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Validation of the SCALE Broad Structure 44-Group ENDF/B-V Cross-Section Library for Use in Criticality Safety Analyses

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Prepared for
U.S. Nuclear Regulatory Commission

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ABSTRACT

This report documents the validation of the recently developed 44-group ENDF/B-V based cross-section library (44GROUPNDF5). This cross-section set has been developed for use in the SCALE code system in the analysis of fresh and spent fuel and radioactive waste systems. Collapsed from a 238-group fine-structure cross-section library (238GROUPNDF5), this broad-group library contains approximately 300 nuclides from the ENDF/B-V data files. Additionally, ENDF/B-VI oxygen data have been substituted for ENDF/B-V oxygen, because of discrepancies in ENDF/B-V data.

The 44GROUPNDF5 library was tested against its parent library using a set of 33 benchmark problems in order to demonstrate that the collapsed set was an acceptable representation of 238GROUPNDF5. Validation of the library within the SCALE system was based on a comparison of calculated values of k_{eff} with that of 93 experiments: 92 critical and 1 subcritical experiments. The experiments primarily consisted of various configura-tions of light-water-reactor-type fuel representative of transportation and storage conditions. Additional experi-ments were included to allow comparison with results obtained in earlier validation of the 27GROUPNDF4 library.

Results show that the broad 44-group structure is an acceptable representation of its parent 238-group library for thermal as well as hard fast spectrum systems. Accurate broad-group analyses of intermediate spectrum systems will require either a more detailed group structure in this energy range or a more appropriate collapsing spectrum. Further, validation calculations indicate that the 44-group library is an accurate tool in the prediction of criticality for arrays of light-water-reactor-type fuel assemblies, as would be encountered in fresh or spent fuel transportation or storage environments. However, a bias caused by inadequate representation of plutonium cross sections was identified. Futher, a possible bias exists with respect to uranium enrichment; however, experiments referenced in this report provide an inadequate sampling of uranium enrichments. Additional work will be required to quantify any bias that may be present.

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FOREWORD

This report has been prepared to fulfill documentation requirements for the project entitled "Methods Validation for the Criticality Sequences in the SCALE-4 Code System Using ENDF/B-V Data" (FIN L20262), funded by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Regulatory Research, Division of Regulatory Applications. The objective of this project is to perform methods validation of the criticality analytical sequences in the SCALE-4 code system using ENDF/B-V cross-section data. This has been accomplished through the analysis of 93 benchmark critical and subcritical experiments whose parameters (e.g., enrichment, geometry, composition, fuel/moderator ratio, etc.) cover the range of interest for light-water reactor spent fuel storage and transportation concerns. A broad-group (44 energy group) cross-section library based on ENDF/B-V data has been generated and used in all critical and subcritical analyses. The existing SCALE 27-group cross-section library has been selectively applied in order to provide a comparison with ENDF/B-IV data. The calculated values of k_{eff} have been evaluated to identify trends as a function of varied experimental parameters.

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1 INTRODUCTION

Calculations with existing neutron cross-section libraries in the analysis of spent fuel and radioactive-waste-related problems have been limited due to the lack of cross sections for many of the isotopes occurring in waste materials. Thus, in the late 1980s an effort was undertaken to produce a fine-energy-group neutron cross-section library based on evaluated data and containing a comprehensive list of nuclides. The result of this effort was a 238-group library[1] with as many nuclides as could be found in Version 5 of the Evaluated Nuclear Data Files (ENDF/B-V).[2] Although this cross-section set has been assembled for use in the SCALE system,[3] it can also be prepared in various formats for use by other independent radiation transport codes.

A broad-group library has been produced by collapse of the original 238-group library to a 44-group set of cross sections. The group structure specification for each library was based on knowledge gained from the definition and use of the 218-group and 27-group libraries developed for the SCALE system from ENDF/B-IV data.[3] Within the SCALE systgem, the designated names for the respective ENDF/B-V fine- and broad-group libraries are 238GROUPNDF5 and 44GROUPNDF5. Broad-group boundaries were chosen as a subset of the parent 238GROUPNDF5 boundaries, emphasizing the key spectral aspects of a "typical" light-water-reactor (LWR) spent fuel package. Specifically, the broad-group structure was designed to accommodate the following features: two windows in the oxygen cross-section spectrum; a window in the cross section of iron; the Maxwellian peak in the thermal range; and the 0.3-eV resonance in ^{239}Pu (which, due to its low energy and lack of resonance data, cannot be properly modeled via the SCALE Norheim Integral Treatment module NITAWL-II[4]). The resulting boundaries represent 22 fast and 22 thermal energy groups; the full group structure is given in Table 1.1. The table gives the number of fine groups represented by each broad group, to provide an indication of which energy regions are best represented or more coarsely approximated. The fine-group 238GROUPNDF5 cross sections were collapsed into this broad-group structure using a fuel cell spectrum calculated based on a 17 × 17 Westinghouse LWR assembly.[5] With the exception of the upper bound of group 23 in the 44-group cross-section set, all boundaries in the earlier 27-group ENDF/B-IV library (designated as 27GROUPNDF4 within SCALE) correspond to those used in the 44GROUPNDF5 library.

Although originally based on ENDF/B-V cross sections, both the 238GROUPNDF5 and 44GROUPNDF5 libraries have been modified to contain ENDF/B-VI oxygen cross sections. Earlier analyses with the cross-section sets have indicated that use of ENDF/B-V oxygen results in a bias in leakage with respect to k_{eff}.[1] This trend is mitigated by the use of ENDF/B-VI oxygen. Note that the differences between ENDF/B-VI and earlier ENDF/B-IV and ENDF/B-V oxygen evaluations are significant only under highly anisotropic (e.g., high leakage) situations, and that the error in ENDF/B-IV and -V oxygen is conservative, resulting in a higher calculated k_{eff}.

The purpose of this report is to validate the 44GROUPNDF5 cross-section library, using criticality safety sequences of the SCALE system. This is accomplished in two phases. First, benchmark calculations based on the collapsed 44-group library are compared with results computed from the original 238-group library. The 44-group library is then used to calculate k_{eff} for a series of critical experiments representative of water-moderated fresh and spent fuel, primarily for LWR-type fuel assemblies. Based on these results, biases and trends in the data are identified. The following paragraphs detail each of these steps.

Comparisons will be made between the 44GROUPNDF5 and 238GROUPNDF5 cross-section libraries based on results obtained for 33 benchmark critical experiments, representing a broad range of fuel types, energy spectra, and geometries. The purpose of such comparisons is to demonstrate the consistency of the collapsed 44GROUPNDF5 library relative to the original 238GROUPNDF5 library. Of the 33 benchmarks, 23 are benchmarks prescribed by the Cross Section Evaluation Working Group (CSEWG), while 5 of the remaining 10 are recognized as potential CSEWG benchmark

Table 1.1 Broad-group structure of the 44GROUPNDF5 library

Fast groups			Thermal groups		
Group	No. fine groups	Upper energy (eV)	Group	No. fine groups	Upper energy (eV)
1	(7)	2.0000×10^{7}[a]	23	(14)	3.0000×10^{0}[b]
2	(1)	8.1873×10^{6}	24	(27)	1.7700×10^{0}[a]
3	(1)	6.4340×10^{6}[a]	25	(10)	1.0000×10^{0}[a]
4	(2)	4.8000×10^{6}	26	(5)	6.2500×10^{-1}
5	(1)	3.0000×10^{6}[a]	27	(1)	4.0000×10^{-1}[a]
6	(1)	2.4790×10^{6}	28	(1)	3.7500×10^{-1}
7	(1)	2.3540×10^{6}	29	(1)	3.5000×10^{-1}
8	(2)	1.8500×10^{6}[a]	30	(2)	3.2500×10^{-1}[a]
9	(8)	1.4000×10^{6}[a]	31	(1)	2.7500×10^{-1}
10	(14)	9.0000×10^{5}[a]	32	(1)	2.5000×10^{-1}
11	(6)	4.0000×10^{5}[a]	33	(1)	2.2500×10^{-1}[a]
12	(10)	1.0000×10^{5}[a]	34	(2)	2.0000×10^{-1}
13	(1)	2.5000×10^{4}	35	(2)	1.5000×10^{-1}
14	(7)	1.7000×10^{4}[a]	36	(3)	1.0000×10^{-1}[a]
15	(11)	3.0000×10^{3}[a]	37	(2)	7.0000×10^{-2}
16	(12)	5.5000×10^{2}[a]	38	(1)	5.0000×10^{-2}[a]
17	(30)	1.0000×10^{2}[a]	39	(1)	4.0000×10^{-2}
18	(16)	3.0000×10^{1}[a]	40	(1)	3.0000×10^{-2}[a]
19	(2)	1.0000×10^{1}[a]	41	(1)	2.5300×10^{-2}
20	(6)	8.1000×10^{0}	42	(1)	1.0000×10^{-2}[a]
21	(3)	6.0000×10^{0}	43	(3)	7.5000×10^{-3}
22	(6)	4.7500×10^{0}	44	(9)	3.0000×10^{-3}
			44 Lower Energy		1.0000×10^{-5}

[a] **27-group boundaries.**
[b] **Adjusted 27-group boundary.**

candidates. Thus, these cases also represent an acceptable test of the capabilities of the reduced cross-section set over the range of conditions encompassed by these benchmark scenarios.

In order to properly validate the 44GROUPNDF5 cross-section library, it is necessary to demonstrate that it can accurately model the portion of the physical world for which its use is intended. This demonstration will be accomplished by the comparison of SCALE criticality calculations with critical experiments for conditions that are considered to be representative of the range of potential characteristics that might be encountered in LWR fresh or spent fuel systems. These calculations will be based on SCALE models of 92 unique critical experiments, comprised of 59 UO_2-fueled LWR fuel-rod lattices, 13 mixed-oxide (UO_2-PuO_2) LWR fuel-rod lattices, 5 mixed-oxide fast-reactor fuel rod lattices, and 15 other low- and high-enrichment uranium critical assemblies. The validity of the collapsed cross-section set will be established based on its capability to predict the critical condition (k_{eff} = 1) within calculational uncertainties. Statistical analyses of these results will be performed to determine any biases or trends as a function of significant variables.

In addition, a calculation based on a single subcritical experiment for a shipping cask geometry will also be included to demonstrate the capability of the library under subcritical conditions. However, because only one case is to be examined, insufficient data will be available for statistical analyses of subcritical capabilities.

Results obtained employing a given cross-section set are bound not only to the cross sections but also to the code or code system used to produce the results. Hence, the validation of the 44GROUPNDF5 library will include implicit validation of the codes and calculational sequences used within the SCALE code system, as described in the following section of this report. However, these analyses assume that because of extensive experience in the use of the SCALE system all significant biases introduced by the code are known; consequently, one can identify trends and biases present in the cross-section library. Thus, it will be possible to globally characterize the strengths and limitations of the 44GROUPNDF5 cross-section library based on the results of this validation.

Results presented in this report are the result of improved resonance processing capabilities recently implemented in the SCALE system. Although enhanced resonance data are included in the 44GROUPNDF5 library for certain isotopes, versions of SCALE prior to and including Version 4.2 are not capable of utiizing these data. Appendix C provides a description of the new resonance data included in the library and provides a comparison between validation results reported herein and those that would be obtained using Version 4.2 of SCALE.

2 DESCRIPTION OF THE CODE PACKAGE AND CALCULATIONAL SEQUENCES

The calculational results included in this report were computed using SCALE 4.2 on an IBM RS-6000/ 580 workstation. Comparisons between 44-group and 238-group libraries, described in more detail in the following section, were principally performed using the CSASN sequence prior to k_{eff} calculations using the one-dimensional (1-D) discrete-ordinates code XSDRNPM-S.[6] The criticality validation calcula-tions, which were based on more complicated geometries, were performed using KENO V.a. These calculations were performed using the CSAS25 or CSAS2X control sequences of the CSAS4 control module, with one exception (which used the CSAS1X sequence followed by a KENO V.a[7] calculation).

Material properties were computed by the SCALE Material Information Processor Library (MIPLIB),[8] based on user specifications and data contained in the SCALE Standard Composition Library.[9] All cases used BONAMI-S[10] to perform unresolved resonance shielding calculations, followed by NITAWL-II calculations to perform resolved resonance range cross-section processing for any nuclides possessing resonance parameter data. Where used, CSAS1X and CSAS2X sequences then invoked XSDRNPM-S to perform 1-D cell homogen-ization calculations to obtain cell-weighted cross sections. Finally, for all validation cases, KENO V.a was used to perform a criticality calculation for the problem, using user-specified geometry data and cross-section data prepared in the earlier steps of the SCALE sequence. Input listings for all test cases are included in Appendix A, identified by case labels used in subsequent sections of this report.

A listing of the contents of the SCALE 44GROUPNDF4 cross-section library is given in Appendix B. Note that in addition to ^{16}O, ENDF/B-VI cross sections are included for ^{14}N, ^{15}N, ^{154}Eu, and ^{155}Eu. Although by default SCALE will use the ENDF/B-V representations of these isotopes, it is possible to utilize the ENDF/B-VI cross sections if desired. The experimental bases for several fission products were expanded in ENDF/B-VI evaluations.[11] Because ^{154}Eu and ^{155}Eu are important in shielding (^{154}Eu gamma decay) and criticality (^{155}Eu decays to ^{155}Gd, a strong neutron absorber) calculations and because their cross sections changed dramatically from version V to version VI, the capability to access ENDF/B-VI data is provided in the library. The ENDF/B-VI versions of ^{14}N and ^{15}N were added together with ENDF/B-VI ^{16}O in the study of effects which were later attributed to ENDF/B-V ^{16}O. No reason was seen to remove them from the library, although no significant differences exist between the two versions.

The latest version of the SCALE code package can be obtained by contacting the Radiation Shielding Information Center (RSIC) at the following address:

Radiation Shielding Information Center
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The input for all test cases listed in Appendix A can be obtained as part of the data package containing both the 44- and 238-group libraries. This data package can also be obtained by contacting RSIC.

3 COMPARISON OF 44-GROUP AND 238-GROUP RESULTS

Initial testing of the 238GROUPNDF5 library was based on the comparison of results for a series of 33 benchmark criticals with the results obtained for these problems using other ENDF/B-V-based cross-section libraries.[1] Therefore, these cases were selected for comparison of the 44GROUPNDF5 cross-section set to its parent library. This benchmark set consists of 7 Pu-fueled, 1 ^{233}U-fueled, and 25 ^{235}U-fueled cases, 15 of which are characterized as fast, while the remainder are thermal systems. Twenty-eight of the cases are CSEWG benchmarks or potential candidates; the remainder were found to be of interest in ENDF/B-V data testing. The specifications for these benchmarks are available elsewhere,[12-16] and are not discussed here.

With only one exception, each of the benchmark calculations was calculated within the SCALE-4 system using the CSASN criticality sequence followed by an XSDRNPM calculation. CSASN used BONAMI-S to perform resonance processing for unresolved resonances in resonance materials; NITAWL-II then performed resolved range resonance processing for these materials. Output cross sections were read by XSDRNPM, which was used to perform a 1-D discrete-ordinates calculation to deter-mine k_{eff} for each problem. For the single exception, the CSAS25 criticality sequence was used because of complexities in the problem geometry. The cross-section resonance processing was performed in the same manner as above; however, the Monte Carlo code, KENO V.a, was used to compute k_{eff}.

Table 3.1 presents the k_{eff} computed for each of the "fast" spectrum benchmarks for each cross-section library. Overall, agreement between fine-group and broad-group results is good; the average difference between the results from the two cross-section sets is 1.02%. This percentage is better than might be expected, especially since the 44GROUPNDF5 library was collapsed using a thermal LWR spectrum, and because the group structure was tailored toward thermal systems. It can be seen from Table 1.1 that a fair degree of the fast group structure was retained in the higher energy fast groups, in order to accurately model fission neutron energies. However, in the range 3 keV to 1 eV, 137 fine groups were collapsed into 11 broad groups, because this region is of little importance in thermal systems due to rapid slowing down. Such group structure implies that (neglecting the effects of the assumed spectrum used for weighting) a fast system with a hard spectrum could be reasonably well modeled, since neutron energies remain principally in the fission energy region. However, one should also expect more error in systems with a softer spectrum, since the neutron population increases in the lower energy regions where the group structure is much more broad. This is confirmed by the results given in Table 3.1; the ZPR and HISS benchmark cases represent a softer energy spectrum than in the other fast benchmarks.[17] Discrepancies in this area are therefore expected, but are not of consequence since such fast systems lie outside the range of applications for which the broad-group library was derived.

The results for the thermal benchmarks are given in Table 3.2. As would be expected, relative results for thermal benchmarks were found to be in better agreement than fast benchmarks. Differences between the broad- and fine-group results ranged from -0.19% to 0.44%, with an average difference of 0.13%.

Based on the results for the benchmarks described above, one may conclude that the 44GROUPNDF5 library is a valid representation of its parent library, and that the collapsing procedure was performed correctly. Additionally, although results are reasonable for fast spectrums, best agreement is seen in the energy range and geometries for which the library was developed. Although validation requires testing of acceptable cross-section performance against "typical" physical systems, this comparison has served to reinforce confidence in the capabilities of the 44GROUPNDF5 library for a wide range of problems.

Table 3.1 Comparison of 238-group and 44-group fast benchmarks

Case name	Description	238GROUPNDF5 k_{eff}	44GROUPNDF5 k_{eff}	Difference
JEZEBEL	Bare sphere of plutonium	0.9965	0.9980	0.16%
JEZEBEL-PU	Bare sphere of plutonium (20.1% ^{240}Pu)	0.9983	1.0002	0.18%
JEZEBEL-23	Bare sphere of U (98.13 atomic % ^{233}U)	0.9939	0.9952	0.14%
GODIVA	Bare sphere of highly enriched uranium	0.9980	1.0014	0.35%
FLATTOP-25	Reflected sphere of highly enriched U	1.0046	0.9982	-0.64%
BIG TEN	Reflected cylinder of U (10 wt % ^{235}U)	1.0103	1.0193	0.89%
ZPR-3/11	7:1 fertile to fissile uranium system	1.0119	1.0205	0.85%
ZPR-3/12	4:1 uranium-graphite system	1.0071	1.0142	0.70%
ZPR-6/6A	Enriched UO_2-fueled fast critical assembly	0.9981	1.0252	2.71%
ZPR-6/7	PuO_2-fueled fast critical assembly	0.9967	1.0356	3.90%
H2OX-1	Water-reflected U-metal sphere	1.0006	1.0045	0.39%
UH3-UR	Uranium hydride/U reflector	1.0112	1.0066	-0.46%
UH3-NI	Uranium hydride/Ni reflector	1.0223	1.0106	-1.15%
HISS(HUG)	Homogeneous uranium-graphite	1.0241	1.0137	-1.02%
HISS(HPG)	Homogeneous plutonium-graphite	1.0005	0.9827	-1.78%
Average		1.0049		0.35%[a]

[a]Average of absolute error = 1.02%.

Table 3.2 Comparison of 238-group and 44-group thermal benchmarks

Case name	Description	238GROUPNDF5 k_{eff}	44GROUPNDF5 k_{eff}	Difference
ORNL-1	$UO_2(NO_3)$ in H_2O	0.9987	0.9986	-0.01%
ORNL-2	$UO_2(NO_3)$ in H_2O w/boron	0.9985	0.9984	-0.01%
ORNL-3	$UO_2(NO_3)$ in H_2O w/boron	0.9955	0.9954	0.00%
ORNL-4	$UO_2(NO_3)$ in H_2O w/boron	0.9969	0.9969	0.00%
ORNL-10	$UO_2(NO_3)$ in H_2O	0.9980	0.9978	-0.01%
TRX-1	Uranium (1.3 wt % ^{235}U) rods	0.9908	0.9927	-0.19%
TRX-2	Uranium (1.3 wt % ^{235}U) rods	0.9946	0.9954	0.07%
BAPL-1	UO_2 (1.3 wt % ^{235}U) rods, H_2O / fuel vol. = 1.43	0.9921	0.9964	0.44%
BAPL-2	UO_2 (1.3 wt % ^{235}U) rods, H_2O / fuel vol. = 1.78	0.9938	0.9972	0.34%
BAPL-3	UO_2 (1.3 wt % ^{235}U) rods, H_2O / fuel vol. = 2.40	0.9963	0.9987	0.24%
L-7	UO_2F_2 in H_2O	1.0031	1.0052	0.21%
L-8	UO_2F_2 in H_2O	1.0064	1.0061	-0.03%
L-9	UO_2F_2 in H_2O	1.0032	1.0029	-0.02%
L-10	UO_2F_2 in H_2O	1.0042	1.0058	0.16%
L-11	UO_2F_2 in H_2O	1.0012	1.0012	0.00%
PNL-3	Homogeneous Pu-H_2O assemblies	0.9951	0.9960	0.09%
PNL-6B	Homogeneous Pu-H_2O assemblies	1.0057	1.0091	0.34%
PNL-11	Homogeneous Pu-H_2O assemblies	1.0000 ± 0.0034	1.0078 ± 0.0010	0.40%
Average		0.9986	1.0001	0.13%[a]

[a]Average of absolute error = 0.14%.

4 VALIDATION AGAINST CRITICAL EXPERIMENTS

Validation of the 44GROUPNDF5 library will be based on the results of a series of 93 calculations created to model 92 relevent critical experiments and one subcritical experiment. These experiments have been selected primarily because of their similarity in physical structure and composition to those for which the library was developed (i.e., fuel assemblies from LWR systems). The set of experiments consists of four subsets based on experiment type: 60 UO_2 LWR-type fuel lattices with a broad variety of arrangements and contents (including one subcritical experiment); 13 mixed-oxide LWR lattice experiments containing varying amounts and enrichments of PuO_2; 15 uranium-based experiments used in the earlier validation of the 27-group ENDF/B-IV SCALE library (27GROUPNDF4);[18] and 5 mixed-oxide, H_2O-moderated experiments using fast reactor rods. These experiments represent a mixed sampling of various moderator/fuel volume ratios, lattice types and pitches, absorber types and concentrations, and reflectors, and are felt to be representative of the many possible configurations of LWR fuel transportation and storage scenarios.

The LWR-type fuel lattice experiments were selected as the most representative of "typical" low-enrichment UO_2 LWR assemblies. The selections contain enrichments ranging from 2.35 to 5.74 wt % ^{235}U; cadmium, boron, Boral, Boroflex, Ag-In-Cd, gadolinium, polyethylene, and stainless steel were used as absorbers; and uranium, lead, and steel reflectors were represented. Various lattice shapes and pitches are represented, with moderator-to-fuel volume ratios ranging from 0.509 to 5.067.

The LWR-type mixed-oxide fuel lattice experiments were included in order to demonstrate the capability of the 44GROUPNDF5 cross-section set to treat the presence of plutonium isotopes in a fuel lattice, as would be expected in an array of spent fuel assemblies. The experiments contained varying amounts of soluble boron, triangular and square-lattice arrangements, varying pitches, and one experiment with a lattice comprised of a pattern of alternating UO_2 and MOX rods. All MOX rods consisted of natural uranium in oxide form, mixed with 90% ^{239}Pu-enriched plutonium oxide, in PuO_2 fractions of 2 and 6.6 wt %.

Experiments using the Fast Flux Test Facility (FFTF)-type fuel rods were selected in order to include fast-reactor-type fuels in the validation study. Although these fuel rods were designed for use in a fast reactor spectrum, the experiments themselves represent thermal systems of water-moderated FFTF rods such as might be experienced in the storage or transportation of such fuels. The fuel rods were comprised of 80 wt % natural UO_2; the balance were comprised of PuO_2, enriched to 86 wt % ^{239}Pu. Such a high content of plutonium grossly exceeds that anticipated in commercial LWR spent fuel assemblies; however, inclusion of these experiments will broaden the range of applicability of this validation, and will help to indicate whether significant trends exist based on the quantity of plutonium present in MOX fuel rods.

The last set of critical experiments contains a wide variety of uranium criticals—some in the form of UO_2, others based on homogenized solid mixtures containing uranium, and the remainder in the form of homogenous solutions containing uranium. The solid systems are all low-enrichment systems (2-4.46 wt % ^{235}U), while the liquid systems are all highly enriched (93.2 wt % ^{235}U) systems. Even though many of these experiments do not match the primary intended applications of the 44GROUPNDF5 library, it was considered important to include them in order (1) to demonstrate the versatility of the cross-section library, and (2) to allow comparison with results obtained for these experiments using the 27GROUPNDF4 library.

The final experiment calculated in this report was that of a subcritical transportation cask configuration. This experiment consisted of 4.31 wt % enriched UO_2 rods arranged in a shipping cask geometry. The measured k_{eff} for the geometry has been reported as between 0.91 and 0.92. The significance of this calculation will be discussed briefly later in this report, but clearly cannot be included in the analyses of critical systems described herein. The purpose of the inclusion of this single experiment was

Table 4.1 Validation test cases using the 44GROUPNDF5 library cross sections

Case No.	Case Designation	Enrich. (wt %)	Description	Lattice water/fuel volume ratio	Ref.	k_{eff}	$\pm\sigma$	Average fission group
LWR-type UO_2 fuel pin lattices								
1	p2438x05	2.35	No absorber plates	2.92	19	0.9947	0.0013	36.29
2	p2438x17	2.35	Boral absorber plates	2.92	19	0.9974	0.0010	36.21
3	p2438x28	2.35	Stainless steel absorber plates	2.92	19	1.0007	0.0014	36.28
4	p2615x14	4.31	Stainless steel absorber plates	3.88	20	0.9966	0.0014	35.75
5	p2615x23	4.31	Cadmium absorber plates	3.88	20	0.9976	0.0015	35.73
6	p2615x31	4.31	Boral absorber plates	3.88	20	0.9990	0.0016	35.74
7	p2827u2a	2.35	Uranium reflector	2.92	21	1.0021	0.0012	35.14
8	p2827l2a	2.35	Lead reflector	2.92	21	1.0029	0.0014	36.23
9	p2827non	2.35	No reflector	2.92	21	0.9946	0.0014	36.30
10	p2827u2b	4.31	Uranium reflector	3.88	21	1.0033	0.0014	34.12
11	p2827l2b	4.31	Lead reflector	3.88	21	1.0096	0.0008	35.67
12	p3314a	4.31	0.226 cm Boroflex absorber plates	1.6	22	1.0038	0.0016	33.24
13	p3314b	4.31	0.452 cm Boroflex absorber plates	1.6	22	1.0001	0.0011	33.23
14	p3602n2	2.35	Steel reflector, no absorber	2.92	23	0.9917	0.0013	36.18
15	p3602non	4.31	Steel reflector, no absorber	1.6	23	0.9981	0.0016	33.43
16	p3602s4	4.31	Steel reflector, borated steel absorber plates	1.6	23	0.9936	0.0016	33.32
17	p3602b4	4.31	Steel reflector, Boral absorber plates	1.6	23	0.9950	0.0015	33.29
18	p3602c4	4.31	Steel reflector, cadmium absorber plates	1.6	23	0.9979	0.0011	33.28
19	p3926u2a	2.35	Uranium reflector	1.6	24	1.0020	0.0013	33.68
20	p3926l2a	2.35	Lead reflector	1.6	24	1.0010	0.0013	34.94
21	p3926n2	2.35	No reflector	1.6	24	0.9974	0.0014	35.07
22	p3926u4a	4.31	Uranium reflector	1.6	24	1.0036	0.0016	32.46
23	p3926l4a	4.31	Lead reflector	1.6	24	1.0069	0.0015	33.42
24	p3926nob	4.31	No reflector	1.6	24	0.9988	0.0016	33.59
25	p4267a	4.31	No soluble boron	1.59	25	0.9975	0.0011	33.55
26	p4267b	4.31	2550 ppm soluble boron	1.59	25	1.0037	0.0013	31.57
27	p4267c	4.31	No soluble boron	1.09	25	0.9994	0.0011	32.04
28	p4267d	4.31	2550 ppm soluble boron	1.09	25	0.9945	0.0013	30.01
29	pnl194	4.31	Hexagonal lattice, narrow pitch	0.509	26	1.0088	0.0014	27.66
30	ft214r	4.31	Flux traps, no voids	1.6	27	0.9955	0.0016	32.86
31	ft214v3	4.31	Flux traps with voids	1.6	27	0.9967	0.0011	32.87
32	baw1231a	4	Core I - 1152 ppm soluble borom	0.994	28	0.9962	0.0010	31.14
33	baw1231b	4	Core I - 3389 ppm soluble borom	0.994	28	0.9981	0.0008	29.93
34	baw1273m	2.46	Core XX - 1675 ppm soluble boron	0.999	29	0.9980	0.0011	32.22
35	baw1484a	2.46	Core IV - 84 B4C pins - 1 pitch between assemblies	1.84	30	0.9942	0.0010	34.65
36	baw1484b	2.46	Core IX - No B4C pins - 4 pitches between assemblies	1.84	30	0.9944	0.0014	35.42
37	baw1484c	2.46	Core XIII - 1.6 wt% Boral - 1 pitch between assemblies	1.84	30	0.9962	0.0014	34.55
38	baw1484d	2.46	Core XXI - 0.1 wt% Boral - 3 pitches between assemblies	1.84	30	0.9920	0.0015	35.17
39	baw1645t	2.46	Triangular pitch, pitch = pin O.D.	0.149	31	1.0069	0.0009	29.08

Table 4.1 (continued)

Case No.	Case Designation	Enrich. (wt %)	Description	Lattice water/fuel volume ratio	Ref.	k_{eff}	$\pm\sigma$	Average fission group
LWR-type UO_2 fuel pin lattices								
40	baw1645s	2.46	Square pitch, pitch = pin O.D.	0.383	31	1.0045	0.0012	30.00
41	bw1645so	2.46	Square pitch, pitch = 1.17*pin O.D.	1.014	31	0.9986	0.0012	32.77
42	bnw1810a	2.46 and 4.02	Core 12 - No Gd fuel rods	1.84 and 1.53	32	1.0008	0.0011	32.93
43	bnw1810b	2.46 and 4.02	Core 14 - 12 Gd fuel rods	1.84 and 1.53	32	0.9999	0.0011	33.11
44	bnw1810c	2.46 and 4.02	Core 16 - 16 Gd fuel rods	1.84 and 1.53	32	0.9958	0.0011	33.14
45	e196u6n	2.35	0.615 in. pitch, 0 ppm soluble boron	1.196	33	0.9936	0.0015	33.91
46	epru615b	2.35	0.615 in. pitch, 464 ppm soluble boron	1.196	33	1.0004	0.0013	33.40
47	epru75	2.35	0.750 in. pitch, 0 ppm soluble boron	2.408	33	0.9966	0.0010	35.87
48	epru75b	2.35	0.750 in. pitch, 568 ppm soluble boron	2.408	33	0.9986	0.0008	35.30
49	e196u87c	2.35	0.870 in. pitch, 0 ppm soluble boron	3.687	33	0.9998	0.0013	36.63
50	epru87b	2.35	0.870 in. pitch, 286 ppm soluble boron	3.687	33	1.0000	0.0012	36.34
51	saxu56	5.74	2 lattice pitches, SS clad, 0.56 in. pitch	1.933	34	0.9932	0.0017	33.27
52	saxu792	5.74	2 lattice pitches, SS clad, 0.792 in. pitch	5.067	34	0.9995	0.0011	35.91
53	w3269a	3.7	Ag-In-Cd (0.330 in. O.D) absorber rods, 0.405 in. pitch	2.2	35	1.0063	0.0010	31.38
54	w3269b	3.7	Ag-In-Cd (0.330 in. O.D) absorber rods, 0.435 in. pitch	2.9	35	0.9983	0.0014	32.49
55	w3269c	2.72	Ag-In-Cd (0.403 in. O.D) absorber rods, 0.600 in. pitch	3.1	35	0.9939	0.0010	33.87
56	ans33bp2	4.75	Cruciform box, polyethylene powder absorbers	1.81	36	0.9987	0.0012	34.07
57	ans33bb2	4.75	Cruciform box, polyethylene balls absorbers	1.81	36	1.0096	0.0011	34.30
58	ans33bh2	4.75	Cruciform box only	1.81	36	1.0129	0.0012	34.42
59	ans33h2	4.75	No absorbers	1.81	36	0.9983	0.0011	34.42
LWR-type mixed-oxide (UO_2-PuO_2) fuel pin lattices								
60	epri70un	^{235}U: 0.72 ^{239}Pu: 90	0.700 in. pitch, 0 ppm soluble boron, 2 wt % PuO_2	1.195	33	0.9991	0.0015	31.67
61	epri70b	^{235}U: 0.72 ^{239}Pu: 90	0.700 in. pitch, 681 ppm soluble boron, 2 wt % PuO_2	1.195	33	1.0007	0.0014	30.91
62	epri87un	^{235}U: 0.72 ^{239}Pu: 90	0.870 in. pitch, 0 ppm soluble boron,	1.527	33	1.0046	0.0010	34.36
63	epri87b	^{235}U: 0.72 ^{239}Pu: 90	0.870 in. pitch, 1090 ppm soluble boron, 2 wt % PuO_2	1.527	33	1.0079	0.0012	33.33
64	epri99un	^{235}U: 0.72 ^{239}Pu: 90	0.990 in. pitch, 0 ppm soluble boron, 2 wt % PuO_2	3.641	33	1.0059	0.0015	35.20
65	epri99b	^{235}U: 0.72 ^{239}Pu: 90	0.990 in. pitch, 767 ppm soluble boron, 2 wt % PuO_2	3.641	33	1.0111	0.0009	34.42

Table 4.1 (continued)

Case No.	Case Designation	Enrich. (wt %)	Description	Lattice water/fuel volume ratio	Ref.	k_{eff}	$\pm\sigma$	Average fission group
LWR-type mixed-oxide (UO_2-PuO_2) fuel pin lattices (continued)								
66	saxton52	^{235}U: 0.72 ^{239}Pu: 90	UO_2/PuO_2 square lattice, 0.52 in. pitch, 6.6 wt % PuO_2	1.681	34	0.9985	0.0011	30.28
67	saxton56	^{235}U: 0.72 ^{239}Pu: 90	UO_2/PuO_2 square lattice, 0.56 in. pitch, 6.6 wt % PuO_2	2.165	34	0.9993	0.0016	31.47
68	saxtn56b	^{235}U: 0.72 ^{239}Pu: 90	UO_2/PuO_2 square lattice, 0.56 in. pitch, 337 ppm boron, 6.6 wt % PuO_2	2.165	34	0.9986	0.0016	31.01
69	saxtn735	^{235}U: 0.72 ^{239}Pu: 90	UO_2/PuO_2 square lattice, 0.735 in. pitch, 6.6 wt % PuO_2	4.699	34	1.0034	0.0016	34.18
70	saxtn792	^{235}U: 0.72 ^{239}Pu: 90	UO_2/PuO_2 square lattice, 0.792 in. pitch, 6.6 wt % PuO_2	5.673	34	1.0017	0.0016	34.67
71	saxtn104	^{235}U: 0.72 ^{239}Pu: 90	UO_2/PuO_2 square lattice, 1.04 in. pitch, 6.6 wt % PuO_2	10.754	34	1.0042	0.0016	35.82
72	pnl4976	^{235}U: 0.72 ^{239}Pu: 90 and ^{235}U: 4.31	MOX & UO_2 rods in uniform pattern, 2 wt % PuO_2 in MOX	0.460 and 0.509	26	1.0021	0.0013	27.10
Fast Reactor (FFTF) Mixed-Oxide (UO_2-PuO_2) Fuel Pin Lattices								
73	p5803x21	^{235}U: 0.72 ^{239}Pu: 86	FFTF rods, H_2O Moderated, 0.968 cm pitch, 20 wt % PuO_2	3.49	37	1.0031	0.0011	30.10
74	p5803x32	^{235}U: 0.72 ^{239}Pu: 86	FFTF rods, H_2O Moderated, 1.935 cm pitch, 20 wt % PuO_2	18.13	37	1.0068	0.0016	35.42
75	p5803x43	^{235}U: 0.72 ^{239}Pu: 86	FFTF rods, H_2O Moderated, 1.242 cm pitch, 20 wt % PuO_2	6.65	37	1.0044	0.0011	32.88
76	p5803x67	^{235}U: 0.72 ^{239}Pu: 86	FFTF rods, H_2O Moderated, 0.761 cm pitch, 20 wt % PuO_2	1.62	37	1.0009	0.0011	27.53
77	p5803x68r	^{235}U: 0.72 ^{239}Pu: 86	FFTF rods, H_2O Moderated, 1.537 cm pitch, 20 wt % PuO_2	10.93	37	1.0065	0.0016	34.37
Miscellaneous Uranium Criticals								
78	cr1071as	4.46	U_3O_8, 42 fuel cans, 2.44 cm spacing	0.77	38	1.0207	0.0011	32.45
79	cr1653as	4.46	U_3O_8, 38 fuel cans, 2.44 cm spacing	1.25	39	1.0146	0.0011	32.77
80	cr1653b	4.46	U_3O_8, 119+2S fuel cans, 93.2 wt % uranium driver	1.25	39	1.0148	0.0012	28.78
81	cr2500s	4.46	U_3O_8, 30 fuel cans, 2.44 cm spacing	2.03	40	1.0194	0.0012	33.22
82	ydr14un2	2	Homogenized uranium in paraffin, unreflected	H/^{235}U= 293.9	41	1.0020	0.0014	35.39
83	ydr14pl2	2	Homogenized uranium in paraffin, Plexiglas & paraffin reflectors	H/^{235}U= 406.3	41	1.0023	0.0013	36.48

Table 4.1 (continued)

Case No.	Case Designation	Enrich. (wt %)	Description	Lattice water/fuel volume ratio	Ref.	keff	±σ	Average fission group
Miscellaneous Uranium Criticals (continued)								
84	ydr14pl3	3	Homogenized uranium in paraffin, Plexiglas & paraffin reflectors	$H/^{235}U$= 133.4	41	1.0180	0.0015	33.88
85	ydr14un3	3	Homogenized uranium in paraffin, no reflector	$H/^{235}U$ = 133.4	41	1.0177	0.0016	33.12
86	or260901	93.2	UO_2F_2 solution sphere, no reflector	$H/^{235}U$ = 1112	42	1.0077	0.0014	38.60
87	or260906	93.2	UO_2F_2 solution sphere, H_2O reflector	$H/^{235}U$ = 1270	42	1.0020	0.0013	38.71
88	rfp2710u	93.2	$UO_2(NO_3)_2$ solution, 142.9 g U/l, cylinder, no reflector		43	1.0052	0.0021	36.08
89	rfp2710r	93.2	$UO_2(NO_3)_2$ solution, 345.3 g U/l, cylinder, Plexiglas reflector		43	1.0031	0.0020	33.22
90	or2968s1	4.89	UO_2F_2 solution, 42.54 g ^{235}U/l, SS cylinder, no reflector	$H/^{235}U$ = 524	44	0.9909	0.0016	37.46
91	or2968al	4.89	UO_2F_2 solution, 42.54 g ^{235}U/l, Al box, H_2O reflector	$H/^{235}U$ = 524	44	1.0062	0.0010	37.66
92	or2968s2	4.89	UO_2F_2 solution, 24.22 g ^{235}U/l, SS cylinder, no reflector	$H/^{235}U$ = 994	44	0.9990	0.0008	38.27
Subcritical								
93	p6838	4.31	Shipping cask geom, Experiment TTC-5, measured k_{eff} = 0.91 - 0.92	1.6	45	0.9057	0.0016	33.17

to demonstrate the capability of 44GROUPNDF5 cross sections to adequately repre-sent such a system. Results of the criticality calculations for the 92 critical experiments and the single subcritical experiment are given in Table 4.1 (Refs. 19–45). In addition to the calculated values of effective multiplication factors with their associated standard deviations, this table includes a brief description of each experiment, including fuel enrichment, water/fuel volume ratios, average energy group in which fission occurs, and the reference number corresponding to the document in which each experiment is fully described. The table is divided into five sections, representing the five subsets of experiments described earlier: (1) cases 1–59 are LWR UO_2 lattice experiments; (2) cases 60–72 are LWR MOX lattice experiments; (3) cases 73–77 are FFTF MOX lattices; (4) cases 78–92 represent miscellaneous uranium criticals; and (5) case 93 is the single LWR UO_2 subcritical lattice experiment. In the following paragraphs, each of these five classes of experiments are discussed, based on trends or biases observed within each subset. Four additional classes of experiments are also studied, based on groupings of two or more of the original subsets: LWR-type lattices (critical UO_2 LWR lattice plus MOX LWR lattice experiments, cases 1–72), MOX lattices (MOX LWR lattice plus MOX FFTF lattice experiments, cases 60–77), lattice (combined LWR-UO_2, LWR-MOX, and FFTF-MOX lattice experiments, cases 1–77), and total (all critical experiments, cases 1–92).

4.1 LWR UO_2 CRITICAL EXPERIMENTS

The calculational results are good for calculations based on this set of criticals, with the nominal computed value of k_{eff} ranging from 0.9917 to 1.0129, and a mean value for k_{eff} of 0.9993 ± 0.0047. Statistical analyses of k_{eff} vs various independent variables [i.e., enrichment, moderator/fuel ratios, average energy group for fission (AEG), boron concentration, and reference number] indicate no significant correlations, with one exception. The line fit through the data appears to indicate an increase in calculated k_{eff} with increasing ^{235}U enrichment, as shown in Fig. 4.1. However, the set of experiments is limited to only a few specific enrichments, and there is a wide spread in the k_{eff} values for most enrichments. Visual examination of Fig. 4.1 and the low measure of correlation (R = 0.368) suggest that the statistical validity of this trend is questionable. Based on these results, no conclusions can be drawn.

Table 4.2 provides a comparison of results using the 44GROUPNDF5 and 27GROUPNDF4 libraries for most of the UO_2 LWR cases.[46,47] Note that better results are obtained using the ENDF/B-V cross sections, and that on the average the k_{eff} values calculated with these cross sections are 0.5% higher than those computed using ENDF/B-IV cross sections.

4.2 LWR MIXED-OXIDE CRITICAL EXPERIMENTS

Results are also found to be acceptably close to unity for this set of criticality calculations. Nominal k_{eff} values range from 0.9985 to 1.0111 and have a mean value of 1.0029 ± 0.0039. As with the previous group of experiments, statistical analyses were performed for relationships between k_{eff} and other independent parameters. Enrichments in both ^{235}U and ^{239}Pu are the same for all experiments; hence, there are insufficient data to determine the effect of enrichment on k_{eff}. However, a strong positive correlation is seen between the average fission energy group and k_{eff}, as illustrated in Fig. 4.2; no such trend was observed in the UO_2 critical experiments. A positive correlation is also observed between k_{eff} and the moderator-to-fuel volume ratio; however, this results from the previous correlation and the fact that the volume ratio is strongly correlated to the average energy group, as would be expected.

Table 4.3 presents k_{eff} results using both the 44GROUPNDF5 and 27GROUPNDF4 libraries for all of the MOX LWR cases. An interesting trend can be seen in these results: while the Electric Power Research Institute (EPRI) and Pacific Northwest Laboratory (PNL) calculations based on ENDF/B-IV cross sections (2% PuO_2 by weight) tend to be less than the ENDF/B-V results (averaging 0.42% lower), the SAXTON (6.6 wt % PuO_2) 27GROUPNDF4 results are greater than those obtained using the 44GROUPNDF5 library (averaging 0.33% higher). This comparison indicates a difference in the trend for k_{eff} to increase with larger plutonium content.

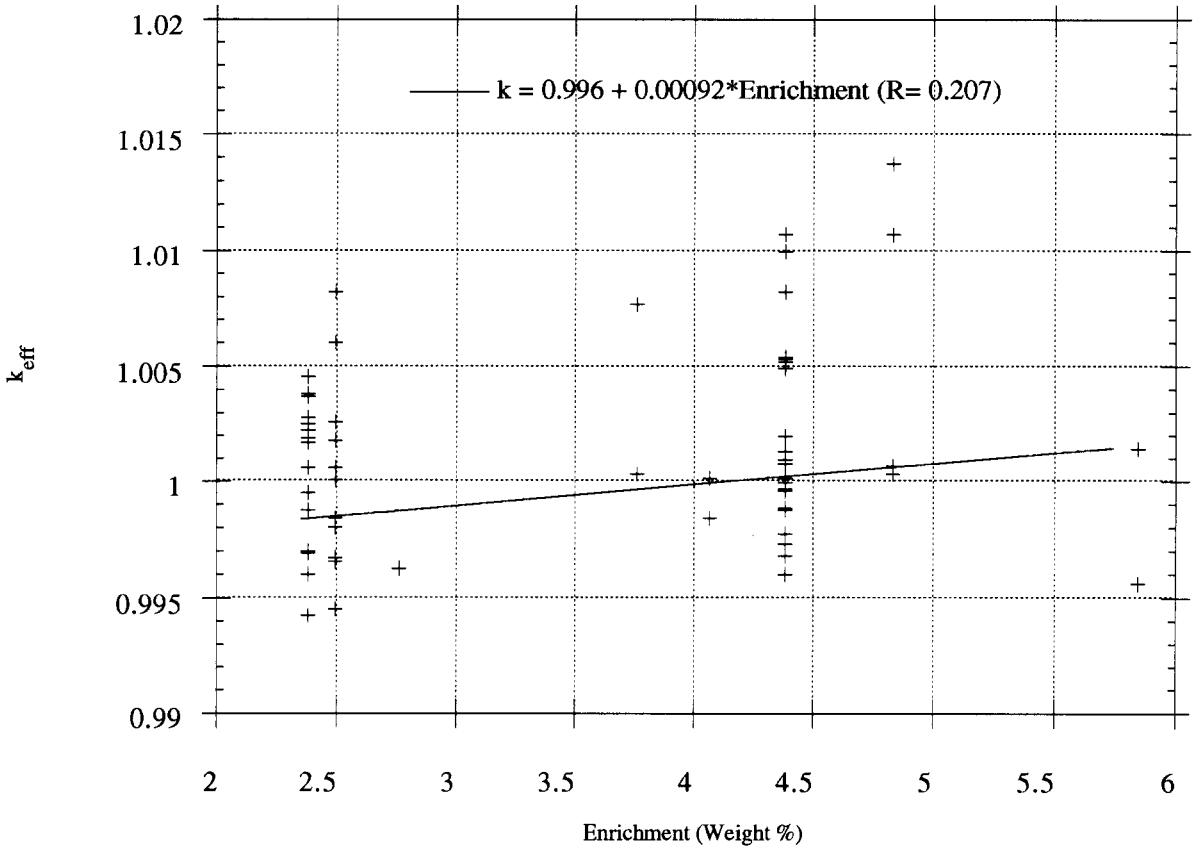

Figure 4.1 k_{eff} as a function of ^{235}U enrichment for UO_2 LWR critical experiments

Table 4.2 Comparison of 44GROUPNDF5 and 27GROUPNDF4 results for UO_2 LWR lattice cases

Case No.	Case Designation	44GROUPNDF5 k_{eff}	44GROUPNDF5 ±σ	27GROUPNDF4 k_{eff}	27GROUPNDF4 ±σ
1	p2438x05	0.9947	0.0013	0.9950	0.0021
2	p2438x17	0.9974	0.0010	0.9970	0.0022
3	p2438x28	1.0007	0.0014	0.9890	0.0029
15	p3602non	0.9981	0.0016	0.9979	0.0023
22	p3926u4a	1.0036	0.0016	0.9971	0.0020
23	p3926l4a	1.0069	0.0015	1.0046	0.0024
25	p4267a	0.9975	0.0011	0.9920	0.0024
26	p4267b	1.0037	0.0013	0.9925	0.0016
27	p4267c	0.9994	0.0011	0.9903	0.0023
28	p4267d	0.9945	0.0013	0.9870	0.0015
30	ft214r	0.9955	0.0016	0.9894	0.0021
31	ft214v3	0.9967	0.0011	0.9971	0.0022
35	baw1484a	0.9942	0.0010	0.9893	0.0022
42	bnw1810a	1.0008	0.0011	0.9919	0.0015
43	bnw1810b	0.9999	0.0011	0.9939	0.0011
44	bnw1810c	0.9958	0.0011	0.9911	0.0011
45	e196u6n	0.9936	0.0015	0.9903	0.0021
49	e196u87c	0.9998	0.0013	0.9953	0.0019
51	saxu56	0.9932	0.0017	0.9902	0.0024
52	saxu792	0.9995	0.0011	0.9940	0.0024
Average			0.9983		0.9932

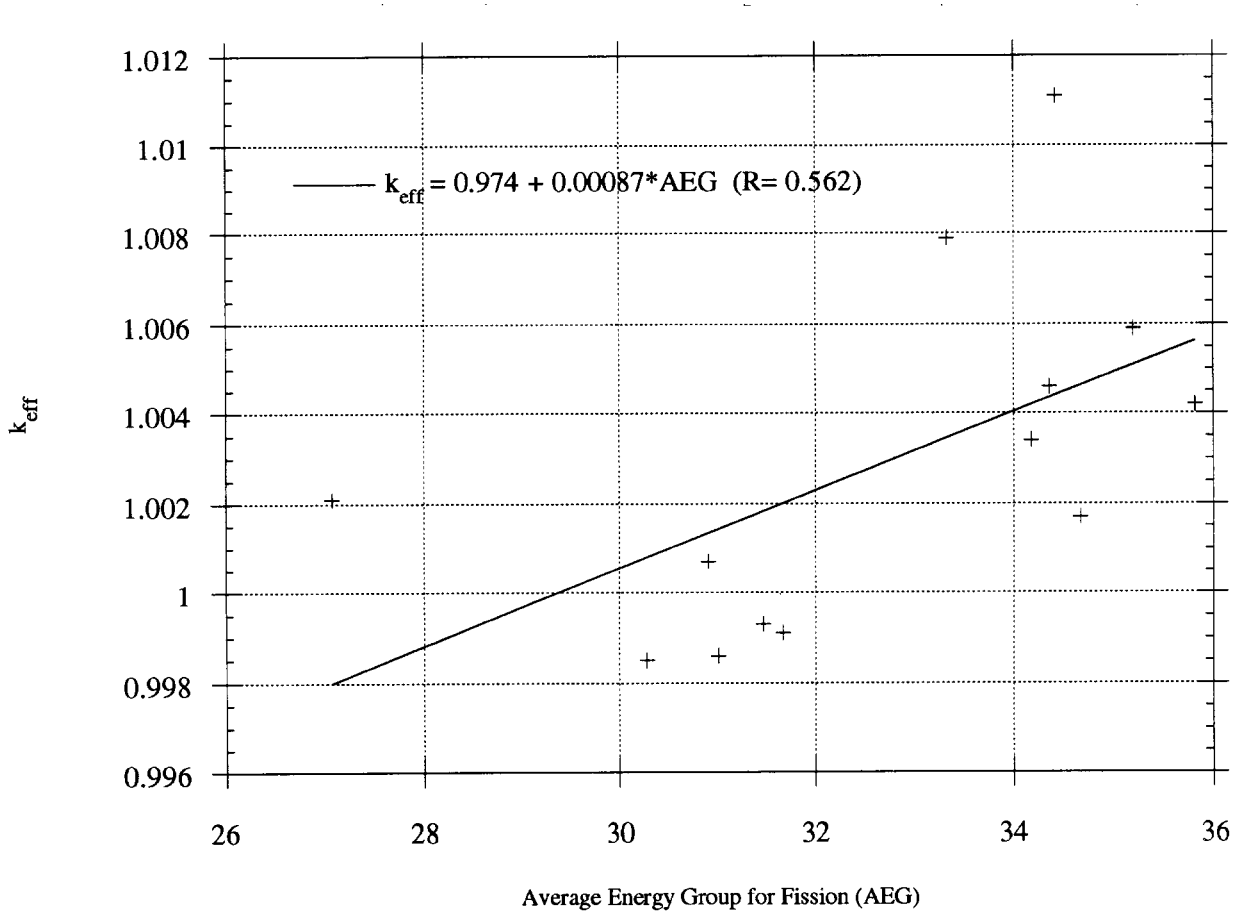

Figure 4.2 k_{eff} as a function of AEG for LWR-MOX critical experiments

Table 4.3 Comparison of 44GROUPNDF5 and 27GROUPNDF4 results for mixed-oxide LWR lattice cases

Case No.	Case Designation	44GROUPNDF5 k_{eff}	44GROUPNDF5 ±σ	27GROUPNDF4 k_{eff}	27GROUPNDF4 ±σ
60	epri70un	0.9991	0.0015	0.9945	0.0017
61	epri70b	1.0007	0.0014	0.9943	0.0016
62	epri87un	1.0046	0.0010	1.0002	0.0017
63	epri87b	1.0079	0.0012	1.0085	0.0012
64	epri99un	1.0059	0.0015	1.0055	0.0020
65	epri99b	1.0111	0.0009	1.0057	0.0019
66	saxton52	0.9985	0.0011	0.9981	0.0023
67	saxton56	0.9993	0.0016	1.0052	0.0021
68	saxtn56b	0.9986	0.0016	1.0011	0.0027
69	saxtn735	1.0034	0.0016	1.0068	0.0025
70	saxtn792	1.0017	0.0016	1.0067	0.0025
71	saxtn104	1.0042	0.0016	1.0075	0.0019
72	pnl4976	1.0021	0.0013	0.9840	0.0020
Average		1.0029	1.0014		

Such a trend is known to exist using ENDF/B-IV cross sections; this difference indicates that perhaps the trend is not as large when ENDF/B-V cross sections are used. This will be examined further in the discussion of the combined results for all MOX lattice calculations which contain a larger distribution of plutonium concentrations.

4.3 FFTF MIXED-OXIDE CRITICAL EXPERIMENTS

For SCALE calculations based on this set of five experiments, a mean k_{eff} of 1.0043 ± 0.0025 was obtained. These results are acceptable, but indicate a possible bias in k_{eff}. In these experiments, the only parameter that was changed was the lattice pitch. Because the systems were H_2O moderated, one would expect to observe increased moderation with increasing pitch size and thus see the AEG value increase (i.e., average energy decrease) with increasing pitch. This behavior is found to be the case; an exponential variation in AEG is observed as the pitch increases, as shown in Fig. 4.3. Furthermore, based on the trend observed for the LWR MOX calculations, one would also expect to observe a dependence of k_{eff} on AEG. This trend is indeed observed, and is very close to linear, as illustrated in Fig. 4.4. This indicates that there is an increasing bias in k_{eff} as the average neutron energy causing fission decreases, and that this bias is driven by the presence of plutonium, since it is absent in UO_2-only fueled lattices.

Note that as the PuO_2 content increases in each set of experiments (0% in UO_2-LWR lattices, 2–6.6% in MOX-LWR lattices, and 20% in the FFTF-MOX lattices), the mean k_{eff} for the set of calculations also increases (0.9993, 1.0021, and 1.0043, respectively). This would seem to indicate that there is a tendency for ENDF/B-V cross sections to overpredict k_{eff} as Pu content increases. Again, this trend will be studied more closely later in this section.

