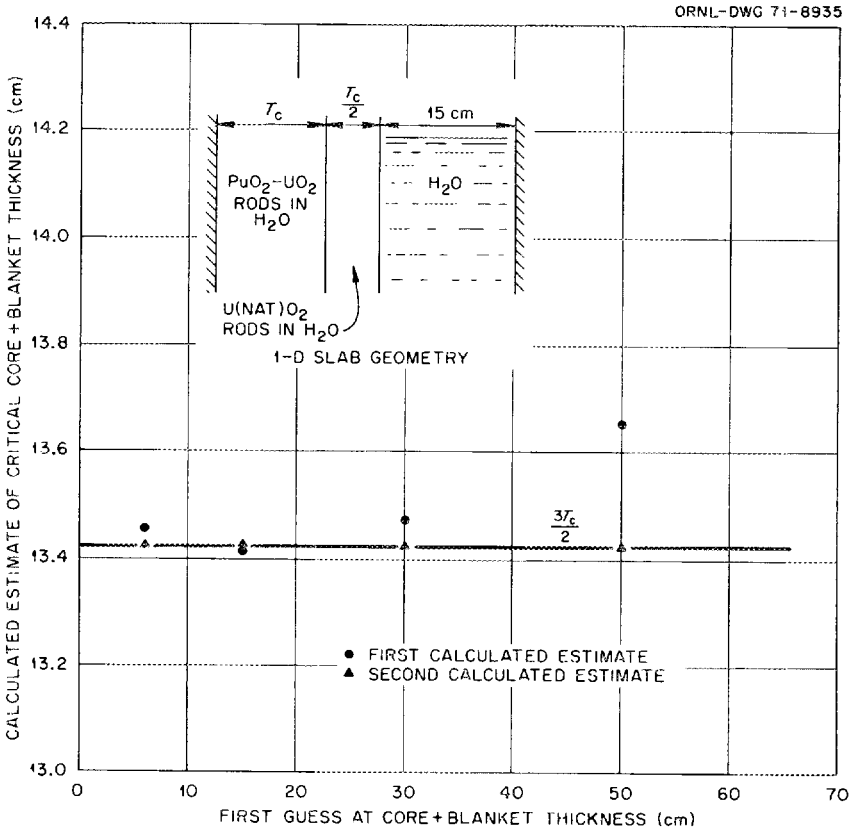

Fig. A.3. Critical Slab Thickness Problem with Blanket Region.

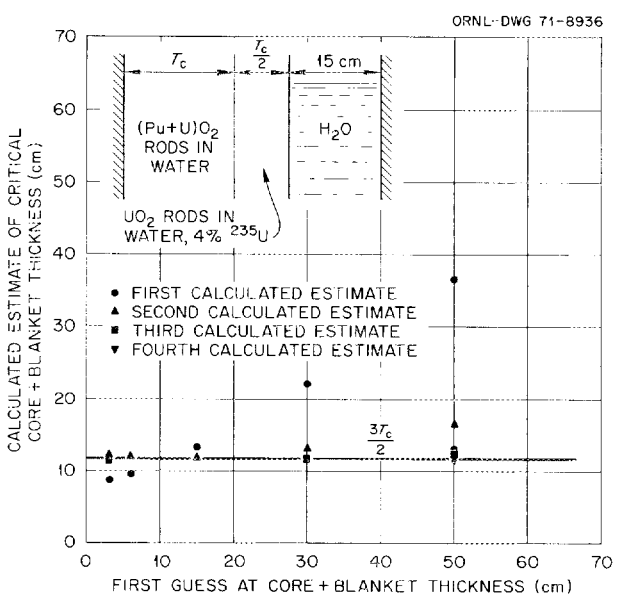

Fig. A.4. Critical Slab Thickness Problem with Fissile Blanket Region.

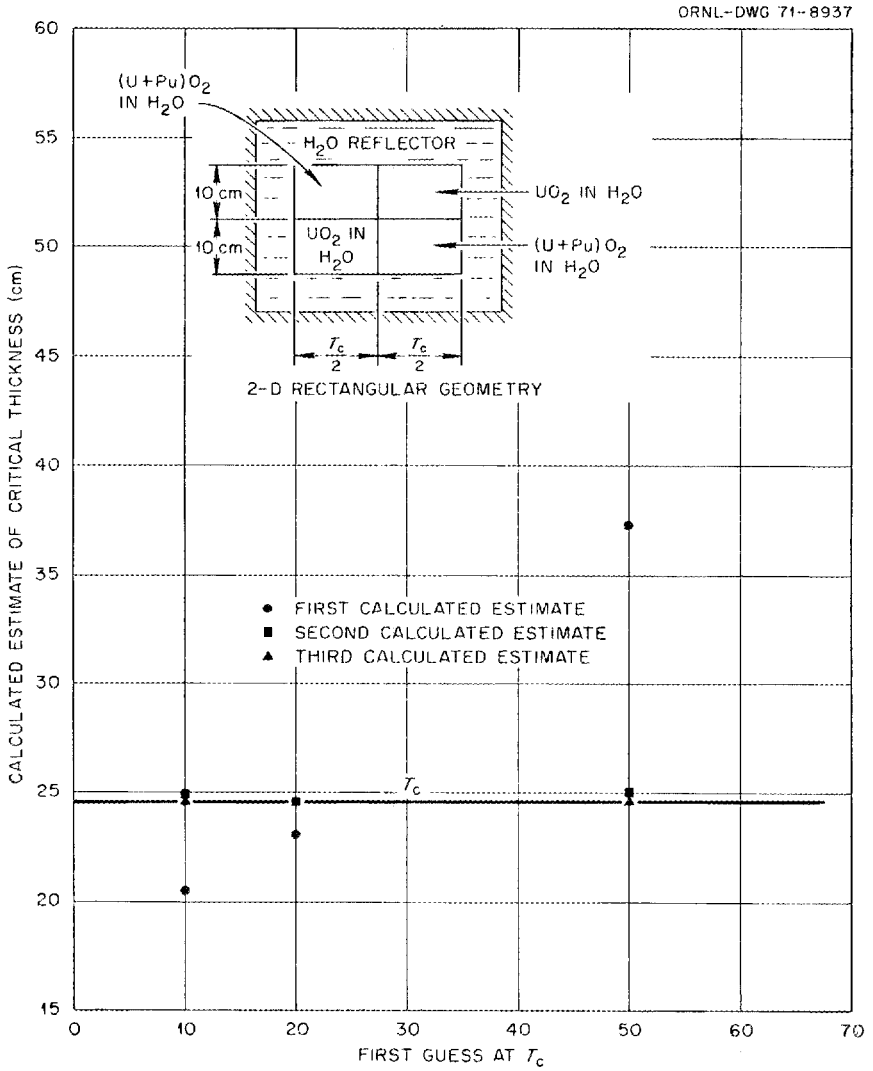

Fig. A.5. Two-Dimensional Multiregion Critical Thickness Problem.

required. The third and fourth problems are for slabs with blanket and reflector regions. In problem 3 the blanket was natural uranium, so the B_M^2 for the central region from an auxiliary calculation was used. Here also the process converged in two iterations. In problem 4, the blanket contained enriched uranium, and hence B_M^2 was not easily defined and had to be determined during the iteration process. In this problem the process converged in three iterations, except when the first guess was 50 cm, which took four iterations. Problem 5 illustrates that the method

is easily applied to higher dimensional problems with multiregion geometry. Here again the iterative process converged to the correct critical thickness in three iterations or less.

Appendix B

TABULATED CRITICALITY DATA

The criticality data presented in this appendix were derived from the three quantities k_∞, B_M^2, and R_c calculated directly by the method outlined in this report. For each fuel type and pin diameter, two tables are presented; the first gives the critical parameters at ten different water-to-fuel volume ratios and the second gives the safe parameters for which $k_{eff} = 0.95$.

The first three columns of each table give the water-to-fuel volume ratio for the cylindrical fuel pins on a regular hexagonal array, the average mixed-oxide fuel density at the given water-to-fuel volume ratio for a 90% theoretical fuel density in the pin itself, and the hydrogen-to-plutonium atom ratio for the system with a water density of 1.0 g/cm^3. For the nitric acid cases, the first column is the acid-to-fuel ratio, and the hydrogen-to-plutonium atom ratio is for 8 M HNO_3 at room temperature with a density of 1.251 g/cm^3 (Ref. 14).

The tabulated values of material buckling, B_M^2, and the cylinder radius, R_c, are the directly calculated quantities. The migration area, M^2, was calculated from

$$M^2 = \frac{k_\infty - 1}{B_M^2} , \tag{B.1}$$

and the extrapolation distances were obtained from

$$\lambda = \frac{2.405}{\sqrt{B_M^2}} - R_c . \tag{B.2}$$

The critical sphere radius, R_s, and slab thickness, T, were obtained from the buckling conversion formulas,

$$R_s = \frac{\pi}{\sqrt{B_M^2}} - \lambda \tag{B.3}$$

and

$$T = \frac{\pi}{\sqrt{B_M^2}} - 2\lambda \ . \tag{B.4}$$

The sphere volume and the reflected-sphere critical mass were calculated by using the sphere radius and the fuel densities and compositions.

The safe parameters that give a multiplication factor of $k_{eff} = 0.95$ were obtained from safe bucklings derived in the following manner. The effective multiplication factor for a finite system with geometric buckling B_g^2 is given by

$$k_{eff} = \frac{1 + M^2B_M^2}{1 + M^2B_g^2} = \frac{k_\infty}{1 + M^2B_g^2} \ , \tag{B.5}$$

which solved for the buckling, B_g^2, is

$$B_g^2 = \frac{\dfrac{k_\infty}{k_{eff}} - 1}{M^2} \ , \tag{B.6}$$

or, with M^2 expressed in terms of B_M^2 and k_∞,

$$B_g^2 = \frac{\left(\dfrac{k_\infty}{k_{eff}} - 1\right)}{(k_\infty - 1)} B_M^2 \ . \tag{B.7}$$

Thus the buckling of a finite system of material with $k_{eff} = 0.95$ is

$$B_{0.95}^2 = \frac{\left(\dfrac{k_\infty}{0.95} - 1\right)}{(k_\infty - 1)} B_M^2 \ . \tag{B.8}$$

The safe cylinder and sphere radii and the slab thickness are then calculated from the buckling conversion formulas (B.3) and (B.4) by using $B_{0.95}^2$ instead of B_M^2. The sphere volume and safe mass of plutonium are calculated as before.

Fuel-Water Systems

The following tables present the calculated criticality data for the unpoisoned fuel-water systems with the various fuel mixtures and fuel pin diameters.