4.4 MISCELLANEOUS URANIUM CRITICAL EXPERIMENTS

Agreement between calculations and experiments for this set of problems is reasonable but not as good as

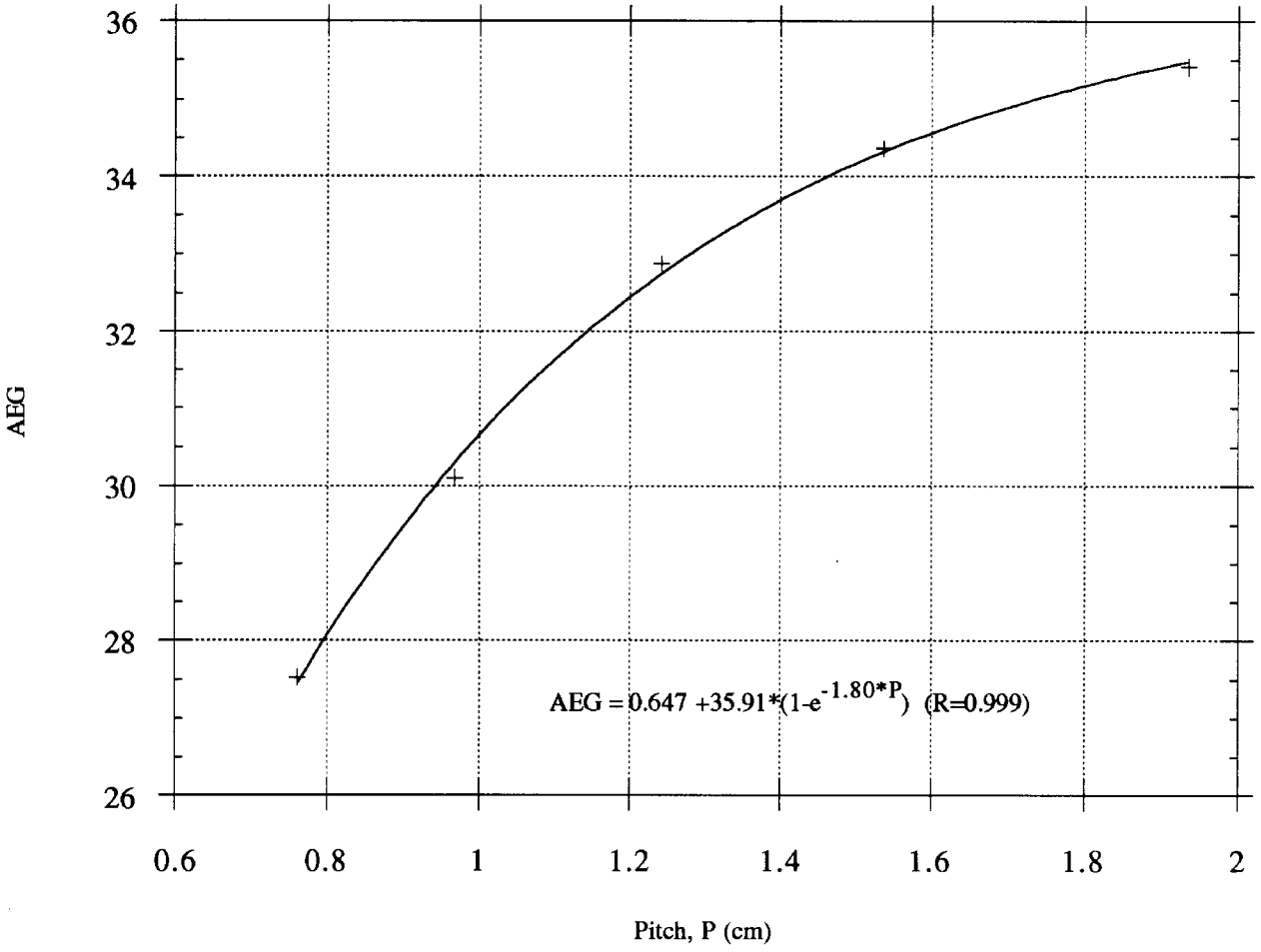

Figure 4.3 AEG as a function of lattice pitch for FFTF lattice calculations

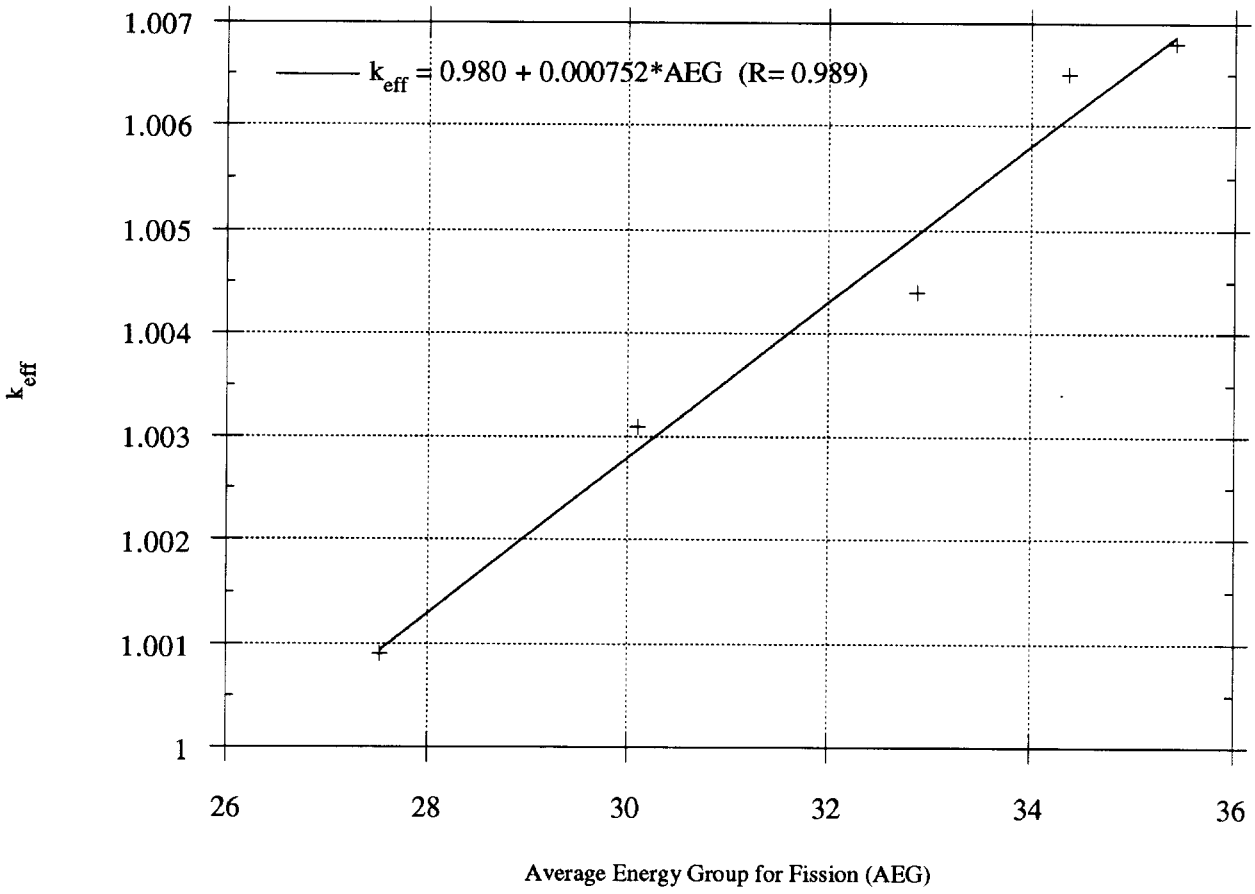

Figure 4.4 k_{eff} as a function of AEG for FFTF-MOX critical experiments

in the previous cases. The mean value of the computed k_{eff} values is 1.0082 ± 0.0088. However, this set of calculations was not expected to yield the best results, as neither the geometries nor the compositions are well matched with the specific type of problem for which the cross-section set was developed. However, comparison of 44GROUPNDF5 results with 27GROUPENDF4 results are reasonably consistent; the results are summarized in Table 4.4. This table shows the 44-group solution for each of the 15 critical calculations, along with the corresponding solution obtained based on the same critical experiments as reported in an earlier 27GROUPENDF4 validation report.[18] The largest disagreement is seen for cases 78–81; however, further examination has shown that the reported values for the 27-group calculations were based on a slightly different geometry model than was used in the 44-group calculations. More recent validation of the 27-group library gives better agreement with the 44-group library, in spite of the geometry modeling differences.[48] This agreement indicates that code modifications and improvements have affected the results originally reported in ref. 18. These values are given in parentheses in Table 4.4.

4.5 COMBINED LWR LATTICE CRITICAL EXPERIMENTS

This set of experiments represents geometries and contents that are most characteristic of LWR fuel assemblies. For the calculations based on these experiments, agreement is very good; the mean value of k_{eff} is 1.0000 ± 0.0047. Trending analysis shows a slight dependence of k_{eff} on the weight fraction of PuO_2. No other significant biases were found. The trend for k_{eff} to increase with increasing AEG was not observed in this combined set of data. It would appear that this trend is a result of the presence of Pu only, and is not observed here because of the small fraction (13/72) of LWR-type experiments which actually contained plutonium.

4.6 COMBINED MOX LATTICE CRITICAL EXPERIMENTS

The calculations based on this set of experiments represent all cases in which some fraction of the fuel is comprised of plutonium. The mean k_{eff} for this set of calculations is 1.0033 ± 0.0035. For both ENDF/B-IV (27GROUPNDF4) and ENDF/B-V (44GROUPNDF5) cross sections, a trend for k_{eff} to increase with increasing plutonium content is observed, as shown in Fig. 4.5. It appears that the trend is not as strong in the newer 44GROUPNDF5 results. However, the scatter in the data, especially for low-plutonium-content fuels, makes it difficult to accurately quantify the magnitude of the effect of the plutonium content. Nevertheless, the trend indicates the possibility of a slight bias due to the presence of plutonium.

A more readily observable trend can be identified in the computed value of k_{eff} as a function of AEG, as illustrated in Fig. 4.6. There is a definite bias toward a higher value of k_{eff} as the average energy for fission decreases. This bias is believed to be related to two distinct plutonium resonances. The first is a 1-eV resonance in ^{240}Pu absorption, while the second is the 0.3-eV resonance in ^{239}Pu fission mentioned earlier. For these experiments, the mixed-oxide fuels consisted of plutonium enriched from 86 to 90% in ^{239}Pu; hence, the most dominant effect is likely caused by the ^{239}Pu resonance.

4.7 COMBINED LATTICE CRITICAL EXPERIMENTS

The average value of k_{eff} computed for all lattice-type experiments is 1.0002 ± 0.0047. This number is very close to the expected value of 1.0; however, the average is strongly weighted by the large number of UO_2 lattice calculations relative to MOX lattices. On the other hand, the plutonium content in the MOX criticals was in all cases higher than that which would be expected in a nominal LWR spent fuel assembly (up to ~1.5 wt % Pu). Hence, the positive bias resulting from the presence of plutonium is somewhat exaggerated.

4.8 ALL CRITICAL EXPERIMENTS COMBINED

Combining the results for all 92 critical experiments, a mean k_{eff} of 1.0015 ± 0.0063 is calculated. The nominal average is close to unity, although not in as

Table 4.4 Comparison of 44GROUPNDF5 and 27GROUPNDF4 results for miscellaneous uranium critical cases

Case No.	Case designation	44GROUPNDF5 k_{eff}	44GROUPNDF5 $\pm\sigma$	Case Designation	27GROUPNDF4 k_{eff}	27GROUPNDF4 $\pm\sigma$
78	cr1071as	1.0207	0.0011	CAR01	1.0081 (1.0126)	0.0034 (0.0031)
79	cr1653as	1.0146	0.0011	CAR11	1.0073 (1.0070)	0.0032 (0.0033)
80	cr1653b	1.0148	0.0012	CAR16	0.9978 (1.0090)	0.0036 (0.0034)
81	cr2500s	1.0194	0.0012	CAR18	1.0005 (1.0087)	0.0030 (0.0031)
82	ydr14un2	1.0020	0.0014	CAS14	1.0028	0.0027
83	ydr14pl2	1.0023	0.0013	CAS15	0.9967	0.0024
84	ydr14pl3	1.0180	0.0015	CAS22	1.0228	0.0030
85	ydr14un3	1.0177	0.0016	CAS26	1.0152 (1.0072)	0.0025 (0.0028)
86	or260901	1.0077	0.0014	CAA01	1.0096	0.0026
87	or260906	1.0020	0.0013	CAA06	0.9964	0.0023
88	rfp2710u	1.0052	0.0021	CAA12	1.0090	0.0039
89	rfp2710r	1.0031	0.0020	CAA24	1.0113	0.0047
90	or2968s1	0.9909	0.0016	CAA30	0.9861	0.0032
91	or2968al	1.0062	0.0010	CAA36	1.0106	0.0026
92	or2968s2	0.9990	0.0008	CAA39	1.0001	0.0025
Average		1.0082			1.0050	

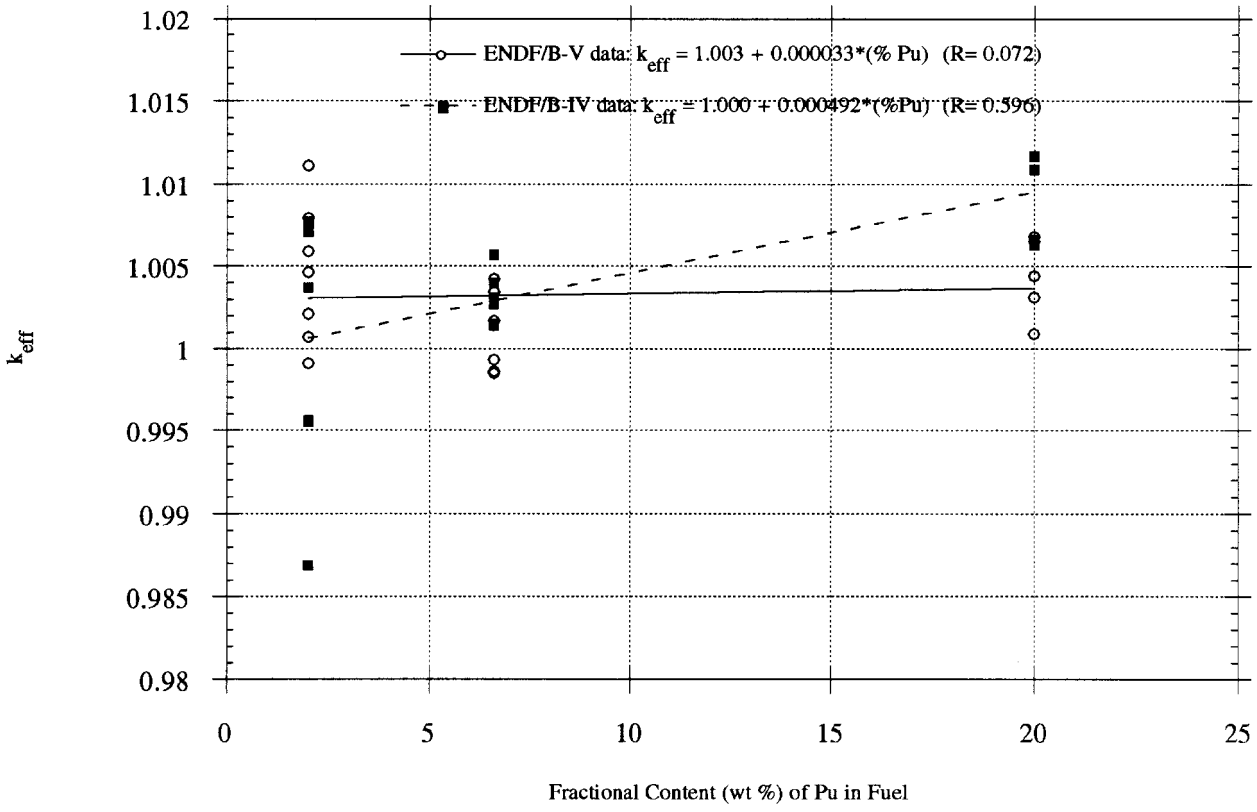

Figure 4.5 k_{eff} as a function of plutonium content for MOX critical experiments

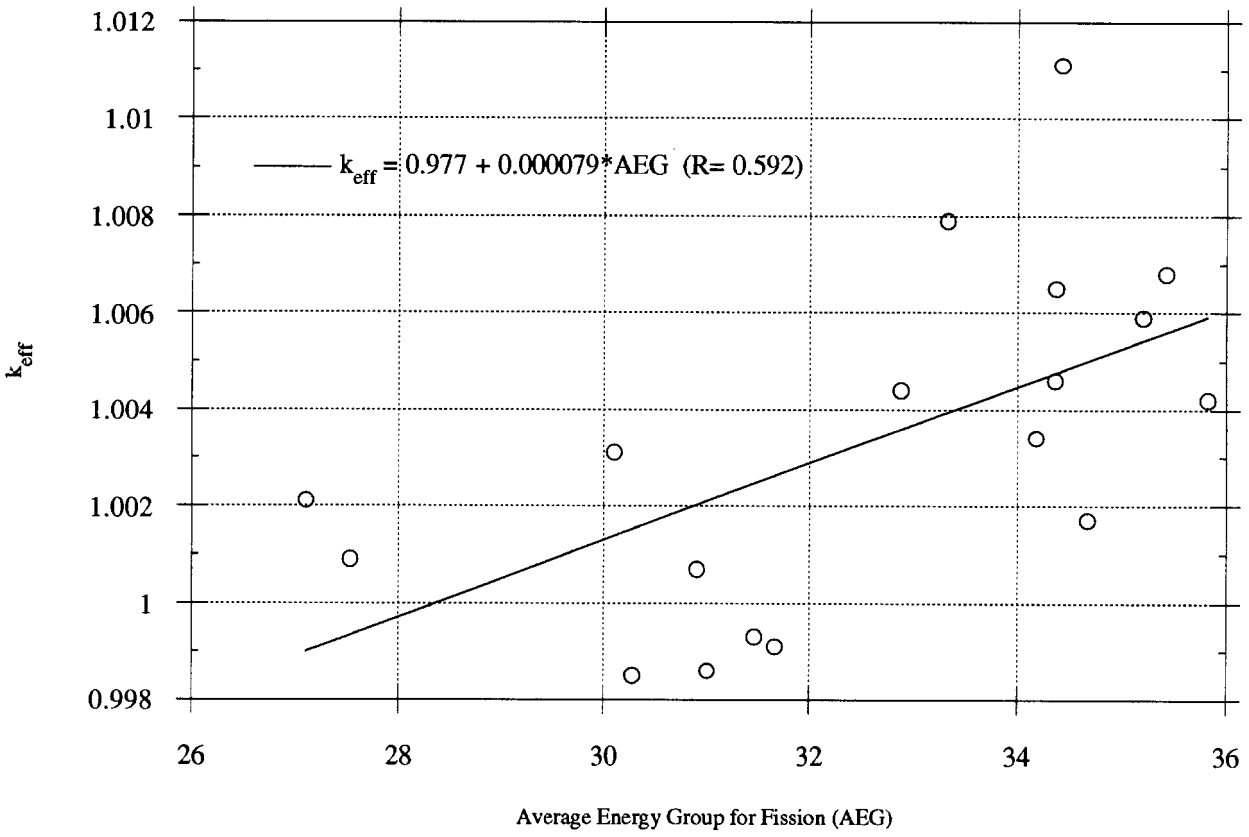

Figure 4.6 k_{eff} as a function of AEG for combined MOX experiments

close agreement as that of the combined lattice calculations; also, the uncertainty associated with the value is larger because of the wider scatter of the k_{eff} computed for the miscellaneous (nonlattice) criticals. This shows that even though the 44GROUPNDF5 cross-section library is valid for a wide range of compositions and geometries, it is best suited for the analysis of LWR-type fuel assemblies. Note that when all critical experiments are combined and tested for correlations, no significant correlations are found between the key parameters tested.

Table 4.5 provides a summary of the statistical distribution of each of the subsets described in the preceding paragraphs. The reported mean in each case is the average of the nominal value of k_{eff} computed for each class of experiments, and the standard deviation characterizes the distribution of the nominal values around this mean. These statistics do not include the uncertainties associated with each individual Monte Carlo calculation.

4.9 SUBCRITICAL SHIPPING CASK GEOMETRY EXPERIMENT

Because only a single experiment was included in this analysis, it is not possible to analyze results from a statistical standpoint. For this experiment, the value of k_{eff} was measured to be in the range 0.91 to 0.92. The calculation based on the experimental geometry gave a k_{eff} of 0.9057 ± 0.0016. This experiment, as with other subcritical measurements, has significant uncertainty associated with the definition and measurement of "k_{eff}." For this reason, the analysis of subcritical systems has not been thoroughly pursued. Until methods are devised which can more accurately measure the multiplication factor for subcritical experiments, it will be extremely difficult to obtain reasonable statistical quantification of biases and trends in such systems.

Table 4.5 Mean computed k_{eff} for various subsets of experiments

Experiment Subset	Mean k_{eff}	$\sigma(\overline{k_{eff}})$	Maximum	Minimum
LWR-type UO_2 Fuel Pin Lattices (1)	0.9993	0.0047	1.0129	0.9917
LWR-type MOX Fuel Pin Lattices (2)	1.0029	0.0039	1.0111	0.9985
FFTF MOX Fuel Pin Lattices (3)	1.0043	0.0025	1.0068	1.0009
Miscellaneous Uranium Criticals (4)	1.0082	0.0088	1.0207	0.9909
Combined LWR Lattices (1 + 2)	1.0000	0.0047	1.0129	0.9917
Combined MOX (2 + 3)	1.0033	0.0035	1.0111	0.9985
Combined Lattices (1 + 2 + 3)	1.0002	0.0047	1.0129	0.9917
All Critical Experiments (1 + 2 + 3 + 4) 1.0015	0.0063	1.0207	0.9909	

5 SUMMARY

Based on criticality calculations using SCALE 4.2 and the 44GROUPNDF5 library, the overall agreement between experimentally measured and computed values of k_{eff} is very good. For the set of 92 critical experiments discussed in this report, the average computed k_{eff} for all experiments is within almost 1% of unity when uncertainties are taken into account. Figure 5.1 shows distribution of the computed k_{eff} for all lattice calculations (this excludes the results of the Miscellaneous Criticals). This chart shows that the computed criticals approximate a normal distribution about a peak at approximately 0.9975. Variations from a statistically normal distribution are most likely due to biases present in the results and a small sample size. Two biases were identified, as discussed in the following paragraphs. These trends are small over the ranges studied, and are expected to be close to zero for a nominal spent fuel assembly based on commercial LWR lattice designs.

A possible bias was identified with respect to ^{235}U enrichment; however, the scatter of the data is such that the correlation is weak, and quantification of any possible bias is difficult. [In fact, inclusion of data for highly enriched (93.2 wt %) uranium systems, with k_{eff} values of less than 1.01, indicates that the slope of the best-fit regression shown in Fig. 4.1 may be overestimated by as much as a factor of 20.] The results of all UO_2 lattice calculations fell within the range 0.990 to 1.015, and were, for the most part, less than 1.0, even for the higher enrichments. Further calculations based on a broader range of enrichments will be necessary to firmly identify and quantify the suspected bias.

The second bias identified was associated with the presence of plutonium. An increase in k_{eff} with a decrease in the average energy at which fission occurs was noted in mixed-oxide experiments. The bias is positive and on the order of 0.5 to 1.0% k for soft spectrum thermal (AEG > 32) systems. This behavior is most likely due to inadequate representation of low-energy plutonium resonances. No such trend was identified in UO_2 lattice calculations, as illustrated in Fig. 5.2. This plot compares the behavior of the computed k_{eff} as a function of AEG for UO_2 lattice-type criticals vs MOX lattices. The two lines represent linear regression fits to each set of data. The figure shows a clear trend for k_{eff} to increase with AEG for the MOX-based calculations, while there is little, if any, such trend in the UO_2-based calculations. Note that the fit for the UO_2 data may be a poor estimate of trends in the results, due to the broad spread of the data. It is not known if the trend in the MOX cases results from the broad-group representation of cross sections or if it is inherent in the ENDF/B-V data. However, comparison with results generated with ENDF/B-IV cross sections indicates that the shortcomings in the resonance treatment of Pu have been partially ameliorated in the 44-group representation of ENDF/B-V cross sections.

In order to better understand and thereby correct biases present in cross-section libraries, continuing study of the nature of these biases is necessary. In the case of the 44GROUPNDF5 library, additional critical calculations are desirable over a more varied distribution of uranium enrichments in the 1 to 6 wt % range and for more mixed-oxide experiments, consisting of lower (~1.5 wt %) plutonium contents and a broader range of energy spectra.

Results for cases other than LWR-type assemblies (i.e., the set of miscellaneous criticals and the fast and thermal benchmark problems of Tables 3.1 and 3.2, respectively) indicate that the 44GROUPNDF5 library is appropriate for a broad class of uranium and mixed oxide configurations beyond the domain of LWR fuel analysis. This suggests that the LWR fuel-pin-based weighting spectrum used to collapse the fine-structure 238GROUPNDF5 library to its broad-group form emphasizes physics of the component materials more than their geometrical distribution. When analyzing such non-LWR type systems, the adequacy of the library should be confirmed by application-specific benchmark calculations. If such calculations indicate that this library is unsuitable for accurate criticality evaluations, then consideration should be given to utilizing the fine-group 238GROUPNDF5 library for limited analyses, or to the creation of a new broad-structure library based on a spectrum more characteristic of

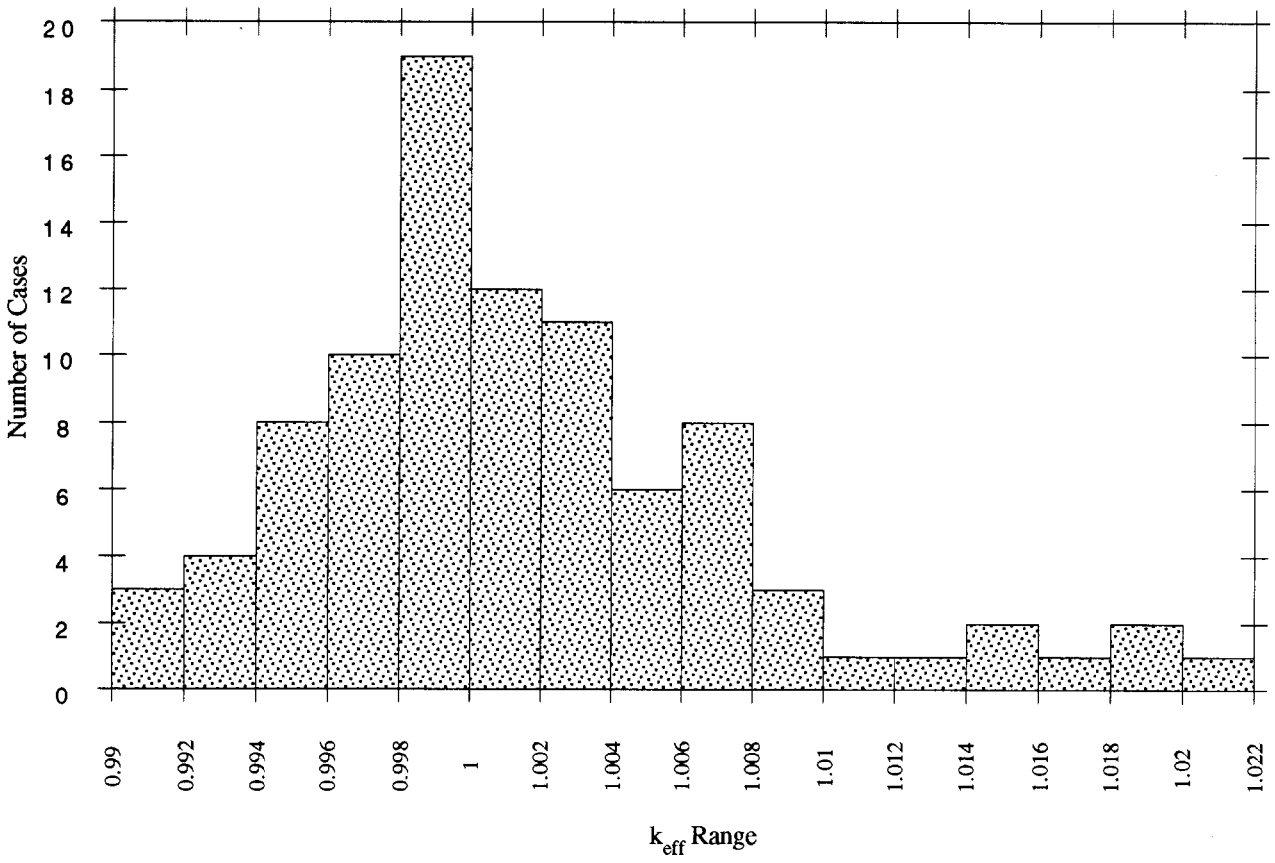

Figure 5.1 Distribution of k_{eff} for all lattice calculations

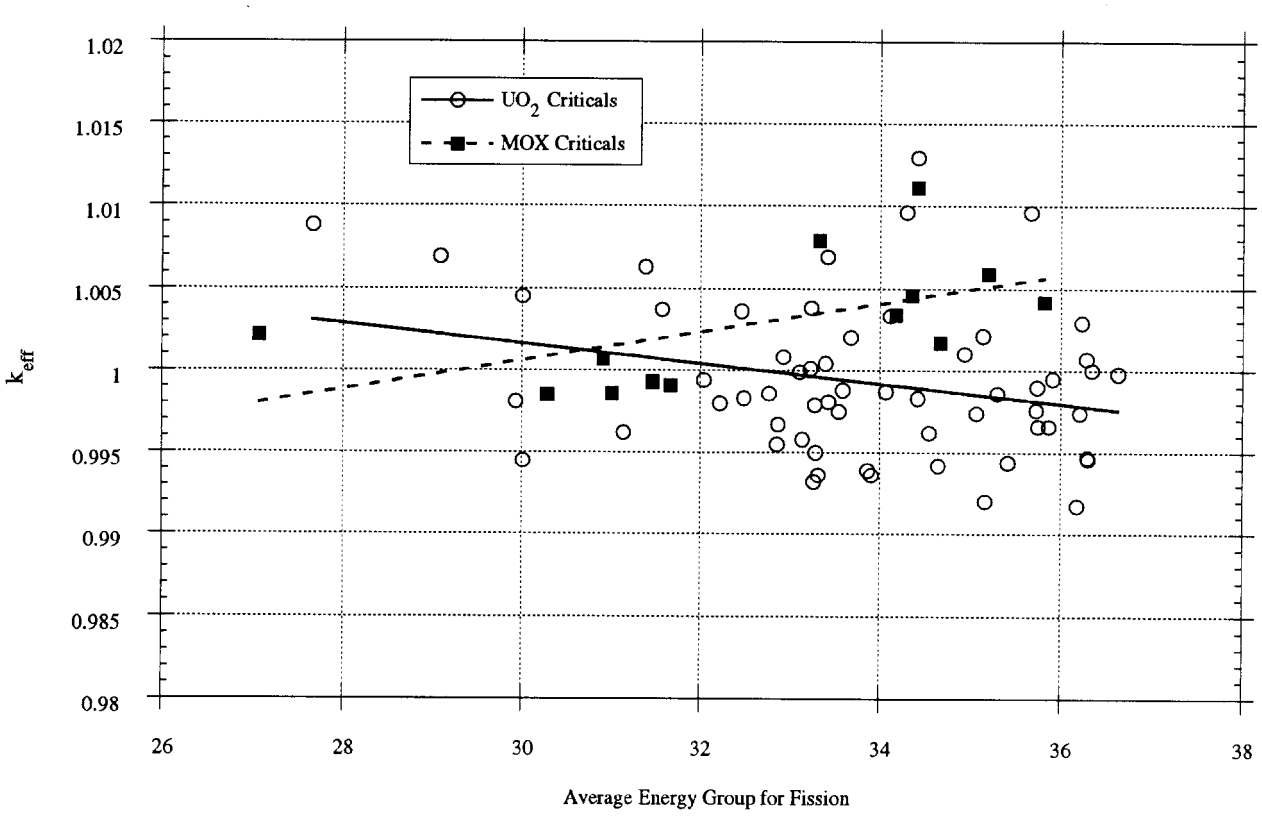

Figure 5.2 k_{eff} vs AEG for UO_2 and MOX lattice calculations

the system being analyzed, using the approach described in Ref. 1.

The adequacy of the 44GROUPNDF5 library for plutonium systems and systems containing significant epithermal fission contributions is inconclusive based on this report. Indications are that a more appropriate collapsing spectrum could be developed to emphasize these types of systems.

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APPENDIX A
SCALE INPUT LISTINGS

p2438x05

```
=csas25
'
' problem id 1051024
' citation id 2094  exp. no.  005
'
' 2.35% u-235 enriched uo2 rods, 1.1176 cm diam. al clad, 1.1176 cm id,
' 1.270 cm od. uo2 91.44 cm long, rod 97.79 cm long. h2o moderated and
' reflected. no plates between clusters.
' 3 20x16 clusters, 2.032 cm square pitch.
' ---- cm between central cluster and absorbers,  8.39 cm separation
' between clusters. exp. no. 5
' reference: pnl-2438
' scale module: csas25
'
0.8 in pitch lattice cell,2.35 wt% enriched fuel.
44group latticecell
uo2  1 0.84 293 92235 2.35 92238 97.65 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2  end geometry
exp#5, 8.39 cm h2o separating 3 20x16 arrays
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=80
wrs=34 res=205 nub=yes    end parm
read geom
unit 2
cylinder  1 1 0.5588                    91.44   0.0
cylinder  2 1 0.635                     96.52  -1.27
cuboid    3 1 1.016 -1.016 1.016 -1.016 96.52  -1.27
unit 5
array  2 3*0.0
unit 6
cuboid    5 1 8.39   0.0  32.512  0.0   97.79   0.0
global unit 7
array 3  3*0.0
reflector   4 1 5r0 2.54    1
reflector   5 2 6r3.04  5
reflector   5 7 4r3.06  0 0 5
end geometry

read bias id=500 2 11 end bias

read array
ara=2 nux=20 nuy=16 nuz=1   fill f2                   end fill
ara=3 nux=5  nuy=1  nuz=1   fill  5 6 5 6 5   end fill
end array
read plot
ttl='x-y slice of m1051024 at z=50'
xul=0.0    yul=35.5   zul=50
xlr=143.   ylr=0.0    zlr=50
uax=1 vdn=-1 nax=260  nch=' 12 4 67'  end
end plot
end data
end
```

p2438x17

```
=csas25
'
' problem id 1171024
' citation id 2094  exp. no.  017
'
' 2.35% u-235 enriched uo2 rods, 1.1176 cm diam. al clad, 1.1176 cm id,
' 1.270 cm od. uo2 91.44 cm long, rod 97.79 cm long. h2o moderated and
' reflected. boral plates between clusters 0.713 cm thickness
' 2 22x16 clusters, with 1 20x16 central cluster,2.032 cm square pitch.
' 0.645cm between central cluster and absorbers,  5.05 cm separation
' between clusters. exp. no. 17
' reference: pnl-2438
' scale module: csas25
'
0.8 in pitch lattice cell,2.35 wt% enriched fuel.
44group latticecell
uo2  1 0.84 293 92235 2.35 92238 97.65 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o  5      end
arbmboral   2.49  4 1 0 1 5000 28.7 13027 63.0
            6012 7.97   26000 .33     6     1 293         end boral
end comp
squarepitch  2.032 1.1176 1 3 1.27 2  end geometry
exp#017, 5.05 cm h2o/boral separating 2 22x16 arrays and 1 20x16 array
read parm plt=yes run=yes gen=805 npg=600 nsk=5 tme=240
wrs=34 res=205 nub=yes  end parm
read geom
unit 2
cylinder  1 1 0.5588                    91.44   0.0
cylinder  2 1 0.635                     96.52  -1.27
cuboid    3 1 1.016 -1.016 1.016 -1.016 96.52  -1.27
unit 6
array  2 3*0.0
replicate 5 1 2r0.0 2r1.994 2r0.0  1
unit 7
cuboid    6 1 4.303 3.794 36.5    0.0   91.5    0.0
cuboid    2 1 4.405 3.692 36.5    0.0   91.5    0.0
cuboid    5 1 5.05   0.0  36.5    0.0   97.79   0.0
unit 8
cuboid    6 1 1.256 0.747 36.5    0.0   91.5    0.0
cuboid    2 1 1.358 0.645 36.5    0.0   91.5    0.0
cuboid    5 1 5.05   0.0  36.5    0.0   97.79   0.0
unit 9
array 4  3*0.0
replicate 5 1 2r0.0 2r1.994 2r0.0  1
global
unit 10
array 5  3*0.0
reflector   4 1 5r0  2.54   1
reflector   5 2 6r3.04  5
reflector   5 7 4r3.06  0 0 5
end geometry

read bias  id=500 2 11 end bias
read array
```

```
ara=2 nux=22 nuy=16 nuz=1   fill f2                    end fill
ara=4 nux=20 nuy=16 nuz=1   fill f2                    end fill
ara=5 nux=5  nuy=1  nuz=1   fill           6 7 9 8 6   end fill
end array
read plot
ttl='x-y slice of m1171024 at z=50'
xul=0.0    yul=35.5   zul=50
xlr=145.6  ylr=0.0    zlr=50
uax=1 vdn=-1 nax=260  nch=' 12 467'  end
end plot
end data
end
```

p2438x28

```
=csas25
'
' problem id 1281024
' citation id 2094  exp. no.  028
'
' 2.35% u-235 enriched uo2 rods, 1.1176 cm diam. al clad, 1.1176 cm id,
' 1.270 cm od. uo2 91.44 cm long, rod 97.79 cm long. h2o moderated and
' reflected. ss plates between clusters 0.485 cm thickness
' 3 20x16 clusters, 2.032 cm square pitch.
' .645 cm between central cluster and absorbers,  6.88 cm separation
' between clusters. exp. no. 28
' reference: pnl-2438
' scale module: csas25
'
0.8 in pitch lattice cell,2.35 wt% enriched fuel.
44group latticecell
uo2  1 0.84 293 92235 2.35 92238 97.65 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5  end
ss304       6  end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2  end geometry
exp#28, 6.88 cm h2o/ss separating 3 20x16 arrays
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=40
res=205 nub=yes wrs=34   end parm
read geom
unit 2
cylinder  1 1 0.5588                    91.44   0.0
cylinder  2 1 0.635                     96.52  -1.27
cuboid    3 1 1.016 -1.016 1.016 -1.016 96.52  -1.27
unit 6
array  2 3*0.0
cuboid    5 1 40.64  0.0  34.056 -1.544 97.79   0.0
unit 7
cuboid    5 1 5.750  0.0  35.6    0.0   91.5    0.0
cuboid    6 1 6.235  0.0  35.6    0.0   91.5    0.0
cuboid    5 1 6.88   0.0  35.6    0.0   97.79   0.0
unit 8
cuboid    5 1 0.645  0.0  35.6    0.0   91.5    0.0
cuboid    6 1 1.130  0.0  35.6    0.0   91.5    0.0
cuboid    5 1 6.88   0.0  35.6    0.0   97.79   0.0
global unit 9
array 3  3*0.0
reflector   4 1 5r0 2.54    1
reflector   5 2 6r3.04  5
reflector   5 7 4r3.06  0 0 5
end geometry

read bias  id=500 2 11  end bias

read array
ara=2 nux=20 nuy=16 nuz=1   fill f2                    end fill
ara=3 nux=5  nuy=1  nuz=1   fill  6 7 6 8 6   end fill
end array
read plot
ttl='x-y slice of m1281024 at z=50'
xul=0.0    yul=35.5   zul=50
xlr=138.0  ylr=0.0    zlr=50
uax=1 vdn=-1 nax=260  nch=' 12 4 6'  end
end plot
end data
end
```

p2615x14

```
=csas25
'
' problem id
' citation id       exp. no. 14
'
' 4.31% u-235 enriched uo2 rods, 1.2649 cm diam. al clad, 1.2827 cm id,
' 1.4147cm od. uo2 91.44 cm long, rod 96.52 cm long. h2o moderated and
' reflected. ss plates between clusters 0.485 cm thickness
' 3 15x8  clusters, 2.540 cm square pitch.
' .245 cm between central cluster and absorbers,  8.58 cm separation
' between clusters. exp. no. 14
' reference: pnl-2615
' scale module: csas25
'
2.540cm pitch lattice cell,4.31 wt% enriched fuel,ss304l plate
44group latticecell
uo2  1 0.949 293 92235 4.31 92238 95.69 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
ss304       6  end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7 end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0 end
exp no. 14 8.58 cm h2o/ss separating 3 15x8 arrays
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205  nub=yes end parm

read geom
unit 1
cylinder  1 1 0.63245                   91.44   0.0
cylinder  0 1 0.64135                   91.44   0.0
```

```
cylinder  7 1 0.64135                  93.98  -2.54
cylinder  2 1 0.70735                  93.98  -2.54
cuboid    3 1 4p1.270                  93.98  -2.54
unit 2
array  1 3*0.0
reflector   3 1 2r0  2r7.64 2r0  1
unit 3
cuboid    6 1  0.0  -0.485 2p17.8       88.96  -2.54
cuboid    5 1 0.245 -8.335 2p17.8       93.98  -2.54
unit 4
cuboid    6 1  0.485  0.0  2p17.8       88.96  -2.54
cuboid    5 1  8.335 -.245 2p17.8       93.98  -2.54
global unit 5
array 2  -65.73   -17.8    0.
reflector   4 1 5r0.0   2.54 1
reflector   5 2 6r3.0        5
reflector   5 7 4r3.0   2r0  5
end geometry

read bias id=500 2 11 end bias

read array
ara=1 nux=15 nuy=8  nuz=1   fill f1                  end fill
ara=2 nux=5  nuy=1  nuz=1   fill  2 3   2 4   2       end fill
end array
read plot
ttl='x-y slice at z=50'
xul=70     yul=20.    zul=50
xlr=-70    ylr=-20.   zlr=50
vax=-1 udn=-1 nax=130  nch='.12 4 67  '  end
ttl='y-z slice at x=0.'
xul=0.0    yul=-5.   zul=10
xlr=0.0    ylr=5.    zlr=-10
vax=1  wdn=-1 nax=130  nch='.12 4 67  '  end
end plot
end data
end
```

p2615x23

```
=csas25
'
' problem id
' citation id       exp. no. 23
'
' 4.31% u-235 enriched uo2 rods, 1.2649 cm diam. al clad, 1.2827 cm id,
' 1.4147cm od. uo2 91.44 cm long, rod 96.52 cm long. h2o moderated and
' reflected. cd plates between clusters 0.2006 cm thickness
' 3 15x8  clusters, 2.540 cm square pitch.
' 3.277 cm between central cluster and absorbers,  7.28 cm separation
' between clusters. exp. no. 23
' reference: pnl-2615
' scale module: csas25
'
2.540cm pitch lattice cell,4.31 wt% enriched fuel,cadmium plate
44group latticecell
uo2  1 0.949 293 92235 4.31 92238 95.69 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
cd          6 0.997 end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7 end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0 end
exp no. 23 7.28 cm h2o/cadmium separating 3 15x8 arrays
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                  91.44   0.0
cylinder  0 1 0.64135                  91.44   0.0
cylinder  7 1 0.64135                  93.98  -2.54
cylinder  2 1 0.70735                  93.98  -2.54
cuboid    3 1 4p1.270                  93.98  -2.54
unit 2
array  1 3*0.0
reflector   3 1 2r0  2r7.64 2r0  1
unit 3
cuboid    6 1  0.0  -0.2006 2p17.8      88.96  -2.54
cuboid    5 1 3.277 -4.003 2p17.8       93.98  -2.54
unit 4
cuboid    6 1  0.2006 0.0  2p17.8       88.96  -2.54
cuboid    5 1  4.003 -3.277 2p17.8       93.98  -2.54
global unit 5
array 2  -64.43   -17.8    0.
reflector   4 1 5r0.0   2.54 1
reflector   5 2 6r3.0        5
reflector   5 7 4r3.0   2r0  5
end geometry


read bias id=500 2 11 end bias

read array
ara=1 nux=15 nuy=8  nuz=1   fill f1                  end fill
ara=2 nux=5  nuy=1  nuz=1   fill  2 3   2 4   2       end fill
end array
read plot
ttl='x-y slice at z=50'
xul=70     yul=20.    zul=95
xlr=-70    ylr=-20.   zlr=95
vax=-1 udn=-1 nax=130  nch='.12 4 67  '  end
ttl='y-z slice at x=0.'
xul=0.0    yul=-0.   zul=5
xlr=0.0    ylr=5.    zlr=-5
vax=1  wdn=-1 nax=130  nch='.12 4 67  '  end
end plot
end data
end
```

p2615x31

```
=csas25
'
' problem id
' citation id       exp. no. 31
'
' 4.31% u-235 enriched uo2 rods, 1.2649 cm diam. al clad, 1.2827 cm id,
' 1.4147cm od. uo2 91.44 cm long, rod 96.52 cm long. h2o moderated and
' reflected. boral plates between clusters 0.713 cm thickness
' 3 15x8  clusters, 2.540 cm square pitch.
' 3.277 cm between central cluster and absorbers,  6.72 cm separation
' between clusters. exp. no. 31
' reference: pnl-2615
' scale module: csas25
'
2.540cm pitch lattice cell,4.31 wt% enriched fuel,boral plate
44group latticecell
uo2  1 0.949 293 92235 4.31 92238 95.69 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
arbmboral   2.49  4 1 0 1 5000 28.7 13027 63.0
            6012 7.97  26000 0.33   6   1   293  end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7 end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0 end
exp no. 31 6.72 cm h2o/boral separating 3 15x8 arrays
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes end parm

read geom
unit 1
cylinder  1 1 0.63245                  91.44   0.0
cylinder  0 1 0.64135                  91.44   0.0
cylinder  7 1 0.64135                  93.98  -2.54
cylinder  2 1 0.70735                  93.98  -2.54
cuboid    3 1 4p1.270                  93.98  -2.54
unit 2
array  1 3*0.0
reflector   3 1 2r0  2r8.09 2r0  1
unit 3
cuboid    6 1 -0.102 -0.611 2p18.25      88.96  -2.54
cuboid    2 1  0.0   -0.713 2p18.25      88.96  -2.54
cuboid    5 1 3.277 -3.443 2p18.25      93.98  -2.54
unit 4
cuboid    6 1  0.611 0.102 2p18.25      88.96  -2.54
cuboid    2 1  0.713 0.0   2p18.25      88.96  -2.54
cuboid    5 1  3.443 -3.277 2p18.25      93.98  -2.54
global unit 5
array 2  -63.87   -18.25   0.
reflector   4 1 5r0.0   2.54 1
reflector   5 2 6r3.0        5
reflector   5 7 4r3.0   2r0  5
end geometry
read bias id=500 2 11 end bias

read array
ara=1 nux=15 nuy=8  nuz=1   fill f1                    end fill
ara=2 nux=5  nuy=1  nuz=1   fill  2 3   2 4   2       end fill
end array
read plot
ttl='x-y slice at z=50'
xul=45     yul=10.    zul=20
xlr=-0     ylr=-0     zlr=20
vax=-1 udn=-1 nax=130  nch='.12 4 67  '  end
ttl='y-z slice at x=0.'
xul=0.6    yul=-0.   zul=3
xlr=0.6    ylr=2.54  zlr=-3
vax=1  wdn=-1 nax=130  nch='.12 4 67  '  end
end plot
end data
end
```

p2827u2a

```
=csas25
'
' problem id --
' citation id --    exp. no.  --
'
' 2.35% u-235 enriched uo2 rods, 1.27cm od al clad, 1.1176 cm id,
' 1.1176 cm od uo2 91.44 cm long, rod 97.79 cm long.
' uranium walls (7.65 x 152.3 x 121.9) on floor reflecting in h2o.
' 3-19x16 clusters, 2.032 cm square pitch. 14.11 cm separation
' between clusters. 1.956 cm from fuel clusters to wall
' reference: pnl-2827 pg.14
' scale module: csas25
'
0.8 in pitch lattice cell,2.35 wt% enriched fuel.
44group latticecell
uo2  1 0.84 293 92235 2.35 92238 97.65 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
uranium   6 .98163 293 92235 .199 92238 99.801 end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2  end
u refl. 1.956 cm from array,   14.11 cm h2o separating 3 19x16 arrays #3
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.5588                   91.44   0.0
cylinder  2 1 0.635                    96.52  -1.27
cuboid    3 1 1.016 -1.016 1.016 -1.016 96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 13.348 0.0  32.512  0.0   97.79   0.0
global unit 4
array 2  -71.26   -16.256  0.
reflector 4 1  5r0.0    2.54                1
```

```
cuboid    5 1  2p76.15  2p18.212  104.06  -17.84
reflector 6 1  2r0.0    2r7.65    2r0.0       1
reflector   5 2 5r3.0     0 3
reflector   5 5 4r3.0   2r0 2
reflector   5 7 2r3.0   4r0 5
end geometry

read bias id=500 2 11 end bias

read array
ara=1 nux=19 nuy=16 nuz=1   fill f1                    end fill
ara=2 nux=5  nuy=1  nuz=1   fill 2 3 2 3 2             end fill
end array
read plot
ttl='x-y slice at z=50'
xul=-95.   yul=55.    zul=50
xlr=95.    ylr=-55.   zlr=50
uax=1 vdn=-1 nax=260  nch=' 12 4 67'  end
end plot
end data
end
```

p2827l2a

```
=csas25
'
' problem id --
' citation id --    exp. no.  --
'
' 2.35% u-235 enriched uo2 rods, 1.27cm od al clad, 1.1176 cm id,
' 1.1176 cm od uo2 91.44 cm long, rod 97.79 cm long.
' lead walls (10.2 x 164.0 x 123.4) on floor reflecting in h2o.
' 3-19x16 clusters, 2.032 cm square pitch. 13.72 cm separation
' between clusters.  0.66 cm from fuel clusters to wall
' reference: pnl-2827 pg.14
' scale module: csas25
'
0.8 in pitch lattice cell,2.35 wt% enriched fuel.
44group  latticecell
uo2  1 0.84 293 92235 2.35 92238 97.65 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
pb        6 .97533 end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2  end
pb refl. .660 cm from array, 13.72 cm h2o separating 3 19x16 arrays #2
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.5588                    91.44   0.0
cylinder  2 1 0.635                     96.52  -1.27
cuboid    3 1 1.016 -1.016 1.016 -1.016 96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 12.958 0.0  32.512  0.0   97.79   0.0
global unit 4
array 2  -70.87   -16.256  0.
reflector 4 1  5r0.0    2.54                  1
cuboid    5 1  2p82.0 2p16.916 105.56 -17.84
reflector 6 1  2r0.0    2r10.2    2r0.0       1
reflector   5 2 4r3.0  2.5 0 3
reflector   5 5 4r3.0   2r0  2
reflector   5 7 2r3.0   4r0  5
end geometry

read bias id=500 2 11 end bias

read array
ara=1 nux=19 nuy=16 nuz=1   fill f1                    end fill
ara=2 nux=5  nuy=1  nuz=1   fill 2 3 2 3 2             end fill
end array
read plot
ttl='x-y slice at z=50'
xul=-95.   yul=55.    zul=50
xlr=95.    ylr=-55.   zlr=50
uax=1 vdn=-1 nax=260  nch=' 12 4 67'  end
end plot
end data
end
```

p2827non

```
=csas25
0.8 in pitch lattice cell,2.35 wt% enriched fuel.
44group latticecell
uo2  1 0.84 293 92235 2.35 92238 97.65 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2  end
no refl. 8.31cm h2o separating 19x16 arrays
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.5588                    91.44   0.0
cylinder  2 1 0.635                     96.52  -1.27
cuboid    3 1 1.016 -1.016 1.016 -1.016 96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 7.548  0.0  32.512  0.0   97.79   0.0
global unit 4
array 2  -65.460  -16.256  0.
reflector   4 1 5r0.0   2.54 1
reflector   5 2 4r3.0   2r3  5
reflector   5 7 4r3.0   2r0  5
end geometry

read bias id=500 2 11 end bias
```

```
read array
ara=1 nux=19 nuy=16 nuz=1   fill f1                    end fill
ara=2 nux=5  nuy=1  nuz=1   fill 2 3 2 3 2             end fill
end array
read plot
ttl='x-y slice at z=50'
xul=100.   yul=50.    zul=50
xlr=-100.  ylr=-50.   zlr=50
vax=-1 udn=-1 nax=130  nch=' 12 4   '  end
ttl='y-z slice at x=0.'
xul=0.0    yul=-50.   zul=110
xlr=0.0    ylr=50.    zlr=-50
vax=1  wdn=-1 nax=130  nch=' 12 4   '  end
end plot
end data
end
```

p2827u2b

```
=csas25
1.0 in pitch lattice cell,4.31 wt% enriched fuel.
44group latticecell
uo2  1 0.949 293 92235 4.31 92238 95.69 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
uranium     6 .98163  293  92235  .199  92238  99.801  end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7 end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0 end
uranium refl. 15.32cm h2o separating 12x8  arrays
' 1.956 cm distance to wall
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.63245                  91.44   0.0
cylinder  0 1 0.64135                  91.44   0.0
cylinder  7 1 0.64135                  93.98  -2.54
cylinder  2 1 0.70735                  93.98  -2.54
cuboid    3 1 4p1.270                  93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 14.1947 0.0 20.32   0.0   96.52   0.0
global unit 4
array 2  -59.9147 -10.16   0.
reflector   4 1 5r0.0   2.54 1
cuboid    5 1 2p76.15 2p12.116  104.06 -17.84
reflector   6 1 2r0.0 2r7.65 2r0.0  1
reflector   5 2 5r3.0     0  3
reflector   5 5 4r3.0   2r0  5
reflector   5 10  2r3.0   4r0  2
end geometry
```

```
read bias id=500 2 11 end bias

read array
ara=1 nux=12 nuy=8  nuz=1   fill f1                    end fill
ara=2 nux=5  nuy=1  nuz=1 fill  2 3 2 3 2  end fill
end array
read plot
ttl='x-y slice at z=50'
xul=110.   yul=45.    zul=50
xlr=-110.  ylr=-45.   zlr=50
vax=-1 udn=-1 nax=130  nch=' ., 4 67'  end
ttl='y-z slice at x=0.'
xul=1.27   yul=-45.   zul=120
xlr=1.27   ylr=45.    zlr=-20
vax=1  wdn=-1 nax=130  nch=' ., 4 67'  end
end plot
end data
end
```

p2827l2b

```
=csas25
1.0 in pitch lattice cell,4.31 wt% enriched fuel.
44group latticecell
uo2  1 0.949 293 92235 4.31 92238 95.69 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
pb          6 .97533  end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7 end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0 end
lead refl. 20.78cm h2o separating 13x8  arrays
' 0.66 cm distance to wall
read parm plt=yes run=yes gen=1605 npg=600 nsk=5 tme=240
wrs=34 res=205 nub=yes  rnd=6516246C6230 end parm
read geom
unit 1
cylinder  1 1 0.63245                  91.44   0.0
cylinder  0 1 0.64135                  91.44   0.0
cylinder  7 1 0.64135                  93.98  -2.54
cylinder  2 1 0.70735                  93.98  -2.54
cuboid    3 1 4p1.270                  93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 19.6547 0.0 20.32   0.0   96.52   0.0
global unit 4
array 2  -69.1847 -10.16   0.
reflector   4 1 5r0.0   2.54 1
cuboid    5 1 2p82.0  2p10.82   105.56 -17.84
reflector   6 1 2r0.0 2r10.2 2r0.0  1
reflector   5 2 5r3.0     0  2
reflector   5 4 4r3.0   2r0  5
reflector   5 9 2r3.0   4r0  3
end geometry
```

```
read bias id=500 2 11 end bias

read array
ara=1 nux=13 nuy=8  nuz=1   fill f1                    end fill
ara=2 nux=5  nuy=1  nuz=1 fill  2 3 2 3 2  end fill
end array
read plot
ttl='x-y slice at z=50'
xul=115.   yul=45.    zul=50
xlr=-115.  ylr=-45.   zlr=50
vax=-1 udn=-1 nax=130  nch=' ., 4 67'  end
ttl='y-z slice at x=0.'
xul=0.0    yul=-45.   zul=120
xlr=0.0    ylr=45.    zlr=-20
vax=1  wdn=-1 nax=130  nch=' ., 4 67'  end
end plot
end data
end
```

p3314a

```
=csas25
1.892cm pitch lattice cell,4.31 wt% enriched fuel,boroflex plate
44group latticecell
uo2  1 0.949 293 92235 4.31 92238 95.69 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 6 end
boron       7 den=1.731 .3274 end
c           7 den=1.731 .2113 end
h           7 den=1.731 .0265 end
cr          7 den=1.731 .0003 end
fe          7 den=1.731 .0005 end
o           7 den=1.731 .2101 end
si          7 den=1.731 .2239 end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0 end
2.83cm and 3.60cm separating 4 11x14 arrays
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.63245                  91.44   0.0
cylinder  0 1 0.64135                  91.44   0.0
cylinder  6 1 0.64135                  93.98  -2.54
cylinder  2 1 0.70735                  93.98  -2.54
cuboid    3 1 4p.9460                  93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 26.488  0.0 13.373   0.0  93.98  -2.54
unit 4
cuboid    7 1 26.488  0.0  2.67  2.444  88.96  -2.54
cuboid    4 1 26.488  0.0  2.83  2.284  88.96  -2.54
cuboid    5 1 26.488  0.0  2.83  0.0    93.98  -2.54
unit 5
cuboid    7 1 0.386   0.16    2p35.6       88.96  -2.54
cuboid    4 1 0.546   0.0     2p35.6       88.96  -2.54
cuboid    5 1 0.546   0.0     2p35.6       93.98  -2.54
unit 6
cuboid    7 1 3.054   0.0  0.386   0.16    88.96  -2.54
cuboid    4 1 3.054   0.0  0.546   0.0     88.96  -2.54
cuboid    5 1 3.054   0.0 34.731 -36.469   93.98  -2.54
unit 7
cuboid    7 1 14.624  0.0  0.386   0.16    88.96  -2.54
cuboid    4 1 14.624  0.0  0.546   0.0     88.96  -2.54
cuboid    5 1 14.624  0.0 34.731 -36.469   93.98  -2.54
unit 8
array  2 3*0.0
global unit 9
array 3  3*0.0
reflector   4 1 5r0.0   2.54 1
reflector   5 2 6r3.0        5
reflector   5 5 4r3.0   2r0  5
end geometry

read bias id=500 2 11 end bias

read array
ara=1 nux=14 nuy=11 nuz=1   fill f1                    end fill
ara=2 nux=1  nuy=5  nuz=1   fill  3 2 4 2 3            end fill
ara=3 nux=5  nuy=1  nuz=1   fill  8 5 6 8 7            end fill
end array
read plot
ttl='x-y slice at z=50'
xul=105    yul=-35    zul=50
xlr=-35    ylr=105    zlr=50
vax=1  udn=-1 nax=130  nch=' ., 4 67  '  end
ttl='close up x-y slice at z=50'
xul=75     yul=-0     zul=50
xlr=-0     ylr=75     zlr=50
vax=1  udn=-1 nax=130  nch=' ., 4 67  '  end
ttl='y-z slice at x=0.'
xul=.946   yul=-35    zul=115
xlr=.946   ylr=105    zlr=-20
vax=1  wdn=-1 nax=130  nch=' ., 4 67  '  end
end plot
end data
end
```

p3314b

```
=csas25
1.892cm pitch lattice cell,4.31 wt% enriched fuel,.452 cm boroflex
44group latticecell
uo2  1 0.949 293 92235 4.31 92238 95.69 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 6 end
boron       7 den=1.731 .3274 end
```

```
c           7 den=1.731 .2113 end
h           7 den=1.731 .0265 end
cr          7 den=1.731 .0003 end
fe          7 den=1.731 .0005 end
o           7 den=1.731 .2101 end
si          7 den=1.731 .2239 end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0 end
2.83cm and 4.94cm separating 2 11x14 + 2 11x16 arrays
read parm plt=yes run=yes gen=805 npg=600 nsk=5 tme=120
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.63245                   91.44   0.0
cylinder  0 1 0.64135                   91.44   0.0
cylinder  6 1 0.64135                   93.98  -2.54
cylinder  2 1 0.70735                   93.98  -2.54
cuboid    3 1 4p.9460                   93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 26.488  0.0 13.373   0.0  93.98  -2.54
unit 4
cuboid    7 1 26.488  0.0  2.67  2.218  88.96  -2.54
cuboid    4 1 26.488  0.0  2.83  2.058  88.96  -2.54
cuboid    5 1 26.488  0.0  2.83  0.0    93.98  -2.54
unit 5
array  2 3*0.0
unit 6
cuboid    5 1 30.272  0.0 13.373   0.0  93.98  -2.54
unit 7
cuboid    7 1 30.272  0.0  2.67  2.218  88.96  -2.54
cuboid    4 1 30.272  0.0  2.83  2.058  88.96  -2.54
cuboid    5 1 30.272  0.0  2.83  0.0    93.98  -2.54
unit 8
cuboid    7 1 0.612   0.16    2p35.6       88.96  -2.54
cuboid    4 1 0.772   0.0     2p35.6       88.96  -2.54
cuboid    5 1 0.772   0.0     2p35.6       93.98  -2.54
unit 9
cuboid    7 1 4.168   0.0  0.612   0.16    88.96  -2.54
cuboid    4 1 4.168   0.0  0.772   0.0     88.96  -2.54
cuboid    5 1 4.168   0.0 34.957 -36.243   93.98  -2.54
unit 10
cuboid    7 1 9.500   0.0  0.612   0.16    88.96  -2.54
cuboid    4 1 9.500   0.0  0.772   0.0     88.96  -2.54
cuboid    5 1 9.500   0.0 34.957 -36.243   93.98  -2.54
unit 11
array  3 3*0.0
unit 12
array  4 3*0.0
global unit 13
array 5  3*0.0
reflector   4 1 5r0.0   2.54 1
reflector   5 2 6r3.0        5
reflector   5 5 4r3.0   2r0  5
end geometry

read bias id=500 2 11 end bias
```

```
read array
ara=1 nux=14 nuy=11 nuz=1   fill f1                    end fill
ara=2 nux=16 nuy=11 nuz=1   fill f1                    end fill
ara=3 nux=1  nuy=5  nuz=1   fill  3 2 4 2 3            end fill
ara=4 nux=1  nuy=5  nuz=1   fill  6 5 7 5 6            end fill
ara=5 nux=5  nuy=1  nuz=1   fill  11 8  9  12  10      end fill
end array
read plot
ttl='x-y slice at z=50'
xul=105    yul=-35    zul=50
xlr=-35    ylr=105    zlr=50
vax=1  udn=-1 nax=130  nch=' ., 4 67  '  end
ttl='y-z slice at x=0.'
xul=.946   yul=-35    zul=115
xlr=.946   ylr=105    zlr=-20
vax=1  wdn=-1 nax=130  nch=' ., 4 67  '  end
end plot
end data
end
```

p3602n2

```
=csas25
'
' problem id --
' citation id --    exp. no.  --
'
' 2.35% u-235 enriched uo2 rods, 1.27cm od al clad, 1.1176 cm id,
' 1.1176 cm od uo2 91.44 cm long, rod 97.79 cm long.
' steel walls (17.85 x 147.3 x 121.9) on floor reflecting in h2o.
' 3-19x16 clusters, 2.032 cm square pitch. 11.20 cm separation
' between clusters.  0.66 cm from fuel clusters to wall
' reference: pnl-3602 pg.15
' scale module: csas25
'
0.8 in pitch lattice cell,2.35 wt% enriched fuel.
44group latticecell
uo2  1 0.84 293 92235 2.35 92238 97.65 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28  14000 .22
28304 .79 42000 .49  24304 .12  29000 .13  6 end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2  end
ss refl. 0.66 cm from array, 11.20 cm h2o separating 3 19x16 arrays
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.5588                    91.44   0.0
cylinder  2 1 0.635                     96.52  -1.27
cuboid    3 1 1.016 -1.016 1.016 -1.016 96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 10.438 0.0  32.512  0.0   97.79   0.0
```

```
global unit 4
array 2  -68.35   -16.256  0.
reflector 4 1  5r0.0    2.54                 1
cuboid    5 1  2p73.65  2p16.916  104.06  -17.84
reflector 6 1  2r0.0    2r17.85    2r0.0       1
reflector   5 2 5r3.0     0 3
reflector   5 5 2r3.0   4r0 7
end geometry

read bias id=500 2 11 end bias

read array
ara=1 nux=19 nuy=16 nuz=1   fill f1                    end fill
ara=2 nux=5  nuy=1  nuz=1   fill 2 3 2 3 2             end fill
end array
read plot
ttl='x-y slice at z=50'
xul=95.   yul=45.    zul=50
xlr=-95.    ylr=-45.   zlr=50
vax=-1 udn=-1 nax=130  nch=' 12 4 67'  end
ttl='x-z slice at z=50'
xul=0.    yul=-45.    zul=120
xlr=0.    ylr=45.   zlr=-20
vax=1  wdn=-1 nax=130  nch=' 12 4 67'  end
end plot
end data
end
```

p3602non

```
=csas25
'
' 4.31% u-235 enriched uo2 rods, 1.4147 cm od al clad, 1.2827 cm id,
' 1.2649 cm od. uo2 91.44 cm long, rod 96.52 cm long.
' steel walls (17.85 x 147.3 x 121.9) on floor reflecting in h2o.
' 3-12x16 clusters, 1.892 cm square pitch. 15.84 cm separation
' between clusters.  1.956 cm from fuel clusters
' reference: pnl-3602 pg.16
' scale module: csas25
'
1.892cm pitch lattice cell,4.31 wt% enriched fuel,no absorber
44group  latticecell
uo2  1 0.949 293 92235 4.31 92238 95.69 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28  14000 .22
28304 .79 42000 .49  24304 .12  29000 .13  6 end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7 end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0 end
steel refl. 15.84cm h2o separating 3 12x16 arrays
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.63245                  91.44   0.0
cylinder  0 1 0.64135                  91.44   0.0
cylinder  7 1 0.64135                  93.98  -2.54
cylinder  2 1 0.70735                  93.98  -2.54
cuboid    3 1 4p.9460                  93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 15.3627 0.0 30.272  0.0   93.98  -2.54
global unit 5
array 2  -49.4187 -15.136  0.
reflector   4 1 5r0.0   2.54 1
cuboid    5 1 2p73.65 2p17.092  104.06 -17.84
reflector   6 1 2r0.0 2r17.85 2r0.0  1
reflector   5 2 5r3.0     0  3
reflector   5 5 4r3.0   2r0  1
reflector   5 6 2r3.0   4r0  6
end geometry

read bias id=500 2 11 end bias

read array
ara=1 nux=12 nuy=16 nuz=1   fill f1                    end fill
ara=2 nux=5  nuy=1  nuz=1   fill  2 3   2   3 2        end fill
end array
read plot
ttl='x-y slice at z=50'
xul=110.   yul=50.    zul=50
xlr=-110.  ylr=-50.   zlr=50
vax=-1 udn=-1 nax=130  nch=' ., 4 6789'  end
ttl='y-z slice at x=0.'
xul=.946   yul=-50.   zul=120
xlr=.946   ylr=50.    zlr=-20
vax=1  wdn=-1 nax=130  nch=' ., 4 6789'  end
end plot
end data
end
```

p3602s4

```
=csas25
1.892cm pitch lattice cell,4.31 wt% enriched fuel,b-ss plate
44group  latticecell
uo2  1 0.949 293 92235 4.31 92238 95.69 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28  14000 .22
28304 .79 42000 .49  24304 .12  29000 .13  6 end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7 end
boron       8 den=7.9 .0105  end
crss        8 den=7.9 .1903  end
cu          8 den=7.9 .0028  end
fess        8 den=7.9 .6804  end
mn          8 den=7.9 .0158  end
mo          8 den=7.9 .0049  end
```

```
niss        8 den=7.9 .0953  end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0 end
steel refl.  9.83cm h2o separating 3 12x16 arrays  w/borated ss plates
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.63245                  91.44   0.0
cylinder  0 1 0.64135                  91.44   0.0
cylinder  7 1 0.64135                  93.98  -2.54
cylinder  2 1 0.70735                  93.98  -2.54
cuboid    3 1 4p.9460                  93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1  9.0547 0.0 30.272  0.0   93.98  -2.54
unit 4
cuboid    8 1  0.298  0.0  2p15.1       88.96  -2.54
cuboid    5 1  0.298  0.0  2p15.136     93.98  -2.54
global unit 5
array 2  -43.4087 -15.136  0.
reflector   4 1 5r0.0   2.54 1
cuboid    5 1 2p73.65 2p17.092  104.06 -17.84
reflector   6 1 2r0.0 2r17.85 2r0.0  1
reflector   5 2 5r3.0     0  3
reflector   5 5 4r3.0   2r0  1
reflector   5 6 2r3.0   4r0  6
end geometry

read bias id=500 2 11 end bias

read array
ara=1 nux=12 nuy=16 nuz=1   fill f1                    end fill
ara=2 nux=7  nuy=1  nuz=1   fill  2 3 4 2 4 3 2        end fill
end array
read plot
ttl='x-y slice at z=50'
xul=110.   yul=50.    zul=50
xlr=-110.  ylr=-50.   zlr=50
vax=-1 udn=-1 nax=130  nch=' ., 4 6789'  end
ttl='close up x-y slice at z=50'
xul=45.   yul=16.    zul=50
xlr=-45.  ylr=-16.   zlr=50
vax=-1 udn=-1 nax=130  nch=' ., 4 6789'  end
ttl='y-z slice at x=0.'
xul=.946   yul=-50.   zul=120
xlr=.946   ylr=50.    zlr=-20
vax=1  wdn=-1 nax=130  nch=' ., 4 6789'  end
end plot
end data
end
```

p3602b4

```
=csas25
1.892cm pitch lattice cell,4.31 wt% enriched fuel,boral-b plate
44group latticecell
uo2  1 0.949 293 92235 4.31 92238 95.69 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28  14000 .22
28304 .79 42000 .49  24304 .12  29000 .13  6 end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7 end
al          8 den=2.50 .6121 end
boron       8 den=2.50 .3036 end
c           8 den=2.50 .0843 end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0 end
steel refl.  8.30cm h2o separating 3 12x16 arrays  w/boral plates
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.63245                  91.44   0.0
cylinder  0 1 0.64135                  91.44   0.0
cylinder  7 1 0.64135                  93.98  -2.54
cylinder  2 1 0.70735                  93.98  -2.54
cuboid    3 1 4p.9460                  93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1  7.5307 0.0 30.272  0.0   93.98  -2.54
unit 4
cuboid    8 1  0.292  0.0  2p15.1       88.96  -2.54
cuboid    5 1  0.292  0.0  2p15.136     93.98  -2.54
global unit 5
array 2  -41.8787 -15.136  0.
reflector   4 1 5r0.0   2.54 1
cuboid    5 1 2p73.65 2p17.092  104.06 -17.84
reflector   6 1 2r0.0 2r17.85 2r0.0  1
reflector   5 2 5r3.0     0  3
reflector   5 5 4r3.0   2r0  1
reflector   5 6 2r3.0   4r0  6
end geometry

read bias id=500 2 11 end bias

read array
ara=1 nux=12 nuy=16 nuz=1   fill f1                    end fill
ara=2 nux=7  nuy=1  nuz=1   fill  2 3 4 2 4 3 2        end fill
end array
read plot
ttl='x-y slice at z=50'
xul=110.   yul=50.    zul=50
xlr=-110.  ylr=-50.   zlr=50
vax=-1 udn=-1 nax=130  nch=' ., 4 6789'  end
ttl='y-z slice at x=0.'
xul=.946   yul=-50.   zul=120
xlr=.946   ylr=50.    zlr=-20
vax=1  wdn=-1 nax=130  nch=' ., 4 6789'  end
end plot
end data
end
```

p3602c4

```
=csas25
1.892cm pitch lattice cell,4.31 wt% enriched fuel,cadmium plate
44group latticecell
uo2  1 0.949 293 92235 4.31 92238 95.69 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28  14000 .22
28304 .79 42000 .49  24304 .12  29000 .13  6 end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7 end
cd          8          .997  end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0 end
steel refl.  8.94cm h2o separating 3 12x16 arrays  w/cd plates
read parm plt=yes run=yes gen=805 npg=600 nsk=5 tme=120
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.63245                   91.44   0.0
cylinder  0 1 0.64135                   91.44   0.0
cylinder  7 1 0.64135                   93.98  -2.54
cylinder  2 1 0.70735                   93.98  -2.54
cuboid    3 1 4p.9460                   93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1  8.4017 0.0 30.272  0.0   93.98  -2.54
unit 4
cuboid    8 1  0.061  0.0  2p15.1       88.96  -2.54
cuboid    5 1  0.061  0.0  2p15.136     93.98  -2.54
global unit 5
array 2  -42.5187 -15.136  0.
reflector   4 1 5r0.0   2.54 1
cuboid    5 1 2p73.65 2p17.092  104.06 -17.84
reflector   6 1 2r0.0 2r17.85 2r0.0  1
reflector   5 2 5r3.0     0  3
reflector   5 5 4r3.0   2r0  1
reflector   5 6 2r3.0   4r0  6
end geometry

read bias id=500 2 11 end bias

read array
ara=1 nux=12 nuy=16 nuz=1   fill f1                   end fill
ara=2 nux=7  nuy=1  nuz=1   fill  2 3 4 2 4 3 2       end fill
end array
read plot
ttl='x-y slice at z=50'
xul=110.   yul=50.    zul=50
xlr=-110.  ylr=-50.   zlr=50
vax=-1 udn=-1 nax=130  nch=' ., 4 6789'  end
ttl='close up x-y slice at z=50'
xul=43.   yul=16.    zul=50
xlr=-43.  ylr=-16.   zlr=50
vax=-1 udn=-1 nax=130  nch=' ., 4 6789'  end
ttl='y-z slice at x=0.'
xul=.946   yul=-50.   zul=120
xlr=.946   ylr=50.    zlr=-20
vax=1  wdn=-1 nax=130  nch=' ., 4 6789'  end
end plot
end data
end
```

p3926u2a

```
=csas25
'
' problem id --
' citation id --    exp. no.  --
'
' 2.35% u-235 enriched uo2 rods, 1.27cm od al clad, 1.1176 cm id,
' 1.1176 cm od uo2 91.44 cm long, rod 97.79 cm long.
' uranium walls (7.65 x 152.3 x 121.9) on floor reflecting in h2o.
' 3-19x16 clusters, 1.684 cm square pitch. 9.50 cm separation
' between clusters.  1.321 cm from fuel clusters to wall
' reference: pnl-3926 pg.13
' scale module: csas25
'
1.684 cm pitch lattice cell,2.35 wt% enriched fuel.
44group latticecell
uo2  1 0.84 293 92235 2.35 92238 97.65 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
uranium   6 .98163 293 92235 .199 92238 99.801 end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2  end
u refl 1.321 cm from array, 9.50 cm h2o sep. 23x18/2-20x18 arrays #2
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.5588                    91.44   0.0
cylinder  2 1 0.635                     96.52  -1.27
cuboid    3 1 0.842 -0.842 0.842 -0.842 96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 9.086  0.0  30.312  0.0   97.79   0.0
unit 4
array  2 3*0.0
global unit 5
array 3  -62.132  -15.156  0.
reflector 4 1  5r0.0    2.54                 1
cuboid    5 1  2p76.15  2p16.477  104.06  -17.84
reflector 6 1  2r0.0    2r7.65    2r0.0       1
reflector   5 2 5r3.0     0 3
reflector   5 5 4r3.0   2r0 2
reflector   5 7 2r3.0   4r0 5
end geometry
```

```
read bias id=500 2 11 end bias

read array
ara=1 nux=23 nuy=18 nuz=1   fill f1                   end fill
ara=2 nux=20 nuy=18 nuz=1   fill f1                   end fill
ara=3 nux=5  nuy=1  nuz=1   fill 4 3 2 3 4            end fill
end array
read plot
ttl='x-y slice at z=50'
xul=-95.   yul=55.    zul=50
xlr=95.    ylr=-55.   zlr=50
uax=1 vdn=-1 nax=260  nch=' 12 4 67'  end
end plot
end data
end
```

p3926l2a

```
=csas25
'
' problem id --
' citation id --    exp. no.  --
'
' 2.35% u-235 enriched uo2 rods, 1.27cm od al clad, 1.1176 cm id,
' 1.1176 cm od uo2 91.44 cm long, rod 97.79 cm long.
' lead walls on floor reflecting in h2o.
' 3-19x16 clusters, 1.684 cm square pitch. 10.11 cm separation
' between clusters.  0.660 cm from fuel clusters to wall
' reference: pnl-3926 pg.13
' scale module: csas25
'
1.684 cm pitch lattice cell,2.35 wt% enriched fuel.
44group latticecell
uo2  1 0.84 293 92235 2.35 92238 97.65 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
pb        6 .97533 end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2  end
pb refl 0.660 cm from array, 10.11 cm h2o sep. 23x18/2-20x18 arrays #2
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.5588                   91.44   0.0
cylinder  2 1 0.635                    96.52  -1.27
cuboid    3 1 0.842 -0.842 0.842 -0.842 96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 9.696  0.0  30.312  0.0   97.79   0.0
unit 4
array  2 3*0.0
global unit 5
array 3  -62.742  -15.156  0.
reflector 4 1  5r0.0    2.54                1
cuboid    5 1  2p82.0 2p15.816 105.56 -17.84
reflector 6 1  2r0.0    2r10.2    2r0.0       1
reflector   5 2 4r3.0  2.5 0 3
reflector   5 5 4r3.0   2r0  2
reflector   5 7 2r3.0   4r0  5
end geometry

read bias id=500 2 11 end bias

read array
ara=1 nux=23 nuy=18 nuz=1   fill f1                   end fill
ara=2 nux=20 nuy=18 nuz=1   fill f1                   end fill
ara=3 nux=5  nuy=1  nuz=1   fill 4 3 2 3 4            end fill
end array
read plot
ttl='x-y slice at z=50'
xul=110.   yul=45.    zul=50
xlr=-110.  ylr=-45.   zlr=50
vax=-1 udn=-1 nax=130  nch=' ., 4 67'  end
ttl='y-z slice at x=0.'
xul=0.     yul=-45.   zul=120
xlr=0.     ylr=45.    zlr=-20
vax=1  wdn=-1 nax=130  nch=' ., 4 67'  end
end plot
end data
end
```

p3926n2

```
=csas25
'
' problem id --
' citation id --    exp. no.  --
'
' 2.35% u-235 enriched uo2 rods, 1.27cm od al clad, 1.1176 cm id,
' 1.1176 cm od uo2 91.44 cm long, rod 97.79 cm long.
' no reflecting walls
' 3-19x16 clusters, 1.684 cm square pitch. 6.59 cm separation
' between clusters.  infinite distance from fuel clusters to wall
' reference: pnl-3926 pg.13
' scale module: csas25
'
1.684 cm pitch lattice cell,2.35 wt% enriched fuel.
44group latticecell
uo2  1 0.84 293 92235 2.35 92238 97.65 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
uranium   6 .98163 293 92235 .199 92238 99.801 end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2  end
no refl infinite from array, 6.59 cm h2o sep. 23x18/2-20x18 arrays
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.5588                   91.44   0.0
cylinder  2 1 0.635                    96.52  -1.27
```

```
cuboid    3 1 0.842 -0.842 0.842 -0.842 96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 6.176  0.0  30.312  0.0   97.79   0.0
unit 4
array  2 3*0.0
global unit 5
array 3  -59.222  -15.156  0.
reflector   4 1 5r0    2.54 1
reflector   5 2 6r3.0       5
reflector   5 7 4r3.0   2r0 5
end geometry

read bias id=500 2 11 end bias

read array
ara=1 nux=23 nuy=18 nuz=1   fill f1                   end fill
ara=2 nux=20 nuy=18 nuz=1   fill f1                   end fill
ara=3 nux=5  nuy=1  nuz=1   fill 4 3 2 3 4            end fill
end array
read plot
ttl='x-y slice at z=50'
xul=110.   yul=45.    zul=50
xlr=-110.  ylr=-45.   zlr=50
vax=-1 udn=-1 nax=130  nch=' ., 4 67'  end
ttl='y-z slice at x=0.'
xul=0.     yul=-45.   zul=120
xlr=0.     ylr=45.    zlr=-20
vax=1  wdn=-1 nax=130  nch=' ., 4 67'  end
end plot
end data
end
```

p3926u4a

```
=csas25
'
' problem id --
' citation id --    exp. no.  --
'
' 4.31% u-235 enriched uo2 rods, 1.4147cm od al clad, 1.2827 cm id,
' 1.2649 cm od uo2 91.44 cm long, rod 96.52 cm long.
' uranium walls (7.65 x 152.3 x 121.9) on floor reflecting in h2o.
' 3-12x16 clusters, 1.892 cm square pitch. 19.24 cm separation
' between clusters. , 1.956 cm from fuel clusters
' reference: pnl-3926 pg.13
' scale module: csas25
'
1.892 in pitch lattice cell,4.31 wt% enriched fuel.
44group latticecell
uo2  1 0.949 293 92235 4.31 92238 95.69 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
uranium     6 .98163  293  92235  .199  92238  99.801  end
```



```
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7 end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0 end
uranium refl. 19.24cm h2o separating 12x16 arrays
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.63245                   91.44   0.0
cylinder  0 1 0.64135                   91.44   0.0
cylinder  7 1 0.64135                   93.98  -2.54
cylinder  2 1 0.70735                   93.98  -2.54
cuboid    3 1 4p0.946                   93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 18.7627 0.0 30.272  0.0   96.52   0.0
global unit 4
array 2  -52.8187 -15.136  0.
reflector   4 1 5r0.0   2.54 1
cuboid    5 1 2p76.15 2p17.092  104.06 -17.84
reflector   6 1 2r0.0 2r7.65 2r0.0  1
reflector   5 2 5r3.0     0  3
reflector   5 5 4r3.0   2r0  5
reflector   5 10  2r3.0   4r0  2
end geometry

read bias id=500 2 11 end bias

read array
ara=1 nux=12 nuy=16 nuz=1   fill f1                   end fill
ara=2 nux=5  nuy=1  nuz=1 fill  2 3 2 3 2  end fill
end array
read plot
ttl='x-y slice at z=50'
xul=110.   yul=45.    zul=50
xlr=-110.  ylr=-45.   zlr=50
vax=-1 udn=-1 nax=130  nch=' ., 4 67'  end
ttl='y-z slice at x=0.'
xul=0.9    yul=-45.   zul=120
xlr=0.9    ylr=45.    zlr=-20
vax=1  wdn=-1 nax=130  nch=' ., 4 67'  end
end plot
end data
end
```

p3926l4a

```
=csas25
'
' problem id --
' citation id --    exp. no.  --
'
' 4.31% u-235 enriched uo2 rods, 1.4147cm od al clad, 1.2827 cm id,
' 1.2649 cm od uo2 91.44 cm long, rod 96.52 cm long.
' lead walls (10.2 x 164.0 x 123.4) on floor reflecting in h2o.
' 3-12x16 clusters, 1.892 cm square pitch. 18.18 cm separation
```

```
' between clusters.  0.66  cm from fuel clusters
' reference: pnl-3926 pg.13
' scale module: csas25
'
1.892 cm pitch lattice cell,4.31 wt% enriched fuel.
44group latticecell
uo2  1 0.949 293 92235 4.31 92238 95.69 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end
pb          6 .97533  end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7 end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0 end
lead refl. 18.18cm h2o separating 12x16 arrays
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.63245                   91.44   0.0
cylinder  0 1 0.64135                   91.44   0.0
cylinder  7 1 0.64135                   93.98  -2.54
cylinder  2 1 0.70735                   93.98  -2.54
cuboid    3 1 4p0.946                   93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 17.7027 0.0 30.272  0.0   96.52   0.0
global unit 4
array 2  -51.7587 -15.136  0.
reflector   4 1 5r0.0   2.54 1
cuboid    5 1 2p82.0  2p15.796  105.56 -17.84
reflector   6 1 2r0.0 2r10.2 2r0.0  1
reflector   5 2 5r3.0      0 2
reflector   5 4 4r3.0   2r0  5
reflector   5 9 2r3.0   4r0  3
end geometry

read bias id=500 2 11 end bias

read array
ara=1 nux=12 nuy=16 nuz=1   fill f1                   end fill
ara=2 nux=5  nuy=1  nuz=1 fill  2 3 2 3 2  end fill
end array
read plot
ttl='x-y slice at z=50'
xul=115.   yul=45.    zul=50
xlr=-115.  ylr=-45.   zlr=50
vax=-1 udn=-1 nax=130  nch=' ., 4 67'  end
ttl='y-z slice at x=0.'
xul=0.9    yul=-45.   zul=120
xlr=0.9    ylr=45.    zlr=-20
vax=1  wdn=-1 nax=130  nch=' ., 4 67'  end
end plot
end data
end
```

p3926nob

```
=csas25
1.892cm pitch lattice cell,4.31 wt% enriched fuel,no reflector
44group  latticecell
uo2  1 0.949 293 92235 4.31 92238 95.69 end uo2
al  2 1.0  end al
h2o  3 1.0  end h2o
plexiglass  4 1.0  end plexiglass
h2o         5      end

arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 6 end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0 end
no refl. 12.91cm h2o separating 3 12x16 arrays
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.63245                   91.44   0.0
cylinder  0 1 0.64135                   91.44   0.0
cylinder  6 1 0.64135                   93.98  -2.54
cylinder  2 1 0.70735                   93.98  -2.54
cuboid    3 1 4p.9460                   93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 12.4327 0.0 30.272  0.0   93.98  -2.54
global unit 5
array 2  -46.4887 -15.136  0.
reflector   4 1 5r0.0   2.54 1
reflector   5 2 6r3.0        5
reflector   5 7 4r3.0   2r0  5
end geometry

read bias id=500 2 11 end bias

read array
ara=1 nux=12 nuy=16 nuz=1   fill f1                   end fill
ara=2 nux=5  nuy=1  nuz=1   fill  2 3   2   3 2       end fill
end array
read plot
ttl='x-y slice at z=50'
xul=110.   yul=50.    zul=50
xlr=-110.  ylr=-50.   zlr=50
vax=-1 udn=-1 nax=130  nch=' ., 4 6789'  end
ttl='y-z slice at x=0.'
xul=.946   yul=-50.   zul=120
xlr=.946   ylr=50.    zlr=-20
vax=1  wdn=-1 nax=130  nch=' ., 4 6789'  end
end plot
end data
end
```

p4267a

```
=csas2x
'
' problem id -- pnl-4267
' citation id --    exp. no.  173
'
' 4.31% u-235 enriched uo2 rods, 1.4147 cm od al clad, 1.2827 cm id,
' 1.2649 cm od. uo2 91.44 cm long, rod 96.52 cm long.
' single array 40x8.92 rods (357 total rods), 1.890 cm square pitch.
' no soluble boron
' reference: pnl-4267  exp. 173
' scale module: csas2x
'
1.890 cm pitch lattice cell,4.31 wt% enriched fuel.
44group latticecell
uo2  1 0.949  293 92235 4.31 92238 95.69 end uo2
al   2 1.0  end al
h2o  3 1.0  end h2o
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 4 end
poly(h2o)   5  den=.904 end
h2o  6         end
boron 7 den=.00255 1.0 end
h2o  7         end
plexiglass  8  1.0 end
uo2  9 0.949  293 92235 4.31 92238 95.69 end uo2
al  10 1.0  end al
h2o 11 1.0  end h2o
end comp
'            pitch  fod   f m  cod    c   cid   g
squarepitch  1.890 1.2649 9 11 1.4147 10 1.2827 0  end
more data
res=1 cylinder .63245 dan(1)=.173084
end more
pnl-4267 exp. 173 40 x 8.92 array (357 total rods) boron = 0 g/l
read parm plt=yes run=yes gen=805 npg=600 nsk=5 tme=120
wrs=34 res=205 nub=yes rnd=65162460326C end parm
read geom
unit 1
'bottom of fuel - rubber cap in lower lattice support plate
cylinder  4 1 0.64135                          2.54   0.0
cylinder  2 1 0.70735                          2.54   0.0
cuboid    5 1 4p0.945                          2.54   0.0
unit 2
'fuel between the two lattice support plates
cylinder  1 1 0.63245                         67.29   0.0
cylinder  0 1 0.64135                         67.29   0.0
cylinder  2 1 0.70735                         67.29   0.0
cuboid    3 1 4p0.945                         67.29   0.0
unit 3
'fuel in upper lattice support plate
cylinder  1 1 0.63245                          1.27   0.0
cylinder  0 1 0.64135                          1.27   0.0
cylinder  2 1 0.70735                          1.27   0.0
cuboid    5 1 4p0.945                          1.27   0.0
unit 4
'fuel above the upper lattice support plate
cylinder  1 1 0.63245                         22.86   0.0
cylinder  0 1 0.64135                         22.86   0.0
cylinder  2 1 0.70735                         22.86   0.0
cuboid    3 1 4p0.945                         22.86   0.0
unit 5
'bottom of smeared fuel - rubber cap
cuboid    4 1 1.7483 0  2p0.945               2.54   0.0
cuboid    5 1 1.890  0  2p0.945               2.54   0.0
unit 6
'smeared fuel between the two lattice support plates
cuboid  500 1 1.7483 0  2p0.945              67.29   0.0
cuboid    3 1 1.890  0  2p0.945              67.29   0.0
unit 7
'smeared fuel in upper lattice support plate
cuboid  500 1 1.7483 0  2p0.945               1.27   0.0
cuboid    5 1 1.890  0  2p0.945               1.27   0.0
unit 8
'smeared fuel above the upper lattice support plate
cuboid  500 1 1.7483 0  2p0.945              22.86   0.0
cuboid    3 1 1.890  0  2p0.945              22.86   0.0
unit 9
'top of fuel - rubber cap in h2o
cylinder  4 1 0.64135                          2.54   0.0
cylinder  2 1 0.70735                          2.54   0.0
cuboid    3 1 4p0.945                          2.54   0.0
unit 10
'top of smeared fuel - rubber cap in h2o
cuboid    4 1 1.7483 0  2p0.945               2.54   0.0
cuboid    3 1 1.890  0  2p0.945               2.54   0.0

global
unit 11
array  1 -8.505  -37.80  0.0
cuboid    3 1 2p39.80  2p37.94   111.7  0.0
cuboid    8 1 2p41.705 2p39.845  111.7  -17.105
reflector 6 2 4r3 2r0 10
end geometry

read bias id=500  2 11  end bias

read array
ara=1 nux=9 nuy=40 nuz=5
fill  8r1 5  39q9   8r2 6  39q9
      8r3 7  39q9   8r4 8  39q9  8r9 10 39q9  end fill
end array
read plot
ttl='x-y slice of pnl4267a at z=50'
xul=-45.   yul=45.0   zul=50
xlr= 45.   ylr=-45.   zlr=50
uax=1 vdn=-1 nax=130  nch=' 12 45 8&'  end
end plot
end data
end
```

p4267b

```
=csas2x
'
' problem id -- pnl-4267
' citation id --    exp. no.  177
'
' 4.31% u-235 enriched uo2 rods, 1.4147 cm od al clad, 1.2827 cm id,
' 1.2649 cm od. uo2 91.44 cm long, rod 96.52 cm long.
' single array 40 x 30.92 rods (1237 total rods), 1.890 cm square pitch
' boron conc = 2.55 g/l
' reference: pnl-4267  exp. 177
' scale module: csas2x
'
1.890 cm pitch lattice cell,4.31 wt% enriched fuel.
44group latticecell
uo2  1 0.949  293 92235 4.31 92238 95.69 end uo2
al   2 1.0  end al
h2o  3 1.0  end h2o
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 4 end
poly(h2o)   5  den=.904 end
h2o  6         end
boron 7 den=.00255 1.0 end
h2o  7         end
plexiglass  8  1.0 end
uo2  9 0.949  293 92235 4.31 92238 95.69 end uo2
al  10 1.0  end al
h2o 11 1.0  end h2o
boron 11 den=.00255 1.0 end
end comp
'            pitch  fod   f m  cod    c   cid   g
squarepitch  1.890 1.2649 9 11 1.4147 10 1.2827 0  end
more data
res=1 cylinder .63245 dan(1)=.173084
end more
pnl-4267 exp.177 40 x 30.92 array 1237 total rods) boron = 2.55 g/l
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
'bottom of fuel - rubber cap in lower lattice support plate
cylinder  4 1 0.64135                          2.54   0.0
cylinder  2 1 0.70735                          2.54   0.0
cuboid    5 1 4p0.945                          2.54   0.0
unit 2
'fuel between the two lattice support plates
cylinder  1 1 0.63245                         67.29   0.0
cylinder  0 1 0.64135                         67.29   0.0
cylinder  2 1 0.70735                         67.29   0.0
cuboid    7 1 4p0.945                         67.29   0.0
unit 3
'fuel in upper lattice support plate
cylinder  1 1 0.63245                          1.27   0.0
cylinder  0 1 0.64135                          1.27   0.0
cylinder  2 1 0.70735                          1.27   0.0
cuboid    5 1 4p0.945                          1.27   0.0
unit 4
'fuel above the upper lattice support plate
cylinder  1 1 0.63245                         22.86   0.0
cylinder  0 1 0.64135                         22.86   0.0
cylinder  2 1 0.70735                         22.86   0.0
cuboid    7 1 4p0.945                         22.86   0.0
unit 5
'bottom of smeared fuel - rubber cap
cuboid    4 1 1.7483 0  2p0.945               2.54   0.0
cuboid    5 1 1.890  0  2p0.945               2.54   0.0
unit 6
'smeared fuel between the two lattice support plates
cuboid  500 1 1.7483 0  2p0.945              67.29   0.0
cuboid    7 1 1.890  0  2p0.945              67.29   0.0
unit 7
'smeared fuel in upper lattice support plate
cuboid  500 1 1.7483 0  2p0.945               1.27   0.0
cuboid    5 1 1.890  0  2p0.945               1.27   0.0
unit 8
'smeared fuel above the upper lattice support plate
cuboid  500 1 1.7483 0  2p0.945              22.86   0.0
cuboid    7 1 1.890  0  2p0.945              22.86   0.0
unit 9
'top of fuel - rubber cap in h2o
cylinder  4 1 0.64135                          2.54   0.0
cylinder  2 1 0.70735                          2.54   0.0
cuboid    7 1 4p0.945                          2.54   0.0
unit 10
'top of smeared fuel - rubber cap in h2o
cuboid    4 1 1.7483 0  2p0.945               2.54   0.0
cuboid    7 1 1.890  0  2p0.945               2.54   0.0

global
unit 11
array  1 -29.295 -37.80  0.0
cuboid    7 1 2p39.80  2p37.94   111.7  0.0
cuboid    8 1 2p41.705 2p39.845  111.7  -17.105
reflector 6 2 4r3 2r0 10
end geometry

read bias id=500  2 11  end bias

read array
ara=1 nux=31 nuy=40 nuz=5
fill  30r1 5  39q31  30r2 6  39q31
      30r3 7  39q31  30r4 8  39q31  30r9 10 39q31  end fill
end array
read plot
ttl='x-y slice of pnl4267b at z=50'
xul=-45.   yul=45.0   zul=50
xlr= 45.   ylr=-45.   zlr=50
uax=1 vdn=-1 nax=130  nch=' 12 45  8&'  end
end plot
end data
end
```

p4267c

```
=csas2x
'
' problem id -- pnl-4267
' citation id --    exp. no.  178
'
' 4.31% u-235 enriched uo2 rods, 1.4147 cm od al clad, 1.2827 cm id,
' 1.2649 cm od. uo2 91.44 cm long, rod 96.52 cm long.
' single array 44x11.57 rods(509 total rods), 1.715 cm square pitch.
' no soluble boron
' reference: pnl-4267  exp. 178
' scale module: csas2x
'
1.715 cm pitch lattice cell,4.31 wt% enriched fuel.
44group latticecell
uo2  1 0.949  293 92235 4.31 92238 95.69 end uo2
al   2 1.0  end al
h2o  3 1.0  end h2o
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 4 end
poly(h2o)   5  den=.904 end
h2o  6         end
boron 7 den=.00255 1.0 end
h2o  7         end
plexiglass  8  1.0 end
uo2  9 0.949  293 92235 4.31 92238 95.69 end uo2
al  10 1.0  end al
h2o 11 1.0  end h2o
end comp
'            pitch  fod   f m  cod    c   cid   g
squarepitch  1.715 1.2649 9 11 1.4147 10 1.2827 0  end
more data
res=1 cylinder .63245 dan(1)=.269915
end more
pnl-4267 exp. 178 44 x 11.57array (509 total rods) boron = 0 g/l
read parm plt=yes run=yes gen=805 npg=600 nsk=5 tme=120
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
'bottom of fuel - rubber cap in lower lattice support plate
cylinder  4 1 0.64135                          2.54   0.0
cylinder  2 1 0.70735                          2.54   0.0
cuboid    5 1 4p0.8575                         2.54   0.0
unit 2
'fuel between the two lattice support plates
cylinder  1 1 0.63245                         67.29   0.0
cylinder  0 1 0.64135                         67.29   0.0
cylinder  2 1 0.70735                         67.29   0.0
cuboid    3 1 4p0.8575                        67.29   0.0
unit 3
'fuel in upper lattice support plate
cylinder  1 1 0.63245                          1.27   0.0
cylinder  0 1 0.64135                          1.27   0.0
cylinder  2 1 0.70735                          1.27   0.0
cuboid    5 1 4p0.8575                         1.27   0.0
unit 4
'fuel above the upper lattice support plate
cylinder  1 1 0.63245                         22.86   0.0
cylinder  0 1 0.64135                         22.86   0.0
cylinder  2 1 0.70735                         22.86   0.0
cuboid    3 1 4p0.8575                        22.86   0.0
unit 5
'bottom of smeared fuel - rubber cap
cuboid    4 1 0.9744 0  2p0.8575              2.54   0.0
cuboid    5 1 1.715  0  2p0.8575              2.54   0.0
unit 6
'smeared fuel between the two lattice support plates
cuboid  500 1 0.9744 0  2p0.8575             67.29   0.0
cuboid    3 1 1.715  0  2p0.8575             67.29   0.0
unit 7
'smeared fuel in upper lattice support plate
cuboid  500 1 0.9744 0  2p0.8575              1.27   0.0
cuboid    5 1 1.715  0  2p0.8575              1.27   0.0
unit 8
'smeared fuel above the upper lattice support plate
cuboid  500 1 0.9744 0  2p0.8575             22.86   0.0
cuboid    3 1 1.715  0  2p0.8575             22.86   0.0
unit 9
'top of fuel - rubber cap in h2o
cylinder  4 1 0.64135                          2.54   0.0
cylinder  2 1 0.70735                          2.54   0.0
cuboid    3 1 4p0.8575                         2.54   0.0
unit 10
'top of smeared fuel - rubber cap
cuboid    4 1 0.9744 0  2p0.8575              2.54   0.0
cuboid    3 1 1.715  0  2p0.8575              2.54   0.0

global
unit 11
array  1 -10.29  -37.73  0.0
cuboid    3 1 2p39.80  2p37.94   111.7  0.0
cuboid    8 1 2p41.705 2p39.845  111.7  -17.105
reflector 6 2 4r3 2r0 10
end geometry

read bias id=500  2 11  end bias

read array
ara=1 nux=12 nuy=44 nuz=5
fill 11r1 5  43q12 11r2 6  43q12
     11r3 7  43q12 11r4 8  43q12  11r9 10 43q12  end fill
end array
read plot
ttl='x-y slice of pnl4267c at z=50'
xul=-45.   yul=45.0   zul=50
xlr= 45.   ylr=-45.   zlr=50
uax=1 vdn=-1 nax=130  nch=' 12 45 8&'  end
end plot

end data
end
```

p4267d

```
=csas2x
'
```

```
' problem id -- pnl-4267
' citation id --    exp. no.  181
'
' 4.31% u-235 enriched uo2 rods, 1.4147 cm od al clad, 1.2827 cm id,
' 1.2649 cm od. uo2 91.44 cm long, rod 96.52 cm long.
' single array 44 x 27.09 rods (1192 total rods), 1.715 cm square pitch.
' boron = 2.55 g/l
' reference: pnl-4267  exp. 181
' scale module: csas2x
'
1.715 cm pitch lattice cell,4.31 wt% enriched fuel.
44group latticecell
uo2  1 0.949  293 92235 4.31 92238 95.69 end uo2
al   2 1.0  end al
h2o  3 1.0  end h2o
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 4 end
poly(h2o)   5  den=.904 end
h2o  6         end
boron 7 den=.00255 1.0 end
h2o  7         end
plexiglass  8  1.0 end
uo2  9 0.949  293 92235 4.31 92238 95.69 end uo2
al  10 1.0  end al
h2o 11 1.0  end h2o
boron 11 den=.00255 1.0 end
end comp
'             pitch  fod   f m  cod    c   cid   g
squarepitch  1.715 1.2649 9 11 1.4147 10 1.2827 0  end
more data
res=1 cylinder .63245 dan(1)=.269915
end more
pnl-4267 exp. 181 44 x 27.09 array (1192 total rods) boron = 2.55 g/l
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
'bottom of fuel - rubber cap in lower lattice support plate
cylinder  4 1 0.64135                          2.54   0.0
cylinder  2 1 0.70735                          2.54   0.0
cuboid    5 1 4p0.8575                         2.54   0.0
unit 2
'fuel between the two lattice support plates
cylinder  1 1 0.63245                         67.29   0.0
cylinder  0 1 0.64135                         67.29   0.0
cylinder  2 1 0.70735                         67.29   0.0
cuboid    7 1 4p0.8575                        67.29   0.0
unit 3
'fuel in upper lattice support plate
cylinder  1 1 0.63245                          1.27   0.0
cylinder  0 1 0.64135                          1.27   0.0
cylinder  2 1 0.70735                          1.27   0.0
cuboid    5 1 4p0.8575                         1.27   0.0
unit 4
'fuel above the upper lattice support plate
cylinder  1 1 0.63245                         22.86   0.0
cylinder  0 1 0.64135                         22.86   0.0
cylinder  2 1 0.70735                         22.86   0.0
cuboid    7 1 4p0.8575                        22.86   0.0
unit 5
'bottom of smeared fuel - rubber cap
cuboid    4 1 0.1559 0  2p0.8575               2.54   0.0
cuboid    5 1 1.715  0  2p0.8575               2.54   0.0
unit 6
'smeared fuel between the two lattice support plates
cuboid  500 1 0.1559 0  2p0.8575              67.29   0.0
cuboid    7 1 1.715  0  2p0.8575              67.29   0.0
unit 7
'smeared fuel in upper lattice support plate
cuboid  500 1 0.1559 0  2p0.8575               1.27   0.0
cuboid    5 1 1.715  0  2p0.8575               1.27   0.0
unit 8
'smeared fuel above the upper lattice support plate
cuboid  500 1 0.1559 0  2p0.8575              22.86   0.0
cuboid    7 1 1.715  0  2p0.8575              22.86   0.0
unit 9
'top of fuel - rubber cap in h2o
cylinder  4 1 0.64135                          2.54   0.0
cylinder  2 1 0.70735                          2.54   0.0
cuboid    7 1 4p0.8575                         2.54   0.0
unit 10
'top of smeared fuel - rubber cap
cuboid    4 1 0.1559 0  2p0.8575               2.54   0.0
cuboid    7 1 1.715  0  2p0.8575               2.54   0.0

global
unit 11
array  1 -24.01  -37.73  0.0
cuboid    7 1 2p39.80  2p37.94   111.7  0.0
cuboid    8 1 2p41.705 2p39.845  111.7  -17.105
reflector 6 2 4r3 2r0 10
end geometry

read bias id=500  2 11  end bias

read array
ara=1 nux=28 nuy=44 nuz=5
fill 27r1 5  43q28 27r2 6  43q28
     27r3 7  43q28 27r4 8  43q28  27r9 10 43q28  end fill
end array
read plot
ttl='x-y slice of pnl4267d at z=50'
xul=-45.   yul=45.0   zul=50
xlr= 45.   ylr=-45.   zlr=50
uax=1 vdn=-1 nax=130  nch=' 12 45  8&'  end
end plot
end data
end
```