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							CRITICAL PARAMETERS (KEFF=1.0)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.027	1.54	1.5182	86.687	59.783	7.390	122.085	76.656	26.352	18.441	18.963
1.0000	4.977	14.99	1.2952	91.524	32.252	6.971	63.664	72.502	25.867	18.168	18.896
2.0000	3.318	29.98	1.3210	113.579	29.146	6.843	28.439	48.581	22.636	15.724	15.793
4.0000	1.991	59.95	1.4177	149.821	27.879	6.394	10.531	29.982	19.272	13.254	12.877
8.0000	1.106	119.90	1.4534	164.567	27.550	5.954	5.205	26.677	18.536	12.794	12.582
12.0000	0.766	179.85	1.4128	149.972	27.524	5.767	4.451	32.945	19.887	13.872	14.120
16.0000	0.586	239.80	1.3484	126.661	27.505	5.672	4.761	46.090	22.242	15.697	16.569
20.0000	0.474	299.75	1.2760	100.504	27.460	5.623	5.956	71.223	25.714	18.367	20.092
25.0000	0.383	374.69	1.1897	69.305	27.370	5.589	9.400	139.171	32.148	23.300	26.559
30.0000	0.321	449.63	1.1094	40.145	27.253	5.586	20.211	356.756	43.997	32.372	38.412

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV. FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.027	1.54	1.5182	100.053	59.783	7.390	92.428	58.035	24.018	16.654	16.628
1.0000	4.977	14.99	1.2952	112.660	32.252	6.971	42.611	48.527	22.627	15.688	15.656
2.0000	3.318	29.98	1.3310	137.614	29.146	6.843	19.435	33.199	19.938	13.659	13.095
4.0000	1.991	59.95	1.4177	176.585	27.879	6.394	7.548	21.489	17.247	11.704	10.852
8.0000	1.106	119.90	1.4534	192.332	27.550	5.954	3.806	19.507	16.699	11.388	10.746
12.0000	0.766	179.85	1.4128	176.987	27.524	5.767	3.217	23.815	17.848	12.311	12.081
16.0000	0.586	239.80	1.3484	152.462	27.505	5.672	3.344	32.370	19.771	13.805	14.098
20.0000	0.474	299.75	1.2760	124.960	27.460	5.623	3.980	47.593	22.481	15.892	16.858
25.0000	0.383	374.69	1.1897	92.182	27.370	5.589	5.651	83.662	27.132	19.460	21.543
30.0000	0.321	449.63	1.1094	61.570	27.253	5.586	9.704	171.286	34.452	25.064	28.866

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.18 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							CRITICAL PARAMETERS (KEFF=1.0)				
WATER/FUEL VOL. RATIO	AV. FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.027	1.54	1.5174	86.588	59.758	7.740	117.549	73.808	26.022	18.106	18.282
1.0000	4.977	14.99	1.2726	85.073	32.045	7.364	69.987	79.703	26.697	18.711	19.333
2.0000	3.318	29.98	1.2940	101.876	28.863	7.219	33.505	57.234	23.907	16.609	16.688
4.0000	1.991	59.95	1.3831	138.989	27.565	6.701	11.677	33.244	19.947	13.699	13.246
8.0000	1.106	119.90	1.4541	166.482	27.274	6.160	4.918	25.201	18.188	12.479	12.027
12.0000	0.766	179.85	1.4487	164.343	27.302	5.923	3.631	26.880	18.583	12.837	12.660
16.0000	0.586	239.80	1.4144	151.567	27.344	5.794	3.321	32.142	19.724	13.741	13.930
20.0000	0.474	299.75	1.3676	134.355	27.363	5.715	3.428	40.987	21.389	15.034	15.674
25.0000	0.383	374.69	1.3052	111.559	27.357	5.657	3.954	58.537	24.087	17.113	18.430
30.0000	0.321	449.63	1.2428	88.872	27.321	5.626	5.043	89.014	27.699	19.885	22.072

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.18 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							SAFE PARAMETERS (KEFF=0.95)				
WATER/FUEL VOL. RATIO	AV. FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.027	1.54	1.5174	99.953	59.758	7.740	88.625	55.647	23.684	16.316	15.944
1.0000	4.977	14.99	1.2726	105.975	32.045	7.364	45.656	51.995	23.154	15.999	15.790
2.0000	3.318	29.98	1.2940	125.473	28.863	7.219	22.155	37.845	20.828	14.252	13.609
4.0000	1.991	59.95	1.3831	165.398	27.565	6.701	8.196	23.335	17.727	12.000	11.026
8.0000	1.106	119.90	1.4541	194.541	27.274	6.160	3.581	18.353	16.364	11.082	10.203
12.0000	0.766	179.85	1.4487	192.270	27.302	5.923	2.651	19.626	16.733	11.421	10.810
16.0000	0.586	239.80	1.4144	178.792	27.344	5.794	2.400	23.232	17.701	12.192	11.907
20.0000	0.474	299.75	1.3676	160.660	27.363	5.715	2.430	29.053	19.071	13.259	13.356
25.0000	0.383	374.69	1.3052	136.669	27.357	5.657	2.702	40.001	21.216	14.915	15.559
30.0000	0.321	449.63	1.2428	112.813	27.321	5.626	3.261	57.558	23.952	17.017	18.325

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.10 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							CRITICAL PARAMETERS (KEFF=1.0)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.027	1.54	1.5167	86.498	59.731	8.236	111.178	69.808	25.543	17.623	17.307
1.0000	4.977	14.99	1.2483	78.015	31.824	7.924	77.706	88.493	27.644	19.305	19.721
2.0000	3.318	29.98	1.2487	87.154	28.537	7.762	42.554	72.693	25.890	18.000	18.129
4.0000	1.991	59.95	1.3280	120.717	27.168	7.158	14.490	41.254	21.435	14.731	14.277
8.0000	1.106	119.90	1.4241	157.747	26.882	6.482	5.201	26.654	18.531	12.666	12.048
12.0000	0.766	179.85	1.4520	167.695	26.952	6.170	3.350	24.798	18.090	12.402	11.920
16.0000	0.586	239.80	1.4485	165.817	27.046	5.994	2.697	26.108	18.403	12.683	12.410
20.0000	0.474	299.75	1.4297	158.436	27.120	5.882	2.432	29.081	19.077	13.225	13.195
25.0000	0.383	374.69	1.3959	145.647	27.183	5.792	2.346	34.728	20.239	14.136	14.447
30.0000	0.321	449.63	1.3568	131.100	27.219	5.733	2.427	42.833	21.705	15.272	15.973

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.10 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV. FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.027	1.54	1.5167	99.862	59.731	8.236	83.322	52.317	23.202	15.831	14.966
1.0000	4.977	14.99	1.2483	98.660	31.824	7.924	48.995	55.797	23.705	16.289	15.782
2.0000	3.318	29.98	1.2487	110.184	28.537	7.762	26.711	45.628	22.167	15.150	14.406
4.0000	1.991	59.95	1.3280	146.443	27.168	7.158	9.780	27.844	18.802	12.716	11.644
8.0000	1.106	119.90	1.4241	185.628	26.862	6.482	3.723	19.077	16.576	11.169	10.093
12.0000	0.766	179.85	1.4520	196.048	26.952	6.170	2.436	18.032	16.267	11.007	10.097
16.0000	0.586	239.80	1.4485	194.004	27.046	5.994	1.966	19.027	16.561	11.273	10.568
20.0000	0.474	299.75	1.4297	186.182	27.120	5.882	1.765	21.100	17.142	11.744	11.260
25.0000	0.383	374.69	1.3959	172.674	27.183	5.792	1.682	24.903	18.116	12.510	12.324
30.0000	0.321	449.63	1.3568	157.336	27.219	5.733	1.709	30.175	19.313	13.441	13.581

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.0 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							CRITICAL PARAMETERS (KEFF=1.0)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.027	1.54	1.5159	86.420	59.701	9.091	100.574	63.149	24.704	16.780	15.613
1.0000	4.977	14.99	1.2169	68.773	31.536	8.917	89.384	101.792	28.965	20.083	20.048
2.0000	3.318	29.98	1.1779	63.444	28.046	8.789	70.623	120.641	30.653	21.405	21.864
4.0000	1.991	59.95	1.2066	78.171	26.426	8.218	29.985	85.369	27.315	18.984	19.098
8.0000	1.106	119.90	1.2726	105.256	25.900	7.428	10.198	52.263	23.194	16.014	15.766
12.0000	0.766	179.85	1.3093	119.495	25.880	7.002	5.812	43.024	21.737	14.999	14.735
16.0000	0.586	239.80	1.3274	126.200	25.944	6.737	4.139	40.069	21.228	14.671	14.490
20.0000	0.474	299.75	1.3346	128.557	26.024	6.555	3.315	39.644	21.152	14.656	14.597
25.0000	0.383	374.69	1.3340	127.871	26.121	6.392	2.769	40.993	21.390	14.876	14.998
30.0000	0.321	449.63	1.3269	124.732	26.209	6.270	2.479	43.752	21.859	15.264	15.589

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.0 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV. FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.027	1.54	1.5159	99.784	59.701	9.091	74.572	46.823	22.359	14.985	13.268
1.0000	4.977	14.99	1.2169	89.082	31.536	8.917	53.222	60.611	24.368	16.564	15.451
2.0000	3.318	29.98	1.1779	85.549	28.046	8.789	39.133	66.848	25.177	17.213	16.388
4.0000	1.991	59.95	1.2066	102.201	26.426	8.218	17.572	50.029	22.858	15.572	14.641
8.0000	1.106	119.90	1.2726	131.117	25.900	7.428	6.547	33.551	20.008	13.575	12.580
12.0000	0.766	179.85	1.3093	146.121	25.880	7.002	3.874	28.674	18.987	12.894	11.986
16.0000	0.586	239.80	1.3274	153.129	25.944	6.737	2.807	27.173	18.650	12.698	11.913
20.0000	0.474	299.75	1.3346	155.547	26.024	6.555	2.267	27.103	18.634	12.728	12.079
25.0000	0.383	374.69	1.3340	154.750	26.121	6.392	1.899	28.110	18.862	12.941	12.470
30.0000	0.321	449.63	1.3269	151.378	26.209	6.270	1.696	29.945	19.264	13.277	12.994

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

16.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							CRITICAL PARAMETERS (KEFF=1.0)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.011	1.93	1.3819	63.107	60.513	7.864	169.418	133.210	31.682	22.410	23.818
1.0000	4.968	18.76	1.2432	75.201	32.339	7.292	71.155	101.475	28.935	20.441	21.643
2.0000	3.312	37.53	1.3068	104.769	29.284	6.971	26.137	55.912	23.721	16.525	16.750
4.0000	1.987	75.06	1.4050	144.580	28.012	6.420	8.992	32.059	19.707	13.581	13.287
8.0000	1.104	150.11	1.4377	158.323	27.645	5.952	4.488	28.804	19.016	13.162	13.064
12.0000	0.764	225.17	1.3917	141.980	27.589	5.766	3.950	36.616	20.600	14.418	14.834
16.0000	0.584	300.23	1.3212	116.611	27.543	5.669	4.441	53.830	23.423	16.602	17.754
20.0000	0.473	375.28	1.2484	90.416	27.477	5.622	5.765	86.332	27.417	19.671	21.796
25.0000	0.382	469.10	1.1603	58.593	27.365	5.603	10.056	186.434	35.439	25.816	29.836
30.0000	0.321	562.92	1.0792	29.082	27.229	5.590	27.682	611.894	52.666	39.007	47.076

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

16.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.011	1.93	1.3819	75.126	60.513	7.864	121.786	95.758	28.381	19.883	20.517
1.0000	4.968	18.76	1.2432	95.434	32.339	7.292	45.162	64.405	24.866	17.326	17.574
2.0000	3.312	37.53	1.3068	128.256	29.284	6.971	17.543	37.526	20.769	14.265	13.798
4.0000	1.987	75.06	1.4050	170.978	28.012	6.420	6.411	22.858	17.605	11.972	11.185
8.0000	1.104	150.11	1.4377	185.694	27.645	5.952	3.265	20.954	17.103	11.697	11.151
12.0000	0.764	225.17	1.3917	168.529	27.589	5.766	2.831	26.239	18.434	12.760	12.668
16.0000	0.584	300.23	1.3212	141.857	27.543	5.669	3.068	37.195	20.708	14.523	15.038
20.0000	0.473	375.28	1.2484	114.330	27.477	5.622	3.752	56.184	23.760	16.871	18.138
25.0000	0.382	469.10	1.1603	80.911	27.365	5.603	5.697	105.611	29.323	21.134	23.720
30.0000	0.321	562.92	1.0792	49.942	27.229	5.590	11.125	245.904	38.865	28.442	33.275

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

16.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.18 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				CRITICAL PARAMETERS (KEFF=1.0)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.011	1.93	1.3810	62.987	60.483	8.262	163.705	128.719	31.322	22.041	23.060
1.0000	4.968	18.76	1.2202	68.539	32.123	7.724	81.089	115.641	30.223	21.326	22.499
2.0000	3.312	37.53	1.2709	93.401	29.000	7.358	31.145	66.624	25.149	17.527	17.791
4.0000	1.987	75.06	1.3736	134.819	27.709	6.711	9.895	35.279	20.346	14.002	13.635
8.0000	1.104	150.11	1.4414	161.155	27.387	6.143	4.203	26.973	18.604	12.802	12.461
12.0000	0.764	225.17	1.4286	156.497	27.387	5.906	3.202	29.681	19.207	13.319	13.301
16.0000	0.584	300.23	1.3880	141.580	27.405	5.782	3.030	36.727	20.621	14.430	14.838
20.0000	0.473	375.28	1.3375	123.175	27.403	5.705	3.230	48.364	22.602	15.965	16.897
25.0000	0.382	469.10	1.2713	99.104	27.372	5.654	3.927	72.802	25.903	18.504	20.249
30.0000	0.321	562.92	1.2061	75.447	27.316	5.629	5.397	119.306	30.539	22.059	24.910

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

16.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.18 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.011	1.93	1.3810	75.004	60.483	8.262	117.105	92.078	28.013	19.508	19.750
1.0000	4.968	18.76	1.2202	88.530	32.123	7.724	49.654	70.812	25.665	17.836	17.941
2.0000	3.312	37.53	1.2709	116.466	29.000	7.358	20.155	43.114	21.753	14.927	14.395
4.0000	1.987	75.06	1.3736	160.909	27.709	6.711	6.915	24.655	18.055	12.249	11.345
8.0000	1.104	150.11	1.4414	188.854	27.387	6.143	3.050	19.571	16.718	11.358	10.575
12.0000	0.764	225.17	1.4286	183.951	27.387	5.906	2.322	21.529	17.257	11.826	11.352
16.0000	0.584	300.23	1.3880	168.237	27.405	5.782	2.166	26.259	18.439	12.760	12.656
20.0000	0.473	375.28	1.3375	148.864	27.403	5.705	2.253	33.732	20.044	14.007	14.339
25.0000	0.382	469.10	1.2713	123.548	27.372	5.654	2.611	48.413	22.609	15.983	16.955
30.0000	0.321	562.92	1.2061	98.686	27.316	5.629	3.329	73.582	25.995	18.581	20.366

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

16.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.10 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

CRITICAL PARAMETERS (KEFF=1.0)

WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.011	1.93	1.3801	62.873	60.452	8.785	156.194	122.813	30.936	21.546	22.051
1.0000	4.968	18.76	1.1950	64.145	30.397	7.578	93.105	132.778	31.648	22.451	24.070
2.0000	3.312	37.53	1.2263	78.915	28.670	7.896	40.585	86.817	27.469	19.177	19.573
4.0000	1.987	75.06	1.3222	117.937	27.322	7.139	12.155	43.335	21.790	15.007	14.651
8.0000	1.104	150.11	1.4166	154.188	27.017	6.433	4.384	28.132	18.867	12.935	12.434
12.0000	0.764	225.17	1.4366	161.299	27.065	6.126	2.912	26.997	18.610	12.810	12.483
16.0000	0.584	300.23	1.4254	156.761	27.137	5.958	2.421	29.344	19.134	13.251	13.177
20.0000	0.473	375.28	1.4001	147.129	27.192	5.853	2.254	33.745	20.047	13.974	14.193
25.0000	0.382	469.10	1.3595	132.024	27.232	5.769	2.268	42.053	21.573	15.162	15.804
30.0000	0.321	562.92	1.3152	115.687	27.247	5.713	2.458	54.329	23.495	16.647	17.782

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

16.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.10 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.011	1.93	1.3801	74.889	60.452	8.785	111.012	87.287	27.518	19.006	18.734
1.0000	4.968	18.76	1.1950	84.835	30.397	7.578	54.852	78.225	26.531	18.534	18.953
2.0000	3.312	37.53	1.2263	101.426	28.670	7.896	24.764	52.975	23.298	15.984	15.403
4.0000	1.987	75.06	1.3222	143.407	27.322	7.139	8.180	29.165	19.095	12.944	11.957
8.0000	1.104	150.11	1.4166	181.784	27.017	6.433	3.132	20.103	16.868	11.404	10.434
12.0000	0.764	225.17	1.4366	189.234	27.065	6.126	2.109	19.548	16.711	11.356	10.585
16.0000	0.584	300.23	1.4254	184.406	27.137	5.958	1.751	21.229	17.177	11.753	11.219
20.0000	0.473	375.28	1.4001	174.228	27.192	5.853	1.617	24.215	17.947	12.367	12.094
25.0000	0.382	469.10	1.3595	158.299	27.232	5.769	1.599	29.650	19.201	13.346	13.432
30.0000	0.321	562.92	1.3152	141.092	27.247	5.713	1.689	37.344	20.735	14.534	15.022

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

16.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.0 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							CRITICAL PARAMETERS (KEFF=1.0)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.011	1.93	1.3794	62.787	60.419	9.605	144.441	113.572	30.042	20.746	20.436
1.0000	4.968	18.76	1.1623	51.393	31.582	9.264	121.231	172.888	34.559	24.284	25.295
2.0000	3.312	37.53	1.1554	55.167	28.166	8.880	73.072	156.314	33.417	23.500	24.537
4.0000	1.987	75.06	1.2053	77.226	26.585	8.100	24.833	88.537	27.649	19.267	19.549
8.0000	1.104	150.11	1.2762	105.984	26.064	7.265	8.204	52.651	23.251	16.096	15.986
12.0000	0.764	225.17	1.3080	118.298	26.038	6.852	4.833	44.799	22.032	15.260	15.180
16.0000	0.584	300.23	1.3196	122.467	26.094	6.600	3.574	43.326	21.788	15.132	15.188
20.0000	0.473	375.28	1.3199	122.267	26.166	6.432	2.970	44.478	21.980	15.318	15.547
25.0000	0.382	469.10	1.3113	118.582	26.252	6.281	2.597	48.148	22.568	15.804	16.287
30.0000	0.321	562.92	1.2967	112.710	26.328	6.173	2.434	53.796	23.418	16.480	17.245

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

16.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.0 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.011	1.93	1.3794	74.803	60.419	9.605	101.609	79.894	26.718	18.202	17.113
1.0000	4.968	18.76	1.1623	70.763	31.582	9.264	65.050	92.768	28.083	19.326	18.819
2.0000	3.312	37.53	1.1554	76.757	28.166	8.880	38.451	82.252	26.979	18.571	18.099
4.0000	1.987	75.06	1.2053	101.088	26.585	8.100	14.569	51.942	23.146	15.820	15.046
8.0000	1.104	150.11	1.2762	131.755	26.064	7.265	5.304	34.037	20.104	13.687	12.839
12.0000	0.764	225.17	1.3080	144.737	26.038	6.852	3.229	29.932	19.261	13.139	12.409
16.0000	0.584	300.23	1.3196	149.082	26.094	6.600	2.419	29.322	19.130	13.097	12.529
20.0000	0.473	375.28	1.3199	148.816	26.166	6.432	2.018	30.211	19.321	13.283	12.889
25.0000	0.382	469.10	1.3113	144.871	26.252	6.281	1.759	32.612	19.820	13.700	13.538
30.0000	0.321	562.92	1.2967	138.632	26.328	6.173	1.635	36.132	20.509	14.253	14.335

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

12.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							CRITICAL PARAMETERS (KEFF=1.0)				
WATER/FUEL VOL. RATIO	AV. FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	8.994	2.57	1.2234	36.723	60.834	8.587	322.770	339.000	43.255	31.100	34.668
1.0000	4.959	25.06	1.1915	58.999	32.451	7.679	80.626	153.586	33.222	23.632	25.543
2.0000	3.306	50.12	1.2847	96.607	29.465	7.091	22.556	64.451	24.872	17.378	17.781
4.0000	1.984	100.23	1.3910	138.732	28.181	6.426	7.300	34.766	20.247	13.993	13.821
8.0000	1.102	200.47	1.4137	149.038	27.758	5.939	3.790	32.488	19.795	13.761	13.856
12.0000	0.763	300.70	1.3570	129.090	27.657	5.754	3.551	43.973	21.896	15.413	16.142
16.0000	0.583	400.93	1.2822	102.356	27.575	5.670	4.231	68.501	25.383	18.102	19.713
20.0000	0.472	501.17	1.2055	74.807	27.477	5.633	6.053	121.075	30.689	22.173	25.056
25.0000	0.381	626.46	1.1148	42.006	27.332	5.608	13.321	329.888	42.864	31.499	37.256
30.0000	0.320	751.75	1.0325	11.978	27.169	5.622	87.589	2586.182	85.151	63.868	79.529