pnl194

```
#csas25
pnl-4976 4.3-000-194 4.3%uo2 1.598cm-pitch
44group                latticecell
uo2           1  den=10.40 1.0 293 92234 .022 92235 4.306 92236 .022
92238
 95.65 end
```

```
al              2  1.0 293 end
h               3  den=1.321 .065 293 end
c               3  den=1.321 .58 293 end
o               3  den=1.321 .221 293 end
s               3  den=1.321 .017 293 end
ca              3  den=1.321 .114 293 end
si              3  den=1.321 .003 293 end
h2o             4  1.0 293 end
h               5  den=1.185 .08 293 end
c               5  den=1.185 .60 293 end
o               5  den=1.185 .32 293 end
poly(h2o)       6  den=.905 1.0 293 end
end comp
triangpitch 1.598 1.265 1  4  1.415 2  1.283 0 end
pnl-4976 4.3-000-194 4.3%uo2 1.598cm-pitch
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=120
wrs=34 res=205 nub=yes  end parm
read geom
unit  1
com=!   0.0  to    2.286 cm 01 !
zhemicyl+x 3 1 .6415 2.286 0.0
zhemicyl+x 2 1 .7075 2.286 0.0
zhemicyl+x 4 1 .714 2.286 0.0
unit  2
com=!   0.0  to    2.286 cm 01 !
zhemicyl-y 3 1 .6415 2.286 0.0
zhemicyl-y 2 1 .7075 2.286 0.0
zhemicyl-y 4 1 .714 2.286 0.0
unit  3
com=!   0.0  to    2.286 cm 01 !
zhemicyl-x 3 1 .6415 2.286 0.0
zhemicyl-x 2 1 .7075 2.286 0.0
zhemicyl-x 4 1 .714 2.286 0.0
unit  4
com=!   0.0  to    2.286 cm 01 !
zhemicyl+y 3 1 .6415 2.286 0.0
zhemicyl+y 2 1 .7075 2.286 0.0
zhemicyl+y 4 1 .714 2.286 0.0
unit  5
com=!   0.0 to     35.48 cm 02 !
zhemicyl+x 1 1 .6325 35.48 0.0
zhemicyl+x 0 1 .6415 35.48 0.0
zhemicyl+x 2 1 .7075 35.48 0.0
unit  6
com=!   0.0 to     35.48 cm 02 !
zhemicyl-y 1 1 .6325 35.48 0.0
zhemicyl-y 0 1 .6415 35.48 0.0
zhemicyl-y 2 1 .7075 35.48 0.0
unit  7
com=!   0.0 to     35.48 cm 02 !
zhemicyl-x 1 1 .6325 35.48 0.0
zhemicyl-x 0 1 .6415 35.48 0.0
zhemicyl-x 2 1 .7075 35.48 0.0
unit  8
com=!   0.0 to     35.48 cm 02 !
zhemicyl+y 1 1 .6325 35.48 0.0
zhemicyl+y 0 1 .6415 35.48 0.0
zhemicyl+y 2 1 .7075 35.48 0.0
unit  9
com=!   0.0 to 1.35 cm 03 !
zhemicyl+x 1 1 .6325 1.35 0.0
zhemicyl+x 0 1 .6415 1.35 0.0
zhemicyl+x 2 1 .7075 1.35 0.0
zhemicyl+x 4 1 .714 1.35 0.0
unit 10
com=!   0.0 to 1.35 cm 03 !
zhemicyl-y 1 1 .6325 1.35 0.0
zhemicyl-y 0 1 .6415 1.35 0.0
zhemicyl-y 2 1 .7075 1.35 0.0
zhemicyl-y 4 1 .714 1.35 0.0
unit 11
com=!   0.0 to 1.35 cm 03 !
zhemicyl-x 1 1 .6325 1.35 0.0
zhemicyl-x 0 1 .6415 1.35 0.0
zhemicyl-x 2 1 .7075 1.35 0.0
zhemicyl-x 4 1 .714 1.35 0.0
unit 12
com=!   0.0 to 1.35 cm 03 !
zhemicyl+y 1 1 .6325 1.35 0.0
zhemicyl+y 0 1 .6415 1.35 0.0
zhemicyl+y 2 1 .7075 1.35 0.0
zhemicyl+y 4 1 .714 1.35 0.0
unit 13
com=!   0.0 to     47.291 cm 04 !
zhemicyl+x 1 1 .6325 47.291 0.0
zhemicyl+x 0 1 .6415 47.291 0.0
zhemicyl+x 2 1 .7075 47.291 0.0
unit 14
com=!   0.0 to     47.291 cm 04 !
zhemicyl-y 1 1 .6325 47.291 0.0
zhemicyl-y 0 1 .6415 47.291 0.0
zhemicyl-y 2 1 .7075 47.291 0.0
unit 15
com=!   0.0 to     47.291 cm 04 !
zhemicyl-x 1 1 .6325 47.291 0.0
zhemicyl-x 0 1 .6415 47.291 0.0
zhemicyl-x 2 1 .7075 47.291 0.0
unit 16
com=!   0.0 to     47.291 cm 04 !
zhemicyl+y 1 1 .6325 47.291 0.0
zhemicyl+y 0 1 .6415 47.291 0.0
zhemicyl+y 2 1 .7075 47.291 0.0
unit 17
com=!   0.0 to     6.604 cm 06 !
zhemicyl+x 1 1 .6325 6.604 0.0
zhemicyl+x 0 1 .6415 6.604 0.0
zhemicyl+x 2 1 .7075 6.604 0.0
unit 18
com=!   0.0 to     6.604 cm 06 !
zhemicyl-y 1 1 .6325 6.604 0.0
zhemicyl-y 0 1 .6415 6.604 0.0
zhemicyl-y 2 1 .7075 6.604 0.0
unit 19
com=!   0.0 to     6.604 cm 06 !
zhemicyl-x 1 1 .6325 6.604 0.0
zhemicyl-x 0 1 .6415 6.604 0.0
zhemicyl-x 2 1 .7075 6.604 0.0
unit 20
```

```
com=!   0.0 to     6.604 cm 06 !
zhemicyl+y 1 1 .6325 6.604 0.0
zhemicyl+y 0 1 .6415 6.604 0.0
zhemicyl+y 2 1 .7075 6.604 0.0
unit 21
com=!   0.0  to    .809 cm 01 !
zhemicyl+x 3 1 .6415 .809 0.0
zhemicyl+x 2 1 .7075 .809 0.0
unit 22
com=!   0.0  to    .809 cm 01 !
zhemicyl-y 3 1 .6415 .809 0.0
zhemicyl-y 2 1 .7075 .809 0.0
unit 23
com=!   0.0  to    .809 cm 01 !
zhemicyl-x 3 1 .6415 .809 0.0
zhemicyl-x 2 1 .7075 .809 0.0
unit 24
com=!   0.0  to    .809 cm 01 !
zhemicyl+y 3 1 .6415 .809 0.0
zhemicyl+y 2 1 .7075 .809 0.0
unit 25
com=!   0.0  to    1.35 cm 01 !
zhemicyl+x 3 1 .6415 1.35 0.0
zhemicyl+x 2 1 .7075 1.35 0.0
zhemicyl+x 4 1 .714 1.35 0.0
unit 26
com=!   0.0  to    1.35 cm 01 !
zhemicyl-y 3 1 .6415 1.35 0.0
zhemicyl-y 2 1 .7075 1.35 0.0
zhemicyl-y 4 1 .714 1.35 0.0
unit 27
com=!   0.0  to    1.35 cm 01 !
zhemicyl-x 3 1 .6415 1.35 0.0
zhemicyl-x 2 1 .7075 1.35 0.0
zhemicyl-x 4 1 .714 1.35 0.0
unit 28
com=!   0.0  to    1.35 cm 01 !
zhemicyl+y 3 1 .6415 1.35 0.0
zhemicyl+y 2 1 .7075 1.35 0.0
zhemicyl+y 4 1 .714 1.35 0.0
unit 101
com=!   0.0  to    1.35 cm 01 !
zhemicyl+x 3 1 .6415   1.35   0.0
zhemicyl+x 2 1 .7075   1.35   0.0
zhemicyl+x 4 1 .7140   1.35   0.0
cuboid 6 1 1.598   0     2p1.384  1.35   0.0
hole      26   .799    1.384  0.0
hole      27   1.598   0      0.0
hole      28   .799   -1.384  0.0
unit 102
com=!   0.0  to    1.35 cm 02 !
zhemicyl+x 3 1 .6415   1.35   0.0
zhemicyl+x 2 1 .7075   1.35   0.0
zhemicyl+x 4 1 .7140   1.35   0.0
cuboid 6 1 1.598   0     2p1.384  1.35   0.0
hole      26   .799    1.384  0.0
hole      27   1.598   0      0.0
unit 103
com=!   0.0  to    1.35 cm 03 !
zhemicyl+x 3 1 .6415   1.35   0.0
zhemicyl+x 2 1 .7075   1.35   0.0
zhemicyl+x 4 1 .7140   1.35   0.0
cuboid 6 1 1.598   0     2p1.384  1.35   0.0
hole      26   .799    1.384  0.0
hole      28   .799   -1.384  0.0
unit 104
com=!   0.0  to    1.35 cm 04 !
zhemicyl+x 3 1 .6415   1.35   0
zhemicyl+x 2 1 .7075   1.35   0
zhemicyl+x 4 1 .7140   1.35   0
cuboid 6 1 1.598   0.0   2p1.384  1.35   0.0
hole      27   1.598   0.0    0
hole      28   .799   -1.384  0
unit 105
com=!   0.0  to    1.35 cm 05 !
zhemicyl+x 3 1 .6415   1.35   0
zhemicyl+x 2 1 .7075   1.35   0
zhemicyl+x 4 1 .7140   1.35   0
cuboid 6 1 1.598   0.0   2p1.384  1.35   0.0
hole      26   .799    1.384  0
unit 106
com=!   0.0  to    1.35 cm 06 !
zhemicyl+x 3 1 .6415   1.35   0
zhemicyl+x 2 1 .7075   1.35   0
zhemicyl+x 4 1 .7140   1.35   0
cuboid 6 1 1.598   0.0   2p1.384  1.35   0.0
hole      27   1.598   0.0    0
unit 107
com=!   0.0  to    1.35 cm 07 !
zhemicyl+x 3 1 .6415   1.35   0
zhemicyl+x 2 1 .7075   1.35   0
zhemicyl+x 4 1 .7140   1.35   0
cuboid 6 1 1.598   0.0   2p1.384  1.35   0.0
hole      28   .799   -1.384  0
unit 108
com=!   0.0  to    1.35 cm 08 !
zhemicyl+x 3 1 .6415   1.35   0
zhemicyl+x 2 1 .7075   1.35   0
zhemicyl+x 4 1 .7140   1.35   0
cuboid 6 1 1.598   0.0   2p1.384  1.35   0.0
unit 109
com=!   0.0  to    1.35 cm 09 !
zhemicyl-y 3 1 .6415   1.35   0
zhemicyl-y 2 1 .7075   1.35   0
zhemicyl-y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  0.0 -2.768    1.35   0.0
hole      27    0.799 -1.384  0
hole      28    0.0   -2.768  0
unit 110
com=!   0.0  to    1.35 cm 10 !
zhemicyl-y 3 1 .6415   1.35   0
zhemicyl-y 2 1 .7075   1.35   0
zhemicyl-y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  0.0 -2.768    1.35   0.0
hole      27    0.799 -1.384  0
unit 111
com=!   0.0  to    1.35 cm 11 !
zhemicyl-y 3 1 .6415   1.35   0
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zhemicyl-y 2 1 .7075   1.35   0
zhemicyl-y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  0.0 -2.768    1.35   0.0
hole      28    0.0   -2.768  0
unit 112
com=!   0.0  to    1.35 cm 12 !
zhemicyl-y 3 1 .6415   1.35   0
zhemicyl-y 2 1 .7075   1.35   0
zhemicyl-y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799 0   -2.768     1.35   0
unit 113
com=!   0.0  to    1.35 cm 13 !
zhemicyl-x 3 1 .6415   1.35   0
zhemicyl-x 2 1 .7075   1.35   0
zhemicyl-x 4 1 .7140   1.35   0
cuboid 6 1 0    -1.598  2p1.384   1.35   0
hole      28    -0.799  -1.384  0
unit 114
com=!   0.0  to    1.35 cm 14 !
zhemicyl-x 3 1 .6415   1.35   0
zhemicyl-x 2 1 .7075   1.35   0
zhemicyl-x 4 1 .7140   1.35   0
cuboid 6 1 0    -1.598  2p1.384   1.35   0
unit 115
com=!   0.0  to    1.35 cm 15 !
zhemicyl+y 3 1 .6415   1.35   0
zhemicyl+y 2 1 .7075   1.35   0
zhemicyl+y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  2.768     0   1.35   0
unit 116
com=!   0.0  to    1.35 cm 16 !
cuboid 6 1 2p0.799  2p1.384       1.35   0
unit 201
com=!   0.0  to    35.48 cm 01 !
zhemicyl+x 1 1 .6325   35.48 0.0
zhemicyl+x 0 1 .6415   35.48 0.0
zhemicyl+x 2 1 .7075   35.48 0.0
cuboid 4 1 1.598   0     2p1.384  35.48 0.0
hole       6   .799    1.384  0.0
hole       7   1.598   0      0.0
hole       8   .799   -1.384  0.0
unit 202
com=!   0.0  to    35.48 cm 02 !
zhemicyl+x 1 1 .6325   35.48 0.0
zhemicyl+x 0 1 .6415   35.48 0.0
zhemicyl+x 2 1 .7075   35.48 0.0
cuboid 4 1 1.598   0     2p1.384  35.48 0.0
hole       6   .799    1.384  0.0
hole       7   1.598   0      0.0
unit 203
com=!   0.0  to    35.48 cm 03 !
zhemicyl+x 1 1 .6325   35.48 0.0
zhemicyl+x 0 1 .6415   35.48 0.0
zhemicyl+x 2 1 .7075   35.48 0.0
cuboid 4 1 1.598   0     2p1.384  35.48 0.0
hole       6   .799    1.384  0.0
hole       8   .799   -1.384  0.0
unit 204
com=!   0.0  to    35.48 cm 04 !
zhemicyl+x 1 1 .6325   35.48 0
zhemicyl+x 0 1 .6415   35.48 0
zhemicyl+x 2 1 .7075   35.48 0
cuboid 4 1 1.598   0.0   2p1.384  35.48 0.0
hole       7   1.598   0.0    0
hole       8   .799   -1.384  0
unit 205
com=!   0.0  to    35.48 cm 05 !
zhemicyl+x 1 1 .6325   35.48 0
zhemicyl+x 0 1 .6415   35.48 0
zhemicyl+x 2 1 .7075   35.48 0
cuboid 4 1 1.598   0.0   2p1.384  35.48 0.0
hole       6   .799    1.384  0
unit 206
com=!   0.0  to    35.48 cm 06 !
zhemicyl+x 1 1 .6325   35.48 0
zhemicyl+x 0 1 .6415   35.48 0
zhemicyl+x 2 1 .7075   35.48 0
cuboid 4 1 1.598   0.0   2p1.384  35.48 0.0
hole       7   1.598   0.0    0
unit 207
com=!   0.0  to    35.48 cm 07 !
zhemicyl+x 1 1 .6325   35.48 0
zhemicyl+x 0 1 .6415   35.48 0
zhemicyl+x 2 1 .7075   35.48 0
cuboid 4 1 1.598   0.0   2p1.384  35.48 0.0
hole       8   .799   -1.384  0
unit 208
com=!   0.0  to    35.48 cm 08 !
zhemicyl+x 1 1 .6325   35.48 0
zhemicyl+x 0 1 .6415   35.48 0
zhemicyl+x 2 1 .7075   35.48 0
cuboid 4 1 1.598   0.0   2p1.384  35.48 0.0
unit 209
com=!   0.0  to    35.48 cm 09 !
zhemicyl-y 1 1 .6325   35.48 0
zhemicyl-y 0 1 .6415   35.48 0
zhemicyl-y 2 1 .7075   35.48 0
cuboid 4 1 2p0.799  0.0 -2.768    35.48 0.0
hole       7    0.799 -1.384  0
hole       8    0.0   -2.768  0
unit 210
com=!   0.0  to    35.48 cm 10 !
zhemicyl-y 1 1 .6325   35.48 0
zhemicyl-y 0 1 .6415   35.48 0
zhemicyl-y 2 1 .7075   35.48 0
cuboid 4 1 2p0.799  0.0 -2.768    35.48 0.0
hole       7    0.799 -1.384  0
unit 211
com=!   0.0  to    35.48 cm 11 !
zhemicyl-y 1 1 .6325   35.48 0
zhemicyl-y 0 1 .6415   35.48 0
zhemicyl-y 2 1 .7075   35.48 0
cuboid 4 1 2p0.799  0.0 -2.768    35.48 0.0
hole       8    0.0   -2.768  0
unit 212
com=!   0.0  to    35.48 cm 12 !
zhemicyl-y 1 1 .6325   35.48 0
zhemicyl-y 0 1 .6415   35.48 0
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zhemicyl-y 2 1 .7075   35.48 0
cuboid 4 1 2p0.799  0.0 -2.768    35.48 0.0
unit 213
com=!   0.0  to    35.48 cm 13 !
zhemicyl-x 1 1 .6325   35.48 0
zhemicyl-x 0 1 .6415   35.48 0
zhemicyl-x 2 1 .7075   35.48 0
cuboid 4 1 0    -1.598  2p1.384   35.48 0
hole       8    -0.799  -1.384  0
unit 214
com=!   0.0  to    35.48 cm 14 !
zhemicyl-x 1 1 .6325   35.48 0
zhemicyl-x 0 1 .6415   35.48 0
zhemicyl-x 2 1 .7075   35.48 0
cuboid 4 1 0    -1.598  2p1.384   35.48 0
unit 215
com=!   0.0  to    35.48 cm 15 !
zhemicyl+y 1 1 .6325   35.48 0
zhemicyl+y 0 1 .6415   35.48 0
zhemicyl+y 2 1 .7075   35.48 0
cuboid 4 1 2p0.799  2.768   0.  35.48 0
unit 216
com=!   0.0  to    35.48 cm 16 !
cuboid 4 1 2p0.799  2p1.384       35.48 0
unit 301
com=!   0.0  to    1.35 cm  01 !
zhemicyl+x 1 1 .6325   1.35   0.0
zhemicyl+x 0 1 .6415   1.35   0.0
zhemicyl+x 2 1 .7075   1.35   0.0
zhemicyl+x 4 1 .7140   1.35   0.0
cuboid 6 1 1.598   0     2p1.384  1.35  0.0
hole      10   .799    1.384  0.0
hole      11   1.598   0      0.0
hole      12   .799   -1.384  0.0
unit 302
com=!   0.0  to    1.35 cm  02 !
zhemicyl+x 1 1 .6325   1.35   0.0
zhemicyl+x 0 1 .6415   1.35   0.0
zhemicyl+x 2 1 .7075   1.35   0.0
zhemicyl+x 4 1 .7140   1.35   0.0
cuboid 6 1 1.598   0     2p1.384  1.35  0.0
hole      10   .799    1.384  0.0
hole      11   1.598   0      0.0
unit 303
com=!   0.0  to    1.35 cm  03 !
zhemicyl+x 1 1 .6325   1.35   0.0
zhemicyl+x 0 1 .6415   1.35   0.0
zhemicyl+x 2 1 .7075   1.35   0.0
zhemicyl+x 4 1 .7140   1.35   0.0
cuboid 6 1 1.598   0     2p1.384  1.35  0.0
hole      10   .799    1.384  0.0
hole      12   .799   -1.384  0.0
unit 304
com=!   0.0  to    1.35 cm  04 !
zhemicyl+x 1 1 .6325   1.35   0
zhemicyl+x 0 1 .6415   1.35   0
zhemicyl+x 2 1 .7075   1.35   0
zhemicyl+x 4 1 .7140   1.35   0
cuboid 6 1 1.598   0.0   2p1.384  1.35  0.0
hole      11   1.598   0.0    0
hole      12   .799   -1.384  0
unit 305
com=!   0.0  to    1.35 cm  05 !
zhemicyl+x 1 1 .6325   1.35   0
zhemicyl+x 0 1 .6415   1.35   0
zhemicyl+x 2 1 .7075   1.35   0
zhemicyl+x 4 1 .7140   1.35   0
cuboid 6 1 1.598   0.0   2p1.384  1.35  0.0
hole      10   .799    1.384  0
unit 306
com=!   0.0  to    1.35 cm  06 !
zhemicyl+x 1 1 .6325   1.35   0
zhemicyl+x 0 1 .6415   1.35   0
zhemicyl+x 2 1 .7075   1.35   0
zhemicyl+x 4 1 .7140   1.35   0
cuboid 6 1 1.598   0.0   2p1.384  1.35  0.0
hole      11   1.598   0.0    0
unit 307
com=!   0.0  to    1.35 cm  07 !
zhemicyl+x 1 1 .6325   1.35   0
zhemicyl+x 0 1 .6415   1.35   0
zhemicyl+x 2 1 .7075   1.35   0
zhemicyl+x 4 1 .7140   1.35   0
cuboid 6 1 1.598   0.0   2p1.384  1.35  0.0
hole      12   .799   -1.384  0
unit 308
com=!   0.0  to    1.35 cm  08 !
zhemicyl+x 1 1 .6325   1.35   0
zhemicyl+x 0 1 .6415   1.35   0
zhemicyl+x 2 1 .7075   1.35   0
zhemicyl+x 4 1 .7140   1.35   0
cuboid 6 1 1.598   0.0   2p1.384  1.35  0.0
unit 309
com=!   0.0  to    1.35 cm  09 !
zhemicyl-y 3 1 .6415   1.35   0
zhemicyl-y 2 1 .7075   1.35   0
zhemicyl-y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  0.0 -2.768    1.35  0.0
hole      11    0.799 -1.384  0
hole      12    0.0   -2.768  0
unit 310
com=!   0.0  to    1.35 cm  10 !
zhemicyl-y 1 1 .6325   1.35   0
zhemicyl-y 0 1 .6415   1.35   0
zhemicyl-y 2 1 .7075   1.35   0
zhemicyl-y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  0.0 -2.768    1.35  0.0
hole      11    0.799 -1.384  0
unit 311
com=!   0.0  to    1.35 cm  11 !
zhemicyl-y 1 1 .6325   1.35   0
zhemicyl-y 0 1 .6415   1.35   0
zhemicyl-y 2 1 .7075   1.35   0
zhemicyl-y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  0.0 -2.768    1.35  0.0
hole      12    0.0   -2.768  0
unit 312
com=!   0.0  to    1.35 cm  12 !
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zhemicyl-y 1 1 .6325   1.35   0
zhemicyl-y 0 1 .6415   1.35   0
zhemicyl-y 2 1 .7075   1.35   0
zhemicyl-y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  0.0 -2.768    1.35  0.0
unit 313
com=!   0.0  to    1.35 cm  13 !
zhemicyl-x 1 1 .6325   1.35   0
zhemicyl-x 0 1 .6415   1.35   0
zhemicyl-x 2 1 .7075   1.35   0
zhemicyl-x 4 1 .7140   1.35   0
cuboid 6 1 0    -1.598  2p1.384   1.35  0
hole      12    -0.799  -1.384  0
unit 314
com=!   0.0  to    1.35 cm  14 !
zhemicyl-x 1 1 .6325   1.35   0
zhemicyl-x 0 1 .6415   1.35   0
zhemicyl-x 2 1 .7075   1.35   0
zhemicyl-x 4 1 .7140   1.35   0
cuboid 6 1 0    -1.598  2p1.384   1.35  0
unit 315
com=!   0.0  to    1.35 cm  15 !
zhemicyl+y 1 1 .6325   1.35   0
zhemicyl+y 0 1 .6415   1.35   0
zhemicyl+y 2 1 .7075   1.35   0
zhemicyl+y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  2.768     0  1.35  0
unit 316
com=!   0.0  to    1.35 cm  16 !
cuboid 6 1 2p0.799  2p1.384       1.35  0
unit 401
com=!   0.0  to    47.291 cm 01 !
zhemicyl+x 1 1 .6325   47.291 0.0
zhemicyl+x 0 1 .6415   47.291 0.0
zhemicyl+x 2 1 .7075   47.291 0.0
cuboid 4 1 1.598   0     2p1.384  47.291 0.0
hole      14   .799    1.384  0.0
hole      15   1.598   0      0.0
hole      16   .799   -1.384  0.0
unit 402
com=!   0.0  to    47.291 cm 02 !
zhemicyl+x 1 1 .6325   47.291 0.0
zhemicyl+x 0 1 .6415   47.291 0.0
zhemicyl+x 2 1 .7075   47.291 0.0
cuboid 4 1 1.598   0     2p1.384  47.291 0.0
hole      14   .799    1.384  0.0
hole      15   1.598   0      0.0
unit 403
com=!   0.0  to    47.291 cm 03 !
zhemicyl+x 1 1 .6325   47.291 0.0
zhemicyl+x 0 1 .6415   47.291 0.0
zhemicyl+x 2 1 .7075   47.291 0.0
cuboid 4 1 1.598   0     2p1.384  47.291 0.0
hole      14   .799    1.384  0.0
hole      16   .799   -1.384  0.0
unit 404
com=!   0.0  to    47.291 cm 04 !
zhemicyl+x 1 1 .6325   47.291 0
zhemicyl+x 0 1 .6415   47.291 0
zhemicyl+x 2 1 .7075   47.291 0
cuboid 4 1 1.598   0.0   2p1.384  47.291 0.0
hole      15   1.598   0.0    0
hole      16   .799   -1.384  0
unit 405
com=!   0.0  to    47.291 cm 05 !
zhemicyl+x 1 1 .6325   47.291 0
zhemicyl+x 0 1 .6415   47.291 0
zhemicyl+x 2 1 .7075   47.291 0
cuboid 4 1 1.598   0.0   2p1.384  47.291 0.0
hole      14   .799    1.384  0
unit 406
com=!   0.0  to    47.291 cm 06 !
zhemicyl+x 1 1 .6325   47.291 0
zhemicyl+x 0 1 .6415   47.291 0
zhemicyl+x 2 1 .7075   47.291 0
cuboid 4 1 1.598   0.0   2p1.384  47.291 0.0
hole      15   1.598   0.0    0
unit 407
com=!   0.0  to    47.291 cm 07 !
zhemicyl+x 1 1 .6325   47.291 0
zhemicyl+x 0 1 .6415   47.291 0
zhemicyl+x 2 1 .7075   47.291 0
cuboid 4 1 1.598   0.0   2p1.384  47.291 0.0
hole      16   .799   -1.384  0
unit 408
com=!   0.0  to    47.291 cm 08 !
zhemicyl+x 1 1 .6325   47.291 0
zhemicyl+x 0 1 .6415   47.291 0
zhemicyl+x 2 1 .7075   47.291 0
cuboid 4 1 1.598   0.0   2p1.384  47.291 0.0
unit 409
com=!   0.0  to    47.291 cm 09 !
zhemicyl-y 1 1 .6325   47.291 0
zhemicyl-y 0 1 .6415   47.291 0
zhemicyl-y 2 1 .7075   47.291 0
cuboid 4 1 2p0.799  0.0 -2.768    47.291 0.0
hole      15    0.799 -1.384  0
hole      16    0.0   -2.768  0
unit 410
com=!   0.0  to    47.291 cm 10 !
zhemicyl-y 1 1 .6325   47.291 0
zhemicyl-y 0 1 .6415   47.291 0
zhemicyl-y 2 1 .7075   47.291 0
cuboid 4 1 2p0.799  0.0 -2.768    47.291 0.0
hole      15    0.799 -1.384  0
unit 411
com=!   0.0  to    47.291 cm 11 !
zhemicyl-y 1 1 .6325   47.291 0
zhemicyl-y 0 1 .6415   47.291 0
zhemicyl-y 2 1 .7075   47.291 0
cuboid 4 1 2p0.799  0.0 -2.768    47.291 0.0
hole      16    0.0   -2.768  0
unit 412
com=!   0.0  to    47.291 cm 12 !
zhemicyl-y 1 1 .6325   47.291 0
zhemicyl-y 0 1 .6415   47.291 0
zhemicyl-y 2 1 .7075   47.291 0
cuboid 4 1 2p0.799  0.0 -2.768    47.291 0.0
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unit 413
com=!   0.0  to    47.291 cm 13 !
zhemicyl-x 1 1 .6325   47.291 0
zhemicyl-x 0 1 .6415   47.291 0
zhemicyl-x 2 1 .7075   47.291 0
cuboid 4 1 0    -1.598  2p1.384   47.291 0
hole      16    -0.799  -1.384   0
unit 414
com=!   0.0  to    47.291 cm 14 !
zhemicyl-x 1 1 .6325   47.291 0
zhemicyl-x 0 1 .6415   47.291 0
zhemicyl-x 2 1 .7075   47.291 0
cuboid 4 1 0    -1.598  2p1.384   47.291 0
unit 415
com=!   0.0  to    47.291 cm 15 !
zhemicyl+y 1 1 .6325   47.291 0
zhemicyl+y 0 1 .6415   47.291 0
zhemicyl+y 2 1 .7075   47.291 0
cuboid 4 1 2p0.799  2.768     0 47.291 0
unit 416
com=!   0.0  to    47.291 cm 16 !
cuboid 4 1 2p0.799  2p1.384       47.291 0
unit 501
com=!   0.0  to    6.604 cm 01 !
zhemicyl+x 1 1 .6325   6.604 0.0
zhemicyl+x 0 1 .6415   6.604 0.0
zhemicyl+x 2 1 .7075   6.604 0.0
cuboid 4 1 1.598   0     2p1.384  6.604 0.0
hole      18   .799    1.384  0.0
hole      19   1.598   0      0.0
hole      20   .799   -1.384  0.0
unit 502
com=!   0.0  to    6.604 cm 02 !
zhemicyl+x 1 1 .6325   6.604 0.0
zhemicyl+x 0 1 .6415   6.604 0.0
zhemicyl+x 2 1 .7075   6.604 0.0
cuboid 4 1 1.598   0     2p1.384  6.604 0.0
hole      18   .799    1.384  0.0
hole      19   1.598   0      0.0
unit 503
com=!   0.0  to    6.604 cm 03 !
zhemicyl+x 1 1 .6325   6.604 0.0
zhemicyl+x 0 1 .6415   6.604 0.0
zhemicyl+x 2 1 .7075   6.604 0.0
cuboid 4 1 1.598   0     2p1.384  6.604 0.0
hole      18   .799    1.384  0.0
hole      20   .799   -1.384  0.0
unit 504
com=!   0.0  to    6.604 cm 04 !
zhemicyl+x 1 1 .6325   6.604 0
zhemicyl+x 0 1 .6415   6.604 0
zhemicyl+x 2 1 .7075   6.604 0
cuboid 4 1 1.598   0.0   2p1.384  6.604 0.0
hole      19   1.598   0.0    0
hole      20   .799   -1.384  0
unit 505
com=!   0.0  to    6.604 cm 05 !
zhemicyl+x 1 1 .6325   6.604 0
zhemicyl+x 0 1 .6415   6.604 0
zhemicyl+x 2 1 .7075   6.604 0
cuboid 4 1 1.598   0.0   2p1.384  6.604 0.0
hole      18   .799    1.384  0
unit 506
com=!   0.0  to    6.604 cm 06 !
zhemicyl+x 1 1 .6325   6.604 0
zhemicyl+x 0 1 .6415   6.604 0
zhemicyl+x 2 1 .7075   6.604 0
cuboid 4 1 1.598   0.0   2p1.384  6.604 0.0
hole      19   1.598   0.0    0
unit 507
com=!   0.0  to    6.604 cm 07 !
zhemicyl+x 1 1 .6325   6.604 0
zhemicyl+x 0 1 .6415   6.604 0
zhemicyl+x 2 1 .7075   6.604 0
cuboid 4 1 1.598   0.0   2p1.384  6.604 0.0
hole      20   .799   -1.384  0
unit 508
com=!   0.0  to    6.604 cm 08 !
zhemicyl+x 1 1 .6325   6.604 0
zhemicyl+x 0 1 .6415   6.604 0
zhemicyl+x 2 1 .7075   6.604 0
cuboid 4 1 1.598   0.0   2p1.384  6.604 0.0
unit 509
com=!   0.0  to    6.604 cm 09 !
zhemicyl-y 1 1 .6325   6.604 0
zhemicyl-y 0 1 .6415   6.604 0
zhemicyl-y 2 1 .7075   6.604 0
cuboid 4 1 2p0.799  0.0 -2.768    6.604 0.0
hole      19    0.799 -1.384  0
hole      20    0.0   -2.768  0
unit 510
com=!   0.0  to    6.604 cm 10 !
zhemicyl-y 1 1 .6325   6.604 0
zhemicyl-y 0 1 .6415   6.604 0
zhemicyl-y 2 1 .7075   6.604 0
cuboid 4 1 2p0.799  0.0 -2.768    6.604 0.0
hole      19    0.799 -1.384  0
unit 511
com=!   0.0  to    6.604 cm 11 !
zhemicyl-y 1 1 .6325   6.604 0
zhemicyl-y 0 1 .6415   6.604 0
zhemicyl-y 2 1 .7075   6.604 0
cuboid 4 1 2p0.799  0.0 -2.768    6.604 0.0
hole      20    0.0   -2.768  0
unit 512
com=!   0.0  to    6.604 cm 12 !
zhemicyl-y 1 1 .6325   6.604 0
zhemicyl-y 0 1 .6415   6.604 0
zhemicyl-y 2 1 .7075   6.604 0
cuboid 4 1 2p0.799  0.0 -2.768    6.604 0.0
unit 513
com=!   0.0  to    6.604 cm 13 !
zhemicyl-x 1 1 .6325   6.604 0
zhemicyl-x 0 1 .6415   6.604 0
zhemicyl-x 2 1 .7075   6.604 0
cuboid 4 1 0    -1.598  2p1.384   6.604 0
hole      20    -0.799  -1.384  0
unit 514
```

```
com=!   0.0  to    6.604 cm 14 !
zhemicyl-x 1 1 .6325   6.604 0
zhemicyl-x 0 1 .6415   6.604 0
zhemicyl-x 2 1 .7075   6.604 0
cuboid 4 1 0    -1.598  2p1.384   6.604 0
unit 515
com=!   0.0  to    6.604 cm 15 !
zhemicyl+y 1 1 .6325   6.604 0
zhemicyl+y 0 1 .6415   6.604 0
zhemicyl+y 2 1 .7075   6.604 0
cuboid 4 1 2p0.799  2.768    0   6.604 0
unit 516
com=!   0.0  to    6.604 cm 16 !
cuboid 4 1 2p0.799  2p1.384       6.604 0
unit 601
com=!   0.0  to    2.286 cm 01 !
zhemicyl+x 3 1 .6415   2.286  0.0
zhemicyl+x 2 1 .7075   2.286  0.0
cuboid 4 1 1.598   0     2p1.384  2.286  0.0
hole       2   .799    1.384  0.0
hole       3   1.598   0      0.0
hole       4   .799   -1.384  0.0
unit 602
com=!   0.0  to    2.286 cm 02 !
zhemicyl+x 3 1 .6415   2.286  0.0
zhemicyl+x 2 1 .7075   2.286  0.0
cuboid 4 1 1.598   0     2p1.384  2.286  0.0
hole       2   .799    1.384  0.0
hole       3   1.598   0      0.0
unit 603
com=!   0.0  to    2.286 cm 03 !
zhemicyl+x 3 1 .6415   2.286  0.0
zhemicyl+x 2 1 .7075   2.286  0.0
cuboid 4 1 1.598   0     2p1.384  2.286  0.0
hole       2   .799    1.384  0.0
hole       4   .799   -1.384  0.0
unit 604
com=!   0.0  to    2.286 cm 04 !
zhemicyl+x 3 1 .6415   2.286  0
zhemicyl+x 2 1 .7075   2.286  0
cuboid 4 1 1.598   0.0   2p1.384  2.286  0.0
hole       3   1.598   0.0    0
hole       4   .799   -1.384  0
unit 605
com=!   0.0  to    2.286 cm 05 !
zhemicyl+x 3 1 .6415   2.286  0
zhemicyl+x 2 1 .7075   2.286  0
cuboid 4 1 1.598   0.0   2p1.384  2.286  0.0
hole       2   .799    1.384  0
unit 606
com=!   0.0  to    2.286 cm 06 !
zhemicyl+x 3 1 .6415   2.286  0
zhemicyl+x 2 1 .7075   2.286  0
cuboid 4 1 1.598   0.0   2p1.384  2.286  0.0
hole       3   1.598   0.0    0
unit 607
com=!   0.0  to    2.286 cm 07 !
zhemicyl+x 3 1 .6415   2.286  0
zhemicyl+x 2 1 .7075   2.286  0
cuboid 4 1 1.598   0.0   2p1.384  2.286  0.0
hole       4   .799   -1.384  0
unit 608
com=!   0.0  to    2.286 cm 08 !
zhemicyl+x 3 1 .6415   2.286  0
zhemicyl+x 2 1 .7075   2.286  0
cuboid 4 1 1.598   0.0   2p1.384  2.286  0.0
unit 609
com=!   0.0  to    2.286 cm 09 !
zhemicyl-y 3 1 .6415   2.286  0
zhemicyl-y 2 1 .7075   2.286  0
cuboid 4 1 2p0.799  0.0 -2.768    2.286  0.0
hole       3    0.799 -1.384  0
hole       4    0.0   -2.768  0
unit 610
com=!   0.0  to    2.286 cm 10 !
zhemicyl-y 3 1 .6415   2.286  0
zhemicyl-y 2 1 .7075   2.286  0
cuboid 4 1 2p0.799  0.0 -2.768    2.286  0.0
hole       3    0.799 -1.384  0
unit 611
com=!   0.0  to    2.286 cm 11 !
zhemicyl-y 3 1 .6415   2.286  0
zhemicyl-y 2 1 .7075   2.286  0
cuboid 4 1 2p0.799  0.0 -2.768    2.286  0.0
hole       4    0.0   -2.768  0
unit 612
com=!   0.0  to    2.286 cm 12 !
zhemicyl-y 3 1 .6415   2.286  0
zhemicyl-y 2 1 .7075   2.286  0
cuboid 4 1 2p0.799  0.0 -2.768    2.286  0.0
unit 613
com=!   0.0  to    2.286 cm 13 !
zhemicyl-x 3 1 .6415   2.286  0
zhemicyl-x 2 1 .7075   2.286  0
cuboid 4 1 0    -1.598  2p1.384   2.286  0
hole       4    -0.799  -1.384  0
unit 614
com=!   0.0  to    2.286 cm 14 !
zhemicyl-x 3 1 .6415   2.286  0
zhemicyl-x 2 1 .7075   2.286  0
cuboid 4 1 0    -1.598  2p1.384   2.286  0
unit 615
com=!   0.0  to    2.286 cm 15 !
zhemicyl+y 3 1 .6415   2.286  0
zhemicyl+y 2 1 .7075   2.286  0
cuboid 4 1 2p0.799  2.768     0  2.286  0
unit 616
com=!   0.0  to    2.286 cm 16 !
cuboid 4 1 2p0.799  2p1.384       2.286  0
unit 701
com=!   0.0  to    0.809 cm 01 !
zhemicyl+x 3 1 .6415   0.809  0.0
zhemicyl+x 2 1 .7075   0.809  0.0
cuboid 4 1 1.598   0     2p1.384  0.809  0.0
hole      22   .799    1.384  0.0
hole      23   1.598   0      0.0
hole      24   .799   -1.384  0.0
unit 702
```

```
com=!   0.0  to    0.809 cm 02 !
zhemicyl+x 3 1 .6415   0.809  0.0
zhemicyl+x 2 1 .7075   0.809  0.0
cuboid 4 1 1.598   0     2p1.384  0.809  0.0
hole      22   .799    1.384  0.0
hole      23   1.598   0      0.0
unit 703
com=!   0.0  to    0.809 cm 03 !
zhemicyl+x 3 1 .6415   0.809  0.0
zhemicyl+x 2 1 .7075   0.809  0.0
cuboid 4 1 1.598   0     2p1.384  0.809  0.0
hole      22   .799    1.384  0.0
hole      24   .799   -1.384  0.0
unit 704
com=!   0.0  to    0.809 cm 04 !
zhemicyl+x 3 1 .6415   0.809  0
zhemicyl+x 2 1 .7075   0.809  0
cuboid 4 1 1.598   0.0   2p1.384  0.809  0.0
hole      23   1.598   0.0    0
hole      24   .799   -1.384  0
unit 705
com=!   0.0  to    0.809 cm 05 !
zhemicyl+x 3 1 .6415   0.809  0
zhemicyl+x 2 1 .7075   0.809  0
cuboid 4 1 1.598   0.0   2p1.384  0.809  0.0
hole      22   .799    1.384  0
unit 706
com=!   0.0  to    0.809 cm 06 !
zhemicyl+x 3 1 .6415   0.809  0
zhemicyl+x 2 1 .7075   0.809  0
cuboid 4 1 1.598   0.0   2p1.384  0.809  0.0
hole      23   1.598   0.0    0
unit 707
com=!   0.0  to    0.809 cm 07 !
zhemicyl+x 3 1 .6415   0.809  0
zhemicyl+x 2 1 .7075   0.809  0
cuboid 4 1 1.598   0.0   2p1.384  0.809  0.0
hole      24   .799   -1.384  0
unit 708
com=!   0.0  to    0.809 cm 08 !
zhemicyl+x 3 1 .6415   0.809  0
zhemicyl+x 2 1 .7075   0.809  0
cuboid 4 1 1.598   0.0   2p1.384  0.809  0.0
unit 709
com=!   0.0  to    0.809 cm 09 !
zhemicyl-y 3 1 .6415   0.809  0
zhemicyl-y 2 1 .7075   0.809  0
cuboid 4 1 2p0.799  0.0 -2.768    0.809  0.0
hole      23    0.799 -1.384  0
hole      24    0.0   -2.768  0
unit 710
com=!   0.0  to    0.809 cm 10 !
zhemicyl-y 3 1 .6415   0.809  0
zhemicyl-y 2 1 .7075   0.809  0
cuboid 4 1 2p0.799  0.0 -2.768    0.809  0.0
hole      23    0.799 -1.384  0
unit 711
com=!   0.0  to    0.809 cm 11 !
zhemicyl-y 3 1 .6415   0.809  0
zhemicyl-y 2 1 .7075   0.809  0
cuboid 4 1 2p0.799  0.0 -2.768    0.809  0.0
hole      24    0.0   -2.768  0
unit 712
com=!   0.0  to    0.809 cm 12 !
zhemicyl-y 3 1 .6415   0.809  0
zhemicyl-y 2 1 .7075   0.809  0
cuboid 4 1 2p0.799  0.0 -2.768    0.809  0.0
unit 713
com=!   0.0  to    0.809 cm 13 !
zhemicyl-x 3 1 .6415   0.809  0
zhemicyl-x 2 1 .7075   0.809  0
cuboid 4 1 0    -1.598  2p1.384   0.809  0
hole      24    -0.799  -1.384  0
unit 714
com=!   0.0  to    0.809 cm 14 !
zhemicyl-x 3 1 .6415   0.809  0
zhemicyl-x 2 1 .7075   0.809  0
cuboid 4 1 0    -1.598  2p1.384   0.809  0
unit 715
com=!   0.0  to    0.809 cm 15 !
zhemicyl+y 3 1 .6415   0.809  0
zhemicyl+y 2 1 .7075   0.809  0
cuboid 4 1 2p0.799  2.768     0  0.809  0
unit 716
com=!   0.0  to    0.809 cm 16 !
cuboid 4 1 2p0.799  2p1.384       0.809  0
global unit 800
com=! refrector region!
array   1   -30.362 -29.064  0.0
replicate 5 1 0 0 0 0 0 2.54   1
zcylinder 4 1 76.0 109.14 -22.86
cuboid    0 1 4p77.0 110.0 -23.0
end geom
read array
ara=1 nux=38 nuy=21 nuz=8
com=!full array of fuel pins!
fill
  11r716  3r712    710         9r702   705  2r712  11r716
   8r716    712    710    702 16r701   702    705     712  8r716
   6r716    712    710        22r701   705  7r716
   5r716    710               25r701   702    705  5r716
   4r716    710               28r701   705  4r716
   3r716    710               30r701   705  3r716
   2r716    710               32r701   705  2r716
     716    714               34r701   705    716
     716    710               34r701   703    716
            714               36r701   708          2q38
     716    709               34r701   707    716
     716    713               34r701   708    716
   2r716    713               32r701   707  2r716
   2r716    714    704        30r701   703  3r716
   4r716    713               28r701   707    715   3r716
   5r716    713    704        25r701   707  5r716
   7r716    713               22r701   707    715   6r716
   8r716    715    713    704 16r701   704    707     715  8r716
  11r716  2r715    713         9r704   707  3r715  11r716
  11r116  3r112    110         9r102   105  2r112  11r116
   8r116    112    110    102 16r101   102    105     112  8r116
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6r116	112	110		22r101	105	7r116		
5r116	110			25r101	102	105	5r116	
4r116	110			28r101	105	4r116		
3r116	110			30r101	105	3r116		
2r116	110			32r101	105	2r116		
116	114			34r101	105	116		
116	110			34r101	103	116		
	114			36r101	108		2q38	
116	109			34r101	107	116		
116	113			34r101	108	116		
2r116	113			32r101	107	2r116		
2r116	114	104		30r101	103	3r116		
4r116	113			28r101	107	115	3r116	
5r116	113	104		25r101	107	5r116		
7r116	113			22r101	107	115	6r116	
8r116	115	113	104	16r101	104	107	115	8r116
11r116	2r115	113		9r104	107	3r115	11r116	
11r216	3r212	210		9r202	205	2r212	11r216	
8r216	212	210	202	16r201	202	205	212	8r216
6r216	212	210		22r201	205	7r216		
5r216	210			25r201	202	205	5r216	
4r216	210			28r201	205	4r216		
3r216	210			30r201	205	3r216		
2r216	210			32r201	205	2r216		
216	214			34r201	205	216		
216	210			34r201	203	216		
	214			36r201	208		2q38	
216	209			34r201	207	216		
216	213			34r201	208	216		
2r216	213			32r201	207	2r216		
2r216	214	204		30r201	203	3r216		
4r216	213			28r201	207	215	3r216	
5r216	213	204		25r201	207	5r216		
7r216	213			22r201	207	215	6r216	
8r216	215	213	204	16r201	204	207	215	8r216
11r216	2r215	213		9r204	207	3r215	11r216	
11r316	3r312	310		9r302	305	2r312	11r316	
8r316	312	310	302	16r301	302	305	312	8r316
6r316	312	310		22r301	305	7r316		
5r316	310			25r301	302	305	5r316	
4r316	310			28r301	305	4r316		
3r316	310			30r301	305	3r316		
2r316	310			32r301	305	2r316		
316	314			34r301	305	316		
316	310			34r301	303	316		
	314			36r301	308		2q38	
316	309			34r301	307	316		
316	313			34r301	308	316		
2r316	313			32r301	307	2r316		
2r316	314	304		30r301	303	3r316		
4r316	313			28r301	307	315	3r316	
5r316	313	304		25r301	307	5r316		
7r316	313			22r301	307	315	6r316	
8r316	315	313	304	16r301	304	307	315	8r316
11r316	2r315	313		9r304	307	3r315	11r316	
11r416	3r412	410		9r402	405	2r412	11r416	
8r416	412	410	402	16r401	402	405	412	8r416
6r416	412	410		22r401	405	7r416		
5r416	410			25r401	402	405	5r416	

4r416	410			28r401	405	4r416		
3r416	410			30r401	405	3r416		
2r416	410			32r401	405	2r416		
416	414			34r401	405	416		
416	410			34r401	403	416		
	414			36r401	408		2q38	
416	409			34r401	407	416		
416	413			34r401	408	416		
2r416	413			32r401	407	2r416		
2r416	414	404		30r401	403	3r416		
4r416	413			28r401	407	415	3r416	
5r416	413	404		25r401	407	5r416		
7r416	413			22r401	407	415	6r416	
8r416	415	413	404	16r401	404	407	415	8r416
11r416	2r415	413		9r404	407	3r415	11r416	
11r316	3r312	310		9r302	305	2r312	11r316	
8r316	312	310	302	16r301	302	305	312	8r316
6r316	312	310		22r301	305	7r316		
5r316	310			25r301	302	305	5r316	
4r316	310			28r301	305	4r316		
3r316	310			30r301	305	3r316		
2r316	310			32r301	305	2r316		
316	314			34r301	305	316		
316	310			34r301	303	316		
	314			36r301	308		2q38	
316	309			34r301	307	316		
316	313			34r301	308	316		
2r316	313			32r301	307	2r316		
2r316	314	304		30r301	303	3r316		
4r316	313			28r301	307	315	3r316	
5r316	313	304		25r301	307	5r316		
7r316	313			22r301	307	315	6r316	
8r316	315	313	304	16r301	304	307	315	8r316
11r316	2r315	313		9r304	307	3r315	11r316	
11r516	3r512	510		9r502	505	2r512	11r516	
8r516	512	510	502	16r501	502	505	512	8r516
6r516	512	510		22r501	505	7r516		
5r516	510			25r501	502	505	5r516	
4r516	510			28r501	505	4r516		
3r516	510			30r501	505	3r516		
2r516	510			32r501	505	2r516		
516	514			34r501	505	516		
516	510			34r501	503	516		
	514			36r501	508		2q38	
516	509			34r501	507	516		
516	513			34r501	508	516		
2r516	513			32r501	507	2r516		
2r516	514	504		30r501	503	3r516		
4r516	513			28r501	507	515	3r516	
5r516	513	504		25r501	507	5r516		
7r516	513			22r501	507	515	6r516	
8r516	515	513	504	16r501	504	507	515	8r516
11r516	2r515	513		9r504	507	3r515	11r516	
11r616	3r612	610		9r602	605	2r612	11r616	
8r616	612	610	602	16r601	602	605	612	8r616
6r616	612	610		22r601	605	7r616		
5r616	610			25r601	602	605	5r616	
4r616	610			28r601	605	4r616		
3r616	610			30r601	605	3r616		

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   2r616    610              32r601   605  2r616
     616    614              34r601   605    616
     616    610              34r601   603    616
            614              36r601   608          2q38
     616    609              34r601   607    616
     616    613              34r601   608    616
   2r616    613              32r601   607  2r616
   2r616    614    604       30r601   603  3r616
   4r616    613              28r601   607    615   3r616
   5r616    613    604       25r601   607  5r616
   7r616    613              22r601   607    615   6r616
   8r616    615    613   604 16r601   604    607     615  8r616
  11r616  2r615    613        9r604   607  3r615  11r616
end fill
end array
read bnds +xb=vacuum -xb=vacuum +yb=vacuum -yb=vacuum +zb=vacuum
-zb=vacuum
  end bnds
read plot
ttl=!x-y cross-section at z=1.5cm!
plt=yes pic=mixture xul=0 yul=30 zul=1.5 xlr=30 ylr=0 zlr=1.5
uax=1 vax=0 wax=0 udn=0 vdn=-1 wdn=0 nax=130  nch='-123 5.' end
ttl=!x-y cross-section at z=30.cm!
plt=yes pic=mixture xul=-30 yul=30 zul=30. xlr=0  ylr=0 zlr=30.
uax=1 vax=0 wax=0 udn=0 vdn=-1 wdn=0 nax=130  nch='-123 5.' end
ttl=!x-y cross-section at z=38.cm!
plt=yes pic=mixture xul=0 yul=0  zul=38. xlr=30 ylr=-30 zlr=38.
uax=1 vax=0 wax=0 udn=0 vdn=-1 wdn=0 nax=130  nch='-123 5.' end
ttl=!x-y cross-section at z=95.cm!
plt=yes pic=mixture xul=-30  yul=0  zul=95. xlr=0  ylr=-30  zlr=95.
uax=1 vax=0 wax=0 udn=0 vdn=-1 wdn=0 nax=130  nch='-123 5.' end
ttl=!x-z cross-section at y=16.0cm!
plt=yes pic=mixture xul=0   yul=0   zul=100 xlr=35 ylr=0   zlr=-25
uax=1 vax=0 wax=0 udn=0 vdn=0 wdn=-1 nax=130  nch='-123 5.' end
end plot
end data
end
```

ft214r

```
=csas2x
' 952 fuel rods
' 4.31% u-235 enriched uo2 rods, 1.265 cm diam.; al clad, 1.283 cm id,
' 1.415 cm od. uo2 91.44 cm long, rod 96.52 cm long. h2o moderated and
' reflected, 2 x 2 array of fuel clusters, 1.891 cm square pitch.
' 0.295 cm between clusters and poison plates, 3.73 cm flux trap width.
' reference: pnl-6205
' scale module: csas2x
'
1.891 cm pitch lattice cell, 4.31 wt% enriched fuel,discrete
44group latticecell
uo2  1 0.9489 293 92234 0.022 92235 4.306 92236 0.022 92238 95.650  end
al   2    end
h2o  3    end
uo2  8 0.9489 293 92234 0.022 92235 4.306 92236 0.022 92238 95.650  end
al   9    end
h2o 10    end
al   4    end
arbmboral   2.64 5 1 0 0 5000 29.22 6012 8.16 13027 62.54
            8016 0.06 26000 0.02 5 end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 6 end
h2o  7    end
end comp
squarepitch 1.891 1.265 1 3 1.415 2 1.283 0 end
more data
res=8 cylinder .6325  dan(8)=.173084
end more
flux trap assembly no. 214r
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=120
     wrs=34 res=205 nub=yes  end parm
read geometry
unit 1
cylinder 8 1 .6325 2p45.72
cylinder 0 1 .6415 2p45.72
cylinder 6 1 .6415 2p48.26
cylinder 9 1 .7075 2p48.26
cuboid  10 1 4p.9455 2p48.26
unit 2
array  1 3*0.0
'16x15 cluster
cuboid   7 1 30.313  -14.013    44.269  -.057     96.52  0.0
cuboid   4 1 30.415  -14.013    44.269  -.159     96.52  0.0
cuboid   5 1 30.885  -14.013    44.269  -.629     96.52  0.0
cuboid   4 1 30.987  -14.013    44.269  -.731     96.52  0.0
unit 3
array  1 3*0.0
'16x15 cluster
cuboid   7 1 44.269  -0.057     44.269  -0.057    96.52  0.0
cuboid   4 1 44.269  -0.159     44.269  -0.159    96.52  0.0
cuboid   5 1 44.269  -0.629     44.269  -0.629    96.52  0.0
cuboid   4 1 44.269  -0.731     44.269  -0.731    96.52  0.0
unit 4
array  1 3*0.0
'16x15 cluster
cuboid   7 1 30.313  -14.013    28.422  -15.905   96.52  0.0
cuboid   4 1 30.415  -14.013    28.5235 -15.905   96.52  0.0
cuboid   5 1 30.885  -14.013    28.9935 -15.905   96.52  0.0
cuboid   4 1 30.987  -14.013    29.095  -15.905   96.52  0.0
unit 5
array  2 3*0.0
'15x15 cluster
cuboid   7 1 44.269  -0.057     28.422  -15.905   96.52  0.0
cuboid   4 1 44.269  -0.159     28.5235 -15.905   96.52  0.0
cuboid   5 1 44.269  -0.629     28.9935 -15.905   96.52  0.0
cuboid   4 1 44.269  -0.731     29.095  -15.905   96.52  0.0
unit 6
cuboid   7 1  2.18   -1.55      45.0      0.0     96.52  0.0
'flux trap
unit 7
cuboid   7 1 45.0     0.0        2.18    -1.55    96.52  0.0
'flux trap
unit 8
cuboid   7 1 2.18    -1.55       2.18    -1.55    96.52  0.0
'central moderator
unit 9
com='7 rods smeared over a row of 15'
```

```
cuboid 500 1 .8825 0 1.891 0 2p45.72
cuboid   6 1 .8825 0 1.891 0 2p48.26
cuboid   7 1 1.891 0 1.891 0 2p48.26
global unit 10
array 3 3*0.0
'3x3 array
reflector 7 2 6r3 5
end geom

read bias  id=500 2 6 end bias

read array
ara=1 nux=16 nuy=15  fill f1                end fill
ara=2 nux=16 nuy=15  fill 15r1 9 14q16      end fill
ara=3 nux=3  nuy=3   fill 4 6 5 7 8 7 2 6 3 end fill
end array
read plot
ttl='x-y slice of 214r     '
xul=39   yul=54.7  zul=63.26
xlr=54.7 ylr=39    zlr=63.26
uax=1 vdn=-1  nax=130    nch=' 456 89 s'  end
ttl='x-y slice of 214r     '
xul=-15  yul=108 zul=63.26
xlr=108  ylr=-15 zlr=63.26
uax=1 vdn=-1  nax=260    nch=' 456 89 s'  end
end plot
end data
end
```

ft214v3

```
=csas2x
' 862.1 fuel rods
' 4.31% u-235 enriched uo2 rods, 1.265 cm diam.; al clad, 1.283 cm id,
' 1.415 cm od. uo2 91.44 cm long, rod 96.52 cm long. h2o moderated and
' reflected, 2 x 2 array of fuel clusters, 1.891 cm square pitch.
' 0.295 cm between clusters and poison plates, 3.73 cm flux trap width.
' three 0.63 cm x 45.0 cm x 96 cm al plates between clusters.
' reference: pnl-6205
' scale module: csas2x
'
1.891 cm pitch lattice cell, 4.31 wt% enriched fuel,discrete
44group latticecell
uo2  1 0.9489 293 92234 0.022 92235 4.306 92236 0.022 92238 95.650  end
al   2    end
h2o  3    end
uo2  8 0.9489 293 92234 0.022 92235 4.306 92236 0.022 92238 95.650  end
al   9    end
h2o 10    end
al   4    end
arbmboral   2.64 5 1 0 0 5000 29.22 6012 8.16 13027 62.54
            8016 0.06 26000 0.02 5 end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 6 end
h2o  7    end
end comp
squarepitch 1.891 1.265 1 3 1.415 2 1.283 0 end
more data
res=8 cylinder .6325  dan(8)=.173084
end more
flux trap assembly no. 214v3
read parm plt=yes run=yes gen=805 npg=600 nsk=5 tme=240
     wrs=34 res=205 nub=yes  end parm
read geometry
unit 1
cylinder 8 1 .6325 2p45.72
cylinder 0 1 .6415 2p45.72
cylinder 6 1 .6415 2p48.26
cylinder 9 1 .7075 2p48.26
cuboid  10 1 4p.9455 2p48.26
unit 2
array  1 3*0.0
'14x15 cluster
cuboid   7 1 26.531  -17.795    44.269  -.057     96.52  0.0
cuboid   4 1 26.633  -17.795    44.269  -.159     96.52  0.0
cuboid   5 1 27.103  -17.795    44.269  -.629     96.52  0.0
cuboid   4 1 27.205  -17.795    44.269  -.731     96.52  0.0
unit 3
array  2 3*0.0
'15x15 cluster
cuboid   7 1 44.269  -0.057     44.269  -0.057    96.52  0.0
cuboid   4 1 44.269  -0.159     44.269  -0.159    96.52  0.0
cuboid   5 1 44.269  -0.629     44.269  -0.629    96.52  0.0
cuboid   4 1 44.269  -0.731     44.269  -0.731    96.52  0.0
unit 4
array  1 3*0.0
'14x15 cluster
cuboid   7 1 26.531  -17.795    28.422  -15.904   96.52  0.0
cuboid   4 1 26.633  -17.795    28.524  -15.904   96.52  0.0
cuboid   5 1 27.103  -17.795    28.994  -15.904   96.52  0.0
cuboid   4 1 27.205  -17.795    29.096  -15.904   96.52  0.0
unit 5
array  4 3*0.0
'14x15 cluster
cuboid   7 1 44.269  -0.057     28.422  -15.904   96.52  0.0
cuboid   4 1 44.269  -0.159     28.524  -15.904   96.52  0.0
cuboid   5 1 44.269  -0.629     28.994  -15.904   96.52  0.0
cuboid   4 1 44.269  -0.731     29.096  -15.904   96.52  0.0
unit 6
cuboid   7 1  0.46    0.0       45.0      0.0     96.52  0.0
cuboid   4 1  1.09    0.0       45.0      0.0     96.52  0.0
cuboid   7 1  1.55    0.0       45.0      0.0     96.52  0.0
cuboid   4 1  2.18    0.0       45.0      0.0     96.52  0.0
cuboid   7 1  2.64    0.0       45.0      0.0     96.52  0.0
cuboid   4 1  3.27    0.0       45.0      0.0     96.52  0.0
cuboid   7 1  3.73    0.0       45.0      0.0     96.52  0.0
'flux trap
unit 7
cuboid   7 1  45.0    0.0       0.46      0.0     96.52  0.0
cuboid   4 1  45.0    0.0       1.09      0.0     96.52  0.0
cuboid   7 1  45.0    0.0       1.55      0.0     96.52  0.0
cuboid   4 1  45.0    0.0       2.18      0.0     96.52  0.0
cuboid   7 1  45.0    0.0       2.64      0.0     96.52  0.0
cuboid   4 1  45.0    0.0       3.27      0.0     96.52  0.0
cuboid   7 1  45.0    0.0       3.73      0.0     96.52  0.0
'flux trap
unit 8
```

```
cuboid   7 1 2.18    -1.55       2.18    -1.55    96.52  0.0
'central moderator
unit 9
com='7.1 rods smeared over a row of 15'
cuboid  500 1 .8951 0 1.891 0 2p45.72
cuboid    6 1 .8951 0 1.891 0 2p48.26
cuboid    7 1 1.891 0 1.891 0 2p48.26
global
unit 10
array 3 3*0.0
'3x3 array
reflector 7 2 6r3 5
end geom
read array
ara=1 nux=14 nuy=15  fill f1               end fill
ara=2 nux=15 nuy=15  fill f1               end fill
ara=3 nux=3  nuy=3   fill 4 6 5 7 8 7 2 6 3 end fill
ara=4 nux=15 nuy=15 fill 14r1 9 14q15      end fill
end array

read bias  id=500 2 6 end bias

read plot
ttl='x-y slice of 214rv3   '
xul=39   yul=54.7  zul=63.26
xlr=54.7 ylr=39    zlr=63.26
uax=1 vdn=-1  nax=130    nch=' 456 89 s' end
ttl='x-y slice of 214v3    '
xul=-15  yul=108 zul=63.26
xlr=108  ylr=-15 zlr=63.26
uax=1 vdn=-1  nax=260    nch=' 456 89 s' end
end plot
end data
end
```

baw1231a

```
=csas25
b&w core 4.02% uo2 rods boron=1.152 gm/liter
44group      latticecell
uo2  1 0.863  285  92235  4.02  92238  95.98   end
ss304  2  1.0  285   end
h2o    3  1.0  285  end
boron  3  den=.001152  1.0  285  end
al     4  1.0  285  end
plexiglass  5  1.0  285  end
uo2  6 0.863  285  92235  4.02  92238  95.98   end
end comp
squarepitch  1.511 1.128  1  3  1.208  2  end
more data
res=6 cyl 0.564  dan(6)=0.901122   end
baw-1231 core i 936 rods  boron=1.152 g/l
read parm plt=yes run=yes gen=805 npg=600 nsk=5 tme=120
wrs=34 res=205 nub=yes rnd=6516246C6230 end parm
read geom
unit 1
com='al in bottom of fuel pin in borated h2o---z layer 0'
cylinder  4 1  .564   2p3.0
cylinder  2 1  .604   2p3.0
cuboid    3 1  4p.7555 2p3.0
unit 2
com='borated h2o box---z layer 0'
cuboid    3 1 4p.7555 2p3.0
unit 10
com='fuel pin in borated h2o---z layer 1'
cylinder  1 1  .564   2p43.0
cylinder  2 1  .604   2p43.0
cuboid    3 1  4p.7555 2p43.0
unit 11
com='borated h2o box---z layer 1'
cuboid    3 1 4p.7555 2p43.0
unit 20
com='fuel pin in lucite--z layer 2'
cylinder  1 1  .564   2p.315
cylinder  2 1  .604   2p.315
cuboid    5 1  4p.7555 2p.315
unit 21
com='lucite box---z layer 2'
cuboid    5 1 4p.7555 2p.315
unit 30
com='fuel pin in borated h2o---z layer 3'
cylinder  1 1  .564 50.835 -30.035
cylinder  2 1  .604  50.835 -30.035
cuboid    3 1  4p.7555 50.835 -30.035
unit 31
com='borated h2o box---z layer 3'
cuboid    3 1 4p.7555 50.835  -30.035
unit 40
com='fuel pin in void---z layer 4'
cylinder  6 1  .564 2p1.05
cylinder  2 1  .604  2p1.05
cuboid    0 1  4p.7555 2p1.05
unit 41
com='void box---z layer 4'
cuboid    0 1 4p.7555 2p1.05
'.............................................................
unit 50
array 10 -25.687 -25.687 -86.315
replicate 3 1 4r30.0 2r0 1
replicate 4 1 5r0 10.0   1
unit 60
array 40  -25.687 -25.687 -1.05
replicate 0 1 4r30 2r0   1
global
unit 200
array  200  2r-55.687  0
end geom
read array
ara=10  nux=34 nuy=34 nuz=4
fill
12r2 5r1    n17    9r2   8r1 n17     8r2   9r1 n17
 6r2 11r1    n17   5r2 12r1 n17     4r2 13r1 n17
3r2 14r1    n17    3r2   14r1 n17    2r2 15r1 n17      1r2 16r1 n17
1r2   16r1   n17   1r2 16r1 n17     170r1
n578
12r11 5r10  n17    9r11  8r10 n17    8r11  9r10 n17
 6r11 11r10  n17   5r11 12r10 n17   4r11 13r10 n17
```

```
3r11 14r10  n17    3r11  14r10 n17   2r11 15r10 n17    1r11 16r10 n17
1r11  16r10  n17   1r11 16r10 n17   170r10
n578
12r21 5r20  n17    9r21  8r20 n17    8r21  9r20 n17
 6r21 11r20  n17   5r21 12r20 n17   4r21 13r20 n17
3r21 14r20  n17    3r21  14r20 n17   2r21 15r20 n17    1r21 16r20 n17
1r21  16r20  n17   1r21 16r20 n17   170r20
n578
12r31 5r30  n17    9r31  8r30 n17    8r31  9r30 n17
 6r31 11r30  n17   5r31 12r30 n17   4r31 13r30 n17
3r31 14r30  n17    3r31  14r30 n17   2r31 15r30 n17    1r31 16r30 n17
1r31  16r30  n17   1r31 16r30 n17   170r30
n578
 end fill
ara=40  nux=34 nuy=34 nuz=1
fill
12r41 5r40  n17    9r41  8r40 n17    8r41  9r40 n17
 6r41 11r40  n17   5r41 12r40 n17   4r41 13r40 n17
3r41 14r40  n17    3r41  14r40 n17   2r41 15r40 n17    1r41 16r40 n17
1r41  16r40  n17   1r41 16r40 n17   170r40
n578
 end fill
ara=200  nux=1 nuy=1 nuz=2
fill  50   60   end fill
end array
read plot  ttl='x-y slice through z=59.0'
xul=-28  yul=28 zul=59.0
xlr=28   ylr=-28  zlr=59.0
uax=1.0   vdn=-1.0   nax=130 nch=' *2 45'
end plot
end data
end
```