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

12.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	8.994	2.57	1.2234	47.307	60.834	8.587	203.478	213.709	37.089	26.380	28.502
1.0000	4.959	25.06	1.1915	78.323	32.451	7.679	47.343	90.185	27.819	19.496	20.141
2.0000	3.306	50.12	1.2847	119.553	29.465	7.091	14.859	42.457	21.641	14.905	14.551
4.0000	1.984	100.23	1.3910	164.710	28.181	6.426	5.175	24.646	18.053	12.314	11.628
8.0000	1.102	200.47	1.4137	175.843	27.758	5.939	2.734	23.434	17.752	12.197	11.813
12.0000	0.763	300.70	1.3570	154.914	27.657	5.754	2.503	30.995	19.486	13.568	13.732
16.0000	0.583	400.93	1.2822	126.830	27.575	5.670	2.840	45.992	22.226	15.686	16.557
20.0000	0.472	501.17	1.2055	97.899	27.477	5.633	3.731	74.628	26.118	18.673	20.485
25.0000	0.381	626.46	1.1148	63.474	27.332	5.608	6.546	162.097	33.824	24.579	28.216
30.0000	0.320	751.75	1.0325	31.980	27.169	5.622	17.660	521.438	49.931	36.906	44.309

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

12.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.18 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							CRITICAL PARAMETERS (KEFF=1.0)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	8.994	2.57	1.2224	36.573	60.799	9.032	315.240	331.090	42.916	30.736	33.884
1.0000	4.959	25.06	1.1679	52.122	32.222	8.139	97.348	185.440	35.376	25.173	27.236
2.0000	3.306	50.12	1.2505	85.828	29.184	7.470	27.098	77.431	26.441	18.490	18.971
4.0000	1.984	100.23	1.3637	130.384	27.893	6.691	7.940	37.813	20.822	14.371	14.131
8.0000	1.102	200.47	1.4210	152.960	27.523	6.108	3.510	30.084	19.294	13.338	13.186
12.0000	0.763	300.70	1.3966	144.310	27.454	5.879	2.819	34.900	20.273	14.141	14.394
16.0000	0.583	400.93	1.3473	126.434	27.465	5.762	2.822	45.692	22.178	15.627	16.416
20.0000	0.472	501.17	1.2904	105.853	27.432	5.695	3.210	64.204	24.840	17.681	19.146
25.0000	0.381	626.46	1.2183	79.769	27.366	5.658	4.350	107.725	29.517	21.270	23.860
30.0000	0.320	751.75	1.1493	54.750	27.278	5.631	7.085	209.209	36.827	26.872	31.196

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

12.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.18 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	8.994	2.57	1.2224	47.154	60.799	9.032	197.427	207.354	36.718	25.991	27.685
1.0000	4.959	25.06	1.1679	71.199	32.222	8.139	54.144	103.139	29.092	20.363	20.953
2.0000	3.306	50.12	1.2505	108.379	29.184	7.470	17.164	49.043	22.707	15.632	15.237
4.0000	1.984	100.23	1.3637	156.115	27.893	6.691	5.526	26.318	18.452	12.557	11.761
8.0000	1.102	200.47	1.4210	180.133	27.523	6.108	2.530	21.687	17.300	11.811	11.192
12.0000	0.763	300.70	1.3966	171.055	27.484	5.879	2.020	25.009	18.141	12.509	12.262
16.0000	0.583	400.93	1.3473	152.251	27.465	5.762	1.978	32.020	19.699	13.729	13.937
20.0000	0.472	501.17	1.2904	130.611	27.432	5.695	2.168	43.364	21.794	15.349	16.100
25.0000	0.381	626.46	1.2183	103.200	27.366	5.658	2.729	67.573	25.267	18.017	19.610
30.0000	0.320	751.75	1.1493	76.927	27.278	5.631	3.903	115.236	30.188	21.790	24.557

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

12.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.10 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

CRITICAL PARAMETERS (KEFF=1.0)

WATER/FUEL VOL. RATIO	AV. FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	8.994	2.57	1.2213	36.424	60.762	9.580	305.596	320.962	42.474	30.269	32.894
1.0000	4.959	25.06	1.1423	44.514	31.977	8.720	124.191	236.576	38.367	27.327	29.647
2.0000	3.306	50.12	1.2076	71.953	28.854	7.977	35.970	102.782	29.059	20.375	21.081
4.0000	1.984	100.23	1.3174	115.323	27.521	7.071	9.601	45.725	22.183	15.324	15.112
8.0000	1.102	200.47	1.4026	148.110	27.181	6.358	3.599	30.852	19.457	13.404	13.099
12.0000	0.763	300.70	1.4091	150.440	27.195	6.066	2.527	31.287	19.547	13.542	13.481
16.0000	0.583	400.93	1.3865	141.910	27.235	5.910	2.216	35.888	20.462	14.279	14.553
20.0000	0.472	501.17	1.3517	129.016	27.260	5.815	2.183	43.660	21.844	15.359	16.029
25.0000	0.381	626.46	1.3018	110.690	27.266	5.739	2.374	58.788	24.121	17.120	18.382
30.0000	0.320	751.75	1.2503	91.848	27.248	5.699	2.818	83.200	27.082	19.396	21.383

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

12.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.10 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV. FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	8.994	2.57	1.2213	47.003	60.762	9.580	189.871	199.418	36.243	25.499	26.663
1.0000	4.959	25.06	1.1423	63.316	31.977	8.720	64.010	121.934	30.762	21.505	22.042
2.0000	3.306	50.12	1.2076	93.980	28.854	7.977	21.371	61.067	24.429	16.831	16.451
4.0000	1.984	100.23	1.3174	140.516	27.521	7.071	6.453	30.731	19.431	13.217	12.360
8.0000	1.102	200.47	1.4026	175.269	27.181	6.358	2.562	21.962	17.372	11.809	11.015
12.0000	0.763	300.70	1.4091	177.711	27.195	6.066	1.813	22.451	17.500	11.975	11.434
16.0000	0.583	400.93	1.3865	168.704	27.235	5.910	1.580	25.577	18.278	12.607	12.368
20.0000	0.472	501.17	1.3517	155.113	27.260	5.815	1.531	30.632	19.410	13.496	13.596
25.0000	0.381	626.46	1.3018	135.818	27.266	5.739	1.616	40.012	21.218	14.897	15.479
30.0000	0.320	751.75	1.2503	115.997	27.248	5.699	1.834	54.158	23.471	16.632	17.772

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

12.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.0 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							CRITICAL PARAMETERS (KEFF=1.0)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	8.994	2.57	1.2206	36.330	60.726	10.372	290.230	304.823	41.750	29.529	31.378
1.0000	4.959	25.06	1.1086	34.316	31.652	9.612	187.532	357.236	44.017	31.443	34.405
2.0000	3.306	50.12	1.1377	48.602	28.340	8.868	69.517	198.638	36.196	25.630	27.328
4.0000	1.984	100.23	1.2073	77.350	26.794	7.902	18.935	90.173	27.818	19.443	19.916
8.0000	1.102	200.47	1.2767	105.320	26.268	7.058	6.386	54.741	23.554	16.377	16.497
12.0000	0.763	300.70	1.2982	113.688	26.229	6.671	4.006	49.603	22.793	15.885	16.123
16.0000	0.583	400.93	1.2988	113.727	26.271	6.443	3.154	51.072	23.016	16.109	16.573
20.0000	0.472	501.17	1.2887	109.668	26.327	6.318	2.781	55.626	23.681	16.647	17.362
25.0000	0.381	626.46	1.2683	101.645	26.396	6.164	2.642	65.427	24.997	17.691	18.833
30.0000	0.320	751.75	1.2433	91.996	26.447	6.070	2.695	79.584	26.684	19.004	20.613

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

12.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.0 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	8.994	2.57	1.2206	46.909	60.726	10.372	178.389	187.359	35.497	24.743	25.125
1.0000	4.959	25.06	1.1086	52.750	31.652	9.612	83.734	159.507	33.643	23.501	24.031
2.0000	3.306	50.12	1.1377	69.731	28.340	8.868	34.851	99.583	28.754	19.933	19.886
4.0000	1.984	100.23	1.2073	101.064	26.794	7.902	11.194	53.312	23.348	16.021	15.445
8.0000	1.102	200.47	1.2767	130.899	26.268	7.058	4.149	35.567	20.401	13.963	13.343
12.0000	0.763	300.70	1.2982	139.737	26.229	6.671	2.668	33.037	19.905	13.674	13.235
16.0000	0.583	400.93	1.2988	139.747	26.271	6.443	2.111	34.180	20.132	13.901	13.690
20.0000	0.472	501.17	1.2887	135.431	26.327	6.318	1.851	37.030	20.677	14.347	14.359
25.0000	0.381	626.46	1.2683	126.934	26.396	6.164	1.733	42.925	21.721	15.183	15.557
30.0000	0.320	751.75	1.2433	116.739	26.447	6.070	1.727	51.006	23.006	16.189	16.936

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

8.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							CRITICAL PARAMETERS (KEFF=1.0)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	8.978	3.87	1.0325	5.373	60.435	9.644	5295.598	8357.969	125.894	94.115	116.250
1.0000	4.950	37.65	1.1421	43.552	32.633	8.096	90.240	258.321	39.508	28.347	31.413
2.0000	3.300	75.29	1.2645	89.970	29.395	7.018	17.350	74.497	26.103	18.337	19.085
4.0000	1.980	150.59	1.3694	130.051	28.401	6.395	5.540	39.647	21.153	14.694	14.758
8.0000	1.100	301.18	1.3687	132.207	27.887	5.909	3.193	41.127	21.413	15.007	15.504
12.0000	0.762	451.77	1.2960	106.791	27.715	5.740	3.376	62.822	24.661	17.533	18.921
16.0000	0.582	602.36	1.2111	76.569	27.572	5.674	4.755	115.705	30.229	21.811	24.555
20.0000	0.471	752.95	1.1285	46.848	27.421	5.638	9.095	273.358	40.261	29.499	34.622
25.0000	0.381	941.18	1.0338	12.434	27.222	5.635	65.432	2434.972	83.458	62.569	77.823
30.0000	0.319	1129.42	0.9506	-18.284	27.020	*******	********	********	********	********	********

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

8.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	8.978	3.87	1.0325	14.364	60.435	9.644	1043.000	1646.153	73.248	53.813	63.604
1.0000	4.950	37.65	1.1421	61.973	32.633	8.096	47.106	134.845	31.811	22.455	23.716
2.0000	3.300	75.29	1.2645	112.610	29.395	7.018	11.241	48.266	22.587	15.645	15.569
4.0000	1.980	150.59	1.3694	155.427	28.401	6.395	3.892	27.851	18.804	12.896	12.409
8.0000	1.100	301.18	1.3687	158.038	27.887	5.909	2.259	29.099	19.081	13.221	13.171
12.0000	0.762	451.77	1.2960	131.402	27.715	5.740	2.290	42.604	21.666	15.241	15.927
16.0000	0.582	602.36	1.2111	99.688	27.572	5.674	2.954	71.865	25.792	18.414	20.118
20.0000	0.471	752.95	1.1285	68.507	27.421	5.638	4.704	141.388	32.318	23.418	26.679
25.0000	0.381	941.18	1.0338	32.423	27.222	5.635	13.684	509.218	49.538	36.602	43.903
30.0000	0.319	1129.42	0.9506	0.233	27.020	*******	********	********	********	********	********

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

8.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.18 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							CRITICAL PARAMETERS (KEFF=1.0)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	8.978	3.87	1.0312	5.172	60.392	10.109	5569.906	8790.902	128.031	95.642	117.922
1.0000	4.950	37.65	1.1191	36.774	32.398	8.540	118.512	339.250	43.266	31.119	34.725
2.0000	3.300	75.29	1.2337	79.340	29.453	7.497	20.897	89.729	27.773	19.503	20.275
4.0000	1.980	150.59	1.3479	123.647	28.136	6.619	5.926	42.408	21.633	15.009	15.014
8.0000	1.100	301.18	1.3804	137.404	27.685	6.048	2.906	37.439	20.753	14.469	14.705
12.0000	0.762	451.77	1.3355	121.655	27.578	5.838	2.614	48.643	22.645	15.967	16.808
16.0000	0.582	602.36	1.2717	98.808	27.500	5.740	2.979	72.483	25.865	18.455	20.126
20.0000	0.471	752.95	1.2048	74.694	27.413	5.691	4.016	120.713	30.659	22.136	24.967
25.0000	0.381	941.18	1.1244	45.583	27.287	5.655	7.688	286.083	40.876	29.966	35.221
30.0000	0.319	1129.42	1.0504	18.548	27.147	5.648	28.775	1276.739	67.298	50.195	61.650

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

8.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.18 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	8.978	3.87	1.0312	14.159	60.392	10.109	1048.659	1655.087	73.380	53.805	63.271
1.0000	4.950	37.65	1.1191	54.954	32.398	8.540	56.697	162.299	33.838	23.902	25.298
2.0000	3.300	75.29	1.2337	101.386	29.453	7.497	12.992	55.784	23.703	16.388	16.206
4.0000	1.980	150.59	1.3479	148.860	28.136	6.619	4.097	29.323	19.130	13.092	12.510
8.0000	1.100	301.18	1.3804	163.646	27.685	6.048	2.062	26.565	18.510	12.752	12.462
12.0000	0.762	451.77	1.3355	147.142	27.578	5.838	1.818	33.819	20.061	13.989	14.224
16.0000	0.582	602.36	1.2717	123.146	27.500	5.740	1.979	48.161	22.570	15.933	16.831
20.0000	0.471	752.95	1.2048	97.824	27.413	5.691	2.470	74.235	26.072	18.625	20.381
25.0000	0.381	941.18	1.1244	67.270	27.287	5.655	3.917	145.768	32.648	23.667	26.993
30.0000	0.319	1129.42	1.0504	38.911	27.147	5.648	8.440	374.494	44.715	32.907	39.067

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

8.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.10 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

CRITICAL PARAMETERS (KEFF=1.0)

WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	8.978	3.87	1.0300	4.968	60.348	10.621	5875.023	9272.469	130.327	97.280	119.706
1.0000	4.950	37.65	1.0935	29.079	32.140	9.058	174.277	498.882	49.201	35.541	40.143
2.0000	3.300	75.29	1.1938	66.522	29.128	7.935	27.905	119.822	30.583	21.552	22.648
4.0000	1.980	150.59	1.3082	110.929	27.786	6.930	7.028	50.294	22.899	15.905	15.969
8.0000	1.100	301.18	1.3686	134.643	27.377	6.247	2.938	37.841	20.827	14.479	14.580
12.0000	0.762	451.77	1.3515	128.607	27.332	5.984	2.306	42.910	21.718	15.223	15.734
16.0000	0.582	602.36	1.3102	113.561	27.317	5.849	2.272	55.277	23.631	16.719	17.782
20.0000	0.471	752.95	1.2611	95.671	27.291	5.775	2.548	76.581	26.344	18.813	20.569
25.0000	0.381	941.18	1.1978	72.622	27.237	5.724	3.399	126.505	31.142	22.498	25.418
30.0000	0.319	1129.42	1.1366	50.288	27.163	5.689	5.435	241.133	38.612	28.225	32.923

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

8.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.10 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	8.978	3.87	1.0300	13.951	60.348	10.621	1053.379	1662.535	73.490	53.769	62.869
1.0000	4.950	37.65	1.0935	46.585	32.140	9.058	72.771	208.313	36.774	26.028	27.716
2.0000	3.300	75.29	1.1938	88.092	29.128	7.935	16.246	69.757	25.537	17.689	17.602
4.0000	1.980	150.59	1.3082	135.709	27.786	6.930	4.709	33.703	20.038	13.715	13.109
8.0000	1.100	301.18	1.3686	160.954	27.377	6.247	2.064	26.588	18.515	12.709	12.268
12.0000	0.762	451.77	1.3515	154.632	27.332	5.984	1.613	30.018	19.280	13.356	13.296
16.0000	0.582	602.36	1.3102	138.804	27.317	5.849	1.553	37.782	20.816	14.564	14.967
20.0000	0.471	752.95	1.2611	119.991	27.291	5.775	1.675	50.334	22.905	16.180	17.130
25.0000	0.381	941.18	1.1978	95.768	27.237	5.724	2.066	76.890	26.379	18.852	20.656
30.0000	0.319	1129.42	1.1366	72.311	27.163	5.689	2.882	127.894	31.255	22.593	25.566

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

8.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.0 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							CRITICAL PARAMETERS (KEFF=1.0)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	8.978	3.87	1.0293	4.863	60.309	11.357	5980.707	9439.266	131.104	97.702	119.747
1.0000	4.950	37.65	1.0594	18.688	31.799	9.871	362.432	1037.494	62.801	45.762	52.930
2.0000	3.300	75.29	1.1271	44.439	28.611	8.671	55.477	238.212	38.456	27.406	29.784
4.0000	1.980	150.59	1.2093	77.267	27.083	7.590	13.056	93.435	28.150	19.770	20.560
8.0000	1.100	301.18	1.2630	99.125	26.529	6.792	4.937	63.601	24.762	17.364	17.971
12.0000	0.762	451.77	1.2636	99.636	26.459	6.451	3.527	65.625	25.022	17.643	18.572
16.0000	0.582	602.36	1.2450	92.560	26.470	6.261	3.165	77.013	26.393	18.737	20.132
20.0000	0.471	752.95	1.2181	82.328	26.492	6.136	3.222	96.845	28.488	20.370	22.352
25.0000	0.381	941.18	1.1797	67.781	26.514	6.029	3.733	138.936	32.130	23.183	26.101
30.0000	0.319	1129.42	1.1398	52.694	26.522	5.957	4.908	217.749	37.321	27.174	31.364

TYPICAL LMFBR CORE DISCHARGE FUEL NO NITRATE OR SS-316 INF. WATER REFLECTOR

8.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.0 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	8.978	3.87	1.0293	13.846	60.309	11.357	1035.493	1634.306	73.072	53.276	61.714
1.0000	4.950	37.65	1.0594	36.223	31.799	9.871	110.969	317.659	42.328	30.089	32.457
2.0000	3.300	75.29	1.1271	65.174	28.611	8.671	26.986	115.875	30.244	21.120	21.573
4.0000	1.980	150.59	1.2093	100.767	27.083	7.590	7.798	55.804	23.706	16.368	16.116
8.0000	1.100	301.18	1.2630	124.182	26.529	6.792	3.187	41.050	21.400	14.790	14.608
12.0000	0.762	451.77	1.2636	124.772	26.459	6.451	2.292	42.649	21.674	15.080	15.223
16.0000	0.582	602.36	1.2450	117.315	26.470	6.261	2.025	49.283	22.744	15.943	16.483
20.0000	0.471	752.95	1.2181	106.527	26.492	6.136	2.000	60.122	24.302	17.166	18.167
25.0000	0.381	941.18	1.1797	91.199	26.514	6.029	2.183	81.244	26.868	19.155	20.839
30.0000	0.319	1129.42	1.1398	75.311	26.522	5.957	2.612	115.877	30.244	21.756	24.287

Fuel-Water-Stainless Steel Systems

The following tables present the calculated criticality data for the fuel-water-stainless steel systems for the various fuel mixtures in 0.26-in.-diam pins with a cladding thickness of 0.015 in.