baw1231b

```
=csas25
b&w core 4.02% uo2 rods boron=3.389 gm/liter
44group      latticecell
uo2  1 0.863  287  92235  4.02  92238  95.98   end
ss304  2  1.0  287   end
h2o    3  1.0  287  end
boron  3  den=.003389  1.0  287  end
al     4  1.0  287  end
plexiglass  5  1.0  287  end
uo2  6 0.863  287  92235  4.02  92238  95.98   end
end comp
squarepitch  1.511 1.128  1  3  1.208  2  end
more data
res=6 cyl 0.564  dan(6)=0.901122   end
baw-1231 core i 4904 rods  boron=3.389 g/l
read parm plt=yes run=yes gen=805 npg=600 nsk=5 tme=120
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
com='al in bottom of fuel pin in borated h2o---z layer 0'
cylinder  4 1  .564   2p3.0
cylinder  2 1  .604   2p3.0
cuboid    3 1  4p.7555 2p3.0
unit 2
com='borated h2o box---z layer 0'
cuboid    3 1 4p.7555 2p3.0
unit 10
com='fuel pin in borated h2o---z layer 1'
cylinder  1 1  .564   2p43.0
cylinder  2 1  .604   2p43.0
cuboid    3 1  4p.7555 2p43.0
unit 11
com='borated h2o box---z layer 1'
cuboid    3 1 4p.7555 2p43.0
unit 20
com='fuel pin in lucite--z layer 2'
cylinder  1 1  .564   2p.315
cylinder  2 1  .604   2p.315
cuboid    5 1  4p.7555 2p.315
unit 21
com='lucite box---z layer 2'
cuboid    5 1 4p.7555 2p.315
unit 30
com='fuel pin in borated h2o---z layer 3'
cylinder  1 1  .564  2p30.035
cylinder  2 1  .604   2p30.035
cuboid    3 1  4p.7555  2p30.035
unit 31
com='borated h2o box---z layer 3'
cuboid    3 1 4p.7555  2p30.035
unit 40
com='fuel pin in void---z layer 4'
cylinder  6 1  .564 2p11.45
cylinder  2 1  .604  2p11.45
cuboid    0 1  4p.7555 2p11.45
unit 41
com='void box---z layer 4'
cuboid    0 1 4p.7555 2p11.45
'.............................................................
unit 50
array 10 -60.44 -60.44 -86.315
replicate 3 1 4r30.0 2r0 1
replicate 4 1 5r0 10.0   1
unit 60
array 40  -60.44 -60.44 -11.45
replicate 0 1 4r30 2r0   1
global
unit 200
array  200  2r-90.44   0
end geom
read array
ara=10  nux=80 nuy=80 nuz=4
fill
37r2 3r1 n40         31r2 9r1 n40        27r2   13r1 n40
25r2 15r1 n40        23r2 17r1 n40       21r2 19r1 n40
19r2 21r1 n40        18r2 22r1 n40       16r2   24r1 n40
15r2 25r1 n40        14r2 26r1 n40       13r2 27r1 n40
12r2 28r1 n40        11r2 29r1 n40       10r2 30r1 n40
9r2 31r1 n40         8r2 32r1 n40        8r2 32r1 n40
7r2 33r1 n40         6r2 34r1 n40        6r2 34r1 n40
5r2 35r1 n40         5r2 35r1 n40        4r2 36r1 n40
4r2 36r1 n40        3r2 37r1 n40         3r2 37r1 n40
```

```
2r2   38r1 n40      2r2 38r1 n40         2r2 38r1 n40
2r2 38r1 n40        1r2 39r1 n40        1r2 39r1 n40
1r2 39r1 n40        1r2 39r1 n40       1r2 39r1 n40
1r2   39r1 n40      40r1 n40     40r1 n40    40r1 n40
n3200
37r11 3r10 n40       31r11 9r10 n40      27r11  13r10 n40
25r11 15r10 n40      23r11 17r10 n40     21r11 19r10 n40
19r11 21r10 n40      18r11 22r10 n40     16r11  24r10 n40
15r11 25r10 n40      14r11 26r10 n40     13r11 27r10 n40
12r11 28r10 n40      11r11 29r10 n40     10r11 30r10 n40
9r11 31r10 n40       8r11 32r10 n40      8r11 32r10 n40
7r11 33r10 n40       6r11 34r10 n40      6r11 34r10 n40
5r11 35r10 n40       5r11 35r10 n40      4r11 36r10 n40
4r11 36r10 n40      3r11 37r10 n40       3r11 37r10 n40
2r11  38r10 n40     2r11 38r10 n40       2r11 38r10 n40
2r11 38r10 n40      1r11 39r10 n40      1r11 39r10 n40
1r11 39r10 n40      1r11 39r10 n40     1r11 39r10 n40
1r11  39r10 n40     40r10 n40    40r10 n40   40r10 n40
n3200
37r21 3r20 n40       31r21 9r20 n40      27r21  13r20 n40
25r21 15r20 n40      23r21 17r20 n40     21r21 19r20 n40
19r21 21r20 n40      18r21 22r20 n40     16r21  24r20 n40
15r21 25r20 n40      14r21 26r20 n40     13r21 27r20 n40
12r21 28r20 n40      11r21 29r20 n40     10r21 30r20 n40
9r21 31r20 n40       8r21 32r20 n40      8r21 32r20 n40
7r21 33r20 n40       6r21 34r20 n40      6r21 34r20 n40
5r21 35r20 n40       5r21 35r20 n40      4r21 36r20 n40
4r21 36r20 n40      3r21 37r20 n40       3r21 37r20 n40
2r21  38r20 n40     2r21 38r20 n40       2r21 38r20 n40
2r21 38r20 n40      1r21 39r20 n40      1r21 39r20 n40
1r21 39r20 n40      1r21 39r20 n40     1r21 39r20 n40
1r21  39r20 n40     40r20 n40    40r20 n40   40r20 n40
n3200
37r31 3r30 n40       31r31 9r30 n40      27r31  13r30 n40
25r31 15r30 n40      23r31 17r30 n40     21r31 19r30 n40
19r31 21r30 n40      18r31 22r30 n40     16r31  24r30 n40
15r31 25r30 n40      14r31 26r30 n40     13r31 27r30 n40
12r31 28r30 n40      11r31 29r30 n40     10r31 30r30 n40
9r31 31r30 n40       8r31 32r30 n40      8r31 32r30 n40
7r31 33r30 n40       6r31 34r30 n40      6r31 34r30 n40
5r31 35r30 n40       5r31 35r30 n40      4r31 36r30 n40
4r31 36r30 n40      3r31 37r30 n40       3r31 37r30 n40
2r31  38r30 n40     2r31 38r30 n40       2r31 38r30 n40
2r31 38r30 n40      1r31 39r30 n40      1r31 39r30 n40
1r31 39r30 n40      1r31 39r30 n40     1r31 39r30 n40
1r31  39r30 n40     40r30 n40    40r30 n40   40r30 n40
n3200
end fill
ara=40  nux=80 nuy=80 nuz=1
fill
37r41 3r40 n40       31r41 9r40 n40      27r41  13r40 n40
25r41 15r40 n40      23r41 17r40 n40     21r41 19r40 n40
19r41 21r40 n40      18r41 22r40 n40     16r41  24r40 n40
15r41 25r40 n40      14r41 26r40 n40     13r41 27r40 n40
12r41 28r40 n40      11r41 29r40 n40     10r41 30r40 n40
9r41 31r40 n40       8r41 32r40 n40      8r41 32r40 n40
7r41 33r40 n40       6r41 34r40 n40      6r41 34r40 n40
5r41 35r40 n40       5r41 35r40 n40      4r41 36r40 n40
4r41 36r40 n40      3r41 37r40 n40       3r41 37r40 n40
2r41  38r40 n40     2r41 38r40 n40       2r41 38r40 n40
2r41 38r40 n40      1r41 39r40 n40      1r41 39r40 n40
1r41 39r40 n40      1r41 39r40 n40     1r41 39r40 n40
1r41  39r40 n40     40r40 n40    40r40 n40   40r40 n40
n3200
end fill
ara=200  nux=1 nuy=1 nuz=2
fill  50   60   end fill
end array
read plot  ttl='x-y slice through z=59.0'
xul=-61  yul=61 zul=59.0
xlr=61   ylr=-61  zlr=59.0
uax=1.0   vdn=-1.0   nax=130 nch=' *2 45'
end plot
end data
end
```

baw1273m

```
#csas25
'
' problem id baw 1273          (core xx)
'
' 2.46% u-235 enriched uo2 rods, 1.030 cm diam. al clad, 1.044 cm id,
' 1.206 cm od. uo2 153.34 cm long, h2o moderated and reflected.
' critical h2o height = 93.2 cm
' 5137 rods in borated water (boron=1.675gram/l)
' reference: baw-1273
' scale module: csas25
'
baw 1273 core xx lattice cell pitch=1.511 cm fuel=2.46 w/o u235 uo2
44group  latticecell
uo2   1 den=10.24 1.0 293 92235 2.459 92238 97.541 end
al    2 1.0         end
h2o   3 1.0         end
boron 3 den=1.675e-3 end
al    4 1.0         end
h2o   5 1.0         end
boron 5 den=1.675e-3 end
uo2   6 den=10.24 1.0 293 92235 2.459 92238 97.541 end
end comp
squarepitch  1.511 1.030  1 3 1.206 2 1.044 0 end
more data  res=6 cyl 0.515  dan(6)=0.982883    end
baw-1273 core xx             2.46 wt%u235  5137 rods
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=120
wrs=34 res=205 nub=yes  end parm

read geom
unit 1
com='bottom plug of fuel rod'
cylinder  2 1  .603      .3175 0.0
cuboid    3 1  4p.7555   .3175 0.0

unit 2
com='fuel rod in grid'
cylinder  1 1  .515      2.54  0.0
cylinder  0 1  .522      2.54  0.0
cylinder  2 1  .603      2.54  0.0
```

```
cuboid    3 1  4p.615    2.54  0.0
cuboid    4 1  4p.7555   2.54  0.0

unit 3
com='fuel rod'
cylinder  1 1  .515      93.2  2.54
cylinder  0 1  .522      93.2  2.54
cylinder  2 1  .603      93.2  2.54
cuboid    3 1  4p.7555   93.2  2.54

unit 13
com='fuel rod above water'
cylinder  6 1  .515      153.4  93.2
cylinder  0 1  .522      153.4  93.2
cylinder  2 1  .603      153.4  93.2
cuboid    0 1  4p.7555   153.4  93.2

unit 4
com='water under grid'
cuboid    3 1  4p.7555   .3175 0.0

unit 5
com='water in grid'
cuboid    3 1  4p.615    2.54  0.0
cuboid    4 1  4p.7555   2.54  0.0

unit 6
com='water above grid'
cuboid    3 1  4p.7555   93.2  2.54

unit 16
com='void above water'
cuboid    3 1  4p.7555   153.4  93.2

unit 7
com='fuel rod'
array 1   3*0.0

unit 8
com='water cell'
array 2   3*0.0

global unit 9
array  3   2*0.0     -.3175
reflector 4 1  5r0   5.08  1
reflector 5 1  4r30    2r0 1

end geom

read array
ara=1  nux=1 nuy=1  nuz=4   fill 1 2 3 13       end fill
ara=2  nux=1 nuy=1  nuz=4   fill 4 5 6 16       end fill
ara=3  nux=82 nuy=82  nuz=1   fill
38r8  6r7 38r8   32r8 18r7 32r8   28r8 26r7 28r8   26r8 30r7 26r8
24r8 34r7 24r8   22r8 38r7 22r8   20r8 42r7 20r8   18r8 46r7 18r8
17r8 48r7 17r8   16r8 50r7 16r8   15r8 52r7 15r8   14r8 54r7 14r8
13r8 56r7 13r8   12r8 58r7 12r8   11r8 60r7 11r8   10r8 62r7 10r8
 9r8 64r7  9r8    8r8 66r7  8r8    7r8 68r7  7r8   q82
 6r8 70r7  6r8 q82  5r8 72r7  5r8  q82  4r8 74r7  4r8   q82
 3r8 76r7  3r8 q82  2r8 78r7  2r8 3q82  1r8 80r7  1r8 5q82 82r7 2q82
 n3280 38r8 7r7 37r8
 end fill
end array
read plot
ttl='x-y slice '
xul=-30.9755 yul=165.4545   zul=20.
xlr=165.4545 ylr=-30.9755   zlr=20.
uax=1 vdn=-1 nax=130  nch='.12 4 6   '  end
ttl='x-z slice '
xul=-0.5   yul=61.1955 zul=150.
xlr=30.0   ylr=61.1955 zlr=-10.0
uax=1 wdn=-1 nax=130  nch='.12 4 6   '  end
end plot
end data
end
```


baw1484a

```
=csas25
'
' problem id baw 1484-7 exp 2282 (core iv)
'
' 2.46% u-235 enriched uo2 rods, 1.206 cm od al clad, 1.044 cm id,
' 1.030 cm od fuel. uo2 153.34 cm long, h2o moderated and reflected.
' critical h2o height = 145.68 cm
' 9 14x14 clusters, separated by 1 pin pitch with 84 b4c rods
' reference: baw-1484-7
' scale module: csas25
'
baw 1484-7 core iv lattice cell pitch=1.636 cm fuel=2.46 w/o u235 uo2
44group  latticecell
uo2   1 den=10.22 1.0 293 92235 2.459 92238 97.541 end
al    2 1.0         end
h2o   3 1.0         end
b4c   4 den=1.28 0.986   end
arbmb2o3    1.28 2 1 1 0 5000 2 8016 3 4 0.001  end
al    5 1.0         end
h2o   6 1.0         end
end comp
squarepitch  1.636 1.030  1 3 1.206 2 1.044 0 end
baw-1484-7 core iv exp 2282  2.46 wt%u235  9 assys 14x14 w/ 84 b4c pins
read parm plt=yes run=yes gen=805 npg=600 nsk=5 tme=240
wrs=34 res=205 nub=yes  rnd=6516246C6230 end parm

read geom
unit 1
com='bottom plug of fuel rod'
cylinder  2 1  .603      .3175 0.0
cuboid    3 1  4p.818    .3175 0.0

unit 2
com='bottom plug of b4c rod'
cylinder  2 1  .5565     .3175 0.0
cuboid    3 1  4p.818    .3175 0.0

unit 3
com='bottom of water hole'
```

```
cuboid    3 1  4p.818    .3175 0.0

unit 4
com='fuel rod in grid'
cylinder  1 1  .515      2.54  0.0
cylinder  0 1  .522      2.54  0.0
cylinder  2 1  .603      2.54  0.0
cuboid    3 1  4p.615    2.54  0.0
cuboid    5 1  4p.818    2.54  0.0

unit 5
com='b4c rod in grid'
cylinder  2 1  .4675    0.6345 0.0
cylinder  4 1  .4675     2.54  0.0
cylinder  2 1  .5565     2.54  0.0
cuboid    3 1  4p.615    2.54  0.0
cuboid    5 1  4p.818    2.54  0.0

unit 6
com='water hole in grid'
cuboid    3 1  4p.615    2.54  0.0
cuboid    5 1  4p.818    2.54  0.0

unit 7
com='fuel rod'
cylinder  1 1  .515      142.8225 0.0
cylinder  0 1  .522      142.8225 0.0
cylinder  2 1  .603      142.8225 0.0
cuboid    3 1  4p.818    142.8225 0.0

unit 8
com='b4c rod '
cylinder  4 1  .4675     142.8225 0.0
cylinder  2 1  .5565     142.8225 0.0
cuboid    3 1  4p.818    142.8225 0.0

unit 9
com='water hole'
cuboid    3 1  4p.818    142.8225 0.0

unit 11
com='fuel rod'
array 1   3*0.0
unit 12
com='b4c pin'
array 2   3*0.0
unit 13
com='water hole'
array 3   3*0.0
unit 14
com='fuel assy'
array 4   3*0.0
unit 15
com='bottom vertical row of b4c pins'
array 5   3*0.0
unit 16
com='middle vertical row of b4c pins'
array 6   3*0.0
unit 17
com='top vertical row of b4c pins'
array 7   3*0.0

unit 18
com='bottom row of assemblies '
array  8   3*0.0

unit 19
com='middle row of assemblies'
array  9   3*0.0

unit 20
com='top row of assemblies '
array 10   3*0.0

unit 21
com='horizontal row of b4c pins'
array 11  3*0.0

global unit 22
array  12  3*0.0
cuboid 5 1 71.984 0.0 71.984 0.0 145.68 -5.08
cuboid 6 1 71.984 0.0 71.984 0.0 145.68 -7.62
reflector 6 2    4r3 2r0 8
end geom

read bias id=500 2 9 end bias

read array
com='fuel rod'   ara=1 nux=1  nuy=1  nuz=3   fill 1 4 7      end fill
com='b4c pin'    ara=2 nux=1  nuy=1  nuz=3   fill 2 5 8      end fill
com='water hole' ara=3 nux=1  nuy=1  nuz=3   fill 3 6 9      end fill
com='fuel assy'  ara=4 nux=14 nuy=14 nuz=1   fill f11        end fill
ara=5 nux=1  nuy=14 nuz=1   fill 12 13 6q2      end fill
ara=6 nux=1  nuy=14 nuz=1   fill 13 12 2q2 13 13 12 13 2q2 end fill
ara=7 nux=1  nuy=14 nuz=1   fill 13 12 6q2      end fill
ara=8 nux=5  nuy=1  nuz=1   fill 14 15 14 15 14 end fill
ara=9 nux=5  nuy=1  nuz=1   fill 14 16 14 16 14 end fill
ara=10 nux=5  nuy=1  nuz=1  fill 14 17 14 17 14 end fill
ara=11 nux=44 nuy=1  nuz=1
      fill 13 13 12 13q2 12 12 13 6q2 end fill
ara=12 nux=1 nuy=5  nuz=1   fill 18 21 19 21 20 end fill
end array
read plot
ttl='x-y slice below grid plate'
xul=-0.5   yul=72.5   zul=0.2
xlr=72.5   ylr=-0.5   zlr=0.2
uax=1 vdn=-1 nax=260  nch=' 12 456789'  end
ttl='x-y slice of grid plate'
xul=-0.5   yul=72.5   zul=2.
xlr=72.5   ylr=-0.5   zlr=2.
uax=1 vdn=-1 nax=260  nch=' 12 456789'  end
ttl='x-y slice above grid plate'
xul=-0.5   yul=72.5   zul=50.
xlr=72.5   ylr=-0.5   zlr=50.
uax=1 vdn=-1 nax=260  nch=' 12 456789'  end
end plot
end data
end
```

baw1484b

```
#csas25
'
' problem id baw 1484-7 exp 2321 (core ix)
'
' 2.46% u-235 enriched uo2 rods, 1.030 cm diam. al clad, 1.044 cm id,
' 1.206 cm od. uo2 153.34 cm long, h2o moderated and reflected.
' critical h2o height = 129.65 cm
' 9 14x14 clusters, separated by 4 pin pitch without b4c rods
' reference: baw-1484-7
' scale module: csas25
'
baw 1484-7 core ix lattice cell pitch=1.636 cm fuel=2.46 w/o u235 uo2
44group  latticecell
uo2   1 den=10.22 1.0 293 92235 2.459 92238 97.541 end
al    2 1.0         end
h2o   3 1.0         end
al    4 1.0         end
h2o   5 1.0         end
end comp
squarepitch  1.636 1.030  1 3 1.206 2 1.044 0 end
baw-1484-7 core ix exp 2321  2.46 wt%u235  9 assys 14x14
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=120
wrs=34 res=205 nub=yes  end parm

read geom
unit 1
com='bottom plug of fuel rod'
cylinder  2 1  .603      .3175 0.0
cuboid    3 1  4p.818    .3175 0.0

unit 2
com='fuel rod in grid'
cylinder  1 1  .515      2.54  0.0
cylinder  0 1  .522      2.54  0.0
cylinder  2 1  .603      2.54  0.0
cuboid    3 1  4p.615    2.54  0.0
cuboid    4 1  4p.818    2.54  0.0

unit 3
com='fuel rod'
cylinder  1 1  .515      126.7925 0.0
cylinder  0 1  .522      126.7925 0.0
cylinder  2 1  .603      126.7925 0.0
cuboid    3 1  4p.818    126.7925 0.0

unit 4
com='fuel assy'
array 1   3*0.0
reflector 3 1    4r3.272 2r0 1

global unit 5
array  2   3*0.0
reflector 4 1 5r0.0 5.08 1
reflector 5 1 5r0.0 7.62 1
reflector 5 1    4r24 2r0 1

end geom

read array
com='fuel assy'  ara=1 nux=14 nuy=14 nuz=3
      fill 196r1 196r2 196r3          end fill
ara=2  nux=3 nuy=3  nuz=1   fill f4             end fill
end array
read plot
ttl='x-y slice '
xul=-0.5   yul=90.0   zul=20.
xlr=90.0   ylr=-0.5   zlr=20.
uax=1 vdn=-1 nax=130  nch='.12 4     '  end
ttl='x-y slice '
xul=-0.5   yul=40.0   zul=2.
xlr=40.0   ylr=-0.5   zlr=2.
uax=1 vdn=-1 nax=130  nch='.12 4     '  end
ttl='x-z slice '
xul=-0.5   yul=4.09   zul=10.
xlr=30.0   ylr=4.09   zlr=-10.0
uax=1 wdn=-1 nax=130  nch='.12 4     '  end
end plot
end data
end
```

baw1484c

```
#csas25
'
' problem id baw 1484-7 exp 2378 (core xiii)
'
' 2.46% u-235 enriched uo2 rods, 1.030 cm diam. al clad, 1.044 cm id,
' 1.206 cm od. uo2 153.34 cm long, h2o moderated and reflected.
' critical h2o height = 150.27 cm
' 9 14x14 clusters, separated by 1 pin pitch with b/al sheets no.5
' reference: baw-1484-7
' scale module: csas25
'
baw 1484-7 core xiii lattice cell pitch=1.636 cm fuel=2.46 w/o u235 uo2
44group  latticecell
uo2   1 den=10.22 1.0 293 92235 2.459 92238 97.541 end
al    2 1.0         end
h2o   3 1.0         end
boron 3 den=15e-6   end
al    4 0.4347      end
h2o   4 0.5653      end
boron 4 den=15e-6 .5653   end
al    5 den=2.7 .98385 end
boron 5 den=2.7 .01615 end
al    6 1.0         end
h2o   7 1.0         end
boron 7 den=15e-6   end
end comp
squarepitch  1.636 1.030  1 3 1.206 2 1.044 0 end
baw-1484-7 core xiii exp 2378  2.46 wt%u235  9 assys 14x14
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=120
wrs=34 res=205 nub=yes  end parm

read geom
unit 1
com='fuel rod'
```

```
cylinder  1 1  .515      145.47 0.0
cylinder  0 1  .522      145.47 0.0
cylinder  2 1  .603      145.47 0.0
cuboid    3 1  4p.818    145.47 0.0
unit 2
com='al rod'
cylinder  2 1  .635      145.47 0.0
cuboid    3 1  4p.818    145.47 0.0

unit 3
com='fuel assy 11'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    .5855 9.808  .5855  9.808  2r0  1
reflector 5 1    .3225 0 .3225 3r0              1
unit 4
com='fuel assy 12'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    2r.4055 .5855  9.808  2r0  1
reflector 5 1    3r.3225 3r0               1
unit 5
com='fuel assy 13'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    9.808 .5855  .5855  9.808  2r0  1
reflector 5 1    0    2r.3225 3r0               1
unit 6
com='fuel assy 21'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    .5855 9.808  2r.4055       2r0  1
reflector 5 1    .3225 0  2r.3225 2r0                1
unit 7
com='fuel assy 22'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    4r.4055              2r0  1
reflector 5 1    4r.3225 2r0               1
unit 8
com='fuel assy 23'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    9.808 .5855  2r.4055         2r0  1
reflector 5 1    0    3r.3225 2r0              1

unit 9
com='fuel assy 31'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    .5855 9.808  9.808  .5855  2r0  1
reflector 5 1    .3225 2r0 .3225 2r0              1
unit 10
com='fuel assy 32'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    2r.4055 9.808  .5855  2r0  1
reflector 5 1    2r.3225 0 .3225 2r0               1
unit 11
com='fuel assy 33'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    9.808 .5855  9.808  .5855  2r0  1
reflector 5 1    0    .3225 0 .3225 2r0               1

global unit 12
array  2   2*-45.8 -1.9425
reflector 4 1    5r0 2.54 1
reflector 7 1    5r0 .3175 1
reflector 6 1    5r0 5.08  1
reflector 7 1    5r0 2.54  1
reflector 6 1    5r0 1.27  1
reflector 7 1    4r20 2r0  1

end geom

read array
com='fuel assy'  ara=1 nux=14 nuy=14 nuz=1
fill 2 12r1 2 14r1 11q14 2 12r1 2 end fill
ara=2  nux=3 nuy=3  nuz=1   fill 3 4 5 6 7 8 9 10 11 end fill
end array
read plot
ttl='x-y slice '
xul=-50    yul=50.0   zul=20.
xlr=50     ylr=-50.   zlr=20.
uax=1 vdn=-1 nax=130  nch='.12 456   '  end
ttl='x-y slice '
xul=-0     yul=50.0   zul=2.
xlr=20.0   ylr=-50    zlr=2.
uax=1 vdn=-1 nax=130  nch='.12 456   '  end
ttl='x-z slice '
xul=-0.5   yul=.818   zul=10.
xlr=30.0   ylr=.818   zlr=-15.0
uax=1 wdn=-1 nax=130  nch='.12 456   '  end
end plot
end data
end
```

baw1484d

```
#csas25
'
' problem id baw 1484-7 exp 2420 (core xxi)
'
' 2.46% u-235 enriched uo2 rods, 1.030 cm diam. al clad, 1.044 cm id,
' 1.206 cm od. uo2 153.34 cm long, h2o moderated and reflected.
' critical h2o height = 151.69 cm
' 9 14x14 clusters, separated by 1 pin pitch with b/al sheets no.1
' reference: baw-1484-7
' scale module: csas25
'
baw 1484-7 core xxi lattice cell pitch=1.636 cm fuel=2.46 w/o u235 uo2
44group  latticecell
uo2   1 den=10.22 1.0 293 92235 2.459 92238 97.541 end
al    2 1.0         end
h2o   3 1.0         end
boron 3 den=72e-6   end
```

```
al    4 0.4347      end
h2o   4 0.5653      end
boron 4 den=72e-6 .5653   end
al    5 den=2.7 .99899 end
boron 5 den=2.7 .00101 end
al    6 1.0         end
h2o   7 1.0         end
boron 7 den=72e-6   end
end comp
squarepitch  1.636 1.030  1 3 1.206 2 1.044 0 end
baw-1484-7 core xxi exp 2420   2.46 wt%u235  9 assys 14x14
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=120
wrs=34 res=205 nub=yes  end parm

read geom
unit 1
com='fuel rod'
cylinder  1 1  .515      146.89 0.0
cylinder  0 1  .522      146.89 0.0
cylinder  2 1  .603      146.89 0.0
cuboid    3 1  4p.818    146.89 0.0
unit 2
com='al rod'
cylinder  2 1  .635      146.89 0.0
cuboid    3 1  4p.818    146.89 0.0

unit 3
com='fuel assy 11'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    3.8575 6.536 3.8575 6.536  2r0  1
reflector 5 1    .3225 0 .3225 3r0               1
unit 4
com='fuel assy 12'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    2r.4055 3.8575 6.536  2r0  1
reflector 5 1    3r.3225 3r0                1
unit 5
com='fuel assy 13'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    6.536 3.8575 3.8575 6.536  2r0  1
reflector 5 1    0    2r.3225 3r0                1

unit 6
com='fuel assy 21'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    3.8575 6.536 2r.4055       2r0  1
reflector 5 1    .3225 0  2r.3225 2r0                1
unit 7
com='fuel assy 22'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    4r.4055               2r0  1
reflector 5 1    4r.3225 2r0                1
unit 8
com='fuel assy 23'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    6.536 3.8575 2r.4055         2r0  1
reflector 5 1    0    3r.3225 2r0                1

unit 9
com='fuel assy 31'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    3.8575 6.536 6.536  3.8575 2r0  1
reflector 5 1    .3225 2r0 .3225 2r0                1
unit 10
com='fuel assy 32'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    2r.4055 6.536  3.8575 2r0  1
reflector 5 1    2r.3225 0 .3225 2r0                1
unit 11
com='fuel assy 33'
array 1   2r-22.904  0.0
reflector 6 1    5r0   1.9425 1
reflector 3 1    6.536 3.8575 6.536  3.8575 2r0  1
reflector 5 1    0    .3225 0 .3225 2r0                1

global unit 12
array  2   2*-45.8 -1.9425
reflector 4 1    5r0 2.54 1
reflector 7 1    5r0 .3175 1
reflector 6 1    5r0 5.08  1
reflector 7 1    5r0 2.54  1
reflector 6 1    5r0 1.27  1
reflector 7 1    4r20 2r0  1

end geom

read array
com='fuel assy'  ara=1 nux=14 nuy=14 nuz=1
fill 2 12r1 2 14r1 11q14 2 12r1 2 end fill
ara=2  nux=3 nuy=3  nuz=1   fill 3 4 5 6 7 8 9 10 11 end fill
end array
read plot
ttl='x-y slice '
xul=-50    yul=50.0   zul=20.
xlr=50     ylr=-50.   zlr=20.
uax=1 vdn=-1 nax=130  nch='.12 456   '  end
ttl='x-y slice '
xul=-0     yul=50.0   zul=2.
xlr=20.0   ylr=-50    zlr=2.
uax=1 vdn=-1 nax=130  nch='.12 456   '  end
ttl='x-z slice '
xul=-0.5   yul=.818   zul=10.
xlr=30.0   ylr=.818   zlr=-15.0
uax=1 wdn=-1 nax=130  nch='.12 456   '  end
end plot
end data
end
```

baw1645t

```
#csas25
baw-1645-4 exp,mt=2452  triangular pitch=o.d.    boron=435ppm
44group                 latticecell
uo2            1  0.9325 293 92235 2.459  92238 97.541   end
al             2  1.0 293 end
h2o            3  1.0 293 end
boron          3  den=435.0-6     end
al             4  .25 293 end
h2o            4  .75 293 end
boron          4  den=435.0-6 .75    end
carbonsteel    5  1.0 293 end
al             6  1.0 293 end
h2o            7  1.0 293 end
boron          7  den=435.0-6     end
end comp
triangpitch 1.2093 1.0300 1  3  1.2060 2  1.0440 0 end
baw-1645-4 exp,mt=2452  triangular pitch=o.d.    boron=435ppm
read parm gen=805 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes tme=120
wrs=34  end parm
read geom
unit  1
com=!fuel pin -y!
zhemicyl-y 1 1 .5150              143.96   0.0
zhemicyl-y 0 1 .5220              143.96   0.0
zhemicyl-y 2 1 .6030              143.96   -0.318
unit  2
com=!fuel pin +y!
zhemicyl+y 1 1 .5150              143.96   0.0
zhemicyl+y 0 1 .5220              143.96   0.0
zhemicyl+y 2 1 .6030              143.96   -0.318
unit  3
com=!fuel pin -x!
zhemicyl-x 1 1 .5150              143.96   0.0
zhemicyl-x 0 1 .5220              143.96   0.0
zhemicyl-x 2 1 .6030              143.96   -0.318
unit  4
com=!fuel pin +x!
zhemicyl+x 1 1 .5150              143.96   0.0
zhemicyl+x 0 1 .5220              143.96   0.0
zhemicyl+x 2 1 .6030              143.96   -0.318
unit  5
com=!al pin -y  !
zhemicyl-y 2 1 .6030              143.96   -0.318
unit  6
com=!al pin +y  !
zhemicyl+y 2 1 .6030              143.96   -0.318
unit  11
com=!4-fuel pin!
zhemicyl-y 1 1 .5150              143.96   0.0
zhemicyl-y 0 1 .5220              143.96   0.0
zhemicyl-y 2 1 .6030              143.96   -.318
cuboid     3 1  2p.6047  0 -2.0946 143.96   -.318
hole       2    0        -2.0946   -.0
hole       3    +0.6047  -1.0473   -.0
hole       4    -0.6047  -1.0473   -.0
unit  12
com=!3-fuel pin!
zhemicyl-y 1 1 .5150              143.96   0.0
zhemicyl-y 0 1 .5220              143.96   0.0
zhemicyl-y 2 1 .6030              143.96   -.318
cuboid     3 1  2p.6047  0 -2.0946 143.96   -.318
hole       2    0        -2.0946   -.0
hole       3    +0.6047  -1.0473   -.0
unit  13
com=!3-fuel pin!
zhemicyl-y 1 1 .5150              143.96   0.0
zhemicyl-y 0 1 .5220              143.96   0.0
zhemicyl-y 2 1 .6030              143.96   -.318
cuboid     3 1  2p.6047  0 -2.0946 143.96   -.318
hole       2    0        -2.0946   -.0
hole       4    -0.6047  -1.0473   -.0
unit  14
com=!3-fuel pin!
zhemicyl-y 1 1 .5150              143.96   0.0
zhemicyl-y 0 1 .5220              143.96   0.0
zhemicyl-y 2 1 .6030              143.96   -.318
cuboid     3 1  2p.6047  0 -2.0946 143.96   -.318
hole       6    0        -2.0946   -.0
hole       3    +0.6047  -1.0473   -.0
unit  15
com=!3-fuel pin!
zhemicyl-y 1 1 .5150              143.96   0.0
zhemicyl-y 0 1 .5220              143.96   0.0
zhemicyl-y 2 1 .6030              143.96   -.318
cuboid     3 1  2p.6047  0 -2.0946 143.96   -.318
hole       6    0        -2.0946   -.0
hole       4    -0.6047  -1.0473   -.0
unit  16
com=!3-fuel pin!
zhemicyl-y 2 1 .6030              143.96   -.318
cuboid     3 1  2p.6047  0 -2.0946 143.96   -.318
hole       2    0        -2.0946   -.0
hole       3    +0.6047  -1.0473   -.0
unit  17
com=!3-fuel pin!
zhemicyl-y 2 1 .6030              143.96   -.318
cuboid     3 1  2p.6047  0 -2.0946 143.96   -.318
hole       2    0        -2.0946   -.0
hole       4    -0.6047  -1.0473   -.0
unit  18
com=!1-fuel pin!
zhemicyl-y 1 1 .5150              143.96   0.0
zhemicyl-y 0 1 .5220              143.96   0.0
zhemicyl-y 2 1 .6030              143.96   -.318
cuboid     3 1  2p.6047  0 -.6047  143.96   -.318
unit  19
com=!1-fuel pin!
zhemicyl+y 1 1 .5150              143.96   0.0
zhemicyl+y 0 1 .5220              143.96   0.0
zhemicyl+y 2 1 .6030              143.96   -.318
cuboid     3 1  2p.6047  .6047  0  143.96   -.318
unit  20
com=!1-al pin!
zhemicyl-y 2 1 .6030              143.96   -.318
cuboid     3 1  2p.6047  0 -.6047  143.96   -.318
unit  21
```

```
com=!1-al pin!
zhemicyl+y 2 1 .6030              143.96   -.318
cuboid     3 1  2p.6047  .6047  0  143.96   -.318
unit  31
com=!fuel module w/o al side plate below water !
array      1   -9.0705 -8.9831 -0.318
cuboid     3 1 2p9.9578  2p8.9831  143.96 -.318
unit  32
com=!water gap !
cuboid     3 1 2p9.9578 2p0.9708   143.96 -.318
unit  33
com=!water gap w/2 side plates!
cuboid     3 1 2p7.62   2p0.8946   143.96 -.318
cuboid     2 1 2p7.62   2p0.9708   143.96 -.318
cuboid     3 1 2p9.9578 2p0.9708   143.96 -.318
global unit  34
com=!reflector region!
array      2   -49.789  -48.7987 -.318
replicate  4 1 5r0         1.067     1
replicate  2 1 5r0         1.815     1
replicate  7 1 10 10 10 10 0  0      1
replicate  6 1 4r0     0   8.9       1
replicate  7 1 4r0     0   2.86      1
replicate  5 1 4r0     0   1.0       1
replicate  7 1 4r20    0   0         1
end geom
read array
ara=1 nux=15 nuy=10 nuz=1
com=!fuel module under water!
fill 20 13r18 20 14 13r11 15 12 13r11 13  5q15 16 13r11 17 21 13r19 21
end fill
ara=2 nux=5  nuy=9  nuz=1
com=!5x5x1 array under water!
fill  5r31 32 3r33 32 3q10 5r31
end fill
end array
read bnds +xb=vacuum -xb=vacuum +yb=vacuum -yb=vacuum +zb=vacuum
-zb=vacuum
  end bnds
read plot
ttl=!x-y cross-section at z=20 cm!
plt=yes pic=mixture xul=7  yul=15  zul=20 xlr=15  ylr=0  zlr=20 uax=1
vax=0 wax=0 udn=0 vdn=-1 wdn=0 nax=130  nch=' 12 .56 ' end
ttl=!x-z cross-section at y=1.0cm!
plt=yes pic=mixture xul=-1 yul=0  zul=20  xlr=30  ylr=0 zlr=-20 uax=1
vax=0 wax=0 udn=0 vdn=0 wdn=-1 nax=130  nch=' 12 .56 ' end
end plot
end data
end
```

baw1645s

```
#csas25
baw-1645-4 exp,mt=2485  pitch=o.d.    boron=886ppm
44group                 latticecell
uo2            1  0.9325 293 92235 2.459  92238 97.541   end
al             2  1.0 293 end
h2o            3  1.0 293 end
boron          3  den=886.0-6     end
al             4  .25 293 end
h2o            4  .75 293 end
boron          4  den=886.0-6 .75    end
carbonsteel    5  1.0 293 end
al             6  1.0 293 end
h2o            7  1.0 293 end
boron          7  den=886.0-6     end
end comp
squarepitch 1.2090 1.0300 1  3  1.2060 2  1.0440 0 end
baw-1645-4 exp,mt=2485  pitch=o.d.    boron=886ppm
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes
wrs=34  end parm
read geom
unit  1
com=!al pin below water!
cylinder   2 1 .6030               145.0  -.318
cuboid     3 1     4p.6045         145.0  -.318
unit  2
com=!fuel pin below water!
cylinder   1 1 .5150               145.0    0.0
cylinder   0 1 .5220               145.0    0.0
cylinder   2 1 .6030               145.0  -.318
cuboid     3 1     4p.6045         145.0  -.318
unit  3
com=!fuel module w/o al side plate below water !
array      1   -9.0675 -9.0675 -0.318
cuboid     3 1 2p9.9550 2p9.0675   145.0  -.318
unit  10
com=!water gap!
cuboid     3 1 2p9.9550 2p0.8875   145.0  -.318
unit  11
com=!water gap w/2 side plates!
cuboid     3 1 2p7.62   2p0.8113   145.0  -.318
cuboid     2 1 2p7.62   2p0.8875   145.0  -.318
cuboid     3 1 2p9.9550 2p0.8875   145.0  -.318
global unit  5
com=!reflector region!
array      2     -49.775  -48.8875  -.318
replicate  4 1 5r0  1.067            1
replicate  2 1 5r0  1.815            1
replicate  7 1 10 10 10 10 0  0      1
replicate  6 1 4r0     0   8.9       1
replicate  7 1 4r0     0   2.86      1
replicate  5 1 4r0     0   1.0       1
replicate  7 1 4r20    0   0         1
end geom
read array
ara=1 nux=15 nuy=15 nuz=1
com=!fuel module under water!
fill  1 13r2 1 15r2 12q15 1 13r2 1
end fill
ara=2 nux=5  nuy=9  nuz=1
com=!5x5x1 array under water!
fill  5r3 10 3r11 10 3q10  5r3
end fill
end array
read bnds +xb=vacuum -xb=vacuum +yb=vacuum -yb=vacuum +zb=vacuum
-zb=vacuum
```

```
  end bnds
read plot
ttl=!x-y cross-section at z=20 cm!
plt=yes pic=mixture xul=0  yul=50  zul=20 xlr=15  ylr=0  zlr=20 uax=1
vax=0 wax=0 udn=0 vdn=-1 wdn=0 nax=130  nch=' 12 .56 ' end
ttl=!x-z cross-section at y=1.0cm!
plt=yes pic=mixture xul=-1 yul=0  zul=20  xlr=30  ylr=0 zlr=-20 uax=1
vax=0 wax=0 udn=0 vdn=0 wdn=-1 nax=130  nch=' 12 .56 ' end
end plot
end data
end
```

bw1645so

```
#csas25
baw-1645-4 exp,mt=2500  pitch=1.17*o.d.    boron=1156ppm
44group                 latticecell
uo2            1  0.9325 293 92235 2.459  92238 97.541   end
al             2  1.0 293 end
h2o            3  1.0 293 end
boron          3  den=1156.0-6    end
carbonsteel    4  1.0 293 end
al             5  1.0 293 end
h2o            6  1.0 293 end
boron          6  den=1156.0-6    end
end comp
squarepitch 1.4097 1.0300 1  3  1.2060 2  1.0440 0 end
baw-1645-4 exp,mt=2500  pitch=1.17*o.d.    boron=1156ppm
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes
wrs=34  end parm
read geom
unit  1
com=!al pin below water!
cylinder   2 1 .6030               144.85 -.318
cuboid     3 1     4p.7049         144.85 -.318
unit  2
com=!fuel pin below water!
cylinder   1 1 .5150               144.85   0.0
cylinder   0 1 .5220               144.85   0.0
cylinder   2 1 .6030               144.85 -.318
cuboid     3 1     4p.7049         144.85 -.318
unit  3
com=!fuel module w/o al side plate below water !
array      1   -9.1637 -9.1637 -0.318
cuboid     3 1 2p9.9578  2p9.1637  144.85 -.318
unit  10
com=!water gap !
cuboid     3 1 2p9.9578 2p0.7941   144.85 -.318
unit  11
com=!water gap w/2 side plates!
cuboid     3 1 2p7.62   2p0.7179   144.85 -.318
cuboid     2 1 2p7.62   2p0.7941   144.85 -.318
cuboid     3 1 2p9.9578 2p0.7941   144.85 -.318
global unit  5
com=!reflector region!
array      2   -49.789  -48.9949 -.318
replicate  2 1 5r0         2.882     1
replicate  6 1 10 10 10 10 0  0      1
replicate  5 1 4r0     0   8.9       1
replicate  6 1 4r0     0   2.86      1
replicate  4 1 4r0     0   1.0       1
replicate  6 1 4r20    0   0         1
end geom
read array
ara=1 nux=13 nuy=13 nuz=1
com=!fuel module under water!
fill  1 11r2 1 13r2 10q13 1 11r2 1
end fill
ara=2 nux=5  nuy=9  nuz=1
com=!5x5x1 array under water!
fill  5r3 10 3r11 10 3q10 5r3
end fill
end array
read bnds +xb=vacuum -xb=vacuum +yb=vacuum -yb=vacuum +zb=vacuum
-zb=vacuum
  end bnds
read plot
ttl=!x-y cross-section at z=20 cm!
plt=yes pic=mixture xul=7  yul=15  zul=20 xlr=15  ylr=7  zlr=20 uax=1
vax=0 wax=0 udn=0 vdn=-1 wdn=0 nax=130  nch='.12 45  ' end
ttl=!x-z cross-section at y=0.0cm!
plt=yes pic=mixture xul=-50 yul=0 zul=10  xlr=-30  ylr=0 zlr=-5  uax=1
vax=0 wax=0 udn=0 vdn=0 wdn=-1 nax=130  nch='.12 45  ' end
end plot
end data
end
```

bnw1810a

```
=csas25
baw-1810 4.02 w/o u235 uo2 rods .4755 inches o.d.
44group                  latticecell
uo2 1  den=9.46 1.0 293 92235 4.02 92238 95.98  end
ss304 2  1.0 293  end
h2o 3   den=1.0  0.998101  end
boron 3 den=1.0  0.001899  end
uo2 4  den=10.24 1.0 293 92235 2.459 92238 97.541  end
al 5  1.0 293  end
end comp
squarepitch 1.636  1.128  1  3  1.208  2  end
more data
res=4 cylinder .51486 dan(4)=.189732
end more data
baw-1810 core 12 - 4.02 & 2.46 w/o uo2 1899.3 ppm; no uo2-gd2o3 rods
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes tme=60
wrs=35 end parm
read geom
unit  1
com="4.02 w/o fuel rod"
cylinder   1 1 .5639 145 5.969
cylinder   2 1 .6039 145 0
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  2
com="2.46 w/o uo2 fuel rod"
cylinder   4 1 .5149 145 .3175
cylinder   0 1 .5217 145 .3175
```

```
cylinder   5 1 .603  145  0
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  3
com="water hole"
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  4
com="inner row fuel"
array 2  -49.898  -6.544  0
unit 5
com="bottom row fuel"
array 3  -33.538  -8.180   0
unit 6
com="top row fuel"
array 4  -33.538  -8.180   0
global unit 7
array  1  -66.258   -36.81    0
cylinder  3 1 76.2         145   0.0
hole  4    0         -43.3542    0
hole  4    0          43.3542    0
hole  5    0         -58.0784    0
hole  6    0          58.0784    0
cylinder  5 1 76.2         145  -5.08
cylinder  3 1 76.2         145  -7.62
cylinder  5 1 77.47        145  -8.890
cuboid    0 1 4p77.47      145  -8.890
end geom
read array
ara=1
com="core center"
nux=81 nuy=45 loop
2   1 81  1   1 45  1  1 1 1
1  26 56  1   8 38  1  1 1 1
3  24 54 15   3 33 15  1 1 1
3  28 58 15   3 33 15  1 1 1
3  24 54 15  13 43 15  1 1 1
3  28 58 15  13 43 15  1 1 1
3  22 52 15   4 34 15  1 1 1
3  30 60 15   4 34 15  1 1 1
3  22 52 15  12 42 15  1 1 1
3  30 60 15  12 42 15  1 1 1
3  21 51 15   6 36 15  1 1 1
3  24 54 15   6 36 15  1 1 1
3  28 58 15   6 36 15  1 1 1
3  31 61 15   6 36 15  1 1 1
3  21 51 15  10 40 15  1 1 1
3  24 54 15  10 40 15  1 1 1
3  28 58 15  10 40 15  1 1 1
3  31 61 15  10 40 15  1 1 1
3  26 56 15   8 38 15  1 1 1
3   1 10  1   1  2  1  1 1 1
3  72 81  1   1  2  1  1 1 1
3   1  5  1   3 12  1  1 1 1
3  77 81  1   3 12  1  1 1 1
3   1 10  1  44 45  1  1 1 1
3  72 81  1  44 45  1  1 1 1
3   1  5  1  34 43  1  1 1 1
3  77 81  1  34 43  1  1 1 1
  end loop
ara=2
com="fuel inner outer row"
nux=61 nuy=8 fill f2  end fill
ara=3
com="fuel bottom outer row"
nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   1  5  1   1 1 1
3  32 41  1   1  5  1   1 1 1   end loop
ara=4
com="fuel top outer row"
nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   6 10  1   1 1 1
3  32 41  1   6 10  1   1 1 1   end loop
end array
read start
nst=0 xsm=-66.258 xsp=66.258 ysm=-66.258 ysp=66.258 zsm=0. zsp=145.
end start
read plot
ttl='x-y slice of baw1810 core 12 at z=50'
xul=-73.6092 yul= 73.6092    zul=50
xlr= 73.6092 ylr=-73.6092    zlr=50
uax=1 vdn=-1 dlx=1.63576 dld=1.63576 nch=' 12 456789abc'  end
end plot
end data
end
```


bnw1810b

```
=csas25
baw-1810 4.02 w/o u235 uo2 rods .4755 inches o.d.
44group                 latticecell
uo2    1 den=9.46   1.0 293 92235 4.02 92238 95.98  end
ss304  2            1.0       end
h2o    3 den=1.0    0.998346  end
boron  3 den=1.0    0.001654  end
uo2    4 den=10.24  1.0 293 92235 2.459 92238 97.541  end
al     5            1.0       end
uo2    6 den=10.24  0.96 293 92235 1.944 92238 98.056  end
gd-152 6 den=0.3555 0.002  end
gd-154 6 den=0.3555 0.0218 end
gd-155 6 den=0.3555 0.148  end
gd-156 6 den=0.3555 0.2047 end
gd-157 6 den=0.3555 0.1565 end
gd-158 6 den=0.3555 0.2484 end
gd-160 6 den=0.3555 0.2186 end
o      6 den=0.0541 1      end
end comp
squarepitch 1.636  1.128  1  3  1.208  2  end
more data
res=4 cylinder .51486 dan(4)=.189732
res=6 cylinder .51499 dan(6)=.189958
end more data
baw-1810 core 14 - 4.02 & 2.46 w/o uo2 1654 ppm; 28 uo2-gd2o3 rods
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes tme=60
wrs=35 end parm
read geom
unit  1
```

```
com="4.02 w/o fuel rod"
cylinder   1 1 .5639 145 5.969
cylinder   2 1 .6039 145 0
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  2
com="2.46 w/o uo2 fuel rod"
cylinder   4 1 .5149 145 .3175
cylinder   0 1 .5217 145 .3175
cylinder   5 1 .603  145  0
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  3
com="water hole"
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  8
com="uo2/gd2o3 fuel rod"
cylinder   6 1 .51499 145 .3175
cylinder   0 1 .52197 145 .3175
cylinder   5 1 .60325 145 0
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  4
com="inner row fuel"
array 2  -49.898  -6.544  0
unit 5
com="bottom row fuel"
array 3  -33.538  -8.180   0
unit 6
com="top row fuel"
array 4  -33.538  -8.180   0
global unit 7
array  1  -66.258   -36.81    0
cylinder  3 1 76.2         145   0.0
hole  4    0        -43.3542    0
hole  4    0         43.3542    0
hole  5    0        -58.0784    0
hole  6    0         58.0784    0
cylinder  5 1 76.2         145  -5.08
cylinder  3 1 76.2         145  -7.62
cylinder  5 1 77.47        145  -8.890
cuboid    0 1 4p77.47      145  -8.890
end geom
read array
ara=1
com="core center"
nux=81 nuy=45 loop
2   1 81  1   1 45  1  1 1 1
1  26 56  1   8 38  1  1 1 1
3  24 54 15   3 33 15  1 1 1
3  28 58 15   3 33 15  1 1 1
3  24 54 15  13 43 15  1 1 1
3  28 58 15  13 43 15  1 1 1
3  22 52 15   4 34 15  1 1 1
3  30 60 15   4 34 15  1 1 1
3  22 52 15  12 42 15  1 1 1
3  30 60 15  12 42 15  1 1 1
3  21 51 15   6 36 15  1 1 1
3  24 54 15   6 36 15  1 1 1
3  28 58 15   6 36 15  1 1 1
3  31 61 15   6 36 15  1 1 1
3  21 51 15  10 40 15  1 1 1
3  24 54 15  10 40 15  1 1 1
3  28 58 15  10 40 15  1 1 1
3  31 61 15  10 40 15  1 1 1
3  26 56 15   8 38 15  1 1 1
3   1 10  1   1  2  1  1 1 1
3  72 81  1   1  2  1  1 1 1
3   1  5  1   3 12  1  1 1 1
3  77 81  1   3 12  1  1 1 1
3   1 10  1  44 45  1  1 1 1
3  72 81  1  44 45  1  1 1 1
3   1  5  1  34 43  1  1 1 1
3  77 81  1  34 43  1  1 1 1
8  29 53 24   8 38 30  1 1 1
8  26 56 30  11 35 24  1 1 1
8  29 53 24  11 35 24  1 1 1
8  31 51 20  13 33 20  1 1 1
8  36 46 10  18 28 10  1 1 1
8  38 44  6  20 26  6  1 1 1
8  38 44  6  23 23  1  1 1 1
8  41 41  1  20 26  6  1 1 1
  end loop
ara=2
com="fuel inner outer row"
nux=61 nuy=8 fill f2  end fill
ara=3
com="fuel bottom outer row"
nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   1  5  1   1 1 1
3  32 41  1   1  5  1   1 1 1   end loop
ara=4
com="fuel top outer row"
nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   6 10  1   1 1 1
3  32 41  1   6 10  1   1 1 1   end loop
end array
read start
nst=0 xsm=-66.258 xsp=66.258 ysm=-66.258 ysp=66.258 zsm=0. zsp=145.
end start
read plot
ttl='x-y slice of baw1810 core 14 at z=50'
xul=-73.6092 yul= 73.6092    zul=50
xlr= 73.6092 ylr=-73.6092    zlr=50
uax=1 vdn=-1 dlx=1.63576 dld=1.63576 nch=' 12 456789abc'  end
end plot
end data
end
```

bnw1810c

```
=csas25
baw-1810 4.02 w/o u235 uo2 rods .4755 inches o.d.
44group                 latticecell
uo2    1 den=9.46   1.0 293 92235 4.02 92238 95.98  end
ss304  2            1.0       end
h2o    3 den=1.0    0.998421  end
boron  3 den=1.0    0.001579  end
```

```
uo2    4 den=10.24  1.0 293 92235 2.459 92238 97.541  end
al     5            1.0       end
uo2    6 den=10.24  0.96 293 92235 1.944 92238 98.056  end
gd-152 6 den=0.3555 0.002  end
gd-154 6 den=0.3555 0.0218 end
gd-155 6 den=0.3555 0.148  end
gd-156 6 den=0.3555 0.2047 end
gd-157 6 den=0.3555 0.1565 end
gd-158 6 den=0.3555 0.2484 end
gd-160 6 den=0.3555 0.2186 end
o      6 den=0.0541 1      end
end comp
squarepitch 1.636  1.128  1  3  1.208  2  end
more data
res=4 cylinder .51486 dan(4)=.189732
res=6 cylinder .51499 dan(6)=.189958
end more data
baw-1810 core 16 - 4.02 & 2.46 w/o uo2 1579 ppm; 36 uo2-gd2o3 rods
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes tme=60
wrs=35 end parm
read geom
unit  1
com="4.02 w/o fuel rod"
cylinder   1 1 .5639 145 5.969
cylinder   2 1 .6039 145 0
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  2
com="2.46 w/o uo2 fuel rod"
cylinder   4 1 .5149 145 .3175
cylinder   0 1 .5217 145 .3175
cylinder   5 1 .603  145  0
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  3
com="water hole"
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  8
com="uo2/gd2o3 fuel rod"
cylinder   6 1 .51499 145 .3175
cylinder   0 1 .52197 145 .3175
cylinder   5 1 .60325 145 0
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  4
com="inner row fuel"
array 2  -49.898  -6.544  0
unit 5
com="bottom row fuel"
array 3  -33.538  -8.180   0
unit 6
com="top row fuel"
array 4  -33.538  -8.180   0
global unit 7
array  1  -66.258   -36.81    0
cylinder  3 1 76.2         145   0.0
hole  4    0        -43.3542    0
hole  4    0         43.3542    0
hole  5    0        -58.0784    0
hole  6    0         58.0784    0
cylinder  5 1 76.2         145  -5.08
cylinder  3 1 76.2         145  -7.62
cylinder  5 1 77.47        145  -8.890
cuboid    0 1 4p77.47      145  -8.890
end geom
read array
ara=1
com="core center"
nux=81 nuy=45 loop
2   1 81  1   1 45  1  1 1 1
1  26 56  1   8 38  1  1 1 1
3  24 54 15   3 33 15  1 1 1
3  28 58 15   3 33 15  1 1 1
3  24 54 15  13 43 15  1 1 1
3  28 58 15  13 43 15  1 1 1
3  22 52 15   4 34 15  1 1 1
3  30 60 15   4 34 15  1 1 1
3  22 52 15  12 42 15  1 1 1
3  30 60 15  12 42 15  1 1 1
3  21 51 15   6 36 15  1 1 1
3  24 54 15   6 36 15  1 1 1
3  28 58 15   6 36 15  1 1 1
3  31 61 15   6 36 15  1 1 1
3  21 51 15  10 40 15  1 1 1
3  24 54 15  10 40 15  1 1 1
3  28 58 15  10 40 15  1 1 1
3  31 61 15  10 40 15  1 1 1
3  26 56 15   8 38 15  1 1 1
3   1 10  1   1  2  1  1 1 1
3  72 81  1   1  2  1  1 1 1
3   1  5  1   3 12  1  1 1 1
3  77 81  1   3 12  1  1 1 1
3   1 10  1  44 45  1  1 1 1
3  72 81  1  44 45  1  1 1 1
3   1  5  1  34 43  1  1 1 1
3  77 81  1  34 43  1  1 1 1
8  29 53 24   8 38 30  1 1 1
8  26 56 30  11 35 24  1 1 1
8  28 54 26  14 32 18  1 1 1
8  32 50 18  10 36 26  1 1 1
8  31 51 20  13 33 20  1 1 1
8  36 46 10  18 28 10  1 1 1
8  35 47 12  21 25  4  1 1 1
8  39 43  4  17 29 12  1 1 1
8  38 44  6  23 23  1  1 1 1
8  41 41  1  20 26  6  1 1 1
  end loop
ara=2
com="fuel inner outer row"
nux=61 nuy=8 fill f2  end fill
ara=3
com="fuel bottom outer row"
nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   1  5  1   1 1 1
3  32 41  1   1  5  1   1 1 1   end loop
ara=4
com="fuel top outer row"
nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   6 10  1   1 1 1
```

```
3  32 41  1   6 10  1   1 1 1   end loop
end array
read start
nst=0 xsm=-66.258 xsp=66.258 ysm=-66.258 ysp=66.258 zsm=0. zsp=145.
end start
read plot
ttl='x-y slice of baw1810 core 16 at z=50'
xul=-73.6092 yul= 73.6092    zul=50
xlr= 73.6092 ylr=-73.6092    zlr=50
uax=1 vdn=-1 dlx=1.63576 dld=1.63576 nch=' 12 456789abc'  end
end plot
end data
end
```