TYPICAL LMFBR CORE DISCHARGE FUEL 0.015 IN. SS316 CLAD INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	CRITICAL PARAMETERS (KEFF=1.0) MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1278	7.256	1.91	1.4416	69.174	63.836	7.211	153.064	119.565	30.561	21.705	23.350
1.0000	4.436	14.99	1.2642	77.082	34.275	6.896	79.017	100.969	28.887	20.497	21.991
2.0000	3.068	29.98	1.2992	98.826	30.277	6.798	34.603	63.919	24.804	17.394	18.005
4.0000	1.898	59.95	1.3775	132.775	28.431	6.395	12.750	38.073	20.869	14.477	14.475
8.0000	1.077	119.90	1.4046	145.937	27.722	5.981	6.390	33.633	20.024	13.927	14.043
12.0000	0.752	179.85	1.3627	131.703	27.542	5.804	5.575	42.040	21.570	15.152	15.766
16.0000	0.577	239.80	1.3000	109.338	27.442	5.712	6.146	60.345	24.332	17.288	18.620
20.0000	0.469	299.75	1.2304	84.245	27.347	5.669	8.065	97.562	28.558	20.533	22.889
25.0000	0.379	374.69	1.1483	54.467	27.226	5.639	14.116	210.950	36.929	26.948	31.289
30.0000	0.319	449.63	1.0721	26.626	27.092	5.634	39.707	706.417	55.249	40.974	49.615

TYPICAL LMFBR CORE DISCHARGE FUEL 0.015 IN. SS316 CLAD INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV. FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1278	7.256	1.91	1.4416	81.060	63.836	7.211	113.754	88.858	27.682	19.501	20.471
1.0000	4.436	14.99	1.2642	96.494	34.275	6.896	51.748	66.124	25.086	17.587	18.190
2.0000	3.068	29.98	1.2992	121.411	30.277	6.798	23.213	42.880	21.713	15.028	14.915
4.0000	1.898	59.95	1.3775	158.275	28.431	6.395	8.993	26.853	18.577	12.722	12.182
8.0000	1.077	119.90	1.4046	172.603	27.722	5.981	4.588	24.150	17.931	12.325	11.950
12.0000	0.752	179.85	1.3627	157.744	27.542	5.804	3.937	29.689	19.209	13.344	13.405
16.0000	0.577	239.80	1.3000	134.272	27.442	5.712	4.181	41.050	21.400	15.043	15.688
20.0000	0.469	299.75	1.2304	107.925	27.347	5.669	5.137	62.139	24.571	17.481	18.902
25.0000	0.379	374.69	1.1483	76.665	27.226	5.639	7.752	115.841	30.241	21.828	24.601
30.0000	0.319	449.63	1.0721	47.454	27.092	5.634	15.036	267.499	39.971	29.278	34.337

TYPICAL LMFBR CORE DISCHARGE FUEL 0.015 IN. SS316 CLAD INF. WATER REFLECTOR

16.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							CRITICAL PARAMETERS (KEFF=1.0)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1278	7.243	2.40	1.3129	48.729	64.211	7.619	223.743	218.866	37.385	26.833	29.766
1.0000	4.428	18.76	1.2103	61.294	34.310	7.205	93.412	149.473	32.922	23.514	25.718
2.0000	3.063	37.53	1.2717	89.410	30.385	6.928	32.926	76.165	26.296	18.506	19.368
4.0000	1.895	75.06	1.3607	126.388	28.541	6.421	11.170	41.769	21.524	14.972	15.103
8.0000	1.075	150.11	1.3852	138.610	27.793	5.986	5.635	37.145	20.698	14.442	14.713
12.0000	0.750	225.17	1.3389	122.847	27.584	5.806	5.078	47.960	22.539	15.893	16.733
16.0000	0.576	300.23	1.2706	98.543	27.457	5.718	5.939	73.022	25.929	18.509	20.211
20.0000	0.468	375.28	1.2007	73.642	27.249	5.677	8.183	123.963	30.931	22.348	25.254
25.0000	0.379	469.10	1.1180	43.377	27.205	5.647	16.647	311.515	42.053	30.869	36.406
30.0000	0.318	562.92	1.0414	15.292	27.056	5.665	78.285	1744.085	74.672	55.836	69.007

TYPICAL LMFBR CORE DISCHARGE FUEL 0.015 IN. SS316 CLAD INF. WATER REFLECTOR

16.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1278	7.243	2.40	1.3129	59.491	64.211	7.619	155.454	152.065	33.112	23.562	25.492
1.0000	4.428	18.76	1.2103	79.861	34.310	7.205	57.157	91.459	27.950	19.707	20.745
2.0000	3.063	37.53	1.2717	111.437	30.385	6.928	21.552	49.854	22.832	15.854	15.903
4.0000	1.895	75.06	1.3607	151.481	28.541	6.421	7.811	29.209	19.105	13.120	12.684
8.0000	1.075	150.11	1.3852	164.842	27.793	5.986	4.013	26.450	18.483	12.746	12.498
12.0000	0.750	225.17	1.3389	148.392	27.564	5.806	3.540	33.429	19.984	13.937	14.178
16.0000	0.576	300.23	1.2706	122.898	27.457	5.718	3.943	48.483	22.620	15.976	16.902
20.0000	0.468	375.28	1.2007	96.833	27.249	5.677	5.001	75.750	26.248	18.763	20.571
25.0000	0.379	469.10	1.1180	65.006	27.205	5.647	8.279	154.920	33.318	24.182	27.670
30.0000	0.318	562.92	1.0414	35.550	27.056	5.665	19.552	435.592	47.025	34.671	41.360

TYPICAL LMFBR CORE DISCHARGE FUEL 0.015 IN. SS316 CLAD INF. WATER REFLECTOR

12.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

						CRITICAL PARAMETERS (KEFF=1.0)					
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1278	7.230	3.20	1.1637	25.524	64.141	8.215	503.922	658.442	53.969	39.389	45.754
1.0000	4.420	25.06	1.1551	45.160	34.355	7.570	117.859	251.912	39.179	28.218	31.609
2.0000	3.057	50.12	1.2441	79.957	30.525	7.045	30.043	92.828	28.089	19.851	21.044
4.0000	1.891	100.23	1.3402	118.660	28.671	6.435	9.432	47.111	22.405	15.643	15.970
8.0000	1.073	200.47	1.3556	127.623	27.866	5.979	4.949	43.578	21.830	15.310	15.851
12.0000	0.749	300.70	1.2998	108.572	27.614	5.804	4.792	60.448	24.346	17.277	18.542
16.0000	0.575	400.93	1.2287	83.284	27.457	5.727	6.027	98.995	28.697	20.626	22.970
20.0000	0.467	501.17	1.1565	57.268	27.319	5.683	9.523	192.686	35.831	26.097	30.147
25.0000	0.378	626.46	1.0713	26.252	27.150	5.664	28.882	721.960	55.651	41.275	49.987
30.0000	0.317	751.75	0.9941	-2.193	26.971	*******	********	********	********	********	********

TYPICAL LMFBR CORE DISCHARGE FUEL 0.015 IN. SS316 CLAD INF. WATER REFLECTOR

12.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1278	7.230	3.20	1.1637	35.073	64.141	8.215	288.880	377.460	44.833	32.395	36.618
1.0000	4.420	25.06	1.1551	62.856	34.355	7.570	64.551	137.973	32.055	22.765	24.485
2.0000	3.057	50.12	1.2441	101.407	30.525	7.045	19.099	59.015	24.152	16.838	17.107
4.0000	1.891	100.23	1.3402	143.262	28.671	6.435	6.522	32.575	19.812	13.658	13.377
8.0000	1.073	200.47	1.3556	153.227	27.866	5.979	3.474	30.587	19.401	13.450	13.422
12.0000	0.749	300.70	1.2998	133.346	27.614	5.804	3.255	41.061	21.402	15.023	15.598
16.0000	0.575	400.93	1.2287	106.836	27.457	5.727	3.828	62.869	24.667	17.541	18.940
20.0000	0.467	501.17	1.1565	79.547	27.319	5.683	5.336	107.979	29.540	21.282	23.857
25.0000	0.378	626.46	1.0713	47.019	27.150	5.664	10.847	271.142	40.152	29.409	34.488
30.0000	0.317	751.75	0.9941	17.206	26.971	*******	********	********	********	********	********

TYPICAL LMFBR CORE DISCHARGE FUEL 0.015 IN. SS316 CLAD INF. WATER REFLECTOR

8.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

						CRITICAL PARAMETERS (KEFF=1.0)					
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1278	7.217	4.81	0.9845	-2.455	63.319	*******	********	********	********	********	********
1.0000	4.412	37.65	1.0986	28.639	34.439	7.952	170.484	547.584	50.752	36.988	42.800
2.0000	3.052	75.29	1.2134	69.470	30.713	7.120	25.779	119.696	30.572	21.735	23.453
4.0000	1.688	150.59	1.3068	106.448	28.817	6.416	7.747	58.148	24.033	16.894	17.617
8.0000	1.071	301.18	1.3011	107.821	27.922	5.961	4.539	60.058	24.294	17.200	18.332
12.0000	0.748	451.77	1.2321	84.060	27.606	5.801	5.096	96.600	28.464	20.430	22.663
16.0000	0.574	602.36	1.1531	55.882	27.397	5.730	8.115	200.284	36.295	26.442	30.566
20.0000	0.466	752.95	1.0765	28.124	27.216	5.701	21.141	642.816	53.539	39.649	47.838
25.0000	0.377	941.18	0.9889	-4.116	27.004	*******	********	********	********	********	********
30.0000	0.317	1129.42	0.9116	-32.975	26.800	*******	********	********	********	********	********

TYPICAL LMFBR CORE DISCHARGE FUEL 0.015 IN. SS316 CLAD INF. WATER REFLECTOR

8.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							SAFE PARAMETERS (KEFF=0.95)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1278	7.217	4.81	0.9845	5.728	63.319	*******	********	********	********	********	********
1.0000	4.412	37.65	1.0986	45.429	34.439	7.952	75.344	242.000	38.658	27.730	30.706
2.0000	3.052	75.29	1.2134	90.262	30.713	7.120	15.760	73.176	25.947	18.194	18.828
4.0000	1.888	150.59	1.3068	130.314	28.817	6.416	5.246	39.372	21.104	14.652	14.688
8.0000	1.071	301.18	1.3011	132.345	27.922	5.961	3.080	40.748	21.347	14.944	15.386
12.0000	0.748	451.77	1.2321	107.550	27.606	5.801	3.246	61.540	24.492	17.389	18.691
16.0000	0.574	602.36	1.1531	78.034	27.397	5.730	4.507	111.229	29.834	21.495	24.104
20.0000	0.466	752.95	1.0765	48.942	27.216	5.701	8.302	252.424	39.206	28.677	33.505
25.0000	0.377	941.18	0.9889	15.157	27.004	*******	********	********	********	********	********
30.0000	0.317	1129.42	0.9116	-15.072	26.800	*******	********	********	********	********	********

Fuel-8 M HNO_3 Systems

The following tables present the calculated criticality data for the 20 wt % PuO_2-UO_2 fuel-nitric acid systems with the various fuel pin diameters considered.

TYPICAL LMFBR CORE DISCHARGE FUEL 8 MOLAR HNO3 INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

						CRITICAL PARAMETERS (KEFF=1.0)					
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1254	8.845	1.54	1.5130	84.560	60.665	7.427	124.946	80.064	26.737	18.727	19.311
1.2205	4.483	14.95	1.2827	80.123	35.279	7.165	72.195	91.284	27.932	19.703	20.767
2.4411	2.893	29.98	1.3135	95.539	32.817	7.095	33.587	65.811	25.046	17.510	17.951
4.8822	1.692	59.95	1.3835	119.640	32.052	6.691	13.373	44.793	22.031	15.297	15.341
9.7644	0.925	119.90	1.3807	119.055	31.973	6.282	7.795	47.781	22.511	15.760	16.229
14.6466	0.636	179.85	1.3072	96.234	31.926	6.118	8.175	72.832	25.907	18.398	19.789
19.5288	0.485	239.80	1.2177	68.465	31.797	6.038	11.665	136.360	31.930	23.028	25.893
24.4110	0.392	299.75	1.1268	40.116	31.610	5.996	24.002	347.285	43.605	31.975	37.609
30.5137	0.316	374.69	1.0256	8.163	31.344	6.053	261.844	4698.594	103.903	78.122	97.850
36.6165	0.265	449.63	0.9367	-20.365	31.066	*******	********	********	********	********	********

TYPICAL LMFBR CORE DISCHARGE FUEL 8 MOLAR HNO3 INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV. FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1254	8.845	1.54	1.5130	97.686	60.665	7.427	94.485	60.545	24.359	16.907	16.933
1.2205	4.483	14.99	1.2827	99.259	35.279	7.165	47.936	60.610	24.368	16.975	17.203
2.4411	2.893	29.98	1.3135	116.605	32.817	7.095	22.757	44.590	21.998	15.177	14.903
4.8822	1.692	59.95	1.3835	142.357	32.052	6.691	9.474	31.733	19.640	13.466	12.949
9.7644	0.925	119.90	1.3807	141.782	31.973	6.282	5.552	34.028	20.102	13.916	13.821
14.6466	0.636	179.85	1.3072	117.784	31.926	6.118	5.594	49.837	22.829	16.042	16.711
19.5288	0.485	239.80	1.2177	88.621	31.797	6.038	7.319	85.549	27.334	19.510	21.297
24.4110	0.392	299.75	1.1268	58.878	31.610	5.996	12.355	178.768	34.946	25.347	28.950
30.5137	0.316	374.69	1.0256	25.384	31.344	6.053	41.660	747.563	56.301	41.682	50.249
36.6165	0.265	449.63	0.9367	-4.495	31.066	*******	********	********	********	********	********

TYPICAL LMFBR CORE DISCHARGE FUEL 8 MOLAR HNO3 INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.18 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							CRITICAL PARAMETERS (KEFF=1.0)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1254	8.845	1.54	1.5122	84.462	60.640	7.782	120.304	77.089	26.402	18.387	18.620
1.2205	4.483	14.99	1.2605	74.305	35.053	7.579	79.683	100.752	28.866	20.321	21.287
2.4411	2.893	29.98	1.2784	85.646	32.501	7.493	39.573	77.540	26.453	18.494	18.960
4.8822	1.692	59.95	1.3551	111.984	31.711	7.011	14.583	48.845	22.677	15.716	15.666
9.7644	0.925	119.90	1.3959	124.782	31.727	6.499	6.911	42.360	21.625	15.031	15.126
14.6466	0.636	179.85	1.3626	114.033	31.800	6.276	5.828	51.927	23.144	16.246	16.868
19.5288	0.485	239.80	1.3050	95.928	31.795	6.160	6.237	72.908	25.916	18.395	19.756
24.4110	0.392	299.75	1.2391	75.368	31.729	6.097	7.887	114.125	30.091	21.606	23.994
30.5137	0.316	374.69	1.1587	50.217	31.594	6.048	13.099	235.048	38.285	27.890	32.236
36.6165	0.265	449.63	1.0833	26.515	31.427	6.018	32.524	696.635	54.993	40.688	48.975

TYPICAL LMFBR CORE DISCHARGE FUEL 8 MOLAR HNO3 INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.18 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1254	8.845	1.54	1.5122	97.586	60.640	7.782	90.595	58.052	24.020	16.564	16.238
1.2205	4.483	14.99	1.2605	93.230	35.053	7.579	51.499	65.116	24.957	17.329	17.378
2.4411	2.893	29.98	1.2784	106.347	32.501	7.493	25.911	50.770	22.971	15.828	15.477
4.8822	1.692	59.95	1.3551	134.475	31.711	7.011	10.126	33.917	20.081	13.729	13.070
9.7644	0.925	119.90	1.3959	147.938	31.727	6.499	4.936	30.256	19.330	13.274	12.832
14.6466	0.636	179.85	1.3626	136.585	31.800	6.276	4.113	36.647	20.605	14.303	14.330
19.5288	0.485	239.80	1.3050	117.530	31.795	6.160	4.257	49.767	22.818	16.024	16.658
24.4110	0.392	299.75	1.2391	95.923	31.729	6.097	5.076	73.452	25.980	18.459	19.883
30.5137	0.316	374.69	1.1587	69.518	31.594	6.048	7.387	132.560	31.631	22.796	25.582
36.6165	0.265	449.63	1.0833	44.658	31.427	6.018	13.472	288.563	40.994	29.971	34.976

TYPICAL LMFBR CORE DISCHARGE FUEL 8 MOLAR HNO3 INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.10 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

CRITICAL PARAMETERS (KEFF=1.0)

WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1254	8.845	1.54	1.5114	84.372	60.612	8.285	113.798	72.920	25.917	17.898	17.632
1.2205	4.483	14.99	1.2364	67.916	34.810	8.172	88.992	112.522	29.949	21.011	21.777
2.4411	2.893	29.98	1.2346	73.012	32.134	8.065	50.545	99.038	28.701	20.081	20.636
4.8822	1.692	59.95	1.3056	97.730	31.266	7.491	17.918	60.015	24.288	16.837	16.797
9.7644	0.925	119.90	1.3797	121.228	31.325	6.834	6.982	42.796	21.699	15.009	14.865
14.6466	0.636	179.85	1.3859	122.519	31.497	6.533	4.904	43.694	21.850	15.195	15.317
19.5288	0.485	239.80	1.3629	114.819	31.602	6.363	4.335	50.667	22.955	16.081	16.592
24.4110	0.392	299.75	1.3270	103.340	31.648	6.259	4.333	62.700	24.645	17.399	18.386
30.5137	0.316	374.69	1.2754	87.021	31.645	6.178	4.854	87.106	27.499	19.603	21.321
36.6165	0.265	449.63	1.2217	70.160	31.597	6.132	6.039	129.358	31.374	22.580	25.241

TYPICAL LMFBR CORE DISCHARGE FUEL 8.MOLAR HNO3 INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.10 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							SAFE PARAMETERS (KEFF=0.95)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1254	8.845	1.54	1.5114	97.496	60.612	8.285	85.183	54.584	23.532	16.072	15.247
1.2205	4.483	14.99	1.2364	86.610	34.810	8.172	55.484	70.155	25.585	17.670	17.413
2.4411	2.893	29.98	1.2346	93.234	32.134	8.065	31.327	61.382	24.471	16.842	16.406
4.8822	1.692	59.95	1.3056	119.707	31.266	7.491	11.955	40.042	21.223	14.491	13.732
9.7644	0.925	119.90	1.3797	144.410	31.325	6.834	4.920	30.154	19.309	13.179	12.475
14.6466	0.636	179.85	1.3859	145.677	31.497	6.533	3.484	31.041	19.496	13.393	12.963
19.5288	0.485	239.80	1.3629	137.516	31.602	6.363	3.054	35.701	20.427	14.145	14.063
24.4110	0.392	299.75	1.3270	125.409	31.648	6.259	2.997	43.362	21.794	15.217	15.535
30.5137	0.316	374.69	1.2754	108.232	31.645	6.178	3.235	58.045	24.019	16.939	17.841
36.6165	0.265	449.63	1.2217	90.509	31.597	6.132	3.802	81.440	26.890	19.147	20.757

TYPICAL LMFBR CORE DISCHARGE FUEL 8 MOLAR HNO3 INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.0 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

CRITICAL PARAMETERS (KEFF=1.0)

WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1254	8.845	1.54	1.5107	84.295	60.582	9.151	102.960	65.976	25.067	17.044	15.916
1.2205	4.483	14.99	1.2053	59.523	34.493	9.226	103.491	130.854	31.494	21.947	22.269
2.4411	2.893	29.98	1.1654	52.390	31.576	9.139	86.000	168.509	34.265	24.088	25.126
4.8822	1.692	59.95	1.1902	62.554	30.410	8.586	37.747	126.428	31.135	21.822	22.549
9.7644	0.925	119.90	1.2450	81.115	30.208	7.800	13.573	83.197	27.082	18.903	19.281
14.6466	0.636	179.85	1.2694	88.886	30.314	7.378	8.210	73.146	25.944	18.131	18.566
19.5288	0.485	239.80	1.2757	90.591	30.434	7.115	6.220	72.708	25.892	18.153	18.777
24.4110	0.392	299.75	1.2716	88.927	30.537	6.937	5.313	76.872	26.377	18.566	19.440
30.5137	0.316	374.69	1.2580	84.207	30.636	6.850	4.794	86.025	27.385	19.358	20.535
36.6165	0.265	449.63	1.2391	77.849	30.707	6.796	4.677	100.169	28.810	20.462	22.015

TYPICAL LMFBR CORE DISCHARGE FUEL 8 MOLAR HNO3 INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.0 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							SAFE PARAMETERS (KEFF=0.95)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1254	8.845	1.54	1.5107	97.419	60.582	9.151	76.247	48.858	22.679	15.216	13.528
1.2205	4.483	14.99	1.2053	77.914	34.493	9.226	60.717	76.771	26.366	18.021	17.140
2.4411	2.893	29.98	1.1654	71.816	31.576	9.139	46.591	91.290	27.933	19.241	18.794
4.8822	1.692	59.95	1.1902	83.153	30.410	8.586	21.642	72.487	25.866	17.788	17.280
9.7644	0.925	119.90	1.2450	102.807	30.208	7.800	8.516	52.196	23.184	15.919	15.384
14.6466	0.636	179.85	1.2694	110.926	30.314	7.378	5.320	47.397	22.450	15.457	15.072
19.5288	0.485	239.80	1.2757	112.653	30.434	7.115	4.073	47.612	22.484	15.544	15.369
24.4110	0.392	299.75	1.2716	110.843	30.537	6.937	3.478	50.319	22.902	15.906	15.965
30.5137	0.316	374.69	1.2580	105.819	30.636	6.850	3.103	55.688	23.690	16.529	16.839
36.6165	0.265	449.63	1.2391	99.086	30.707	6.796	2.970	63.620	24.765	17.365	17.969

Fuel-Water-Boron Systems

The following tables present the calculated criticality data for the 20 wt % PuO_2-UO_2 fuel-water systems containing 0.3 M boron at the various fuel pin diameters considered.