e196u6n

```
#csas25
epri np-196 .615 inch pitch unborated uo2
44group                  latticecell
uo2            1  den=9.20 1.0 293
     92234 0.0137  92235 2.35  92236 0.0171  92238 97.62  end
al             3  1.0 293 end
h2o            4  1.0 293 end
pb             5  1.0 293 end
end comp
squarepitch 1.5621 1.1176 1 4  1.2700 3  end
epri np-196 .615 inch pitch unborated uo2
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes tme=60
wrs=34  end parm
read geom
unit  1
com=!61 1/8 to 62 1/8!
cylinder   3 1 .635 2.540 2.2225
cuboid     4 1     .78105 -.78105 .78105 -.78105 2.540 2.2225
cuboid     3 1     .78105 -.78105 .78105 -.78105 2.540 0
unit  2
com=!62 1/8 to 63 1/8!
cylinder   3 1 .635 5.080 2.540
cuboid     4 1     .66675 -.66675 .66675 -.66675 5.080 2.540
cuboid     3 1     .78105 -.78105 .78105 -.78105 5.080 2.540
unit  3
com=!63 1/8 to 98 7/8!
cylinder   3 1 .5588 7.3025 5.080
cylinder   1 1 .5588 95.885 5.080
cylinder   3 1 .635 95.885 5.080
cuboid     4 1     .78105 -.78105 .78105 -.78105 95.885 5.080
unit  4
com=!98 7/8 to 99 7/8!
cylinder   1 1 .5588 98.4250 95.885
cylinder   3 1 .635 98.4250 95.885
cuboid     4 1     .74041 -.74041 .74041 -.74041 98.4250 95.885
cuboid     3 1     .78105 -.78105 .78105 -.78105 98.4250 95.885
unit  5
com=!99 7/8 to 100 7/8!
cylinder   1 1 .5588 98.7425 98.4250
cylinder   3 1 .635 100.0125 98.4250
cuboid     4 1     .78105 -.78105 .78105 -.78105 100.0125 98.4250
cuboid     5 1     .78105 -.78105 .78105 -.78105 100.965 98.4250
unit  6
com=!61 1/8 to 62 1/8 with no fuel!
cuboid     4 1     .78105 -.78105 .78105 -.78105 2.540 2.2225
cuboid     3 1     .78105 -.78105 .78105 -.78105 2.540 0
unit  7
com=!62 1/8 to 63 1/8 with no fuel!
cuboid     4 1     .66675 -.66675 .66675 -.66675 5.080 2.540
cuboid     3 1     .78105 -.78105 .78105 -.78105 5.080 2.540
unit  8
com=!63 1/8 to 98 7/8 with no fuel!
cuboid     4 1     .78105 -.78105 .78105 -.78105 95.885 5.080
unit  9
com=!98 7/8 to 99 7/8 with no fuel!
cuboid     4 1     .74041 -.74041 .74041 -.74041 98.4250 95.885
cuboid     3 1     .78105 -.78105 .78105 -.78105 98.4250 95.885
unit  10
com=!99 7/8 to 100 7/8 with no fuel!
cuboid     4 1     .78105 -.78105 .78105 -.78105 100.0125 98.4250
cuboid     5 1     .78105 -.78105 .78105 -.78105 100.965 98.4250
global unit  11
com=!reflector region!
array      1   0 0 0
replicate  4 1 30 30 30 30 15.24 30  1
end geom
read array
ara=1 nux=31 nuy=31 nuz=5
com=!epri np-196 .615 inch pitch unborated uo2 core - 708 rods!
fill
 13r6  5r1 23r6  11r1 18r6  15r1 15r6  17r1 13r6  19r1 11r6  21r1 9r6
      23r1  7r6  25r1  5r6  27r1  2r6  1q31  1r6  29r1  1r6  2q31
 154r1 1r6 155b403
 13r7  5r2 23r7  11r2 18r7  15r2 15r7  17r2 13r7  19r2 11r7  21r2 9r7
      23r2  7r7  25r2  5r7  27r2  2r7  1q31  1r7  29r2  1r7  2q31
 154r2 1r7 155b403
 13r8  5r3 23r8  11r3 18r8  15r3 15r8  17r3 13r8  19r3 11r8  21r3 9r8
      23r3  7r8  25r3  5r8  27r3  2r8  1q31  1r8  29r3  1r8  2q31
 154r3 1r8 155b403
 13r9  5r4 23r9  11r4 18r9  15r4 15r9  17r4 13r9  19r4 11r9  21r4 9r9
      23r4  7r9  25r4  5r9  27r4  2r9  1q31  1r9  29r4  1r9  2q31
 154r4 1r9 155b403
 13r10 5r5 23r10 11r5 18r10 15r5 15r10 17r5 13r10 19r5 11r10 21r5 9r10
      23r5  7r10 25r5  5r10 27r5  2r10 1q31  1r10 29r5  1r10 2q31
 154r5 1r10 155b403
end fill
end array
read plot
ttl=!x-y cross-section at z=5.0cm!
plt=yes pic=mixture xul=-5 yul=-5 zul=5 xlr=60 ylr=60 zlr=5 uax=1 vax=0
wax=0
udn=0 vdn=1 wdn=0 nax=130  nch=' 13 5' end
end plot
end data
end
```

epru615b

```
=csas25
epri np-196 .615 inch pitch borated uo2
44group                 latticecell
uo2            1  den=9.20 1.0 293
     92234 0.0137  92235 2.35  92236 0.0171  92238 97.62  end
al             3  1.0 293 end
h2o            4  1.0 293 end
boron          4  den=463.8-6  end
end comp
squarepitch 1.5621 1.1176 1 4  1.2700 3  end
epri np-196 .615 inch pitch borated uo2
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes
wrs=34  end parm
read geom
unit  1
com=!61 1/8 to 62 1/8!
cylinder   3 1 .635 2.540 2.2225
cuboid     4 1     .78105 -.78105 .78105 -.78105 2.540 2.2225
cuboid     3 1     .78105 -.78105 .78105 -.78105 2.540 0
unit  2
com=!62 1/8 to 63 1/8!
cylinder   3 1 .635 5.080 2.540
cuboid     4 1     .66675 -.66675 .66675 -.66675 5.080 2.540
cuboid     3 1     .78105 -.78105 .78105 -.78105 5.080 2.540
unit  3
com=!63 1/8 to 98 7/8!
cylinder   3 1 .5588 7.3025 5.080
cylinder   1 1 .5588 95.885 5.080
cylinder   3 1 .635 95.885 5.080
cuboid     4 1     .78105 -.78105 .78105 -.78105 95.885 5.080
unit  4
com=!98 7/8 to 99 7/8!
cylinder   1 1 .5588 98.4250 95.885
cylinder   3 1 .635 98.4250 95.885
cuboid     4 1     .74041 -.74041 .74041 -.74041 98.4250 95.885
cuboid     3 1     .78105 -.78105 .78105 -.78105 98.4250 95.885
unit  5
com=!99 7/8 to 100 7/8!
cylinder   1 1 .5588 98.7425 98.4250
cylinder   3 1 .635 100.0125 98.4250
cuboid     4 1     .78105 -.78105 .78105 -.78105 100.0125 98.4250
unit  6
com=!61 1/8 to 62 1/8 with no fuel!
cuboid     4 1     .78105 -.78105 .78105 -.78105 2.540 2.2225
cuboid     3 1     .78105 -.78105 .78105 -.78105 2.540 0
unit  7
com=!62 1/8 to 63 1/8 with no fuel!
cuboid     4 1     .66675 -.66675 .66675 -.66675 5.080 2.540
cuboid     3 1     .78105 -.78105 .78105 -.78105 5.080 2.540
unit  8
com=!63 1/8 to 98 7/8 with no fuel!
cuboid     4 1     .78105 -.78105 .78105 -.78105 95.885 5.080
unit  9
com=!98 7/8 to 99 7/8 with no fuel!
cuboid     4 1     .74041 -.74041 .74041 -.74041 98.4250 95.885
cuboid     3 1     .78105 -.78105 .78105 -.78105 98.4250 95.885
unit  10
com=!99 7/8 to 100 7/8 with no fuel!
cuboid     4 1     .78105 -.78105 .78105 -.78105 100.0125 98.4250
global unit  11
com=!reflector region!
array      1   0 0 0
replicate  4 1 30 30 30 30 15.24 30  1
end geom
read array
ara=1 nux=39 nuy=39 nuz=5
com=!epri np-196 .615 inch pitch borated uo2 core -1201 rods!
fill
 15r6  9r1 27r6  15r1 22r6  19r1 18r6  23r1 15r6  25r1 13r6  27r1 11r6
      29r1  9r6  31r1  7r6  33r1  3r6  1q39  2r6  35r1  2r6  1q39
       1r6 37r1   1r6 2q39 351r1 351b585
 15r7  9r2 27r7  15r2 22r7  19r2 18r7  23r2 15r7  25r2 13r7  27r2 11r7
      29r2  9r7  31r2  7r7  33r2  3r7  1q39  2r7  35r2  2r7  1q39
       1r7 37r2   1r7 2q39 351r2 351b585
 15r8  9r3 27r8  15r3 22r8  19r3 18r8  23r3 15r8  25r3 13r8  27r3 11r8
      29r3  9r8  31r3  7r8  33r3  3r8  1q39  2r8  35r3  2r8  1q39
       1r8 37r3   1r8 2q39 351r3 351b585
 15r9  9r4 27r9  15r4 22r9  19r4 18r9  23r4 15r9  25r4 13r9  27r4 11r9
      29r4  9r9  31r4  7r9  33r4  3r9  1q39  2r9  35r4  2r9  1q39
       1r9 37r4   1r9 2q39 351r4 351b585
 15r10 9r5 27r10 15r5 22r10 19r5 18r10 23r5 15r10 25r5 13r10 27r5 11r10
      29r5  9r10 31r5  7r10 33r5  3r10 1q39  2r10 35r5  2r10 1q39
      1r10 37r5  1r10 2q39 351r5 351b585
end fill
end array
read plot
ttl=!x-y cross-section at z=5.0cm!
plt=yes pic=mixture xul=-5 yul=-5 zul=5 xlr=70 ylr=70 zlr=5 uax=1 vax=0
wax=0
udn=0 vdn=1 wdn=0 nax=130  nch=' 13 5' end
end plot
end data
end
```

epru75

```
#csas25
epri np-196 .75 inch pitch unborated uo2
44group                 latticecell
uo2            1  den=9.20 1.0 293
     92234 0.0137  92235 2.35  92236 0.0171  92238 97.62  end
al             3  1.0 293 end
h2o            4  1.0 293 end
end comp
squarepitch 1.905  1.1176 1 4  1.2700 3  end
epri np-196 .75 inch pitch unborated uo2
read parm gen=805 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes
tme=120 wrs=34 rnd=6516246C6230 end parm
read geom
unit  1
com=!61 1/8 to 63 1/8!
cylinder   3 1 .635 5.080 3.175
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 5.080 3.175
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 5.080 0
unit  2
```

```
com=!63 1/8 to 63 7/8!
cylinder   3 1 .635   6.985 5.080
cylinder   4 1 .74422 6.985 5.080
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 6.985 5.080
unit  3
com=!63 7/8 to 98 1/8!
cylinder   1 1 .5588 93.98 6.985
cylinder   3 1 .635 93.98 6.985
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 93.98 6.985
unit  4
com=!98 1/8 to 98 7/8!
cylinder   1 1 .5588  95.8850 93.98
cylinder   3 1 .635   95.8850 93.98
cylinder   4 1 .74422 95.8850 93.98
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 95.8850 93.98
unit  5
com=!98 7/8 to 100 3/4!
cylinder   1 1 .5588 98.425  95.8850
cylinder   3 1 .635  99.695  95.8850
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525  99.695  95.8850
unit  6
com=!61 1/8 to 63 1/8 with no fuel!
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 5.080 3.175
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 5.080 0
unit  7
com=!63 1/8 to 63 7/8 with no fuel!
cylinder   4 1 .74422 6.985 5.080
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 6.985 5.080
unit  8
com=!63 7/8 to 98 1/8 with no fuel!
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 93.98 6.985
unit  9
com=!98 1/8 to 98 7/8 with no fuel!
cylinder   4 1 .74422 95.8850 93.98
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 95.8850 93.98
unit  10
com=!98 7/8 to 100 3/4 with no fuel!
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525  99.695  95.8850
global unit  11
com=!reflector region!
array      1   0 0 0
replicate  4 1 30 30 30 30 15.24 30  1
end geom
read array
ara=1 nux=21 nuy=21 nuz=5
com=!epri np-196 .75 inch pitch unborated uo2 core - 383 rods!
fill
  8r6  5r1  9r6  19r1  1r6  5q21  1r6  145r1 1r6  147b147
  8r7  5r2  9r7  19r2  1r7  5q21  1r7  145r2 1r7  147b147
  8r8  5r3  9r8  19r3  1r8  5q21  1r8  145r3 1r8  147b147
  8r9  5r4  9r9  19r4  1r9  5q21  1r9  145r4 1r9  147b147
  8r10 5r5  9r10 19r5  1r10 5q21  1r10 145r5 1r10 147b147
end fill
end array
read plot
ttl=!x-y cross-section at z=5.0cm!
plt=yes pic=mixture xul=-5 yul=-5 zul=5 xlr=45 ylr=45 zlr=5 uax=1 vax=0
wax=0
udn=0 vdn=1 wdn=0 nax=130  nch=' 13 5' end
ttl=!x-z cross-section at y=0.9cm!
plt=yes pic=mixture xul=0 yul=.9 zul=100 xlr=45 ylr=.9 zlr=0 uax=1 vax=0
wax=0
udn=0 vdn=0 wdn=-1 nax=130  nch=' 13 5' end
end plot
end data
end
```

epru75b

```
#csas25
epri np-196 .75 inch pitch borated uo2
27burnuplib                 latticecell
uo2            1  den=9.20 1.0 293
     92234 0.0137  92235 2.35  92236 0.0171  92238 97.62  end
al             3  1.0 293 end
h2o            4  1.0 293 end
boron          4 den=568.1-6 end
end comp
squarepitch 1.905  1.1176 1 4  1.2700 3  end
epri np-196 .75 inch pitch borated uo2
read parm gen=805 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes
wrs=34  tme=120 rnd=6516246C6230 end parm
read geom
unit  1
com=!61 1/8 to 63 1/8!
cylinder   3 1 .635 5.080 3.175
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 5.080 3.175
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 5.080 0
unit  2
com=!63 1/8 to 63 7/8!
cylinder   3 1 .635   6.985 5.080
cylinder   4 1 .74422 6.985 5.080
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 6.985 5.080
unit  3
com=!63 7/8 to 98 1/8!
cylinder   1 1 .5588 93.98 6.985
cylinder   3 1 .635 93.98 6.985
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 93.98 6.985
unit  4
com=!98 1/8 to 98 7/8!
cylinder   1 1 .5588  95.8850 93.98
cylinder   3 1 .635   95.8850 93.98
cylinder   4 1 .74422 95.8850 93.98
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 95.8850 93.98
unit  5
com=!98 7/8 to 100 3/4!
cylinder   1 1 .5588 98.425  95.8850
cylinder   3 1 .635  99.695  95.8850
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525  99.695  95.8850
unit  6
com=!61 1/8 to 63 1/8 with no fuel!
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 5.080 3.175
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 5.080 0
unit  7
com=!63 1/8 to 63 7/8 with no fuel!
cylinder   4 1 .74422 6.985 5.080
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 6.985 5.080
```

```
unit  8
com=!63 7/8 to 98 1/8 with no fuel!
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 93.98 6.985
unit  9
com=!98 1/8 to 98 7/8 with no fuel!
cylinder   4 1 .74422 95.8850 93.98
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 95.8850 93.98
unit  10
com=!98 7/8 to 100 3/4 with no fuel!
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525  99.695  95.8850
global unit  11
com=!reflector region!
array      1   0 0 0
replicate  4 1 30 30 30 30 15.24 30  1
end geom
read array
ara=1 nux=39 nuy=39 nuz=5
com=!epri np-196 .75 inch pitch borated uo2 core -1201 rods!
fill
 15r6  9r1 27r6  15r1 22r6  19r1 18r6  23r1 15r6  25r1 13r6  27r1 11r6
      29r1  9r6  31r1  7r6  33r1  3r6  1q39  2r6  35r1  2r6  1q39
       1r6 37r1   1r6 2q39 351r1 351b585
 15r7  9r2 27r7  15r2 22r7  19r2 18r7  23r2 15r7  25r2 13r7  27r2 11r7
      29r2  9r7  31r2  7r7  33r2  3r7  1q39  2r7  35r2  2r7  1q39
       1r7 37r2   1r7 2q39 351r2 351b585
 15r8  9r3 27r8  15r3 22r8  19r3 18r8  23r3 15r8  25r3 13r8  27r3 11r8
      29r3  9r8  31r3  7r8  33r3  3r8  1q39  2r8  35r3  2r8  1q39
       1r8 37r3   1r8 2q39 351r3 351b585
 15r9  9r4 27r9  15r4 22r9  19r4 18r9  23r4 15r9  25r4 13r9  27r4 11r9
      29r4  9r9  31r4  7r9  33r4  3r9  1q39  2r9  35r4  2r9  1q39
       1r9 37r4   1r9 2q39 351r4 351b585
 15r10 9r5 27r10 15r5 22r10 19r5 18r10 23r5 15r10 25r5 13r10 27r5 11r10
      29r5  9r10 31r5  7r10 33r5  3r10 1q39  2r10 35r5  2r10 1q39
      1r10 37r5  1r10 2q39 351r5 351b585
end fill
end array
read plot
ttl=!x-y cross-section at z=9.0cm!
plt=yes pic=mixture xul=-5 yul=-5 zul=9 xlr=80 ylr=80 zlr=9 uax=1 vax=0
wax=0
udn=0 vdn=1 wdn=0 nax=130  nch=' 13 5' end
ttl=!x-z cross-section at y=.9 cm!
plt=yes pic=mixture xul=0 yul=.9 zul=100 xlr=80 ylr=.9 zlr=0 uax=1 vax=0
wax=0
udn=0 vdn=0 wdn=-1 nax=130  nch=' 13 5' end
end plot
end data
end
```

e196u87c

```
#csas25
epri np-196 .87 inch pitch unborated uo2
44group                      latticecell
uo2            1  den=9.20 1.0 293
     92234 0.0137  92235 2.35  92236 0.0171  92238 97.62  end
al             3  1.0 293 end
h2o            4  1.0 293 end
pb             5  1.0 293 end
end comp
squarepitch 2.2098 1.1176 1 4  1.2700 3  end
epri np-196 .87 inch pitch unborated uo2
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes tme=60
wrs=34  end parm
read geom
unit  1
com=!61 1/8 to 62 1/8!
cylinder   3 1 .635 2.540 2.225
cuboid     4 1     .78105 -.78105 .78105 -.78105 2.540 2.225
cuboid     3 1     .78105 -.78105 .78105 -.78105 2.540 0
unit  2
com=!62 1/8 to 63 1/8!
cylinder   3 1 .635 5.080 2.540
cuboid     4 1     .66675 -.66675 .66675 -.66675 5.080 2.540
cuboid     3 1     .78105 -.78105 .78105 -.78105 5.080 2.540
unit  3
com=!63 1/8 to 98 7/8!
cylinder   3 1 .5588 7.3025 5.080
cylinder   1 1 .5588 95.885 5.080
cylinder   3 1 .635 95.885 5.080
cuboid     4 1     .78105 -.78105 .78105 -.78105 95.885 5.080
unit  4
com=!98 7/8 to 99 7/8!
cylinder   1 1 .5588 98.4250 95.885
cylinder   3 1 .635 98.4250 95.885
cuboid     4 1     .74041 -.74041 .74041 -.74041 98.4250 95.885
cuboid     3 1     .78105 -.78105 .78105 -.78105 98.4250 95.885
unit  5
com=!99 7/8 to 100 7/8!
cylinder   1 1 .5588 98.7425 98.4250
cylinder   3 1 .635 100.0125 98.4250
cuboid     4 1     .78105 -.78105 .78105 -.78105 100.0125 98.4250
cuboid     5 1     .78105 -.78105 .78105 -.78105 100.965 98.4250
unit  6
com=!61 1/8 to 62 1/8 with no fuel!
cuboid     4 1     .78105 -.78105 .78105 -.78105 2.540 2.225
cuboid     3 1     .78105 -.78105 .78105 -.78105 2.540 0
unit  7
com=!62 1/8 to 63 1/8 with no fuel!
cuboid     4 1     .66675 -.66675 .66675 -.66675 5.080 2.540
cuboid     3 1     .78105 -.78105 .78105 -.78105 5.080 2.540
unit  8
com=!63 1/8 to 98 7/8 with no fuel!
cuboid     4 1     .78105 -.78105 .78105 -.78105 95.885 5.080
unit  9
com=!98 7/8 to 99 7/8 with no fuel!
cuboid     4 1     .74041 -.74041 .74041 -.74041 98.4250 95.885
cuboid     3 1     .78105 -.78105 .78105 -.78105 98.4250 95.885
unit  10
com=!99 7/8 to 100 7/8 with no fuel!
cuboid     4 1     .78105 -.78105 .78105 -.78105 100.0125 98.4250
cuboid     5 1     .78105 -.78105 .78105 -.78105 100.965 98.4250
global unit  11
com=!reflector region!
array      1   0 0 0
replicate  4 1 30 30 30 30 15.24 30  1
end geom
```

```
read array
ara=1 nux=29 nuy=29 nuz=5
com=!epri np-196 .87 inch pitch unborated uo2 core - 342 rods!
fill
 10r6 1 6 4q2  9r6  9r6 1 6 6q2  6r6  6r6 1 6 8q2 5r6  5r6 1 6 9q2 4r6
  4r6 1 6 10q2 3r6  3r6 1 6 11q2 2r6  2r6 1 6 12q2 6        1q58
      6 1 13q2 6        1 6 13q2 1        4q58      261b232
  9r6 1 6 5q2  8r6  10r6 1 6 4q2 9r6
 10r7 2 7 4q2  9r7  9r7 2 7 6q2  6r7  6r7 2 7 8q2 5r7  5r7 2 7 9q2 4r7
  4r7 2 7 10q2 3r7  3r7 2 7 11q2 2r7  2r7 2 7 12q2 7        1q58
      7 2 13q2 7        2 7 13q2 2        4q58      261b232
  9r7 2 7 5q2  8r7  10r7 2 7 4q2 9r7
 10r8 3 8 4q2  9r8  9r8 3 8 6q2  6r8  6r8 3 8 8q2 5r8  5r8 3 8 9q2 4r8
  4r8 3 8 10q2 3r8  3r8 3 8 11q2 2r8  2r8 3 8 12q2 8        1q58
      8 3 13q2 8        3 8 13q2 3        4q58      261b232
  9r8 3 8 5q2  8r8  10r8 3 8 4q2 9r8
 10r9 4 9 4q2  9r9  9r9 4 9 6q2  6r9  6r9 4 9 8q2 5r9  5r9 4 9 9q2 4r9
  4r9 4 9 10q2 3r9  3r9 4 9 11q2 2r9  2r9 4 9 12q2 9        1q58
      9 4 13q2 9        4 9 13q2 4        4q58      261b232
  9r9 4 9 5q2  8r9  10r9 4 9 4q2 9r9
 10r10 5 10 4q2 9r10 9r10 5 10 6q2 6r10 6r10 5 10 8q2 5r10 5r10 5 10 9q2
4r10
  4r10 5 10 10q2 3r10 3r10 5 10 11q2 2r10 2r10 5 10 12q2 10 1q58
      10 5 13q2 10      5 10 13q2 5       4q58      261b232
  9r10 5 10 5q2 8r10 10r10 5 10 4q2 9r10
end fill
end array
read plot
ttl=!x-y cross-section at z=25.0cm!
plt=yes pic=mixture xul=-5 yul=-5 zul=25 xlr=50 ylr=50 zlr=25
uax=1 vax=0 wax=0
udn=0 vdn=1 wdn=0 nax=130  nch=' 13 5' end
end plot
end data
end
```

epru87b

```
#csas25
epri np-196 .87 inch pitch borated uo2
44group                 latticecell
uo2            1  den=9.20 1.0 293
     92234 0.0137  92235 2.35  92236 0.0171  92238 97.62  end
al             3  1.0 293 end
h2o            4  1.0 293 end
boron          4 den=285.8-6 end
end comp
squarepitch 2.2098 1.1176 1 4  1.2700 3  end
epri np-196 .87 inch pitch borated uo2
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes
wrs=34  end parm
read geom
unit  1
com=!61 1/8 to 62 1/8!
cylinder   3 1 .635 2.540 2.2225
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 2.540 2.2225
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 2.540 0
unit  2
com=!62 1/8 to 63 1/8!
cylinder   3 1 .635 5.080 2.540
cuboid     4 1     .99060 -.99060 .99060 -.99060 5.080 2.540
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 5.080 2.540
unit  3
com=!63 1/8 to 98 7/8!
cylinder   3 1 .5588 7.3025 5.080
cylinder   1 1 .5588 95.885 5.080
cylinder   3 1 .635 95.885 5.080
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 95.885 5.080
unit  4
com=!98 7/8 to 99 7/8!
cylinder   1 1 .5588 98.4250 95.885
cylinder   3 1 .635 98.4250 95.885
cuboid     4 1     1.06426 -1.06426 1.06426 -1.06426 98.4250 95.885
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 98.4250 95.885
unit  5
com=!99 7/8 to 100 7/8!
cylinder   1 1 .5588 98.7425 98.4250
cylinder   3 1 .635 100.0125 98.4250
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 100.0125 98.4250
unit  6
com=!61 1/8 to 62 1/8 with no fuel!
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 2.540 2.2225
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 2.540 0
unit  7
com=!62 1/8 to 63 1/8 with no fuel!
cuboid     4 1     .99060 -.99060 .99060 -.99060 5.080 2.540
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 5.080 2.540
unit  8
com=!63 1/8 to 98 7/8 with no fuel!
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 95.885 5.080
unit  9
com=!98 7/8 to 99 7/8 with no fuel!
cuboid     4 1     1.06426 -1.06426 1.06426 -1.06426 98.4250 95.885
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 98.4250 95.885
unit  10
com=!99 7/8 to 100 7/8 with no fuel!
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 100.0125 98.4250
global unit  11
com=!reflector region!
array      1   0 0 0
replicate  4 1 30 30 30 30 15.24 30  1
end geom
read array
ara=1 nux=33 nuy=33 nuz=5
com=!epri np-196 .87 inch pitch borated uo2 core - 885 rods!
fill
 11r6 11r1 20r6  15r1 16r6  19r1 13r6  21r1 11r6  23r1  9r6  25r1 7r6
 27r1  5r6 29r1   2r6 1q33   1r6 31r1   1r6 1q33  363r1 363b363
 11r7 11r2 20r7  15r2 16r7  19r2 13r7  21r2 11r7  23r2  9r7  25r2 7r7
 27r2  5r7 29r2   2r7 1q33   1r7 31r2   1r7 1q33  363r2 363b363
 11r8 11r3 20r8  15r3 16r8  19r3 13r8  21r3 11r8  23r3  9r8  25r3 7r8
 27r3  5r8 29r3   2r8 1q33   1r8 31r3   1r8 1q33  363r3 363b363
 11r9 11r4 20r9  15r4 16r9  19r4 13r9  21r4 11r9  23r4  9r9  25r4 7r9
 27r4  5r9 29r4   2r9 1q33   1r9 31r4   1r9 1q33  363r4 363b363
11r10 11r5 20r10 15r5 16r10 19r5 13r10 21r5 11r10 23r5 9r10 25r5 7r10
 27r5  5r10 29r5  2r10 1q33  1r10 31r5  1r10 1q33 363r5 363b363
end fill
```

```
end array
read plot
ttl=!x-y cross-section at z=5.0cm!
plt=yes pic=mixture xul=-5 yul=-5 zul=5 xlr=80 ylr=80 zlr=5 uax=1 vax=0
wax=0
udn=0 vdn=1 wdn=0 nax=130  nch='1 3 5' end
end plot
end data
end
```

saxu56

```
#csas25
saxton uo2 5.742 wt% u-235 critical exp. 0.56 inch pitch (wcap-3385-54)
44group                 latticecell
uo2            1  den=10.065 1.0 291.0  92235 5.742  92238 94.258  end
ss304          2  1.0 291.0 end
h2o            3  1.0 291.0 end
al             4  1.0 291.0 end
uo2            5  den=10.065 1.0 291.0  92235 5.742  92238 94.258  end
end comp
squarepitch 1.4224 .9068 1 3  .9931 2  .9169 0  end
more data
res=5 cyl .4534   dan(5)=.922095    end
saxton uo2 5.742 wt% u-235 critical exp. 0.56 inch pitch (wcap-3385-54)
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes tme=60
wrs=35 end parm
read geom
unit  1
com=!fuel pin (no fuel) in bottom plate, 0 to .25 inches!
cylinder   2 1 .4966 .635 0
cylinder   3 1 .5042 .635 0
cuboid     4 1     .7112 -.7112 .7112 -.7112 .635 0
unit  2
com=!fuel pin between lower plates, .25 to 18.75 inches!
cylinder   1 1 .4534 47.625 1.905
cylinder   0 1 .4585 47.625 1.905
cylinder   2 1 .4966 47.625 .635
cuboid     3 1     .7112 -.7112 .7112 -.7112 47.625 .635
unit  3
com=!fuel pin in middle plate, 18.75 to 19.0 inches!
cylinder   1 1 .4534 48.26 47.625
cylinder   0 1 .4585 48.26 47.625
cylinder   2 1 .4966 48.26 47.625
cylinder   3 1 .5042 48.26 47.625
cuboid     4 1     .7112 -.7112 .7112 -.7112 48.26 47.625
unit  4
com=!fuel pin above middle plate, 19.0 to 32.96 inches!
cylinder   1 1 .4534 83.71 48.26
cylinder   0 1 .4585 83.71 48.26
cylinder   2 1 .4966 83.71 48.26
cuboid     3 1     .7112 -.7112 .7112 -.7112 83.71 48.26
unit  5
com=!fuel pin above water, 32.96 to 37.35 inches!
cylinder   5 1 .4534 94.869 83.71
cylinder   0 1 .4585 94.869 83.71
cylinder   2 1 .4966 94.869 83.71
cuboid     0 1     .7112 -.7112 .7112 -.7112 94.869 83.71
unit  6
com=!top of fuel pin (no fuel), 37.35 to 37.75 inches!
cylinder   2 1 .4966 95.885 94.869
cuboid     0 1     .7112 -.7112 .7112 -.7112 95.885 94.869
unit  7
com=!fuel pin (no fuel) in top plate, 37.75 to 38.25 inch!
cylinder   2 1 .4966 97.155 95.885
cylinder   0 1 .5042 97.155 95.885
cuboid     4 1     .7112 -.7112 .7112 -.7112 97.155 95.885
unit  8
com=!19 x 19 core (in water)!
array      1   0 0 0
replicate  3 2 3 3 3 3 0 0  10
replicate  4 1 0 0 0 0 0 2.54  1
replicate  3 1 0 0 0 0 0 6.35  1
replicate  4 1 0 0 0 0 0 5.08  1
unit  9
com=!19 x 19 core (above water)!
array      2   0 0 0
replicate  0 1 30 30 30 30 0 0  1
end geom
read array
ara=1 nux=19 nuy=19 nuz=4
com=!19 x 19 fuel pin array (in water)!
fill 361r1 361r2 361r3 361r4  end fill
ara=2 nux=19 nuy=19 nuz=3
com=!19 x 19 fuel pin array (above water)!
fill 361r5 361r6 361r7  end fill
ara=3 gbl=3 nux=1 nuy=1 nuz=2
com=!complete fuel core!
fill 8 9  end fill
end array
read bias id=500  2  11   end bias
read plot
ttl=!x-y view of core!
plt=yes pic=mixture xul=28  yul=44 zul=62 xlr=44 ylr=28  zlr=62 uax=1
vax=0
wax=0 udn=0 vdn=-1 wdn=0 nax=130
nch=! 12.-                                                              ! end
ttl=!x-z view of core!
plt=yes pic=mixture xul=28 yul=35 zul=113 xlr=44 ylr=35 zlr=0  uax=1
vax=0
wax=0 udn=0 vdn=0 wdn=-1 nax=130
nch=! 12./                                                              ! end
end plot
end data
end
```

saxu792

```
#csas25
saxton uo2 5.742 wt% u-235 critical exp. 0.792inch pitch (wcap-3385-54)
44group                 latticecell
uo2            1  den=10.065 1.0 290.3  92235 5.742  92238 94.258  end
ss304          2  1.0 290.3 end
h2o            3  1.0 290.3 end
al             4  1.0 290.3 end
uo2            5  den=10.065 1.0 290.3  92235 5.742  92238 94.258  end
```

```
end comp
squarepitch 2.01168 .9068 1 3  .9931 2  .9169 0  end
more data
res=5 cyl .4534  dan(5)=.945902  end
saxton uo2 5.742 wt% u-235 critical exp. 0.792inch pitch (wcap-3385-54)
read parm gen=805 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes tme=190
wrs=35 end parm
read geom
unit  1
com=!fuel pin (no fuel) in bottom plate, 0 to .25 inches!
cylinder   2 1 .4966 .635 0
cylinder   3 1 .5042 .635 0
cuboid     4 1     1.00584 -1.00584 1.00584 -1.00584 .635 0
unit  2
com=!fuel pin between lower plates, .25 to 18.75 inches!
cylinder   1 1 .4534 47.625 1.905
cylinder   0 1 .4585 47.625 1.905
cylinder   2 1 .4966 47.625 .635
cuboid     3 1     1.00584 -1.00584 1.00584 -1.00584 47.625 .635
unit  3
com=!fuel pin in middle plate, 18.75 to 19.0 inches!
cylinder   1 1 .4534 48.26 47.625
cylinder   0 1 .4585 48.26 47.625
cylinder   2 1 .4966 48.26 47.625
cylinder   3 1 .5042 48.26 47.625
cuboid     4 1     1.00584 -1.00584 1.00584 -1.00584 48.26 47.625
unit  4
com=!fuel pin above middle plate, 19.0 to 35.67 inches!
cylinder   1 1 .4534 90.60 48.26
cylinder   0 1 .4585 90.60 48.26
cylinder   2 1 .4966 90.60 48.26
cuboid     3 1     1.00584 -1.00584 1.00584 -1.00584 90.60 48.26
unit  5
com=!fuel pin above water, 35.67 to 37.35 inches!
cylinder   5 1 .4534 94.869 90.60
cylinder   0 1 .4585 94.869 90.60
cylinder   2 1 .4966 94.869 90.60
cuboid     0 1     1.00584 -1.00584 1.00584 -1.00584 94.869 90.60
unit  6
com=!top of fuel pin (no fuel), 37.35 to 37.75 inches!
cylinder   2 1 .4966 95.885 94.869
cuboid     0 1     1.00584 -1.00584 1.00584 -1.00584 95.885 94.869
unit  7
com=!fuel pin (no fuel) in top plate, 37.75 to 38.25 inch!
cylinder   2 1 .4966 97.155 95.885
cylinder   0 1 .5042 97.155 95.885
cuboid     4 1     1.00584 -1.00584 1.00584 -1.00584 97.155 95.885
unit  8
com=!13 x 14 core (in water)!
array      1   0 0 0
replicate  3 2 3 3 3 3 0 0  10
replicate  4 1 0 0 0 0 0 2.54  1
replicate  3 1 0 0 0 0 0 6.35  1
replicate  4 1 0 0 0 0 0 5.08  1
unit  9
com=!13 x 14 core (above water)!
array      2   0 0 0
replicate  0 1 30 30 30 30 0 0  1
end geom
read array
ara=1 nux=13 nuy=14 nuz=4
com=!13 x 14 fuel pin array (in water)!
fill 182r1 182r2 182r3 182r4  end fill
ara=2 nux=13 nuy=14 nuz=3
com=!13 x 14 fuel pin array (above water)!
fill 182r5 182r6 182r7  end fill
ara=3 gbl=3 nux=1 nuy=1 nuz=2
com=!complete fuel core!
fill 8 9  end fill
end array
read bias id=500  2  11   end bias
read plot
ttl=!x-y view of core!
plt=yes pic=mixture xul=28  yul=44 zul=62 xlr=44 ylr=28  zlr=62 uax=1
vax=0
wax=0 udn=0 vdn=-1 wdn=0 nax=130
nch=! 12.-                                                              ! end
ttl=!x-z view of core!
plt=yes pic=mixture xul=28 yul=35 zul=113 xlr=44 ylr=35 zlr=0  uax=1
vax=0
wax=0 udn=0 vdn=0 wdn=-1 nax=130
nch=! 12./                                                              ! end
end plot
end data
end
```

w3269a

```
=csas1x
wcap-3269-39, table iv(8) .330 inch ag-in-cd rod, .405 inch pitch
44group      latticecell
uo2   1 0.950 293 92235 3.70 92238 96.30 end uo2
ss304 2 1.0  end ss304
h2o   3 1.0  end h2o
arbmagincd  10.18 5 0 0 1 47107 40.97   47109 38.78
                         49113   0.64  49115 14.53  48000 5.08   4 end
h2o         5      end
al          6      end
uo2   7 0.950 293 92235 3.70 92238 96.30 end uo2
ss304 8 1.0  end ss304
h2o   9 1.0  end h2o
end comp
squarepitch  1.029  0.754  1 3 0.860  2  0.779  0 end
more data dan(7)=.37267  res=7 cyl .377 end
end
=kenova
wcap-3269-39, 2692 fuel rods, 16 ag-in-cd rods,h2o ht=115.55
read parm plt=yes run=yes gen=805 npg=600 nsk=5 tme=120 lib=3
wrs=34 res=405 nub=yes end parm

read mixt
sct=2
mix=500   92235 3.316-4  92238  8.522-3  8016 1.771-2
          24304 1.555-3  25055  1.549-4 26304 5.296-3
          28304 6.888-4   1001  3.368-2 308016 1.684-2
mix=4     47107 1.800-2 47109 1.673-2
          49113 2.663-4 49115 5.940-3 48000  2.114-3
```

```
mix=5     501001 6.67514-2  508016 3.33757-2
mix=6     13027  6.02374-2
mix=7   792235 8.70065-4  792238  2.23592-2   708016 4.64585-2
mix=8   824304 1.74286-2  825055  1.73633-3   826304 5.93579-2
        828304 7.72074-3
mix=9   901001 6.67514-2  908016  3.33757-2
end mixt
read geom
unit 1
cylinder  7 1 0.377                   115.55  0.00
cylinder  0 1 0.389                   115.55  0.00
cylinder  8 1 0.430                   115.55  0.00
cuboid    9 1 4p.5145                 115.55  0.00
unit 2
cuboid  500 1 4p.5145                 115.55  0.00
unit 3
cylinder  4 1 0.4191                  115.55  0.00
cuboid    9 1 4p.5145                 115.55  0.00
unit 4
cuboid    9 1 4p.5145                 115.55  0.00
global unit 5
array 1  3r0
reflector   5 1 5r0.0 10.16  1
reflector   6 1 5r0.0   2.54 1
reflector   5 1 4r30.0  2r0  1
end geometry

read array
ara=1 nux=58 nuy=58 nuz=1   fill
10r4  2  36r4  2  10r4 2q58
 3r4  7r1 2  36r1  2 7r1 3r4 6q58
21r2 16r1 21r2
 3r4  7r1 2  36r1  2 7r1 3r4 7q58
 3r4  7r1 2  17r1  2  18r1 2 7r1 3r4  1q58
 3r4 25r1  2  26r1 3r4   q58
 3r4 19r1 3 3r1 3 1 2 1 3 3r1 3 20r1 3r4
 3r4 25r1  2  26r1 3r4  2q58
 3r4 19r1 3 3r1 3 1 2 1 3 3r1 3 20r1 3r4
 3r4 25r1  2  26r1 3r4
 3r4 15r1  21r2  16r1 3r4
 3r4 25r1  2  26r1 3r4
 3r4 19r1 3 3r1 3 1 2 1 3 3r1 3 20r1 3r4
 3r4 25r1  2  26r1 3r4  2q58
 3r4 19r1 3 3r1 3 1 2 1 3 3r1 3 20r1 3r4
 3r4 25r1  2  26r1 3r4
 3r4  7r1 2  17r1  2  18r1 2 7r1 3r4 2q58
 3r4  7r1 2  36r1  2 7r1 3r4 6q58
21r2 16r1 21r2
 3r4  7r1 2  36r1  2 7r1 3r4 6q58
10r4  2  36r4  2  10r4  2q58
          t  end fill
end array
read plot
ttl='x-y slice at z=30'
xul=60.   yul=60.    zul=30
xlr=-2.  ylr=-2.   zlr=30
vax=-1 udn=-1 nax=130  nch=' 4.aus,*  '  end
ttl='core center  x-y slice at z=30'
xul=40.   yul=40.    zul=30
xlr=20    ylr=20     zlr=30
vax=-1 udn=-1 nax=130  nch=' 4.aus,*  '  end
end plot
end data
end
```


w3269b

```
=csas2x
wcap-3269-39, table v(9) .330 inch o.d. ag-in-cd rod, .435 inch pitch
44group      latticecell
uo2   1 0.950 293 92235 3.70 92238 96.30 end uo2
ss304 2 1.0  end ss304
h2o   3 1.0  end h2o
arbmagincd  10.18 5 0 0 1 47107 40.97   47109 38.78
                          49113   0.64  49115 14.53  48000 5.08   4 end
h2o         5      end
al          6      end
uo2   7 0.950 293 92235 3.70 92238 96.30 end uo2
ss304 8 1.0  end ss304
h2o   9 1.0  end h2o
uo2  10 0.950 293 92235 3.70 92238 96.30 end uo2
ss304 11 1.0  end ss304
end comp
squarepitch  1.105  0.754  1 3 0.860  2  0.779  0 end
more data dan(7)=.296284  res=7 cyl .377
          dan(10)=.914387  res=10 cyl .377 end
wcap-3269-39, 2209 fuel rods, 24 ag-in-cd rods,h2o ht=64.56 cm
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=60
wrs=34 res=205 nub=yes end parm
       read geom

unit 1
com='fuel rod '
cylinder  7 1 0.377                   64.56   0.00
cylinder  0 1 0.389                   64.56   0.00
cylinder  8 1 0.430                   64.56   0.00
cuboid    9 1 4p.5525                 64.56   0.00
unit 2
com='fuel follower'
cuboid  500 1 4p.5525                 64.56   0.00
unit 3
com='control rod'
cylinder  4 1 0.4191                  64.56   0.00
cuboid    9 1 4p.5525                 64.56   0.00
unit 4
com='water hole'
cuboid    9 1 4p.5525                 64.56   0.00
unit 5
com='array in water'
array 1  3r0
reflector   5 1 5r0.0  10.16 1
reflector   6 1 5r0.0   2.54 1
reflector   5 1 4r30.   2r0  1
unit 11
com='fuel rod in air'
cylinder  10 1 0.377                  121.92   64.56
```

```
cylinder  0 1 0.389                    121.92   64.56
cylinder  11 1 0.430                   121.92   64.56
cuboid    0 1 4p.5525                  121.92   64.56
unit 12
com='fuel follower in air'
cuboid  500 1 4p.5525                  121.92   64.56
unit 13
com='control rod in air'
cylinder  4 1 0.4191                   121.92   64.56
cuboid   0 1 4p.5525                   121.92   64.56
unit 14
com='void'
cuboid   0  1 4p.5525                  121.92   64.56
unit 15
com='array in air'
array 2  3r0
reflector   0 1 4r30.0  2r0  1
global unit 20
array 3  3r0
end geometry

read array
ara=1 nux=53 nuy=53 nuz=1   fill
 9r4  2  33r4  2   9r4 2q53
 3r4  6r1 2  33r1  2 6r1 3r4 5q53
19r2 15r1 19r2
 3r4  6r1 2  33r1  2 6r1 3r4 8q53
 3r4 47r1 3r4  3q53
 3r4 20r1 3 1 3q2 19r1 3r4
 3r4 47r1 3r4
 3r4 20r1 3 5r1 3 20r1 3r4
 3r4 47r1 3r4                        53b424
 3r4  6r1 2 1  3 1 3q2 24r1  2 6r1 3r4
 3r4  6r1 2  33r1  2 6r1 3r4
 3r4  6r1 2 1  3 5r1 3 25r1  2 6r1 3r4
 3r4  6r1 2  33r1  2 6r1 3r4
 3r4  6r1 2 1  3 5r1 3 25r1  2 6r1 3r4
 3r4  6r1 2  33r1  2 6r1 3r4
 3r4  6r1 2 1  3 1 3q2 24r1  2 6r1 3r4
 3r4  6r1 2  33r1  2 6r1 3r4
19r2 15r1 19r2
 3r4  6r1 2  33r1  2 6r1 3r4 5q53
 9r4  2  33r4  2   9r4 2q53
         t  end fill
ara=2 nux=53 nuy=53 nuz=1   fill
 9r14  12  33r14  12   9r14 2q53
 3r14  6r11 12  33r11  12 6r11 3r14 5q53
19r12 15r11 19r12
 3r14  6r11 12  33r11  12 6r11 3r14 8q53
 3r14 47r11 3r14  3q53
 3r14 20r11 13 11 3q2 19r11 3r14
 3r14 47r11 3r14
 3r14 20r11 13 5r11 13 20r11 3r14
 3r14 47r11 3r14                       53b424
 3r14  6r11 12 11  13 11 3q2 24r11  12 6r11 3r14
 3r14  6r11 12  33r11  12 6r11 3r14
 3r14  6r11 12 11  13 5r11 13 25r11 12 6r11 3r14
 3r14  6r11 12  33r11  12 6r11 3r14
 3r14  6r11 12 11  13 5r11 13 25r11 12 6r11 3r14
 3r14  6r11 12  33r11  12 6r11 3r14
 3r14  6r11 12 11  13 11 3q2 24r11  12 6r11 3r14
 3r14  6r11 12  33r11  12 6r11 3r14
19r12 15r11 19r12
 3r14  6r11 12  33r11  12 6r11 3r14 5q53
 9r14  12  33r14  12   9r14 2q53
         t  end fill
ara=3 nux=1 nuy=1 nuz=2   fill
   5  15  t  end fill
end array
read plot
ttl='x-y slice at z=30'
xul=60.   yul=60.    zul=30
xlr=-2.  ylr=-2.   zlr=30
vax=-1 udn=-1 nax=130  nch=' 4.aus,*  '  end
ttl='core center  x-y slice at z=30'
       xul=40.   yul=40.    zul=30
xlr=20    ylr=20     zlr=30
vax=-1 udn=-1 nax=130  nch=' 4.aus,*  '  end
end plot
end data
end
```

w3269c

```
=csas25
wcap-3269-39, table vii-9 .403 inch ag-in-cd rod, .600 inch pitch
44group      latticecell
uo2   1 0.950 293 92235 2.72 92238 97.28 end uo2
arbmzir2   6.44 14 0 0 1  40000 98.225 26000  0.125
  50112  0.015  50114  0.010  50115  0.005  50116  0.218  50117  0.115
  50118  0.363  50119  0.129  50120  0.489  50122  0.069  50124  0.087
                          24000  0.10    7014  0.05   2  end
h2o   3 1.0  end h2o
arbmagincd 10.18  5 0 0 1 47107 40.97   47109 38.78
                          49113   0.64  49115 14.53  48000 5.08   4 end
h2o         5      end
al          6      end
end comp
squarepitch  1.524  1.016  1 3 1.189  2  1.030  0 end
wcap-3269-39,  945 fuel rods, 16 ag-in-cd rods,h2o ht=89.75
read parm plt=yes run=yes gen=805 npg=600 nsk=5 tme=120
wrs=34 res=405 nub=yes end parm
       read geom

unit 1
cylinder  1 1 0.508                    89.75    0.00
cylinder  0 1 0.515                    89.75    0.00
cylinder  2 1 0.5945                   89.75   -2.07
cuboid    3 1 4p.762                   89.75   -2.07
unit 3
cylinder  4 1 0.5118                   89.75   -2.07
cuboid    3 1 4p.762                   89.75   -2.07
global unit 5
array 1  3r0
reflector   6 1 5r0.0   1.27 1
reflector   5 1 5r0.0   0.48 1
reflector   6 1 5r0.0   5.08 1
```

```
reflector   5 1 4r30.   2r0  1
end geometry

read array
ara=1 nux=31 nuy=31 nuz=1   fill
31r1  9q31
10r1  3 2r1 3q3 9r1
31r1
12r1  3 4r1 3  13r1
10r1  3 8r1 3  11r1
31r1  1b464 32r1
     end fill
end array
read plot
ttl='x-y slice at z=30'
xul=50.   yul=50.    zul=30
xlr=-2.   ylr=-2.    zlr=30
vax=-1 udn=-1 nax=130  nch=' uz.$a,   '  end
ttl='x-y slice at z=30'
xul=33.   yul=33.    zul=30
xlr=13    ylr=13     zlr=30
vax=-1 udn=-1 nax=130  nch=' uz.$a,   '  end
end plot
end data
end
```

ans33bp2

```
#csas25
ans33-362,manaranche et al.,1.35cm pitch,4-18x18 array,4.75% uo2
44group  latticecell
uo2   1 den=10.38 1.0 293 92235 4.742 92238 95.258 end
arbmag5  2.70 4 0 0 1  13027 98.85 12000 0.50 14000 0.43 26000 0.22 2 1
         293 end
h2o   3 1.0         end
poly(h2o) 4 den=.3335 end
arbmstl  7.90 3 0 0 1 26304 71.39 24304 19.16 28304 9.44 5 1 end
h2o   6 1.0         end
al    7 1.0         end
uo2   8 den=10.38 1.0 293 92235 4.742 92238 95.258 end
end comp
squarepitch  1.35  0.79   1 3 0.94  2 0.82  0 end
more data res=8 cyl 0.395  dan(8)=0.989254   end
4-18x18 array 5.0cm int.,polyethylene powder in box,30.16cm h2o height
read parm plt=yes run=yes gen=805 npg=600 nsk=5 tme=240
wrs=34 res=205 nub=yes rnd=6516246C6230  end parm
read geom

unit 1
com='bottom plug of fuel rod'
cylinder  2 1  .470     -.25  -1.8
cuboid    3 1  4p.675   -.25  -1.8

unit 2
com='bottom plug of fuel rod in grid'
cylinder  2 1  .470     -.00  -0.25
cylinder  3 1  .500     -.00  -0.25
cuboid    5 1  4p.675   -.00  -0.25

unit 3
com='fuel rod under water'
cylinder  1 1  .395      30.16 0.0
cylinder  0 1  .410      30.16 0.0
cylinder  2 1  .470      30.16 0.0
cuboid    3 1  4p.675    30.16 0.0

unit 4
com='fuel assy lower left'
array 1   3*0.0
reflector 5 1  5r0    0.4    1
reflector 6 1  0 .3 0 .3 2r0 1
reflector 7 1  .3 0 .3 0 2r0 1

unit 5
com='fuel assy lower right'
array 1   3*0.0
reflector 5 1  5r0    0.4    1
reflector 6 1  .3 0 0 .3 2r0 1
reflector 7 1  0 .3 .3 0 2r0 1

unit 6
com='fuel assy upper left'
array 1   3*0.0
reflector 5 1  5r0    0.4    1
reflector 6 1  0 .3 .3 0 2r0 1
reflector 7 1  .3 0 0 .3 2r0 1

unit 7
com='fuel assy upper right'
array 1   3*0.0
reflector 5 1  5r0    0.4    1
reflector 6 1  .3 0 .3 0 2r0 1
reflector 7 1  0 .3 0 .3 2r0 1

unit 8
com='polyethylene powder in box lower part'
cuboid    4 1  2p2.2  2p12.30  30.16  -1.9
replicate 7 1  2r0.0  0 0.3  0  0.3   1

unit 9
com='polyethylene powder in box left part'
cuboid    4 1  2p12.30 2p2.2   30.16  -1.9
replicate 7 1  0 0.3  2r0.0  0  0.3   1

unit 10
com='polyethylene powder in center part'
cuboid    4 1  2p2.2 2p2.2     30.16  -1.9
replicate 7 1  5r0.0            0.3   1

unit 11
com='polyethylene powder in box right part'
cuboid    4 1  2p12.30 2p2.2   30.16  -1.9
replicate 7 1  0.3 0  2r0.0  0  0.3   1

unit 12
com='polyethylene powder in box upper part'
cuboid    4 1  2p2.2  2p12.30  30.16  -1.9
replicate 7 1  2r0.0  0.3 0  0   0.3  1
```

```
unit 13
com='fuel rod above water'
cylinder  8 1  .395      90.00 30.16
cylinder  0 1  .410      96.9  30.16
cylinder  2 1  .470      98.2  30.16
cuboid    0 1  4p.675    98.2  30.16

unit 14
com='fuel assy lower left above water '
array 3   3*0.0
reflector 0 1  0 .3 0 .3 2r0 1
reflector 7 1  .3 0 .3 0 2r0 1

unit 15
com='fuel assy lower right above water'
array 3   3*0.0
reflector 0 1  .3 0 0 .3 2r0 1
reflector 7 1  0 .3 .3 0 2r0 1

unit 16
com='fuel assy upper left above water'
array 3   3*0.0
reflector 0 1  0 .3 .3 0 2r0 1
reflector 7 1  .3 0 0 .3 2r0 1

unit 17
com='fuel assy upper right above water'
array 3   3*0.0
reflector 0 1  .3 0 .3 0 2r0 1
reflector 7 1  0 .3 0 .3 2r0 1

unit 18
com='void in box lower part'
cuboid    0 1  2p2.2  2p12.30  98.2  30.16
replicate 7 1  2r0.0  0 0.3  2r0      1

unit 19
com='void in box left part'
cuboid    0 1  2p12.30 2p2.2   98.2  30.16
replicate 7 1  0 0.3  2r0.0  2r0      1

unit 20
com='void in center part'
cuboid    0 1  2p2.2 2p2.2     98.2  30.16
replicate 7 1  4r0.0         2r0      1

unit 21
com='void in box right part'
cuboid    0 1  2p12.30 2p2.2   98.2  30.16
replicate 7 1  0.3 0  2r0.0  2r0      1

unit 22
com='void in box upper part'
cuboid    0 1  2p2.2  2p12.30  98.2  30.16
replicate 7 1  2r0.0  0.3 0  2r0      1

unit 23
array  2  2r-27.1 -2.2
replicate 5 1 5r0  .8  1
reflector 6 2 4r3 0 3    7

unit 24
array  4  2r-27.1 30.16
reflector 0 1 4r21 2r0   1

global unit 25
array  5 2r-48.1 -24.0
end geom

read bias id=500 2 8 end bias

read array
com='fuel assy'  ara=1 nux=18 nuy=18 nuz=3
      fill 324r1 324r2 324r3          end fill
ara=2  nux=3 nuy=3  nuz=1   fill 4 8 5  9 10 11  6 12 7  end fill
com='fuel assy above water'  ara=3 nux=18 nuy=18 nuz=1
      fill 324r13                     end fill
ara=4  nux=3 nuy=3  nuz=1
      fill 14 18 15  19 20 21  16 22 17  end fill
ara=5  nux=1 nuy=1  nuz=2   fill 23  24    end fill
end array
read plot
ttl='x-y slice '
xul=-27    yul=27     zul=20.
xlr=27     ylr=-27    zlr=20.
uax=1 vdn=-1 nax=130  nch='.12 45 78 '  end
ttl='x-y slice '
xul=-28    yul=-12    zul=50.0
xlr=-12    ylr=-28    zlr=50.0
uax=1 vdn=-1 nax=130  nch='.12 45 78 '  end
ttl='x-z slice '
xul=2.     yul=3.175   zul=100.
xlr=28.0   ylr=3.175   zlr=-5.0
uax=1 wdn=-1 nax=130  nch='.12 45 78 '  end
end plot
end data
end
```