TYPICAL LMFBR CORE DISCHARGE FUEL 0.30 MOLAR BORON INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							CRITICAL PARAMETERS (KEFF=1.0)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.027	1.54	1.5165	86.453	59.741	7.372	122.972	77.213	26.416	18.494	19.044
1.0000	4.977	14.99	1.2649	82.761	32.003	6.874	77.827	88.632	27.659	19.562	20.784
2.0000	3.318	29.98	1.2424	84.695	28.619	6.756	50.336	85.986	27.381	19.377	20.625
4.0000	1.991	59.95	1.1796	67.333	26.680	6.729	46.234	131.631	31.557	22.580	24.828
8.0000	1.106	119.90	0.9649	-13.981	25.121	*******	********	********	********	********	********
12.0000	0.766	179.85	0.7806	-90.390	24.271	*******	********	********	********	********	********
16.0000	0.586	239.80	0.6438	-149.967	23.752	*******	********	********	********	********	********
20.0000	0.474	299.75	0.5411	-195.843	23.433	*******	********	********	********	********	********
25.0000	0.383	374.69	0.4499	-236.982	23.214	*******	********	********	********	********	********
30.0000	0.321	449.63	0.3837	-266.726	23.108	*******	********	********	********	********	********

TYPICAL LMFBR CORE DISCHARGE FUEL 0.30 MOLAR BORON INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.26 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.027	1.54	1.5165	99.813	59.741	7.372	93.074	58.440	24.074	16.701	16.702
1.0000	4.977	14.99	1.2649	103.563	32.003	6.874	50.824	57.880	23.996	16.758	17.122
2.0000	3.318	29.98	1.2424	107.543	28.619	6.756	31.979	54.628	23.538	16.435	16.782
4.0000	1.991	59.95	1.1796	90.604	26.680	6.729	26.691	75.989	26.276	18.537	19.547
8.0000	1.106	119.90	0.9649	6.234	25.121	*******	********	********	********	********	********
12.0000	0.766	179.85	0.7806	-73.462	24.271	*******	********	********	********	********	********
16.0000	0.586	239.80	0.6438	-135.701	23.752	*******	********	********	********	********	********
20.0000	0.474	299.75	0.5411	-183.689	23.433	*******	********	********	********	********	********
25.0000	0.383	374.69	0.4499	-226.782	23.214	*******	********	********	********	********	********
30.0000	0.321	449.63	0.3837	-257.987	23.108	*******	********	********	********	********	********

TYPICAL LMFBR CORE DISCHARGE FUEL 0.30 MOLAR BORON INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.18 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

							CRITICAL PARAMETERS (KEFF=1.0)				
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.027	1.54	1.5157	86.355	59.716	7.720	118.428	74.360	26.087	18.160	18.366
1.0000	4.977	14.99	1.2461	77.330	31.821	7.262	84.818	96.593	28.463	20.087	21.201
2.0000	3.318	29.98	1.2219	78.050	28.425	7.126	56.374	96.301	28.435	20.097	21.309
4.0000	1.991	59.95	1.1928	72.432	26.614	6.741	40.415	115.064	30.173	21.518	23.432
8.0000	1.106	119.90	1.0439	17.334	25.320	6.469	268.372	1375.329	68.988	51.296	62.519
12.0000	0.766	179.85	0.8883	-45.489	24.554	*******	********	********	********	********	********
16.0000	0.586	239.80	0.7603	-99.715	24.041	*******	********	********	********	********	********
20.0000	0.474	299.75	0.6577	-144.523	23.684	*******	********	********	********	********	********
25.0000	0.383	374.69	0.5603	-187.934	23.394	*******	********	********	********	********	********
30.0000	0.321	449.63	0.4863	-221.260	23.216	*******	********	********	********	********	********

TYPICAL LMFBR CORE DISCHARGE FUEL 0.30 MOLAR BORON INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.18 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.027	1.54	1.5157	99.713	59.716	7.720	89.264	56.048	23.741	16.364	16.020
1.0000	4.977	14.99	1.2461	97.940	31.821	7.262	53.977	61.470	24.483	17.040	17.221
2.0000	3.318	29.98	1.2219	100.673	28.425	7.126	34.688	59.256	24.185	16.844	17.059
4.0000	1.991	59.95	1.1928	96.020	26.614	6.741	23.882	67.994	25.320	17.803	18.579
8.0000	1.106	119.90	1.0439	39.033	25.320	6.469	68.757	352.359	43.816	32.026	37.347
12.0000	0.766	179.85	0.8883	-26.449	24.554	*******	********	********	********	********	********
16.0000	0.586	239.80	0.7603	-83.071	24.041	*******	********	********	********	********	********
20.0000	0.474	299.75	0.6577	-129.907	23.684	*******	********	********	********	********	********
25.0000	0.383	374.69	0.5603	-175.327	23.394	*******	********	********	********	********	********
30.0000	0.321	449.63	0.4863	-210.235	23.216	*******	********	********	********	********	********

TYPICAL LMFBR CORE DISCHARGE FUEL 0.30 MOLAR BORON INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.10 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

						CRITICAL PARAMETERS (KEFF=1.0)					
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.027	1.54	1.5149	86.265	59.689	8.214	112.064	70.364	25.611	17.680	17.397
1.0000	4.977	14.99	1.2251	71.172	31.622	7.817	93.682	106.687	29.422	20.691	21.606
2.0000	3.318	29.98	1.1911	67.832	28.178	7.656	69.495	118.713	30.489	21.545	22.833
4.0000	1.991	59.95	1.1830	69.221	26.443	7.170	42.116	119.906	30.590	21.737	23.421
8.0000	1.106	119.90	1.1023	40.296	25.389	6.736	63.876	327.347	42.754	31.150	36.017
12.0000	0.766	179.85	0.9901	-3.972	24.803	*******	********	********	********	********	********
16.0000	0.586	239.80	0.8845	-47.422	24.352	*******	********	********	********	********	********
20.0000	0.474	299.75	0.7931	-86.143	24.013	*******	********	********	********	********	********
25.0000	0.383	374.69	0.6986	-127.184	23.697	*******	********	********	********	********	********
30.0000	0.321	449.63	0.6219	-161.129	23.467	*******	********	********	********	********	********

TYPICAL LMFBR CORE DISCHARGE FUEL 0.30 MOLAR BORON INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.10 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.027	1.54	1.5149	99.623	59.689	8.214	83.968	52.723	23.261	15.882	15.048
1.0000	4.977	14.99	1.2251	91.562	31.622	7.817	57.575	65.568	25.015	17.317	17.198
2.0000	3.318	29.98	1.1911	90.080	28.178	7.656	40.395	69.004	25.445	17.684	17.789
4.0000	1.991	59.95	1.1830	92.768	26.443	7.170	24.247	69.032	25.448	17.800	18.279
8.0000	1.106	119.90	1.1023	63.147	25.389	6.736	28.837	147.783	32.798	23.528	26.061
12.0000	0.766	179.85	0.9901	17.039	24.803	*******	********	********	********	********	********
16.0000	0.586	239.80	0.8845	-28.305	24.352	*******	********	********	********	********	********
20.0000	0.474	299.75	0.7931	-68.759	24.013	*******	********	********	********	********	********
25.0000	0.383	374.69	0.6986	-111.667	23.697	*******	********	********	********	********	********
30.0000	0.321	449.63	0.6219	-147.181	23.467	*******	********	********	********	********	********

TYPICAL LMFBR CORE DISCHARGE FUEL 0.30 MOLAR BORON INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.0 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

						CRITICAL PARAMETERS (KEFF=1.0)					
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	MATERIAL BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.027	1.54	1.5142	86.188	59.659	9.065	101.451	63.700	24.775	16.841	15.711
1.0000	4.977	14.99	1.1970	62.822	31.356	8.795	107.903	122.882	30.841	21.548	22.046
2.0000	3.318	29.98	1.1352	48.677	27.767	8.647	118.082	201.712	36.382	25.824	27.735
4.0000	1.991	59.95	1.1120	43.154	25.947	8.141	91.932	261.737	39.682	28.469	31.540
8.0000	1.106	119.90	1.0720	28.775	25.006	7.530	108.652	556.808	51.036	37.304	43.506
12.0000	0.766	179.85	1.0135	5.492	24.593	7.111	1157.524	8568.398	126.942	95.511	119.831
16.0000	0.586	239.80	0.9509	-20.189	24.304	*******	********	********	********	********	********
20.0000	0.474	299.75	0.8907	-45.411	24.076	*******	********	********	********	********	********
25.0000	0.383	374.69	0.8219	-74.696	23.841	*******	********	********	********	********	********
30.0000	0.321	449.63	0.7610	-101.051	23.653	*******	********	********	********	********	********

TYPICAL LMFBR CORE DISCHARGE FUEL 0.30 MOLAR BORON INF. WATER REFLECTOR

20.0 WT. PCT. PUO2 IN (U+PU)O2 RODS AT 0.0 IN. DIA.

ISOTOPIC COMPOSITIONS (WT.PCT.)

PLUTONIUM-238,239,240,241,242/ 1.00,60.00,27.00, 7.00, 5.00

URANIUM-235,238/ 0.20,99.80

				SAFE PARAMETERS (KEFF=0.95)							
WATER/FUEL VOL. RATIO	AV.FUEL DENSITY (GM/CC)	H TO PU RATIO	K-INFINITY	SAFE BUCKLING (M**-2)	MIGRATION AREA (CM**2)	EXTRAP. DISTANCE (CM)	MASS OF PLUTONIUM (KG)	VOLUME OF SPHERE (LITERS)	RADIUS OF SPHERE (CM)	RADIUS OF CYLINDER (CM)	THICKNESS OF SLAB (CM)
0.1027	9.027	1.54	1.5142	99.546	59.659	9.065	75.211	47.225	22.423	15.040	13.358
1.0000	4.977	14.99	1.1970	82.913	31.356	8.795	62.482	71.156	25.706	17.617	16.911
2.0000	3.318	29.98	1.1352	70.194	27.767	8.647	58.885	100.589	28.851	20.059	20.204
4.0000	1.991	59.95	1.1120	65.709	25.947	8.141	42.215	120.189	30.614	21.527	22.473
8.0000	1.106	119.90	1.0720	51.337	25.006	7.530	39.150	200.632	36.316	26.036	28.787
12.0000	0.766	179.85	1.0135	27.182	24.593	7.111	84.943	628.778	53.146	39.018	46.035
16.0000	0.586	239.80	0.9509	0.404	24.304	*******	********	********	********	********	********
20.0000	0.474	299.75	0.8907	-25.940	24.076	*******	********	********	********	********	********
25.0000	0.383	374.69	0.8219	-56.552	23.841	*******	********	********	********	********	********
30.0000	0.321	449.63	0.7610	-84.117	23.653	*******	********	********	********	********	********

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