ans33bb2

```
#csas25
ans33-362,manaranche et al.,1.35cm pitch,4-18x18 array,4.75% uo2
44group latticecell
uo2   1 den=10.38 1.0 293 92235 4.742 92238 95.258 end
arbmag5  2.70 4 0 0 1  13027 98.85 12000 0.50 14000 0.43 26000 0.22 2 1
       293 end
h2o   3 1.0         end
poly(h2o) 4 den=.5796 end
arbmstl  7.90 3 0 0 1 26304 71.39 24304 19.16 28304 9.44 5 1 end
h2o   6 1.0         end
al    7 1.0         end
uo2   8 den=10.38 1.0 293 92235 4.742 92238 95.258 end
end comp
squarepitch  1.35  0.79   1 3 0.94  2 0.82  0 end
more data res=8 cyl 0.395  dan(8)=0.989254   end
4-18x18 array 5.0cm int.,polyethylene balls in box,30.73cm h2o height
```

```
read parm plt=yes run=yes gen=805 npg=600 nsk=5 tme=240
wrs=34 res=205 nub=yes rnd=6516246C6230 end parm
read geom
unit 1
com='bottom plug of fuel rod'
cylinder  2 1  .470     -.25  -1.8
cuboid    3 1  4p.675   -.25  -1.8

unit 2
com='bottom plug of fuel rod in grid'
cylinder  2 1  .470     -.00  -0.25
cylinder  3 1  .500     -.00  -0.25
cuboid    5 1  4p.675   -.00  -0.25

unit 3
com='fuel rod under water'
cylinder  1 1  .395      30.73 0.0
cylinder  0 1  .410      30.73 0.0
cylinder  2 1  .470      30.73 0.0
cuboid    3 1  4p.675    30.73 0.0

unit 4
com='fuel assy lower left'
array 1   3*0.0
reflector 5 1  5r0    0.4    1
reflector 6 1  0 .3 0 .3 2r0 1
reflector 7 1  .3 0 .3 0 2r0 1

unit 5
com='fuel assy lower right'
array 1   3*0.0
reflector 5 1  5r0    0.4    1
reflector 6 1  .3 0 0 .3 2r0 1
reflector 7 1  0 .3 .3 0 2r0 1

unit 6
com='fuel assy upper left'
array 1   3*0.0
reflector 5 1  5r0    0.4    1
reflector 6 1  0 .3 .3 0 2r0 1
reflector 7 1  .3 0 0 .3 2r0 1

unit 7
com='fuel assy upper right'
array 1   3*0.0
reflector 5 1  5r0    0.4    1
reflector 6 1  .3 0 .3 0 2r0 1
reflector 7 1  0 .3 0 .3 2r0 1

unit 8
com='polyethylene balls in box lower part'
cuboid    4 1  2p2.2  2p12.30  30.73  -1.9
replicate 7 1  2r0.0  0 0.3  0  0.3   1

unit 9
com='polyethylene balls in box left part'
cuboid    4 1  2p12.30 2p2.2   30.73  -1.9
replicate 7 1  0 0.3  2r0.0  0  0.3   1

unit 10
com='polyethylene balls in center part'
cuboid    4 1  2p2.2 2p2.2     30.73  -1.9
replicate 7 1  5r0.0            0.3   1

unit 11
com='polyethylene balls in box right part'
cuboid    4 1  2p12.30 2p2.2   30.73  -1.9
replicate 7 1  0.3 0  2r0.0  0  0.3   1

unit 12
com='polyethylene balls in box upper part'
cuboid    4 1  2p2.2  2p12.30  30.73  -1.9
replicate 7 1  2r0.0  0.3 0  0   0.3  1

unit 13
com='fuel rod above water'
cylinder  8 1  .395      90.00 30.73
cylinder  0 1  .410      96.9  30.73
cylinder  2 1  .470      98.2  30.73
cuboid    0 1  4p.675    98.2  30.73

unit 14
com='fuel assy lower left above water '
array 3   3*0.0
reflector 0 1  0 .3 0 .3 2r0 1
reflector 7 1  .3 0 .3 0 2r0 1

unit 15
com='fuel assy lower right above water'
array 3   3*0.0
reflector 0 1  .3 0 0 .3 2r0 1
reflector 7 1  0 .3 .3 0 2r0 1

unit 16
com='fuel assy upper left above water'
array 3   3*0.0
reflector 0 1  0 .3 .3 0 2r0 1
reflector 7 1  .3 0 0 .3 2r0 1

unit 17
com='fuel assy upper right above water'
array 3   3*0.0
reflector 0 1  .3 0 .3 0 2r0 1
reflector 7 1  0 .3 0 .3 2r0 1

unit 18
com='void in box lower part'
cuboid    0 1  2p2.2  2p12.30  98.2  30.73
replicate 7 1  2r0.0  0 0.3  2r0      1

unit 19
com='void in box left part'
cuboid    0 1  2p12.30 2p2.2   98.2  30.73
replicate 7 1  0 0.3  2r0.0  2r0      1

unit 20
com='void in center part'
cuboid    0 1  2p2.2 2p2.2     98.2  30.73
```

```
unit 21
com='void in box right part'
cuboid    0 1  2p12.30 2p2.2   98.2  30.73
replicate 7 1  0.3 0  2r0.0  2r0      1

unit 22
com='void in box upper part'
cuboid    0 1  2p2.2  2p12.30  98.2  30.73
replicate 7 1  2r0.0  0.3 0  2r0      1

unit 23
array  2  2r-27.1 -2.2
replicate 5 1 5r0  .8  1
reflector 6 2 4r3 0 3    7

unit 24
array  4  2r-27.1 30.73
reflector 0 1 4r21 2r0   1

global unit 25
array  5 2r-48.1 -24.0
end geom

read bias id=500 2 8 end bias

read array
com='fuel assy'  ara=1 nux=18 nuy=18 nuz=3
      fill 324r1 324r2 324r3          end fill
ara=2  nux=3 nuy=3  nuz=1   fill 4 8 5  9 10 11  6 12 7  end fill
com='fuel assy above water'  ara=3 nux=18 nuy=18 nuz=1
      fill 324r13                     end fill
ara=4  nux=3 nuy=3  nuz=1
      fill 14 18 15  19 20 21  16 22 17  end fill
ara=5  nux=1 nuy=1  nuz=2   fill 23  24    end fill
end array
read plot
ttl='x-y slice '
xul=-27    yul=27     zul=20.
xlr=27     ylr=-27    zlr=20.
uax=1 vdn=-1 nax=130  nch='.12 45 78 '  end
ttl='x-y slice '
xul=-28    yul=-12    zul=50.0
xlr=-12    ylr=-28    zlr=50.0
uax=1 vdn=-1 nax=130  nch='.12 45 78 '  end
ttl='x-z slice '
xul=2.     yul=3.175   zul=100.
xlr=28.0   ylr=3.175   zlr=-5.0
uax=1 wdn=-1 nax=130  nch='.12 45 78 '  end
end plot
end data
end
```

ans33bh2

```
#csas25
ans33-362,manaranche et al.,1.35cm pitch,4-18x18 array,4.75% uo2
44group  latticecell
uo2   1 den=10.38 1.0 293 92235 4.742 92238 95.258 end
arbmag5  2.70 4 0 0 1  13027 98.85 12000 0.50 14000 0.43 26000 0.22 2 1
      293 end
h2o   3 1.0         end
poly(h2o) 4 den=.5796 end
arbmstl  7.90 3 0 0 1 26304 71.39 24304 19.16 28304 9.44 5 1 end
h2o   6 1.0         end
al    7 1.0         end
uo2   8 den=10.38 1.0 293 92235 4.742 92238 95.258 end
end comp
squarepitch  1.35  0.79   1 3 0.94  2 0.82  0 end
more data res=8 cyl 0.395  dan(8)=0.989254   end
4-18x18 array 5.0cm int.,water in box,32.78cm h2o height
read parm plt=yes run=yes gen=805 npg=600 nsk=5 tme=240
wrs=34 res=205 nub=yes rnd=6516246C6230 end parm

read geom
unit 1
com='bottom plug of fuel rod'
cylinder  2 1  .470     -.25  -1.8
cuboid    3 1  4p.675   -.25  -1.8

unit 2
com='bottom plug of fuel rod in grid'
cylinder  2 1  .470     -.00  -0.25
cylinder  3 1  .500     -.00  -0.25
cuboid    5 1  4p.675   -.00  -0.25

unit 3
com='fuel rod under water'
cylinder  1 1  .395      32.78 0.0
cylinder  0 1  .410      32.78 0.0
cylinder  2 1  .470      32.78 0.0
cuboid    3 1  4p.675    32.78 0.0

unit 4
com='fuel assy lower left'
array 1   3*0.0
reflector 5 1  5r0    0.4    1
reflector 6 1  0 .3 0 .3 2r0 1
reflector 7 1  .3 0 .3 0 2r0 1

unit 5
com='fuel assy lower right'
array 1   3*0.0
reflector 5 1  5r0    0.4    1
reflector 6 1  .3 0 0 .3 2r0 1
reflector 7 1  0 .3 .3 0 2r0 1

unit 6
com='fuel assy upper left'
array 1   3*0.0
reflector 5 1  5r0    0.4    1
reflector 6 1  0 .3 .3 0 2r0 1
reflector 7 1  .3 0 0 .3 2r0 1

unit 7
com='fuel assy upper right'
array 1   3*0.0
reflector 5 1  5r0    0.4    1
```

```
reflector 6 1  .3 0 .3 0 2r0 1
reflector 7 1  0 .3 0 .3 2r0 1

unit 8
com='water in box lower part'
cuboid    6 1  2p2.2  2p12.30  32.78  -1.9
replicate 7 1  2r0.0  0 0.3  0  0.3   1

unit 9
com='water in box left part'
cuboid    6 1  2p12.30 2p2.2   32.78  -1.9
replicate 7 1  0 0.3  2r0.0  0  0.3   1

unit 10
com='water in center part'
cuboid    6 1  2p2.2 2p2.2     32.78  -1.9
replicate 7 1  5r0.0            0.3   1

unit 11
com='water in box right part'
cuboid    6 1  2p12.30 2p2.2   32.78  -1.9
replicate 7 1  0.3 0  2r0.0  0  0.3   1

unit 12
com='water in box upper part'
cuboid    6 1  2p2.2  2p12.30  32.78  -1.9
replicate 7 1  2r0.0  0.3 0  0   0.3  1

unit 13
com='fuel rod above water'
cylinder  8 1  .395      90.00 32.78
cylinder  0 1  .410      96.9  32.78
cylinder  2 1  .470      98.2  32.78
cuboid    0 1  4p.675    98.2  32.78

unit 14
com='fuel assy lower left above water '
array 3   3*0.0
reflector 0 1  0 .3 0 .3 2r0 1
reflector 7 1  .3 0 .3 0 2r0 1

unit 15
com='fuel assy lower right above water'
array 3   3*0.0
reflector 0 1  .3 0 0 .3 2r0 1
reflector 7 1  0 .3 .3 0 2r0 1

unit 16
com='fuel assy upper left above water'
array 3   3*0.0
reflector 0 1  0 .3 .3 0 2r0 1
reflector 7 1  .3 0 0 .3 2r0 1

unit 17
com='fuel assy upper right above water'
array 3   3*0.0
reflector 0 1  .3 0 .3 0 2r0 1
reflector 7 1  0 .3 0 .3 2r0 1

unit 18
com='void in box lower part'
cuboid    0 1  2p2.2  2p12.30  98.2  32.78
replicate 7 1  2r0.0  0 0.3  2r0      1

unit 19
com='void in box left part'
cuboid    0 1  2p12.30 2p2.2   98.2  32.78
replicate 7 1  0 0.3  2r0.0  2r0      1

unit 20
com='void in center part'
cuboid    0 1  2p2.2 2p2.2     98.2  32.78
replicate 7 1  4r0.0         2r0      1

unit 21
com='void in box right part'
cuboid    0 1  2p12.30 2p2.2   98.2  32.78
replicate 7 1  0.3 0  2r0.0  2r0      1

unit 22
com='void in box upper part'
cuboid    0 1  2p2.2  2p12.30  98.2  32.78
replicate 7 1  2r0.0  0.3 0  2r0      1

unit 23
array  2  2r-27.1 -2.2
replicate 5 1 5r0  .8  1
reflector 6 2 4r3 0 3    7

unit 24
array  4  2r-27.1 32.78
reflector 0 1 4r21 2r0   1

global unit 25
array  5 2r-48.1 -24.0
end geom

read bias id=500 2 8 end bias

read array
com='fuel assy'  ara=1 nux=18 nuy=18 nuz=3
      fill 324r1 324r2 324r3          end fill
ara=2  nux=3 nuy=3  nuz=1   fill 4 8 5  9 10 11  6 12 7  end fill
com='fuel assy above water'  ara=3 nux=18 nuy=18 nuz=1
      fill 324r13                     end fill
ara=4  nux=3 nuy=3  nuz=1
      fill 14 18 15  19 20 21  16 22 17  end fill
ara=5  nux=1 nuy=1  nuz=2   fill 23  24    end fill
end array
read plot
ttl='x-y slice '
xul=-27    yul=27     zul=20.
xlr=27     ylr=-27    zlr=20.
uax=1 vdn=-1 nax=130  nch='.12 45 78 '  end
ttl='x-y slice '
xul=-28    yul=-12    zul=50.0
xlr=-12    ylr=-28    zlr=50.0
uax=1 vdn=-1 nax=130  nch='.12 45 78 '  end
```

```
ttl='x-z slice '
xul=2.     yul=3.175   zul=100.
xlr=28.0   ylr=3.175   zlr=-5.0
uax=1 wdn=-1 nax=130  nch='.12 45 78 '  end
end plot
end data
end
```

ans33h2

```
#csas25
ans33-362,manaranche et al.,1.35cm pitch,4-18x18 array,4.75% uo2
44group  latticecell
uo2   1 den=10.38 1.0 293 92235 4.742 92238 95.258 end
arbmag5  2.70 4 0 0 1  13027 98.85 12000 0.50 14000 0.43 26000 0.22 2 1
        293 end
h2o   3 1.0         end
poly(h2o) 4 den=.5796 end
arbmstl  7.90 3 0 0 1 26304 71.39 24304 19.16 28304 9.44 5 1 end
h2o   6 1.0         end
al    7 1.0         end
uo2   8 den=10.38 1.0 293 92235 4.742 92238 95.258 end
end comp
squarepitch  1.35  0.79   1 3 0.94  2 0.82  0 end
more data res=8 cyl 0.395  dan(8)=0.989254   end
4-18x18 array 5.0cm int.,water without box,31.47cm h2o height
read parm plt=yes run=yes gen=805 npg=600 nsk=5 tme=240
wrs=34 res=205 nub=yes rnd=6516246C6230 end parm

read geom
unit 1
com='bottom plug of fuel rod'
cylinder  2 1  .470     -.25  -1.8
cuboid    3 1  4p.675   -.25  -1.8

unit 2
com='bottom plug of fuel rod in grid'
cylinder  2 1  .470     -.00  -0.25
cylinder  3 1  .500     -.00  -0.25
cuboid    5 1  4p.675   -.00  -0.25

unit 3
com='fuel rod under water'
cylinder  1 1  .395      31.47 0.0
cylinder  0 1  .410      31.47 0.0
cylinder  2 1  .470      31.47 0.0
cuboid    3 1  4p.675    31.47 0.0

unit 4
com='fuel assy lower left'
array 1   3*0.0
reflector 5 1  5r0    0.4    1
reflector 6 1  4r.3      2r0 1

unit 5
com='fuel assy lower right'
array 1   3*0.0
reflector 5 1  5r0    0.4    1
reflector 6 1  4r.3      2r0 1

unit 6
com='fuel assy upper left'
array 1   3*0.0
reflector 5 1  5r0    0.4    1
reflector 6 1  4r.3      2r0 1

unit 7
com='fuel assy upper right'
array 1   3*0.0
reflector 5 1  5r0    0.4    1
reflector 6 1  4r.3      2r0 1

unit 8
com='water at lower part'
cuboid    6 1  2p2.2  2p12.30  31.47  -1.9
replicate 6 1  2r0.0  0 0.3  0  0.3   1

unit 9
com='water at left part'
cuboid    6 1  2p12.30 2p2.2   31.47  -1.9
replicate 6 1  0 0.3  2r0.0  0  0.3   1

unit 10
com='water in center part'
cuboid    6 1  2p2.2 2p2.2     31.47  -1.9
replicate 6 1  5r0.0            0.3   1

unit 11
com='water at right part'
cuboid    6 1  2p12.30 2p2.2   31.47  -1.9
replicate 6 1  0.3 0  2r0.0  0  0.3   1

unit 12
com='water at upper part'
cuboid    6 1  2p2.2  2p12.30  31.47  -1.9
replicate 6 1  2r0.0  0.3 0  0   0.3  1

unit 13
com='fuel rod above water'
cylinder  8 1  .395      90.00 31.47
cylinder  0 1  .410      96.9  31.47
cylinder  2 1  .470      98.2  31.47
cuboid    0 1  4p.675    98.2  31.47

unit 14
com='fuel assy lower left above water '
array 3   3*0.0
reflector 0 1  4r.3      2r0 1

unit 15
com='fuel assy lower right above water'
array 3   3*0.0
reflector 0 1  4r.3      2r0 1

unit 16
com='fuel assy upper left above water'
```

```
array 3   3*0.0
reflector 0 1  4r.3      2r0 1

unit 17
com='fuel assy upper right above water'
array 3   3*0.0
reflector 0 1  4r.3      2r0 1

unit 18
com='void at lower part'
cuboid    0 1  2p2.2  2p12.30  98.2  31.47
replicate 0 1  2r0.0  0 0.3  2r0      1

unit 19
com='void at left part'
cuboid    0 1  2p12.30 2p2.2   98.2  31.47
replicate 0 1  0 0.3  2r0.0  2r0      1

unit 20
com='void in center part'
cuboid    0 1  2p2.2 2p2.2     98.2  31.47

unit 21
com='void at right part'
cuboid    0 1  2p12.30 2p2.2   98.2  31.47
replicate 0 1  0.3 0  2r0.0  2r0      1

unit 22
com='void at upper part'
cuboid    0 1  2p2.2  2p12.30  98.2  31.47
replicate 0 1  2r0.0  0.3 0  2r0      1

unit 23
array  2  2r-27.1 -2.2
replicate 5 1 5r0  .8  1
reflector 6 2 4r3 0 3    7

unit 24
array  4  2r-27.1 31.47
reflector 0 1 4r21 2r0   1

global unit 25
array  5 2r-48.1 -24.0
end geom

read bias id=500 2 8 end bias

read array
com='fuel assy'  ara=1 nux=18 nuy=18 nuz=3
      fill 324r1 324r2 324r3          end fill
ara=2  nux=3 nuy=3  nuz=1   fill 4 8 5  9 10 11  6 12 7  end fill
com='fuel assy above water'  ara=3 nux=18 nuy=18 nuz=1
      fill 324r13                     end fill
ara=4  nux=3 nuy=3  nuz=1
      fill 14 18 15  19 20 21  16 22 17  end fill
ara=5  nux=1 nuy=1  nuz=2   fill 23  24    end fill
end array
read plot
ttl='x-y slice '
xul=-27    yul=27     zul=20.
xlr=27     ylr=-27    zlr=20.
uax=1 vdn=-1 nax=130  nch='.12 45 78 '  end
ttl='x-y slice '
xul=-28    yul=-12    zul=50.0
xlr=-12    ylr=-28    zlr=50.0
uax=1 vdn=-1 nax=130  nch='.12 45 78 '  end
ttl='x-z slice '
xul=2.     yul=3.175   zul=100.
xlr=28.0   ylr=3.175   zlr=-5.0
uax=1 wdn=-1 nax=130  nch='.12 45 78 '  end
end plot
end data
end
```


epri70un

```
#csas25
epri .70 inch pitch unborated plutonium
44group                 latticecell
u-234          1  0.0 1.2462-6 293 end
u-235          1  0.0 1.4891-4 293 end
u-236          1  0.0 2.0943-9 293 end
u-238          1  0.0 2.0619-2 293 end
pu-238         1  0.0 3.885-8 293 end
pu-239         1  0.0 3.9477-4 293 end
pu-240         1  0.0 3.3218-5 293 end
pu-241         1  0.0 1.6023-6 293 end
pu-242         1  0.0 1.1887-7 293 end
am-241         1  0.0 1.5024-6 293 end
o              1  0.0 4.3763-2 293 end
arbmzir2   6.44 14 0 0 1  40000 98.225 26000  0.125
  50112  0.015  50114  0.010  50115  0.005  50116  0.218  50117  0.115
  50118  0.363  50119  0.129  50120  0.489  50122  0.069  50124  0.087
                        24000  0.10    7014  0.05   2  end
al             3  1.0 293 end
h2o            4  1.0 293 end
boron          4  den=0.0     end
pb             5  1.0 293 end
end comp
squarepitch 1.778 1.2827 1  4  1.4351 2  end
epri .70inch pitch unborated plutonium
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes tme=60
wrs=34  end parm
read geom
unit  1
com=!62 5/8 to 63 7/8!
cylinder   2 1 .71755 3.175 2.8575
cuboid     4 1     .889 -.889 .889 -.889 3.175 2.8575
cuboid     3 1     .889 -.889 .889 -.889 3.175 0
unit  2
com=!63 7/8 to 64 7/8!
cylinder   1 1 .64135 5.715 3.556
cylinder   2 1 .71755 5.715 3.175
cuboid     4 1     .73025 -.73025 .73025 -.73025 5.715 3.175
cuboid     3 1     .889 -.889 .889 -.889 5.715 3.175
unit  3
com=!64 7/8 to 99!
```

```
cylinder   1 1 .64135 92.3925 5.715
cylinder   2 1 .71755 92.3925 5.715
cuboid     4 1     .889 -.889 .889 -.889 92.3925 5.715
unit  4
com=!99 to 100!
cylinder   1 1 .64135 94.9325 92.3925
cylinder   2 1 .71755 94.9325 92.3925
cuboid     4 1     .73025 -.73025 .73025 -.73025 94.9325 92.3925
cuboid     3 1     .889 -.889 .889 -.889 94.9325 92.3925
unit  5
com=!100 to 100.725!
cylinder   1 1 .64135 94.996 94.9325
cylinder   2 1 .71755 95.8215 94.9325
cuboid     4 1     .889 -.889 .889 -.889 95.8215 94.9325
cuboid     5 1     .889 -.889 .889 -.889 96.774 94.9325
unit  6
com=!62 5/8 to 63 7/8 with no fuel!
cuboid     4 1     .889 -.889 .889 -.889 3.175 2.8575
cuboid     3 1     .889 -.889 .889 -.889 3.175 0
unit  7
com=!63 7/8 to 64 7/8 with no fuel!
cuboid     4 1     .73025 -.73025 .73025 -.73025 5.715 3.175
cuboid     3 1     .889 -.889 .889 -.889 5.715 3.175
unit  8
com=!64 7/8 to 99 with no fuel!
cuboid     4 1     .889 -.889 .889 -.889 92.3925 5.715
unit  9
com=!99 to 100 with no fuel!
cuboid     4 1     .73025 -.73025 .73025 -.73025 94.9325 92.3925
cuboid     3 1     .889 -.889 .889 -.889 94.9325 92.3925
unit  10
com=!100 to 100.725 with no fuel!
cuboid     4 1     .889 -.889 .889 -.889 95.8215 94.9325
cuboid     5 1     .889 -.889 .889 -.889 96.774 94.9325
global unit  11
com=!reflector region!
array      1   0 0 0
replicate  4 1 30 30 30 30 15.24 30  1
end geom
read array
ara=1 nux=23 nuy=23 nuz=5
com=!epri .70inch pitch unborated plutonium!
fill
     5r6 13r1 9r6     15r1 7r6     17r1 5r6     19r1 3r6    21r1 6
     299r1   299b115
     5r7 13r2 9r7     15r2 7r7     17r2 5r7     19r2 3r7    21r2 7
     299r2   299b115
     5r8 13r3 9r8     15r3 7r8     17r3 5r8     19r3 3r8    21r3 8
     299r3   299b115
     5r9 13r4 9r9     15r4 7r9     17r4 5r9     19r4 3r9    21r4 9
     299r4   299b115
     5r10 13r5 9r10   15r5 7r10    17r5 5r10    19r5 3r10   21r5 10
     299r5   299b115    t
end fill
end array
read bnds +xb=vacuum -xb=vacuum +yb=vacuum -yb=vacuum +zb=vacuum
-zb=vacuum
  end bnds
read plot
ttl=!x-y cross-section at z=5.0cm!
plt=yes pic=mixture xul=-5 yul=-5 zul=5 xlr=45 ylr=45 zlr=5 uax=1 vax=0
wax=0
udn=0 vdn=1 wdn=0 nax=130  nch=' 123 5' end
end plot
end data
end
```

epri70b

```
#csas25
epri .70 inch pitch borated plutonium
44group                 latticecell
u-234          1  0.0 1.2462-6 293 end
u-235          1  0.0 1.4891-4 293 end
u-236          1  0.0 2.0943-9 293 end
u-238          1  0.0 2.0619-2 293 end
pu-238         1  0.0 3.885-8 293 end
pu-239         1  0.0 3.9477-4 293 end
pu-240         1  0.0 3.3218-5 293 end
pu-241         1  0.0 1.6023-6 293 end
pu-242         1  0.0 1.1887-7 293 end
am-241         1  0.0 1.5024-6 293 end
o              1  0.0 4.3763-2 293 end
arbmzir2   6.44 14 0 0 1  40000 98.225 26000  0.125
  50112  0.015  50114  0.010  50115  0.005  50116  0.218  50117  0.115
  50118  0.363  50119  0.129  50120  0.489  50122  0.069  50124  0.087
                          24000  0.10    7014  0.05   2  end
al             3  1.0 293 end
h2o            4  1.0 293 end
boron          4  den=687.9-6     end
pb             5  1.0 293 end
end comp
squarepitch 1.778 1.2827 1  4  1.4351 2  end
epri .70inch pitch borated plutonium
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes
wrs=34  end parm
read geom
unit  1
com=!62 5/8 to 63 7/8!
cylinder   2 1 .71755 3.175 2.8575
cuboid     4 1     .889 -.889 .889 -.889 3.175 2.8575
cuboid     3 1     .889 -.889 .889 -.889 3.175 0
unit  2
com=!63 7/8 to 64 7/8!
cylinder   1 1 .64135 5.715 3.556
cylinder   2 1 .71755 5.715 3.175
cuboid     4 1     .73025 -.73025 .73025 -.73025 5.715 3.175
cuboid     3 1     .889 -.889 .889 -.889 5.715 3.175
unit  3
com=!64 7/8 to 99!
cylinder   1 1 .64135 92.3925 5.715
cylinder   2 1 .71755 92.3925 5.715
cuboid     4 1     .889 -.889 .889 -.889 92.3925 5.715
unit  4
com=!99 to 100!
cylinder   1 1 .64135 94.9325 92.3925
cylinder   2 1 .71755 94.9325 92.3925
```

```
cuboid     4 1     .73025 -.73025 .73025 -.73025 94.9325 92.3925
cuboid     3 1     .889 -.889 .889 -.889 94.9325 92.3925
unit  5
com=!100 to 100.725!
cylinder   1 1 .64135 94.996 94.9325
cylinder   2 1 .71755 95.8215 94.9325
cuboid     4 1     .889 -.889 .889 -.889 95.8215 94.9325
cuboid     5 1     .889 -.889 .889 -.889 96.774 94.9325
unit  6
com=!62 5/8 to 63 7/8 with no fuel!
cuboid     4 1     .889 -.889 .889 -.889 3.175 2.8575
cuboid     3 1     .889 -.889 .889 -.889 3.175 0
unit  7
com=!63 7/8 to 64 7/8 with no fuel!
cuboid     4 1     .73025 -.73025 .73025 -.73025 5.715 3.175
cuboid     3 1     .889 -.889 .889 -.889 5.715 3.175
unit  8
com=!64 7/8 to 99 with no fuel!
cuboid     4 1     .889 -.889 .889 -.889 92.3925 5.715
unit  9
com=!99 to 100 with no fuel!
cuboid     4 1     .73025 -.73025 .73025 -.73025 94.9325 92.3925
cuboid     3 1     .889 -.889 .889 -.889 94.9325 92.3925
unit  10
com=!100 to 100.725 with no fuel!
cuboid     4 1     .889 -.889 .889 -.889 95.8215 94.9325
cuboid     5 1     .889 -.889 .889 -.889 96.774 94.9325
global unit  11
com=!reflector region!
array      1   0 0 0
replicate  4 1 30 30 30 30 15.24 30  1
end geom
read array
ara=1 nux=31 nuy=31 nuz=5
com=!epri .70inch pitch borated plutonium!
fill
     12r6  7r1 21r6  13r1 16r6  17r1 12r6  21r1 9r6  23r1 7r6  25r1 3r6
q31
    2r6  27r1 2r6  q31 6  29r1 6  2q31 217r1 217b372
     12r7  7r2 21r7  13r2 16r7  17r2 12r7  21r2 9r7 23r2  7r7  25r2 3r7
q31
    2r7  27r2 2r7  q31 7  29r2 7  2q31 217r2 217b372
     12r8  7r3 21r8  13r3 16r8  17r3 12r8  21r3 9r8 23r3  7r8  25r3 3r8
q31
    2r8  27r3 2r8  q31 8  29r3 8  2q31 217r3 217b372
     12r9  7r4 21r9  13r4 16r9  17r4 12r9  21r4 9r9 23r4  7r9  25r4 3r9
q31
    2r9  27r4 2r9  q31 9  29r4 9  2q31 217r4 217b372
     12r10 7r5 21r10 13r5 16r10 17r5 12r10 21r5 9r10 23r5 7r10 25r5 3r10
q31
    2r10 27r5 2r10 q31 10 29r5 10 2q31 217r5 217b372     t
end fill
end array
read bnds +xb=vacuum -xb=vacuum +yb=vacuum -yb=vacuum +zb=vacuum
-zb=vacuum
  end bnds
read plot
ttl=!x-y cross-section at z=5.0cm!
plt=yes pic=mixture xul=-5 yul=-5 zul=5 xlr=60 ylr=60 zlr=5 uax=1 vax=0
wax=0
udn=0 vdn=1 wdn=0 nax=130  nch=' 123 5' end
end plot
end data
end
```

epri87un

```
#csas25
epri .87 inch pitch unborated plutonium
44group                 latticecell
u-234          1  0.0 1.2462-6 293 end
u-235          1  0.0 1.4891-4 293 end
u-236          1  0.0 2.0943-9 293 end
u-238          1  0.0 2.0619-2 293 end
pu-238         1  0.0 3.885-8 293 end
pu-239         1  0.0 3.9477-4 293 end
pu-240         1  0.0 3.3218-5 293 end
pu-241         1  0.0 1.6023-6 293 end
pu-242         1  0.0 1.1887-7 293 end
am-241         1  0.0 1.5024-6 293 end
o              1  0.0 4.3763-2 293 end
arbmzir2   6.44 14 0 0 1  40000 98.225 26000  0.125
  50112  0.015  50114  0.010  50115  0.005  50116  0.218  50117  0.115
  50118  0.363  50119  0.129  50120  0.489  50122  0.069  50124  0.087
                        24000  0.10    7014  0.05   2  end
al             3  1.0 293 end
h2o            4  1.0 293 end
boron          4  den=0.0     end
pb             5  1.0 293 end
end comp
squarepitch 2.2098 1.2827 1  4  1.4351 2  end
epri .87inch pitch unborated plutonium
read parm gen=805 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes tme=120
wrs=34  end parm
read geom
unit  1
com=!62 5/8 to 63 7/8!
cylinder   2 1 .71755 3.175 2.8575
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 3.175 2.8575
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 3.175 0
unit  2
com=!63 7/8 to 64 7/8!
cylinder   1 1 .64135 5.715 3.556
cylinder   2 1 .71755 5.715 3.175
cuboid     4 1     1.06426 -1.06426 1.06426 -1.06426 5.715 3.175
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 5.715 3.175
unit  3
com=!64 7/8 to 99!
cylinder   1 1 .64135 92.3925 5.715
cylinder   2 1 .71755 92.3925 5.715
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 92.3925 5.715
unit  4
com=!99 to 100!
cylinder   1 1 .64135 94.9325 92.3925
cylinder   2 1 .71755 94.9325 92.3925
cuboid     4 1     1.06426 -1.06426 1.06426 -1.06426 94.9325 92.3925
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 94.9325 92.3925
```

```
unit  5
com=!100 to 100.725!
cylinder   1 1 .64135 94.996 94.9325
cylinder   2 1 .71755 95.8215 94.9325
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 95.8215 94.9325
cuboid     5 1     1.1049 -1.1049 1.1049 -1.1049 96.774 94.9325
unit  6
com=!62 5/8 to 63 7/8 with no fuel!
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 3.175 2.8575
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 3.175 0
unit  7
com=!63 7/8 to 64 7/8 with no fuel!
cuboid     4 1     1.06426 -1.06426 1.06426 -1.06426 5.715 3.175
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 5.715 3.175
unit  8
com=!64 7/8 to 99 with no fuel!
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 92.3925 5.715
unit  9
com=!99 to 100 with no fuel!
cuboid     4 1     1.06426 -1.06426 1.06426 -1.06426 94.9325 92.3925
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 94.9325 92.3925
unit  10
com=!100 to 100.725 with no fuel!
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 95.8215 94.9325
cuboid     5 1     1.1049 -1.1049 1.1049 -1.1049 96.774 94.9325
global unit  11
com=!reflector region!
array      1   0 0 0
replicate  4 1 30 30 30 30 5.715 30  1
end geom
read array
ara=1 nux=17 nuy=17 nuz=5
com=!epri .87inch pitch unborated plutonium!
fill
    7r6  3r1 7r6 5r6 6r1 6r6 4r6 9r1 4r6 3r6 11r1 3r6 2r6 13r1 2r6 6
15r1 6
     q17 51r1 51b119
    7r7  3r2 12r7    6r2 10r7    9r2 7r7     11r2 5r7     13r2 3r7
15r2 7
     q17 51r2 51b119
    7r8  3r3 12r8    6r3 10r8    9r3 7r8     11r3 5r8     13r3 3r8
15r3 8
     q17 51r3 51b119
    7r9  3r4 12r9    6r4 10r9    9r4 7r9     11r4 5r9     13r4 3r9
15r4 9
     q17 51r4 51b119
    7r10 3r5 12r10   6r5 10r10   9r5 7r10    11r5 5r10    13r5 3r10
15r5 10
     q17 51r5 51b119  t
end fill
end array
read bnds +xb=vacuum -xb=vacuum +yb=vacuum -yb=vacuum +zb=vacuum
-zb=vacuum
  end bnds
read plot
ttl=!x-y cross-section at z=5.0cm!
plt=yes pic=mixture xul=-5 yul=-5 zul=5 xlr=40 ylr=40 zlr=5 uax=1 vax=0
wax=0
udn=0 vdn=1 wdn=0 nax=130 nch=' 123 5'  end
end plot
end data
end
```

epri87b

```
#csas25
epri .87 inch pitch borated plutonium
44group                 latticecell
u-234          1  0.0 1.2462-6 293 end
u-235          1  0.0 1.4891-4 293 end
u-236          1  0.0 2.0943-9 293 end
u-238          1  0.0 2.0619-2 293 end
pu-238         1  0.0 3.885-8 293 end
pu-239         1  0.0 3.9477-4 293 end
pu-240         1  0.0 3.3218-5 293 end
pu-241         1  0.0 1.6023-6 293 end
pu-242         1  0.0 1.1887-7 293 end
am-241         1  0.0 1.5024-6 293 end
o              1  0.0 4.3763-2 293 end
arbmzir2   6.44 14 0 0 1  40000 98.225 26000  0.125
  50112  0.015  50114  0.010  50115  0.005  50116  0.218  50117  0.115
  50118  0.363  50119  0.129  50120  0.489  50122  0.069  50124  0.087
                        24000  0.10    7014  0.05   2  end
al             3  1.0 293 end
h2o            4  1.0 293 end
boron          4  den=1090.4-6     end
pb             5  1.0 293 end
end comp
squarepitch 2.2098 1.2827 1  4  1.4351 2  end
epri .87inch pitch borated plutonium
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes
wrs=34  end parm
read geom
unit  1
com=!62 5/8 to 63 7/8!
cylinder   2 1 .71755 3.175 2.8575
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 3.175 2.8575
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 3.175 0
unit  2
com=!63 7/8 to 64 7/8!
cylinder   1 1 .64135 5.715 3.556
cylinder   2 1 .71755 5.715 3.175
cuboid     4 1     1.06426 -1.06426 1.06426 -1.06426 5.715 3.175
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 5.715 3.175
unit  3
com=!64 7/8 to 99!
cylinder   1 1 .64135 92.3925 5.715
cylinder   2 1 .71755 92.3925 5.715
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 92.3925 5.715
unit  4
com=!99 to 100!
cylinder   1 1 .64135 94.9325 92.3925
cylinder   2 1 .71755 94.9325 92.3925
cuboid     4 1     1.06426 -1.06426 1.06426 -1.06426 94.9325 92.3925
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 94.9325 92.3925
unit  5
com=!100 to 100.725!
```

```
cylinder   1 1 .64135 94.996 94.9325
cylinder   2 1 .71755 95.8215 94.9325
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 95.8215 94.9325
cuboid     5 1     1.1049 -1.1049 1.1049 -1.1049 96.774 94.9325
unit  6
com=!62 5/8 to 63 7/8 with no fuel!
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 3.175 2.8575
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 3.175 0
unit  7
com=!63 7/8 to 64 7/8 with no fuel!
cuboid     4 1     1.06426 -1.06426 1.06426 -1.06426 5.715 3.175
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 5.715 3.175
unit  8
com=!64 7/8 to 99 with no fuel!
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 92.3925 5.715
unit  9
com=!99 to 100 with no fuel!
cuboid     4 1     1.06426 -1.06426 1.06426 -1.06426 94.9325 92.3925
cuboid     3 1     1.1049 -1.1049 1.1049 -1.1049 94.9325 92.3925
unit  10
com=!100 to 100.725 with no fuel!
cuboid     4 1     1.1049 -1.1049 1.1049 -1.1049 95.8215 94.9325
cuboid     5 1     1.1049 -1.1049 1.1049 -1.1049 96.774 94.9325
global unit  11
com=!reflector region!
array      1   0 0 0
replicate  4 1 30 30 30 30 15.24 30  1
end geom
read array
ara=1 nux=31 nuy=31 nuz=5
com=!epri .87inch pitch borated plutonium!
fill
    12r6 7r1 12r6 9r6 13r1 9r6 7r6 17r1 7r6 5r6 21r1 5r6 4r6 23r1 4r6
     3r6 25r1 3r6 q31 2r6 27r1 2r6 q31 6 29r1 6 2q31 217r1 217b372
    12r7 7r2 21r7     13r2 16r7    17r2 12r7    21r2 9r7     23r2 4r7
     3r7 25r2 3r7 q31 2r7 27r2 2r7 q31 7 29r2 7 2q31 217r2 217b372
    12r8 7r3 21r8     13r3 16r8    17r3 12r8    21r3 9r8     23r3 4r8
     3r8 25r3 3r8 q31 2r8 27r3 2r8 q31 8 29r3 8 2q31 217r3 217b372
    12r9 7r4 21r9     13r4 16r9    17r4 12r9    21r4 9r9     23r4 4r9
     3r9 25r4 3r9 q31 2r9 27r4 2r9 q31 9 29r4 9 2q31 217r4 217b372
   12r10 7r5 21r10    13r5 16r10   17r5 12r10   21r5 9r10    23r5 4r10
    3r10 25r5 3r10 q31 2r10 27r5 2r10 q31 10 29r5 10 2q31 217r5 217b372
t
end fill
end array
read bnds +xb=vacuum -xb=vacuum +yb=vacuum -yb=vacuum +zb=vacuum
-zb=vacuum
  end bnds
read plot
ttl=!x-y cross-section at z=5.0cm!
plt=yes pic=mixture xul=-5 yul=-5 zul=5 xlr=70 ylr=70 zlr=5 uax=1 vax=0
wax=0
udn=0 vdn=1 wdn=0 nax=130  nch=' 123 5'  end
end plot
end data
end
```

epri99un

```
#csas25
epri .99 inch pitch unborated pu
44group               latticecell
u-234          1  0.0 1.2462-6 293 end
u-235          1  0.0 1.4891-4 293 end
u-236          1  0.0 2.0943-9 293 end
u-238          1  0.0 2.0619-2 293 end
pu-238         1  0.0 3.885-8 293 end
pu-239         1  0.0 3.9477-4 293 end
pu-240         1  0.0 3.3218-5 293 end
pu-241         1  0.0 1.6023-6 293 end
pu-242         1  0.0 1.1887-7 293 end
am-241         1  0.0 1.5024-6 293 end
o              1  0.0 4.3763-2 293 end
arbmzir2   6.44 14 0 0 1  40000 98.225 26000  0.125
  50112  0.015  50114  0.010  50115  0.005  50116  0.218  50117  0.115
  50118  0.363  50119  0.129  50120  0.489  50122  0.069  50124  0.087
                        24000  0.10    7014  0.05   2  end
al             3  1.0 293 end
h2o            4  1.0 293 end
boron          4  den=0.0     end
pb             5  1.0 293 end
end comp
squarepitch 2.5146 1.2827 1  4  1.4351 2  end
epri .99inch pitch unborated plutonium
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes tme=60
wrs=34 end parm
read geom
unit  1
com=!62 5/8 to 63 7/8!
cylinder   2 1 .71755 3.175 2.8575
cuboid     4 1     1.2573 -1.2573 1.2573 -1.2573 3.175 2.8575
cuboid     3 1     1.2573 -1.2573 1.2573 -1.2573 3.175 0
unit  2
com=!63 7/8 to 64 7/8!
cylinder   1 1 .64135 5.715 3.556
cylinder   2 1 .71755 5.715 3.175
cuboid     4 1     1.09855 -1.09855 1.09855 -1.09855 5.715 3.175
cuboid     3 1     1.2573 -1.2573 1.2573 -1.2573 5.715 3.175
unit  3
com=!64 7/8 to 99!
cylinder   1 1 .64135 92.3925 5.715
cylinder   2 1 .71755 92.3925 5.715
cuboid     4 1     1.2573 -1.2573 1.2573 -1.2573 92.3925 5.715
unit  4
com=!99 to 100!
cylinder   1 1 .64135 94.9325 92.3925
cylinder   2 1 .71755 94.9325 92.3925
cuboid     4 1     1.09855 -1.09855 1.09855 -1.09855 94.9325 92.3925
cuboid     3 1     1.2573 -1.2573 1.2573 -1.2573 94.9325 92.3925
unit  5
com=!100 to 100.725!
cylinder   1 1 .64135 94.996 94.9325
cylinder   2 1 .71755 95.8215 94.9325
cuboid     4 1     1.2573 -1.2573 1.2573 -1.2573 95.8215 94.9325
cuboid     5 1     1.2573 -1.2573 1.2573 -1.2573 96.774 94.9325
unit  6
```

```
com=!62 5/8 to 63 7/8 with no fuel!
cuboid     4 1     1.2573 -1.2573 1.2573 -1.2573 3.175 2.8575
cuboid     3 1     1.2573 -1.2573 1.2573 -1.2573 3.175 0
unit  7
com=!63 7/8 to 64 7/8 with no fuel!
cuboid     4 1     1.09855 -1.09855 1.09855 -1.09855 5.715 3.175
cuboid     3 1     1.2573 -1.2573 1.2573 -1.2573 5.715 3.175
unit  8
com=!64 7/8 to 99 with no fuel!
cuboid     4 1     1.2573 -1.2573 1.2573 -1.2573 92.3925 5.715
unit  9
com=!99 to 100 with no fuel!
cuboid     4 1     1.09855 -1.09855 1.09855 -1.09855 94.9325 92.3925
cuboid     3 1     1.2573 -1.2573 1.2573 -1.2573 94.9325 92.3925
unit  10
com=!100 to 100.725 with no fuel!
cuboid     4 1     1.2573 -1.2573 1.2573 -1.2573 95.8215 94.9325
cuboid     5 1     1.2573 -1.2573 1.2573 -1.2573 96.774 94.9325
global unit  11
com=!reflector region!
array      1   0 0 0
replicate  4 1 30 30 30 30 2.286 30  1
end geom
read array
ara=1 nux=17 nuy=17 nuz=5
com=!epri .99inch pitch unborated plutonium!
fill 8r6 1 8r6 7r6 3r1 7r6 5r6 7r1 5r6 4r6 9r1 4r6 3r6 11r1 3r6 2r6 13r1
2r6
     q17 6 15r1 6 17r1 17b136
     8r7 2 8r7 7r7 3r2 7r7 5r7 7r2 5r7 4r7 9r2 4r7 3r7 11r2 3r7 2r7 13r2
2r7
     q17 7 15r2 7 17r2 17b136
     8r8 3 8r8 7r8 3r3 7r8 5r8 7r3 5r8 4r8 9r3 4r8 3r8 11r3 3r8 2r8 13r3
2r8
     q17 8 15r3 8 17r3 17b136
     8r9 4 8r9 7r9 3r4 7r9 5r9 7r4 5r9 4r9 9r4 4r9 3r9 11r4 3r9 2r9 13r4
2r9
     q17 9 15r4 9 17r4 17b136
     8r10 5 15r10  3r5 12r10   7r5 9r10    9r5 7r10    11r5 5r10  13r5
2r10
     q17 10 15r5 10 17r5 17b136 t
end fill
end array
read bnds +xb=vacuum -xb=vacuum +yb=vacuum -yb=vacuum +zb=vacuum
-zb=vacuum
  end bnds
read plot
ttl=!x-y cross-section at z=5.0cm!
plt=yes pic=mixture xul=-5 yul=-5 zul=5 xlr=50 ylr=50 zlr=5 uax=1 vax=0
wax=0
udn=0 vdn=1 wdn=0 nax=130  end
end plot
end data
end
```

epri99b

```
#csas25
epri .99 inch pitch borated plutonium
44group                 latticecell
u-234          1  0.0 1.2462-6 293 end
u-235          1  0.0 1.4891-4 293 end
u-236          1  0.0 2.0943-9 293 end
u-238          1  0.0 2.0619-2 293 end
pu-238         1  0.0 3.885-8 293 end
pu-239         1  0.0 3.9477-4 293 end
pu-240         1  0.0 3.3218-5 293 end
pu-241         1  0.0 1.6023-6 293 end
pu-242         1  0.0 1.1887-7 293 end
am-241         1  0.0 1.5024-6 293 end
o              1  0.0 4.3763-2 293 end
arbmzir2   6.44 14 0 0 1  40000 98.225 26000  0.125
  50112  0.015  50114  0.010  50115  0.005  50116  0.218  50117  0.115
  50118  0.363  50119  0.129  50120  0.489  50122  0.069  50124  0.087
                        24000  0.10    7014  0.05   2  end
al             3  1.0 293 end
h2o            4  1.0 293 end
boron          4  den=767.25-6     end
pb             5  1.0 293 end
end comp
squarepitch 2.5146 1.2827 1  4  1.4351 2  end
epri .99inch pitch borated plutonium
read parm gen=805 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes
wrs=34  tme=60 end parm
read geom
unit  1
com=!62 5/8 to 63 7/8!
cylinder   2 1 .71755 3.175 2.8575
cuboid     4 1     1.2573 -1.2573 1.2573 -1.2573 3.175 2.8575
cuboid     3 1     1.2573 -1.2573 1.2573 -1.2573 3.175 0
unit  2
com=!63 7/8 to 64 7/8!
cylinder   1 1 .64135 5.715 3.556
cylinder   2 1 .71755 5.715 3.175
cuboid     4 1     1.09855 -1.09855 1.09855 -1.09855 5.715 3.175
cuboid     3 1     1.2573 -1.2573 1.2573 -1.2573 5.715 3.175
unit  3
com=!64 7/8 to 99!
cylinder   1 1 .64135 92.3925 5.715
cylinder   2 1 .71755 92.3925 5.715
cuboid     4 1     1.2573 -1.2573 1.2573 -1.2573 92.3925 5.715
unit  4
com=!99 to 100!
cylinder   1 1 .64135 94.9325 92.3925
cylinder   2 1 .71755 94.9325 92.3925
cuboid     4 1     1.09855 -1.09855 1.09855 -1.09855 94.9325 92.3925
cuboid     3 1     1.2573 -1.2573 1.2573 -1.2573 94.9325 92.3925
unit  5
com=!100 to 100.725!
cylinder   1 1 .64135 94.996 94.9325
cylinder   2 1 .71755 95.8215 94.9325
cuboid     4 1     1.2573 -1.2573 1.2573 -1.2573 95.8215 94.9325
cuboid     5 1     1.2573 -1.2573 1.2573 -1.2573 96.774 94.9325
unit  6
```

```
com=!62 5/8 to 63 7/8 with no fuel!
cuboid     4 1     1.2573 -1.2573 1.2573 -1.2573 3.175 2.8575
cuboid     3 1     1.2573 -1.2573 1.2573 -1.2573 3.175 0
unit  7
com=!63 7/8 to 64 7/8 with no fuel!
cuboid     4 1     1.09855 -1.09855 1.09855 -1.09855 5.715 3.175
cuboid     3 1     1.2573 -1.2573 1.2573 -1.2573 5.715 3.175
unit  8
com=!64 7/8 to 99 with no fuel!
cuboid     4 1     1.2573 -1.2573 1.2573 -1.2573 92.3925 5.715
unit  9
com=!99 to 100 with no fuel!
cuboid     4 1     1.09855 -1.09855 1.09855 -1.09855 94.9325 92.3925
cuboid     3 1     1.2573 -1.2573 1.2573 -1.2573 94.9325 92.3925
unit  10
com=!100 to 100.725 with no fuel!
cuboid     4 1     1.2573 -1.2573 1.2573 -1.2573 95.8215 94.9325
cuboid     5 1     1.2573 -1.2573 1.2573 -1.2573 96.774 94.9325
global unit  11
com=!reflector region!
array      1   0 0 0
replicate  4 1 30 30 30 30 15.24 30  1
end geom
read array
ara=1 nux=29 nuy=29 nuz=5
com=!epri .99inch pitch borated plutonium!
fill
     9r6 11r1 9r6 7r6 15r1 7r6 6r6 17r1 6r6 5r6 19r1 5r6 4r6 21r1 4r6
     3r6 23r1 3r6 2r6 25r1 2r6   6 27r1   6 q29 319r1 319b261
     9r7 11r2 16r7    15r2 13r7    17r2 11r7    19r2 9r7     21r2 4r7
     3r7 23r2 5r7     25r2 3r7     27r2   7 q29 319r2 319b261
     9r8 11r3 16r8    15r3 13r8    17r3 11r8    19r3 9r8     21r3 4r8
     3r8 23r3 5r8     25r3 3r8     27r3   8 q29 319r3 319b261
     9r9 11r4 16r9    15r4 13r9    17r4 11r9    19r4 9r9     21r4 4r9
     3r9 23r4 5r9     25r4 3r9     27r4   9 q29 319r4 319b261
    9r10 11r5 16r10   15r5 13r10   17r5 11r10   19r5 9r10    21r5 4r10
    3r10 23r5 5r10    25r5 3r10    27r5  10 q29 319r5 319b261  t
end fill
end array
read bnds +xb=vacuum -xb=vacuum +yb=vacuum -yb=vacuum +zb=vacuum
-zb=vacuum
  end bnds
read plot
ttl=!x-y cross-section at z=5.0cm!
plt=yes pic=mixture xul=-5 yul=-5 zul=5 xlr=75 ylr=75 zlr=5 uax=1 vax=0
wax=0
udn=0 vdn=1 wdn=0 nax=130 nch=' 123 5'  end
end plot
end data
end
```

saxton52

```
#csas25
saxton puo2-uo2 critical exp .52 inch pitch (wcap-3385-54)
44group                 latticecell
uo2           1  den=10.19 .934 298.8 end
puo2          1  den=10.19 .066 298.800 94239 90.49 94240 8.57 94241
.89
94242 .04 end
arbmzir2   6.44 14 0 0 1  40000 98.225 26000  0.125
  50112  0.015  50114  0.010  50115  0.005  50116  0.218  50117  0.115
  50118  0.363  50119  0.129  50120  0.489  50122  0.069  50124  0.087
                        24000  0.10    7014  0.05   2  end
h2o           3  1.0 298.800 end
al            4  1.0 298.800 end
end comp
squarepitch 1.3208 .857 1  3  .9931 2  .875 0  end
saxton puo2-uo2 critical exp. 0.52 inch pitch (wcap-3385-54)
read parm gen=805 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes tme=120
wrs=34  end parm
read geom
unit  1
com=!fuel pin (no fuel) in bottom plate, 0 to .25 inches!
cylinder   2 1 .4966 .635 0
cylinder   3 1 .5042 .635 0
cuboid     4 1     .6604 -.6604 .6604 -.6604 .635 0
unit  2
com=!fuel pin between lower plates, .25 to 18.75 inches!
cylinder   1 1 .4285 47.625 1.905
cylinder   0 1 .4375 47.625 1.905
cylinder   2 1 .4966 47.625 .635
cuboid     3 1     .6604 -.6604 .6604 -.6604 47.625 .635
unit  3
com=!fuel pin in middle plate, 18.75 to 19.0 inches!
cylinder   1 1 .4285 48.26 47.625
cylinder   0 1 .4375 48.26 47.625
cylinder   2 1 .4966 48.26 47.625
cylinder   3 1 .5042 48.26 47.625
cuboid     4 1     .6604 -.6604 .6604 -.6604 48.26 47.625
unit  4
com=!fuel pin above middle plate, 19.0 to 33.29 inches!
cylinder   1 1 .4285 84.56 48.26
cylinder   0 1 .4375 84.56 48.26
cylinder   2 1 .4966 84.56 48.26
cuboid     3 1     .6604 -.6604 .6604 -.6604 84.56 48.26
unit  5
com=!fuel pin above water, 33.29 to 37.35 inches!
cylinder   1 1 .4285 94.869 84.56
cylinder   0 1 .4375 94.869 84.56
cylinder   2 1 .4966 94.869 84.56
cuboid     0 1     .6604 -.6604 .6604 -.6604 94.869 84.56
unit  6
com=!top of fuel pin (no fuel), 37.35 to 37.75 inches!
cylinder   2 1 .4966 95.885 94.869
cuboid     0 1     .6604 -.6604 .6604 -.6604 95.885 94.869
unit  7
com=!fuel pin (no fuel) in top plate, 37.75 to 38.25 inch!
cylinder   2 1 .4966 97.155 95.885
cylinder   0 1 .5042 97.155 95.885
cuboid     4 1     .6604 -.6604 .6604 -.6604 97.155 95.885
unit  8
com=!22 x 23 core (in water)!
array      1   0 0 0
replicate  3 2 3 3 3 3 0 0  10
replicate  4 1 0 0 0 0 0 2.54  1
replicate  3 1 0 0 0 0 0 6.35  1
```

```
replicate  4 1 0 0 0 0 0 5.08  1
unit  9
com=!22 x 23 core (above water)!
array      2   0 0 0
replicate  0 1 30 30 30 30 0 0  1
end geom
read array
ara=1 nux=22 nuy=23 nuz=4
com=!22 x 23 fuel pin array (in water)!
fill 506r1 506r2 506r3 506r4  end fill
ara=2 nux=22 nuy=23 nuz=3
com=!22 x 23 fuel pin array (above water)!
fill 506r5 506r6 506r7  end fill
ara=3 gbl=3 nux=1 nuy=1 nuz=2
com=!complete fuel core!
fill 8 9  end fill
end array
read bias id=500  2  11   end bias
read plot
ttl=!x-y view of core!
plt=yes pic=mixture xul=29  yul=47 zul=62 xlr=47 ylr=29  zlr=62 uax=1
vax=0
wax=0 udn=0 vdn=-1 wdn=0 nax=130
nch=! 12 -                                                          ! end
ttl=!x-z view of core!
plt=yes pic=mixture xul=29 yul=45 zul=113 xlr=47 ylr=45 zlr=-1 uax=1
vax=0
wax=0 udn=0 vdn=0 wdn=-1 nax=130
nch=! 12./                                                          ! end
end plot
end data
end
```

saxton56

```
#csas25
saxton puo2-uo2 critical exp. 0.56 inch pitch (wcap-3385-54)
44group                 latticecell
uo2           1  den=10.19 .934 289.4 end
puo2          1  den=10.19 .066 289.4 94239 90.49 94240 8.57 94241 .89
94242 .04 end
arbmzir2   6.44 14 0 0 1  40000 98.225 26000  0.125
  50112  0.015  50114  0.010  50115  0.005  50116  0.218  50117  0.115
  50118  0.363  50119  0.129  50120  0.489  50122  0.069  50124  0.087
                         24000  0.10    7014  0.05   2  end
h2o           3  1.0 289.4 end
al            4  1.0 289.4 end
end comp
squarepitch 1.4224 .857 1  3  .9931 2  .875 0  end
saxton puo2-uo2 critical exp. 0.56 inch pitch (wcap-3385-54)
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes tme=60
wrs=34 end parm
read geom
unit  1
com=!fuel pin (no fuel) in bottom plate, 0 to .25 inches!
cylinder   2 1 .4966 .635 0
cylinder   3 1 .5042 .635 0
cuboid     4 1     .7112 -.7112 .7112 -.7112 .635 0
unit  2
com=!fuel pin between lower plates, .25 to 18.75 inches!
cylinder   1 1 .4285 47.625 1.905
cylinder   0 1 .4375 47.625 1.905
cylinder   2 1 .4966 47.625 .635
cuboid     3 1     .7112 -.7112 .7112 -.7112 47.625 .635
unit  3
com=!fuel pin in middle plate, 18.75 to 19.0 inches!
cylinder   1 1 .4285 48.26 47.625
cylinder   0 1 .4375 48.26 47.625
cylinder   2 1 .4966 48.26 47.625
cylinder   3 1 .5042 48.26 47.625
cuboid     4 1     .7112 -.7112 .7112 -.7112 48.26 47.625
unit  4
com=!fuel pin above middle plate, 19.0 to 32.66 inches!
cylinder   1 1 .4285 82.96 48.26
cylinder   0 1 .4375 82.96 48.26
cylinder   2 1 .4966 82.96 48.26
cuboid     3 1     .7112 -.7112 .7112 -.7112 82.96 48.26
unit  5
com=!fuel pin above water, 32.66 to 37.35 inches!
cylinder   1 1 .4285 94.869 82.96
cylinder   0 1 .4375 94.869 82.96
cylinder   2 1 .4966 94.869 82.96
cuboid     0 1     .7112 -.7112 .7112 -.7112 94.869 82.96
unit  6
com=!top of fuel pin (no fuel), 37.35 to 37.75 inches!
cylinder   2 1 .4966 95.885 94.869
cuboid     0 1     .7112 -.7112 .7112 -.7112 95.885 94.869
unit  7
com=!fuel pin (no fuel) in top plate, 37.75 to 38.25 inch!
cylinder   2 1 .4966 97.155 95.885
cylinder   0 1 .5042 97.155 95.885
cuboid     4 1     .7112 -.7112 .7112 -.7112 97.155 95.885
unit  8
com=!19 x 19 core (in water)!
array      1   0 0 0
replicate  3 2 3 3 3 3 0 0  10
replicate  4 1 0 0 0 0 0 2.54  1
replicate  3 1 0 0 0 0 0 6.35  1
replicate  4 1 0 0 0 0 0 5.08  1
unit  9
com=!19 x 19 core (above water)!
array      2   0 0 0
replicate  0 1 30 30 30 30 0 0  1
end geom
read array
ara=1 nux=19 nuy=19 nuz=4
com=!19 x 19 fuel pin array (in water)!
fill 361r1 361r2 361r3 361r4  end fill
ara=2 nux=19 nuy=19 nuz=3
com=!19 x 19 fuel pin array (above water)!
fill 361r5 361r6 361r7  end fill
ara=3 gbl=3 nux=1 nuy=1 nuz=2
com=!complete fuel core!
fill 8 9  end fill
end array
read bias id=500  2  11   end bias
read plot
```

```
ttl=!x-y view of core!
plt=yes pic=mixture xul=28  yul=44 zul=62 xlr=44 ylr=28  zlr=62 uax=1
vax=0
wax=0 udn=0 vdn=-1 wdn=0 nax=130
nch=! 12.-                                                              ! end
ttl=!x-z view of core!
plt=yes pic=mixture xul=28 yul=35 zul=113 xlr=44 ylr=35 zlr=65 uax=1
vax=0
wax=0 udn=0 vdn=0 wdn=-1 nax=130
nch=! 12./                                                              ! end
end plot
end data
end
```

saxtn56b

```
#csas25
saxton puo2-uo2 critical exp. 0.56 inch pitch with boron (wcap-3385-54)
44group              latticecell
uo2           1  den=10.19 .934 291.0 end
puo2          1  den=10.19 .066 291.0 94239 90.49 94240 8.57 94241 .89
94242 .04 end
arbmzir2   6.44 14 0 0 1  40000 98.225 26000  0.125
  50112  0.015  50114  0.010  50115  0.005  50116  0.218  50117  0.115
  50118  0.363  50119  0.129  50120  0.489  50122  0.069  50124  0.087
                        24000  0.10    7014  0.05   2  end
h2o           3  1.0 291.0 end
boron         3  den=337e-6  1  291.0 end
al            4  1.0 291.0 end
end comp
squarepitch 1.4224 .857 1  3  .9931 2  .875 0  end
saxton puo2-uo2 critical exp. 0.56 inch pitch with boron (wcap-3385-54)
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes
wrs=34 end parm
read geom
unit  1
com=!fuel pin (no fuel) in bottom plate, 0 to .25 inches!
cylinder   2 1 .4966 .635 0
cylinder   3 1 .5042 .635 0
cuboid     4 1     .7112 -.7112 .7112 -.7112 .635 0
unit  2
com=!fuel pin between lower plates, .25 to 18.75 inches!
cylinder   1 1 .4285 47.625 1.905
cylinder   0 1 .4375 47.625 1.905
cylinder   2 1 .4966 47.625 .635
cuboid     3 1     .7112 -.7112 .7112 -.7112 47.625 .635
unit  3
com=!fuel pin in middle plate, 18.75 to 19.0 inches!
cylinder   1 1 .4285 48.26 47.625
cylinder   0 1 .4375 48.26 47.625
cylinder   2 1 .4966 48.26 47.625
cylinder   3 1 .5042 48.26 47.625
cuboid     4 1     .7112 -.7112 .7112 -.7112 48.26 47.625
unit  4
com=!fuel pin above middle plate, 19.0 to 35.31 inches!
cylinder   1 1 .4285 89.70 48.26
cylinder   0 1 .4375 89.70 48.26
cylinder   2 1 .4966 89.70 48.26
cuboid     3 1     .7112 -.7112 .7112 -.7112 89.70 48.26
unit  5
com=!fuel pin above water, 35.31 to 37.35 inches!
cylinder   1 1 .4285 94.869 89.70
cylinder   0 1 .4375 94.869 89.70
cylinder   2 1 .4966 94.869 89.70
cuboid     0 1     .7112 -.7112 .7112 -.7112 94.869 89.70
unit  6
com=!top of fuel pin (no fuel), 37.35 to 37.75 inches!
cylinder   2 1 .4966 95.885 94.869
cuboid     0 1     .7112 -.7112 .7112 -.7112 95.885 94.869
unit  7
com=!fuel pin (no fuel) in top plate, 37.75 to 38.25 inch!
cylinder   2 1 .4966 97.155 95.885
cylinder   0 1 .5042 97.155 95.885
cuboid     4 1     .7112 -.7112 .7112 -.7112 97.155 95.885
unit  8
com=!21 x 21 core (in water)!
array      1   0 0 0
replicate  3 2 3 3 3 3 0 0  10
replicate  4 1 0 0 0 0 0 2.54  1
replicate  3 1 0 0 0 0 0 6.35  1
replicate  4 1 0 0 0 0 0 5.08  1
unit  9
com=!21 x 21 core (above water)!
array      2   0 0 0
replicate  0 1 30 30 30 30 0 0  1
end geom
read array
ara=1 nux=21 nuy=21 nuz=4
com=!21 x 21 fuel pin array (in water)!
fill 441r1 441r2 441r3 441r4  end fill
ara=2 nux=21 nuy=21 nuz=3
com=!21 x 21 fuel pin array (above water)!
fill 441r5 441r6 441r7  end fill
ara=3 gbl=3 nux=1 nuy=1 nuz=2
com=!complete fuel core!
fill 8 9  end fill
end array
read bias id=500  2  11   end bias
read plot
ttl=!x-y view of core!
plt=yes pic=mixture xul=28  yul=46 zul=62 xlr=46 ylr=28  zlr=62 uax=1
vax=0
wax=0 udn=0 vdn=-1 wdn=0 nax=130
nch=! 12.-                                                              ! end
ttl=!x-z view of core!
plt=yes pic=mixture xul=28 yul=35 zul=113 xlr=46 ylr=35 zlr=65 uax=1
vax=0
wax=0 udn=0 vdn=0 wdn=-1 nax=130
nch=! 12./                                                              ! end
end plot
end data
end
```

saxtn735

```
#csas25
saxton puo2-uo2 critical exp. 0.735 inch pitch (wcap-3385-54)
44group                 latticecell
uo2           1  den=10.19 .934 297.1 end
puo2          1  den=10.19 .066 297.1 94239 90.49 94240 8.57 94241 .89
94242 .04 end
arbmzir2   6.44 14 0 0 1  40000 98.225 26000  0.125
  50112  0.015  50114  0.010  50115  0.005  50116  0.218  50117  0.115
  50118  0.363  50119  0.129  50120  0.489  50122  0.069  50124  0.087
                       24000  0.10    7014  0.05   2  end
h2o           3  1.0 297.1 end
al            4  1.0 297.1 end
end comp
squarepitch 1.8669 .857 1  3  .9931 2  .875 0  end
saxton puo2-uo2 critical exp. 0.735 inch pitch (wcap-3385-54)
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes tme=60
wrs=34 end parm
read geom
unit  1
com=!fuel pin (no fuel) in bottom plate, 0 to .25 inches!
cylinder   2 1 .4966 .635 0
cylinder   3 1 .5042 .635 0
cuboid     4 1     .93345 -.93345 .93345 -.93345 .635 0
unit  2
com=!fuel pin between lower plates, .25 to 18.75 inches!
cylinder   1 1 .4285 47.625 1.905
cylinder   0 1 .4375 47.625 1.905
cylinder   2 1 .4966 47.625 .635
cuboid     3 1     .93345 -.93345 .93345 -.93345 47.625 .635
unit  3
com=!fuel pin in middle plate, 18.75 to 19.0 inches!
cylinder   1 1 .4285 48.26 47.625
cylinder   0 1 .4375 48.26 47.625
cylinder   2 1 .4966 48.26 47.625
cylinder   3 1 .5042 48.26 47.625
cuboid     4 1     .93345 -.93345 .93345 -.93345 48.26 47.625
unit  4
com=!fuel pin above middle plate, 19.0 to 27.60 inches!
cylinder   1 1 .4285 70.11 48.26
cylinder   0 1 .4375 70.11 48.26
cylinder   2 1 .4966 70.11 48.26
cuboid     3 1     .93345 -.93345 .93345 -.93345 70.11 48.26
unit  5
com=!fuel pin above water, 27.60 to 37.35 inches!
cylinder   1 1 .4285 94.869 70.11
cylinder   0 1 .4375 94.869 70.11
cylinder   2 1 .4966 94.869 70.11
cuboid     0 1     .93345 -.93345 .93345 -.93345 94.869 70.11
unit  6
com=!top of fuel pin (no fuel), 37.35 to 37.75 inches!
cylinder   2 1 .4966 95.885 94.869
cuboid     0 1     .93345 -.93345 .93345 -.93345 95.885 94.869
unit  7
com=!fuel pin (no fuel) in top plate, 37.75 to 38.25 inch!
cylinder   2 1 .4966 97.155 95.885
cylinder   0 1 .5042 97.155 95.885
cuboid     4 1     .93345 -.93345 .93345 -.93345 97.155 95.885
unit  8
com=!13 x 13 core (in water)!
array      1   0 0 0
replicate  3 2 3 3 3 3 0 0  10
replicate  4 1 0 0 0 0 0 2.54  1
replicate  3 1 0 0 0 0 0 6.35  1
replicate  4 1 0 0 0 0 0 5.08  1
unit  9
com=!13 x 13 core (above water)!
array      2   0 0 0
replicate  0 1 30 30 30 30 0 0  1
end geom
read array
ara=1 nux=13 nuy=13 nuz=4
com=!13 x 13 fuel pin array (in water)!
fill 169r1 169r2 169r3 169r4  end fill
ara=2 nux=13 nuy=13 nuz=3
com=!13 x 13 fuel pin array (above water)!
fill 169r5 169r6 169r7  end fill
ara=3 gbl=3 nux=1 nuy=1 nuz=2
com=!complete fuel core!
fill 8 9  end fill
end array
read bias id=500  2  11   end bias
read plot
ttl=!x-y view of core!
plt=yes pic=mixture xul=28  yul=42 zul=62 xlr=42 ylr=28  zlr=62 uax=1
vax=0
wax=0 udn=0 vdn=-1 wdn=0 nax=130
nch=! 12.-                                                              ! end
ttl=!x-z view of core!
plt=yes pic=mixture xul=28 yul=44 zul=113 xlr=42 ylr=44 zlr=0  uax=1
vax=0
wax=0 udn=0 vdn=0 wdn=-1 nax=130
nch=! 12./                                                              ! end
end plot
end data
end
```

saxtn792

```
#csas25
saxton puo2-uo2 critical exp. 0.792 inch pitch (wcap-3385-54)
44group                 latticecell
uo2           1  den=10.19 .934 289.1 end
puo2          1  den=10.19 .066 289.1 94239 90.49 94240 8.57 94241 .89
94242 .04 end
arbmzir2   6.44 14 0 0 1  40000 98.225 26000  0.125
  50112  0.015  50114  0.010  50115  0.005  50116  0.218  50117  0.115
  50118  0.363  50119  0.129  50120  0.489  50122  0.069  50124  0.087
                       24000  0.10    7014  0.05   2  end
h2o           3  1.0 289.1 end
al            4  1.0 289.1 end
end comp
squarepitch 2.01168  .857 1  3  .9931 2  .875 0  end
saxton puo2-uo2 critical exp. 0.792 inch pitch (wcap-3385-54)
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes tme=60
wrs=34 end parm
```

```
read geom
unit  1
com=!fuel pin (no fuel) in bottom plate, 0 to .25 inches!
cylinder   2 1 .4966 .635 0
cylinder   3 1 .5042 .635 0
cuboid     4 1     1.00584 -1.00584 1.00584 -1.00584 .635 0
unit  2
com=!fuel pin between lower plates, .25 to 18.75 inches!
cylinder   1 1 .4285 47.625 1.905
cylinder   0 1 .4375 47.625 1.905
cylinder   2 1 .4966 47.625 .635
cuboid     3 1     1.00584 -1.00584 1.00584 -1.00584 47.625 .635
unit  3
com=!fuel pin in middle plate, 18.75 to 19.0 inches!
cylinder   1 1 .4285 48.26 47.625
cylinder   0 1 .4375 48.26 47.625
cylinder   2 1 .4966 48.26 47.625
cylinder   3 1 .5042 48.26 47.625
cuboid     4 1     1.00584 -1.00584 1.00584 -1.00584 48.26 47.625
unit  4
com=!fuel pin above middle plate, 19.0 to 30.88 inches!
cylinder   1 1 .4285 78.43 48.26
cylinder   0 1 .4375 78.43 48.26
cylinder   2 1 .4966 78.43 48.26
cuboid     3 1     1.00584 -1.00584 1.00584 -1.00584 78.43 48.26
unit  5
com=!fuel pin above water, 30.88 to 37.35 inches!
cylinder   1 1 .4285 94.869 78.43
cylinder   0 1 .4375 94.869 78.43
cylinder   2 1 .4966 94.869 78.43
cuboid     0 1     1.00584 -1.00584 1.00584 -1.00584 94.869 78.43
unit  6
com=!top of fuel pin (no fuel), 37.35 to 37.75 inches!
cylinder   2 1 .4966 95.885 94.869
cuboid     0 1     1.00584 -1.00584 1.00584 -1.00584 95.885 94.869
unit  7
com=!fuel pin (no fuel) in top plate, 37.75 to 38.25 inch!
cylinder   2 1 .4966 97.155 95.885
cylinder   0 1 .5042 97.155 95.885
cuboid     4 1     1.00584 -1.00584 1.00584 -1.00584 97.155 95.885
unit  8
com=!12 x 12 core (in water)!
array      1   0 0 0
replicate  3 2 3 3 3 3 0 0  10
replicate  4 1 0 0 0 0 0 2.54  1
replicate  3 1 0 0 0 0 0 6.35  1
replicate  4 1 0 0 0 0 0 5.08  1
unit  9
com=!12 x 12 core (above water)!
array      2   0 0 0
replicate  0 1 30 30 30 30 0 0  1
end geom
read array
ara=1 nux=12 nuy=12 nuz=4
com=!12 x 12 fuel pin array (in water)!
fill 144r1 144r2 144r3 144r4  end fill
ara=2 nux=12 nuy=12 nuz=3
com=!12 x 12 fuel pin array (above water)!
fill 144r5 144r6 144r7  end fill
ara=3 gbl=3 nux=1 nuy=1 nuz=2
com=!complete fuel core!
fill 8 9  end fill
end array
read bias id=500  2  11   end bias
read plot
ttl=!x-y view of core!
plt=yes pic=mixture xul=28  yul=42 zul=60 xlr=42 ylr=28  zlr=60 uax=1
vax=0
wax=0 udn=0 vdn=-1 wdn=0 nax=130
nch=! 12.-                                                              ! end
ttl=!x-z view of core!
plt=yes pic=mixture xul=28 yul=31 zul=113 xlr=42 ylr=31 zlr=0  uax=1
vax=0
wax=0 udn=0 vdn=0 wdn=-1 nax=130
nch=! 12./                                                              ! end
end plot
end data
end
```

saxtn104

```
#csas25
saxton puo2-uo2 critical exp. 01.04 inch pitch (wcap-3385-54)
44group              latticecell
uo2            1  den=10.19 .934 292.9 end
puo2           1  den=10.19 .066 292.9 94239 90.49 94240 8.57 94241 .89
94242 .04 end
arbmzir2   6.44 14 0 0 1  40000 98.225 26000  0.125
  50112  0.015  50114  0.010  50115  0.005  50116  0.218  50117  0.115
  50118  0.363  50119  0.129  50120  0.489  50122  0.069  50124  0.087
                         24000  0.10    7014  0.05   2  end
h2o            3  1.0 292.9 end
al             4  1.0 292.9 end
end comp
squarepitch 2.6416 .857 1  3  .9931 2  .875 0  end
saxton puo2-uo2 critical exp. 01.04 inch pitch (wcap-3385-54)
read parm gen=405 npg=600 nsk=5 res=205 nub=yes run=yes plt=yes tme=60
wrs=34 end parm
read geom
unit  1
com=!fuel pin (no fuel) in bottom plate, 0 to .25 inches!
cylinder   2 1 .4966 .635 0
cylinder   3 1 .5042 .635 0
cuboid     4 1     1.3208 -1.3208 1.3208 -1.3208 .635 0
unit  2
com=!fuel pin between lower plates, .25 to 18.75 inches!
cylinder   1 1 .4285 47.625 1.905
cylinder   0 1 .4375 47.625 1.905
cylinder   2 1 .4966 47.625 .635
cuboid     3 1     1.3208 -1.3208 1.3208 -1.3208 47.625 .635
unit  3
com=!fuel pin in middle plate, 18.75 to 19.0 inches!
cylinder   1 1 .4285 48.26 47.625
cylinder   0 1 .4375 48.26 47.625
cylinder   2 1 .4966 48.26 47.625
cylinder   3 1 .5042 48.26 47.625
cuboid     4 1     1.3208 -1.3208 1.3208 -1.3208 48.26 47.625
```

```
unit  4
com=!fuel pin above middle plate, 19.0 to 31.96 inches!
cylinder   1 1 .4285 81.17 48.26
cylinder   0 1 .4375 81.17 48.26
cylinder   2 1 .4966 81.17 48.26
cuboid     3 1     1.3208 -1.3208 1.3208 -1.3208 81.17 48.26
unit  5
com=!fuel pin above water, 31.96 to 37.35 inches!
cylinder   1 1 .4285 94.869 81.17
cylinder   0 1 .4375 94.869 81.17
cylinder   2 1 .4966 94.869 81.17
cuboid     0 1     1.3208 -1.3208 1.3208 -1.3208 94.869 81.17
unit  6
com=!top of fuel pin (no fuel), 37.35 to 37.75 inches!
cylinder   2 1 .4966 95.885 94.869
cuboid     0 1     1.3208 -1.3208 1.3208 -1.3208 95.885 94.869
unit  7
com=!fuel pin (no fuel) in top plate, 37.75 to 38.25 inch!
cylinder   2 1 .4966 97.155 95.885
cylinder   0 1 .5042 97.155 95.885
cuboid     4 1     1.3208 -1.3208 1.3208 -1.3208 97.155 95.885
unit  8
com=!11 x 11 core (in water)!
array      1   0 0 0
replicate  3 2 3 3 3 3 0 0  10
replicate  4 1 0 0 0 0 0 2.54  1
replicate  3 1 0 0 0 0 0 6.35  1
replicate  4 1 0 0 0 0 0 5.08  1
unit  9
com=!11 x 11 core (above water)!
array      2   0 0 0
replicate  0 1 30 30 30 30 0 0  1
end geom
read array
ara=1 nux=11 nuy=11 nuz=4
com=!11 x 11 fuel pin array (in water)!
fill 121r1 121r2 121r3 121r4  end fill
ara=2 nux=11 nuy=11 nuz=3
com=!11 x 11 fuel pin array (above water)!
fill 121r5 121r6 121r7  end fill
ara=3 gbl=3 nux=1 nuy=1 nuz=2
com=!complete fuel core!
fill 8 9  end fill
end array
read bias id=500  2  11   end bias
read plot
ttl=!x-y view of core!
plt=yes pic=mixture xul=28  yul=45 zul=62 xlr=45 ylr=28  zlr=62 uax=1
vax=0
wax=0 udn=0 vdn=-1 wdn=0 nax=130
nch=! 12.-                                                    ! end
ttl=!x-z view of core!
plt=yes pic=mixture xul=28 yul=34 zul=113 xlr=44 ylr=34 zlr=0  uax=1
vax=0
wax=0 udn=0 vdn=0 wdn=-1 nax=130
nch=! 12./                                                    ! end
end plot
end data
end
```



```
#csas2x
exp.no 021(063) pitch=0.968 (fuel region = pin-array+mix500 with lattice
plate)
44group                    latticecell
pu-238         1  den=9.830 0.000111 293 end
pu-239         1  den=9.830 0.171251 293 end
pu-240         1  den=9.830 0.023150 293 end
pu-241         1  den=9.830 0.002511 293 end
am-241         1  den=9.830 0.000962 293 end
pu-242         1  den=9.830 0.000381 293 end
u-235          1  den=9.830 0.004853 293 end
u-238          1  den=9.830 0.678638 293 end
o              1  den=9.830 0.118143 293 end
pu-238         2  den=9.830 0.000111 293 end
pu-239         2  den=9.830 0.171251 293 end
pu-240         2  den=9.830 0.023150 293 end
pu-241         2  den=9.830 0.002511 293 end
am-241         2  den=9.830 0.000962 293 end
pu-242         2  den=9.830 0.000381 293 end
u-235          2  den=9.830 0.004853 293 end
u-238          2  den=9.830 0.678638 293 end
o              2  den=9.830 0.118143 293 end
ss316          5  1.0 293 end
h2o            6  1.0 293 end
'
uo2            10  den=10.42 1.0 293 end
'inconel       11
ni             11  den=8.30 0.73 end
cr             11  den=8.30 0.15 end
fe             11  den=8.30 0.07 end
ti             11  den=8.30 0.025 end
si             11  den=8.30 0.025 end
ss316          12  1.0 293 end
h2o            13  1.0 293 end
poly(h2o)      14  den=0.904 end
plexiglass     15  1.0 293 end
carbonsteel    16  1.0 293 end
al             17  1.0 293 end
end comp
squarepitch 0.968 .49403 1  6  .5842 5  .508 0  end
more data  res=2  cylinder  0.247  dan(2)=1.87943-1  end more
'======================== keno data ==============================
exp.no 021(063) pitch=968 (fuel region = pin array + mix 500 with
lattice plate)
read parm run=yes plt=yes npg=600 gen=805 nsk=5 nub=yes res=205 wrs=34
tme=120 end parm
read geom
'
unit  1
com=/region under bottom of fuel pin/
cuboid    15 1  25.4 -25.4  25.7 -3.5  14.61 9.53
cylinder  13 1  56.0   14.61  0.95
cylinder  16 1  56.31  14.61  0.0
cuboid     0 1  57.0 -57.0  57.0  -57.0  14.61 0.0
unit  2
com=/fuel pin between lower lattice plate and base plate/
cylinder  11 1  0.254   29.85    18.67
```

```
cylinder  12 1  0.2921  29.85    14.61
cuboid    13 1  0.484  -0.484  0.484 -0.484  29.85 14.61
unit  3
com=/region between lower lattice plate and base plate/
array  1  -12.584  -1.452  14.61
cylinder  13 1  56.0   29.85  14.61
cylinder  16 1  56.31  29.85  14.61
cuboid     0 1  57.0 -57.0  57.0  -57.0  29.85 14.61
unit  4
com=/fuel pin within lower lattice plate/
cylinder  11 1  0.254   31.16  29.85
cylinder  12 1  0.2921  31.16  29.85
cylinder  13 1  0.301   31.16  29.85
cuboid    14 1  0.484  -0.484  0.484 -0.484  31.16 29.85
unit  5
com=/region of lower lattice plate/
array  2  -12.584  -1.452  29.85
cuboid    14 1  25.4 -25.4  25.7 -3.5  31.16 29.85
cylinder  13 1  56.0   31.16  29.85
cylinder  16 1  56.31  31.16  29.85
cuboid     0 1  57.0 -57.0  57.0  -57.0  31.16 29.85
unit  6
com=/fuel pin between bottom of fuel region and lower lattice plate/
cylinder  10 1  0.254   35.18    33.148
cylinder  11 1  0.254   35.18    31.16
cylinder  12 1  0.2921  35.18    31.16
cuboid    13 1  0.484  -0.484  0.484 -0.484  35.18 31.16
unit  7
com=/region between bottom of fuel region and lower lattice plate/
array  3  -12.584  -1.452  31.16
cylinder  13 1  56.0   35.18  31.16
cylinder  16 1  56.31  35.18  31.16
cuboid     0 1  57.0 -57.0  57.0  -57.0  35.18 31.16
unit  8
com=/fuel pin between middle latice plate and bottom of fuel region/
cylinder   2 1  0.247   80.65   35.18
cylinder   0 1  0.254   80.65   35.18
cylinder  12 1  0.2921  80.65   35.18
cuboid    13 1  0.484  -0.484  0.484 -0.484  80.65 35.18
unit  9
com=/region between middle latice plate and bototm of fuel region/
array  4  -11.616  -1.452  35.18
replicate 500 1 0.0 0.840 4r0.0 1
cylinder  13 1  56.0   80.65  35.18
cylinder  16 1  56.31  80.65  35.18
cuboid     0 1  57.0 -57.0  57.0  -57.0  80.65 35.18
unit  10
com=/fuel pin within middle lattice plate/
cylinder   2 1  0.247   81.96  80.65
cylinder   0 1  0.254   81.96  80.65
cylinder  12 1  0.2921  81.96  80.65
cylinder  13 1  0.301   81.96  80.65
cuboid    14 1  0.484  -0.484  0.484 -0.484  81.96 80.65
unit  11
com=/region of middle lattice plate/
array  5  -11.616  -1.452  80.65
replicate 500 1 0.0 0.840 4r0.0 1
cuboid    14 1  25.4  -25.4   25.7    -3.5    81.96 80.65
cylinder  13 1  56.0   81.96  80.65
cylinder  16 1  56.31  81.96  80.65
cuboid     0 1  57.0 -57.0  57.0  -57.0  81.96 80.65
unit  12
com=/fuel pin between top of fuel region and middle latice plate/
cylinder   2 1  0.247   126.62  81.96
cylinder   0 1  0.254   126.62  81.96
cylinder  12 1  0.2921  126.62  81.96
cuboid    13 1  0.484  -0.484  0.484 -0.484  126.62 81.96
unit  13
com=/region between top of fuel region and midle lattice plate/
array  6  -11.616  -1.452  81.96
replicate 500 1 0.0 0.840 4r0.0 1
cylinder  13 1  56.0   126.62  81.96
cylinder  16 1  56.31  126.62  81.96
cuboid     0 1  57.0 -57.0  57.0  -57.0  126.62 81.96
unit  14
com=/fuel pin between upper lattice plate and top of fuel region/
cylinder  10 1  0.254   128.652  126.62
cylinder  11 1  0.254   131.45   126.62
cylinder  12 1  0.2921  131.45   126.62
cuboid    13 1  0.484  -0.484  0.484 -0.484  131.45 126.62
unit  15
com=/region between upper lattice plate and top of fuel region/
array  7  -12.584  -1.452  126.62
cylinder  13 1  56.0   131.45  126.62
cylinder  16 1  56.31  131.45  126.62
cuboid     0 1  57.0 -57.0  57.0  -57.0  131.45 126.62
unit  16
com=/fuel pin between water level and upper lattice plate/
cylinder  11 1  0.254   143.13   132.76
cylinder   0 1  0.254   146.7    132.76
cylinder  12 1  0.2921  146.7    132.76
cuboid    13 1  0.484  -0.484  0.484 -0.484  146.7 132.76
unit  17
com=/region between water level and upper lattice plate/
array  8  -12.584  -1.452  132.76
cylinder  13 1  56.0   146.7   132.76
cylinder  16 1  56.31  146.7   132.76
cuboid     0 1  57.0 -57.0  57.0  -57.0  146.7 132.76
'
global
unit  20
com=/whole system/
array  10  -57.0  -57.0  0.0
'
end geom
read array
com=/23x25 fuel pin array between lower lattice plate and base plate/
ara=1 nux=23 nuy=25 nuz=1 fill f2 end fill
com=/23x25 fuel pin array with lower lattice plate/
ara=2 nux=23 nuy=25 nuz=1 fill f4 end fill
com=/23x25 fuel pin array between fuel bottom and lower lattice plate/
ara=3 nux=23 nuy=25 nuz=1 fill f6 end fill
com=/22x25 fuel pin array between middle latice plate and fuel bottom/
ara=4 nux=22 nuy=25 nuz=1 fill f8 end fill
com=/22x25 fuel pin array with middle lattice plate/
ara=5 nux=22 nuy=25 nuz=1 fill f10 end fill
com=/22x25 fuel pin array between fuel top and midle lattice plate/
ara=6 nux=22 nuy=25 nuz=1 fill f12 end fill
```

```
com=/23x25 fuel pin array between upper lattice plate and fuel top/
ara=7 nux=23 nuy=25 nuz=1 fill f14 end fill
com=/23x25 fuel pin array between water level and upper lattice plate/
ara=8 nux=23 nuy=25 nuz=1 fill f16 end fill
com=/whole system/
ara=10 nux=1 nuy=1 nuz=10 fill 1 3 5 7 9 11 13 15 5 17 end fill
end array
'
read plot
ttl='x-y slice at z=15'
xul=6.0   yul=26.0 zul=15.0
xlr=10.0  ylr=18.0 zlr=15.0
uax=1.0 vax=0.0  wax=0.0
udn=0.0 vdn=-1.0 wdn=0.0
nax=130 nch='0fniswpac*'end
ttl='x-y slice at z=40'
xul=6.0   yul=26.0 zul=40.0
xlr=10.0  ylr=18.0 zlr=40.0  end
ttl='x-y slice at z=81'
xul=6.0   yul=26.0 zul=81.0
xlr=10.0  ylr=18.0 zlr=81.0  end
ttl='x-y slice at z=90 (full array)'
xul=-13   yul=24.0 zul=90.0
xlr=10.0  ylr=-2.0 zlr=90.0  end
ttl='x-y slice at z=132'
xul=6.0   yul=26.0 zul=132.0
xlr=10.0  ylr=18.0 zlr=132.0  end
end plot
end data
end
```

p5803x32

```
#csas2x
exp.no 032(060) pitch=1.935 (fuel region = pin-array+mix500 with lattice
plate)
44group                    latticecell
pu-238         1  den=9.830 0.000111 293 end
pu-239         1  den=9.830 0.171251 293 end
pu-240         1  den=9.830 0.023150 293 end
pu-241         1  den=9.830 0.002498 293 end
am-241         1  den=9.830 0.000975 293 end
pu-242         1  den=9.830 0.000381 293 end
u-235          1  den=9.830 0.004853 293 end
u-238          1  den=9.830 0.678638 293 end
o              1  den=9.830 0.118143 293 end
pu-238         2  den=9.830 0.000111 293 end
pu-239         2  den=9.830 0.171251 293 end
pu-240         2  den=9.830 0.023150 293 end
pu-241         2  den=9.830 0.002498 293 end
am-241         2  den=9.830 0.000975 293 end
pu-242         2  den=9.830 0.000381 293 end
u-235          2  den=9.830 0.004853 293 end
u-238          2  den=9.830 0.678638 293 end
o              2  den=9.830 0.118143 293 end
ss316          5  1.0 293 end
h2o            6  1.0 293 end
'
uo2            10  den=10.42 1.0 293 end
'inconel       11
ni             11  den=8.30 0.73 end
cr             11  den=8.30 0.15 end
fe             11  den=8.30 0.07 end
ti             11  den=8.30 0.025 end
si             11  den=8.30 0.025 end
ss316          12  1.0 293 end
h2o            13  1.0 293 end
poly(h2o)      14  den=0.904 end
plexiglass     15  1.0 293 end
carbonsteel    16  1.0 293 end
al             17  1.0 293 end
end comp
squarepitch 1.935 .49403 1  6  .5842 5  .508 0  end
more data  res=2  cylinder  0.247  dan(2)=1.54131-2  end more
'======================== keno data ==============================
exp.no 032(060) pitch=1.935(fuel region=pin array+mix 500 with lattice
plate)
read parm run=yes plt=yes npg=600 gen=405 nsk=5 nub=yes res=205 wrs=34
tme=60 end parm
read geom
'
unit  1
com=/region under bottom of fuel pin/
cuboid    15 1  25.4 -25.4  25.7 -3.5  14.61 9.53
cylinder  13 1  56.0   14.61  0.95
cylinder  16 1  56.31  14.61  0.0
cuboid     0 1  57.0 -57.0  57.0  -57.0  14.61 0.0
unit  2
com=/fuel pin between lower lattice plate and base plate/
cylinder  11 1  0.254   29.85    18.67
cylinder  12 1  0.2921  29.85    14.61
cuboid    13 1  0.9675  -0.9675  0.9675 -0.9675  29.85 14.61
unit  3
com=/region between lower lattice plate and base plate/
array  1  -10.6425  -3.5585  14.61
cylinder  13 1  56.0   29.85  14.61
cylinder  16 1  56.31  29.85  14.61
cuboid     0 1  57.0 -57.0  57.0  -57.0  29.85 14.61
unit  4
com=/fuel pin within lower lattice plate/
cylinder  11 1  0.254   31.16  29.85
cylinder  12 1  0.2921  31.16  29.85
cylinder  13 1  0.301   31.16  29.85
cuboid    14 1  0.9675  -0.9675  0.9675 -0.9675  31.16 29.85
unit  5
com=/region of lower lattice plate/
array  2  -10.6425  -3.5585  29.85
cuboid    14 1  25.4 -25.4  25.7 -3.5585  31.16 29.85
cylinder  13 1  56.0   31.16  29.85
cylinder  16 1  56.31  31.16  29.85
cuboid     0 1  57.0 -57.0  57.0  -57.0  31.16 29.85
unit  6
com=/fuel pin between bottom of fuel region and lower lattice plate/
cylinder  10 1  0.254   35.18    33.148
cylinder  11 1  0.254   35.18    31.16
cylinder  12 1  0.2921  35.18    31.16
cuboid    13 1  0.9675  -0.9675  0.9675 -0.9675  35.18 31.16
```

```
unit  7
com=/region between bottom of fuel region and lower lattice plate/
array  3  -10.6425  -3.5585  31.16
cylinder  13 1  56.0   35.18  31.16
cylinder  16 1  56.31  35.18  31.16
cuboid     0 1  57.0 -57.0  57.0  -57.0  35.18 31.16
unit  8
com=/fuel pin between middle latice plate and bottom of fuel region/
cylinder   2 1  0.247   80.65   35.18
cylinder   0 1  0.254   80.65   35.18
cylinder  12 1  0.2921  80.65   35.18
cuboid    13 1  0.9675  -0.9675  0.9675 -0.9675  80.65 35.18
unit  9
com=/region between middle latice plate and bototm of fuel region/
array  4  -10.6425  -3.5585  35.18
cuboid   500 1  10.6554 -10.6425  25.4665 -3.5585  80.65 35.18
cylinder  13 1  56.0   80.65  35.18
cylinder  16 1  56.31  80.65  35.18
cuboid     0 1  57.0 -57.0  57.0  -57.0  80.65 35.18
unit  10
com=/fuel pin within middle lattice plate/
cylinder   2 1  0.247   81.96  80.65
cylinder   0 1  0.254   81.96  80.65
cylinder  12 1  0.2921  81.96  80.65
cylinder  13 1  0.301   81.96  80.65
cuboid    14 1  0.9675  -0.9675  0.9675 -0.9675  81.96 80.65
unit  11
com=/region of middle lattice plate/
array  5  -10.6425  -3.5585  80.65
cuboid   500 1  10.6554 -10.6425  25.4665 -3.5585  81.96 80.65
cuboid    14 1  25.4 -25.4  25.7 -3.5585  81.96 80.65
cylinder  13 1  56.0   81.96  80.65
cylinder  16 1  56.31  81.96  80.65
cuboid     0 1  57.0 -57.0  57.0  -57.0  81.96 80.65
unit  12
com=/fuel pin between top of fuel region and middle latice plate/
cylinder   2 1  0.247   126.62  81.96
cylinder   0 1  0.254   126.62  81.96
cylinder  12 1  0.2921  126.62  81.96
cuboid    13 1  0.9675  -0.9675  0.9675 -0.9675  126.62 81.96
unit  13
com=/region between top of fuel region and midle lattice plate/
array  6  -10.6425  -3.5585  81.96
cuboid   500 1  10.6554 -10.6425  25.4665 -3.5585  126.62 81.96
cylinder  13 1  56.0   126.62  81.96
cylinder  16 1  56.31  126.62  81.96
cuboid     0 1  57.0 -57.0  57.0  -57.0  126.62 81.96
unit  14
com=/fuel pin between upper lattice plate and top of fuel region/
cylinder  10 1  0.254   128.652  126.62
cylinder  11 1  0.254   131.45   126.62
cylinder  12 1  0.2921  131.45   126.62
cuboid    13 1  0.9675  -0.9675  0.9675 -0.9675  131.45 126.62
unit  15
com=/region between upper lattice plate and top of fuel region/
array  7  -10.6425  -3.5585  126.62
cylinder  13 1  56.0   131.45  126.62
cylinder  16 1  56.31  131.45  126.62
cuboid     0 1  57.0 -57.0  57.0  -57.0  131.45 126.62
unit  16
com=/fuel pin between water level and upper lattice plate/
cylinder  11 1  0.254   143.13   132.76
cylinder   0 1  0.254   146.7    132.76
cylinder  12 1  0.2921  146.7    132.76
cuboid    13 1  0.9675  -0.9675  0.9675 -0.9675  146.7 132.76
unit  17
com=/region between water level and upper lattice plate/
array  8  -10.6425  -3.5585  132.76
cylinder  13 1  56.0   146.7   132.76
cylinder  16 1  56.31  146.7   132.76
cuboid     0 1  57.0 -57.0  57.0  -57.0  146.7 132.76
'
global
unit  20
com=/whole system/
array  10  -57.0  -57.0  0.0
'
end geom
read array
com=/11x15 fuel pin array between lower lattice plate and base plate/
ara=1 nux=11 nuy=15 nuz=1 fill f2 end fill
com=/11x15 fuel pin array with lower lattice plate/
ara=2 nux=11 nuy=15 nuz=1 fill f4 end fill
com=/11x15 fuel pin array between fuel bottom and lower lattice plate/
ara=3 nux=11 nuy=15 nuz=1 fill f6 end fill
com=/11x15 fuel pin array between middle latice plate and fuel bottom/
ara=4 nux=11 nuy=15 nuz=1 fill f8 end fill
com=/11x15 fuel pin array with middle lattice plate/
ara=5 nux=11 nuy=15 nuz=1 fill f10 end fill
com=/11x15 fuel pin array between fuel top and midle lattice plate/
ara=6 nux=11 nuy=15 nuz=1 fill f12 end fill
com=/11x15 fuel pin array between upper lattice plate and fuel top/
ara=7 nux=11 nuy=15 nuz=1 fill f14 end fill
com=/11x15 fuel pin array between water level and upper lattice plate/
ara=8 nux=11 nuy=15 nuz=1 fill f16 end fill
com=/whole system/
ara=10 nux=1 nuy=1 nuz=10 fill 1 3 5 7 9 11 13 15 5 17 end fill
end array
'
read plot
ttl='x-y slice at z=15'
xul=6.0   yul=26.0 zul=15.0
xlr=12.0  ylr=18.0 zlr=15.0
uax=1.0 vax=0.0  wax=0.0
udn=0.0 vdn=-1.0 wdn=0.0
nax=130 nch='0fniswpac*'end
ttl='x-y slice at z=40'
xul=6.0   yul=26.0 zul=40.0
xlr=12.0  ylr=18.0 zlr=40.0  end
ttl='x-y slice at z=81'
xul=6.0   yul=26.0 zul=81.0
xlr=12.0  ylr=18.0 zlr=81.0  end
ttl='x-y slice at z=90 (full array)'
xul=-12   yul=26.0 zul=90.0
xlr=12.0  ylr=-4.0 zlr=90.0  end
ttl='x-y slice at z=132'
xul=6.0   yul=26.0 zul=132.0
xlr=12.0  ylr=18.0 zlr=132.0  end
```

```
end plot
end data
end
```

p5803x43

```
#csas2x
exp.no 043(062) pitch=1.242 (fuel region = pin-array+mix500 with lattice
plate)
44group                    latticecell
pu-238         1  den=9.830 0.000111 293 end
pu-239         1  den=9.830 0.171251 293 end
pu-240         1  den=9.830 0.023150 293 end
pu-241         1  den=9.830 0.002489 293 end
am-241         1  den=9.830 0.000984 293 end
pu-242         1  den=9.830 0.000381 293 end
u-235          1  den=9.830 0.004853 293 end
u-238          1  den=9.830 0.678638 293 end
o              1  den=9.830 0.118143 293 end
pu-238         2  den=9.830 0.000111 293 end
pu-239         2  den=9.830 0.171251 293 end
pu-240         2  den=9.830 0.023150 293 end
pu-241         2  den=9.830 0.002489 293 end
am-241         2  den=9.830 0.000984 293 end
pu-242         2  den=9.830 0.000381 293 end
u-235          2  den=9.830 0.004853 293 end
u-238          2  den=9.830 0.678638 293 end
o              2  den=9.830 0.118143 293 end
ss316          5  1.0 293 end
h2o            6  1.0 293 end
'
uo2            10  den=10.42 1.0 293 end
'inconel       11
ni             11  den=8.30 0.73 end
cr             11  den=8.30 0.15 end
fe             11  den=8.30 0.07 end
ti             11  den=8.30 0.025 end
si             11  den=8.30 0.025 end
ss316          12  1.0 293 end
h2o            13  1.0 293 end
poly(h2o)      14  den=0.904 end
plexiglass     15  1.0 293 end
carbonsteel    16  1.0 293 end
al             17  1.0 293 end
end comp
squarepitch 1.242 .49403 1  6  .5842 5  .508 0  end
more data  res=2  cylinder  0.247  dan(2)=8.5773-2  end more
'======================== keno data ============================
exp.no 043(062) pitch=1.242(fuel region=pin array+mix 500 with lattice
plate)
read parm run=yes plt=yes npg=600 gen=805 nsk=5 nub=yes res=205 wrs=34
tme=120 end parm
read geom
'
unit  1
com=/region under bottom of fuel pin/
cuboid    15 1  25.4 -25.4  25.7 -3.5  14.61 9.53
cylinder  13 1  56.0   14.61  0.95
cylinder  16 1  56.31  14.61  0.0
cuboid     0 1  57.0 -57.0  57.0  -57.0  14.61 0.0
unit  2
com=/fuel pin between lower lattice plate and base plate/
cylinder  11 1  0.254   29.85    18.67
cylinder  12 1  0.2921  29.85    14.61
cuboid    13 1  0.621  -0.621  0.621 -0.621  29.85 14.61
unit  3
com=/region between lower lattice plate and base plate/
array  1  -8.694  -1.863  14.61
cylinder  13 1  56.0   29.85  14.61
cylinder  16 1  56.31  29.85  14.61
cuboid     0 1  57.0 -57.0  57.0  -57.0  29.85 14.61
unit  4
com=/fuel pin within lower lattice plate/
cylinder  11 1  0.254   31.16  29.85
cylinder  12 1  0.2921  31.16  29.85
cylinder  13 1  0.301   31.16  29.85
cuboid    14 1  0.621  -0.621  0.621 -0.621  31.16 29.85
unit  5
com=/region of lower lattice plate/
array  2  -8.694  -1.863  29.85
cuboid    14 1  25.4 -25.4  25.7 -3.5  31.16 29.85
cylinder  13 1  56.0   31.16  29.85
cylinder  16 1  56.31  31.16  29.85
cuboid     0 1  57.0 -57.0  57.0  -57.0  31.16 29.85
unit  6
com=/fuel pin between bottom of fuel region and lower lattice plate/
cylinder  10 1  0.254   35.18    33.148
cylinder  11 1  0.254   35.18    31.16
cylinder  12 1  0.2921  35.18    31.16
cuboid    13 1  0.621  -0.621  0.621 -0.621  35.18 31.16
unit  7
com=/region between bottom of fuel region and lower lattice plate/
array  3  -8.694  -1.863  31.16
cylinder  13 1  56.0   35.18  31.16
cylinder  16 1  56.31  35.18  31.16
cuboid     0 1  57.0 -57.0  57.0  -57.0  35.18 31.16
unit  8
com=/fuel pin between middle latice plate and bottom of fuel region/
cylinder   2 1  0.247   80.65   35.18
cylinder   0 1  0.254   80.65   35.18
cylinder  12 1  0.2921  80.65   35.18
cuboid    13 1  0.621  -0.621  0.621 -0.621  80.65 35.18
unit  9
com=/region between middle latice plate and bototm of fuel region/
array  4  -8.694  -1.863  35.18
cuboid   500 1  9.55719 -8.694  22.977 -1.863  80.65 35.18
cylinder  13 1  56.0   80.65  35.18
cylinder  16 1  56.31  80.65  35.18
cuboid     0 1  57.0 -57.0  57.0  -57.0  80.65 35.18
unit  10
com=/fuel pin within middle lattice plate/
cylinder   2 1  0.247   81.96  80.65
cylinder   0 1  0.254   81.96  80.65
cylinder  12 1  0.2921  81.96  80.65
cylinder  13 1  0.301   81.96  80.65
cuboid    14 1  0.621  -0.621  0.621 -0.621  81.96 80.65
unit  11
```

```
com=/region of middle lattice plate/
array  5  -8.694  -1.863  80.65
cuboid   500 1  9.55719 -8.694  22.977 -1.863  81.96 80.65
cuboid    14 1  25.4 -25.4  25.7 -3.5  81.96 80.65
cylinder  13 1  56.0   81.96  80.65
cylinder  16 1  56.31  81.96  80.65
cuboid     0 1  57.0 -57.0  57.0  -57.0  81.96 80.65
unit  12
com=/fuel pin between top of fuel region and middle latice plate/
cylinder   2 1  0.247   126.62  81.96
cylinder   0 1  0.254   126.62  81.96
cylinder  12 1  0.2921  126.62  81.96
cuboid    13 1  0.621  -0.621  0.621 -0.621  126.62 81.96
unit  13
com=/region between top of fuel region and midle lattice plate/
array  6  -8.694  -1.863  81.96
cuboid   500 1  9.55719 -8.694  22.977 -1.863  126.62 81.96
cylinder  13 1  56.0   126.62  81.96
cylinder  16 1  56.31  126.62  81.96
cuboid     0 1  57.0 -57.0  57.0  -57.0  126.62 81.96
unit  14
com=/fuel pin between upper lattice plate and top of fuel region/
cylinder  10 1  0.254   128.652  126.62
cylinder  11 1  0.254   131.45   126.62
cylinder  12 1  0.2921  131.45   126.62
cuboid    13 1  0.621  -0.621  0.621 -0.621  131.45 126.62
unit  15
com=/region between upper lattice plate and top of fuel region/
array  7  -8.694  -1.863  126.62
cylinder  13 1  56.0   131.45  126.62
cylinder  16 1  56.31  131.45  126.62
cuboid     0 1  57.0 -57.0  57.0  -57.0  131.45 126.62
unit  16
com=/fuel pin between water level and upper lattice plate/
cylinder  11 1  0.254   143.13   132.76
cylinder   0 1  0.254   146.7    132.76
cylinder  12 1  0.2921  146.7    132.76
cuboid    13 1  0.621  -0.621  0.621 -0.621  146.7 132.76
unit  17
com=/region between water level and upper lattice plate/
array  8  -8.694  -1.863  132.76
cylinder  13 1  56.0   146.7   132.76
cylinder  16 1  56.31  146.7   132.76
cuboid     0 1  57.0 -57.0  57.0  -57.0  146.7 132.76
'
global
unit  20
com=/whole system/
array  10  -57.0  -57.0  0.0
'
end geom
read array
com=/15x20 fuel pin array between lower lattice plate and base plate/
ara=1 nux=15 nuy=20 nuz=1 fill f2 end fill
com=/15x20 fuel pin array with lower lattice plate/
ara=2 nux=15 nuy=20 nuz=1 fill f4 end fill
com=/15x20 fuel pin array between fuel bottom and lower lattice plate/
ara=3 nux=15 nuy=20 nuz=1 fill f6 end fill
com=/14x20 fuel pin array between middle latice plate and fuel bottom/
ara=4 nux=14 nuy=20 nuz=1 fill f8 end fill
com=/14x20 fuel pin array with middle lattice plate/
ara=5 nux=14 nuy=20 nuz=1 fill f10 end fill
com=/14x20 fuel pin array between fuel top and midle lattice plate/
ara=6 nux=14 nuy=20 nuz=1 fill f12 end fill
com=/15x20 fuel pin array between upper lattice plate and fuel top/
ara=7 nux=15 nuy=20 nuz=1 fill f14 end fill
com=/15x20 fuel pin array between water level and upper lattice plate/
ara=8 nux=15 nuy=20 nuz=1 fill f16 end fill
com=/whole system/
ara=10 nux=1 nuy=1 nuz=10 fill 1 3 5 7 9 11 13 15 5 17 end fill
end array
'
read plot
ttl='x-y slice at z=15'
xul=6.0   yul=24.0 zul=15.0
xlr=12.0  ylr=18.0 zlr=15.0
uax=1.0 vax=0.0  wax=0.0
udn=0.0 vdn=-1.0 wdn=0.0
nax=130 nch='0fniswpac*'end
ttl='x-y slice at z=40'
xul=6.0   yul=24.0 zul=40.0
xlr=12.0  ylr=18.0 zlr=40.0  end
ttl='x-y slice at z=81'
xul=6.0   yul=24.0 zul=81.0
xlr=12.0  ylr=18.0 zlr=81.0  end
ttl='x-y slice at z=90 (full array)'
xul=-10   yul=24.0 zul=90.0
xlr=12.0  ylr=0.0 zlr=90.0  end
ttl='x-y slice at z=132'
xul=6.0   yul=24.0 zul=132.0
xlr=12.0  ylr=18.0 zlr=132.0  end
end plot
end data
end
```

p5803x67

```
#csas2x
exp.no 067 pitch=0.761 (fuel region = pin-array+mix500 with lattice
plate)
44group                    latticecell
'type 3.2 fuel
pu-238         1  den=9.830 0.000111 293 end
pu-239         1  den=9.830 0.171251 293 end
pu-240         1  den=9.830 0.023150 293 end
pu-241         1  den=9.830 0.001823 293 end
am-241         1  den=9.830 0.001650 293 end
pu-242         1  den=9.830 0.000381 293 end
u-235          1  den=9.830 0.004853 293 end
u-238          1  den=9.830 0.678638 293 end
o              1  den=9.830 0.118143 293 end
'type 3.1 fuel for mix 500
pu-238         2  den=9.783 0.000130 293 end
pu-239         2  den=9.783 0.210641 293 end
pu-240         2  den=9.783 0.028606 293 end
pu-241         2  den=9.783 0.002193 293 end
am-241         2  den=9.783 0.001772 293 end
```

```
pu-242         2  den=9.783 0.000526 293 end
u-235          2  den=9.783 0.004547 293 end
u-238          2  den=9.783 0.635857 293 end
o              2  den=9.783 0.115728 293 end
'type 3.1 fuel
   pu-238          3  den=9.783 0.000130 293 end
   pu-239          3  den=9.783 0.210641 293 end
   pu-240          3  den=9.783 0.028606 293 end
   pu-241          3  den=9.783 0.002193 293 end
   am-241          3  den=9.783 0.001772 293 end
   pu-242          3  den=9.783 0.000526 293 end
   u-235           3  den=9.783 0.004547 293 end
   u-238           3  den=9.783 0.635857 293 end
   o               3  den=9.783 0.115728 293 end
'
   ss316           5  1.0 293 end
   h2o             6  1.0 293 end
'
   uo2             10  den=10.42 1.0 293 end
'inconel       11
   ni              11  den=8.30 0.73 end
   cr              11  den=8.30 0.15 end
   fe              11  den=8.30 0.07 end
   ti              11  den=8.30 0.025 end
   si              11  den=8.30 0.025 end
   ss316           12  1.0 293 end
   h2o             13  1.0 293 end
   poly(h2o)       14  den=0.904 end
   plexiglass      15  1.0 293 end
   carbonsteel     16  1.0 293 end
   al              17  1.0 293 end
end comp
squarepitch 1.522  .49403 2  6  .5842 5  .508 0  end
more data
   res=1  cylinder  0.247  dan(1)=3.64258-1
   res=3  cylinder  0.247  dan(3)=4.13478-2
end more
'======================== keno data ==============================
exp.no 067 pitch=0.761 (fuel region = pin array + mix 500 with lattice
plate)
read parm run=yes plt=yes npg=600 gen=805 nsk=5 nub=yes res=205 wrs=34
tme=120 end parm
read geom
'part of type 3.2 fuels
unit  1
   com=/fuel pin between lower lattice plate and base plate/
   cylinder  11 1  0.254   29.85    18.67
   cylinder  12 1  0.2921  29.85    14.61
   cuboid    13 1  0.3805  -0.3805  0.3805 -0.3805  29.85 14.61
unit  2
   com=/fuel pin array between lower lattice plate and base plate/
   array  1  0.0  0.0  14.61
   cuboid    13 1  20.547 0.0  28.596 -1.2  29.85 14.61
unit  3
   com=/fuel pin within lower lattice plate/
   cylinder  11 1  0.254   31.16  29.85
   cylinder  12 1  0.2921  31.16  29.85
   cylinder  13 1  0.301   31.16  29.85
   cuboid    14 1  0.3805  -0.3805  0.3805 -0.3805  31.16 29.85
unit  4
   com=/region of lower lattice plate/
   array  2  0.0  0.0  29.85
   cuboid    14 1  20.547 0.0  28.596 -1.2  31.16 29.85
unit  5
   com=/fuel pin between middle and lower lattice plate/
   cylinder   1 1  0.247   80.65   35.18
   cylinder   0 1  0.254   80.65   35.18
   cylinder  10 1  0.254   80.65   33.148
   cylinder  11 1  0.254   80.65   31.16
   cylinder  12 1  0.2921  80.65   31.16
   cuboid    13 1  0.3805 -0.3805  0.3805 -0.3805  80.65 31.16
unit  6
   com=/region between middle and lower lattice plate/
   array  3  0.0  0.0  31.16
   cuboid    13 1  20.547 0.0  28.596 -1.2  80.65 31.16
unit  7
   com=/fuel pin within middle lattice plate/
   cylinder   1 1  0.247   81.96  80.65
   cylinder   0 1  0.254   81.96  80.65
   cylinder  12 1  0.2921  81.96  80.65
   cylinder  13 1  0.301   81.96  80.65
   cuboid    14 1  0.3805 -0.3805  0.3805 -0.3805  81.96 80.65
unit  8
   com=/region of middle lattice plate/
   array  4  0.0  0.0  80.65
   cuboid    14 1  20.547 0.0  28.596 -1.2  81.96 80.65
unit  9
   com=/fuel pin between upper and middle lattice plate/
   cylinder   1 1  0.247   126.62   81.96
   cylinder   0 1  0.254   126.62   81.96
   cylinder  10 1  0.254   128.652  81.96
   cylinder  11 1  0.254   131.45   81.96
   cylinder  12 1  0.2921  131.45   81.96
   cuboid    13 1  0.3805 -0.3805  0.3805 -0.3805  131.45 81.96
unit  10
   com=/region between upper and middle lattice plate/
   array  5  0.0  0.0  81.96
   cuboid    13 1  20.547 0.0  28.596 -1.2  131.45 81.96
unit  11
   com=/fuel pin between water level and upper lattice plate/
   cylinder  11 1  0.254   143.13   132.76
   cylinder   0 1  0.254   146.7    132.76
   cylinder  12 1  0.2921  146.7    132.76
   cuboid    13 1  0.3805 -0.3805  0.3805 -0.3805  146.7 132.76
unit  12
   com=/region between water level and upper lattice plate/
   array  6  0.0  0.0  132.76
   cuboid    13 1  20.547 0.0  28.596 -1.2  146.7 132.76
unit  13
   com=/whole system of type 3.2 fuels/
   array  7  0.0  0.0  14.61
'============================================================
'part of type 3.1 fuels
unit  14
   com=/fuel pin between lower lattice plate and base plate/
   cylinder  11 1  0.254   29.85   18.17
   cylinder  12 1  0.2921  29.85   14.61
   cuboid    13 1  0.3805 -0.3805  0.3805 -0.3805  29.85 14.61
```

```
unit  15
   com=/blank/
   cuboid    13 1  0.3805 -0.3805  0.3805 -0.3805  29.85 14.61
unit  16
   com=/left region between lower lattice plate and base plate/
   array  8  0.0  0.0  14.61
   cuboid    13 1  3.805 -8.761  28.596 -1.2  29.85 14.61
unit  17
   com=/right region between lower lattice plate and base plate/
   array  8  0.0  0.0  14.61
   cuboid    13 1  17.688 0.0  28.596 -1.2  29.85 14.61
unit  18
   com=/fuel pin within lower lattice plate/
   cylinder  11 1  0.254   31.16  29.85
   cylinder  12 1  0.2921  31.16  29.85
   cylinder  13 1  0.301   31.16  29.85
   cuboid    14 1  0.3805 -0.3805  0.3805 -0.3805  31.16 29.85
unit  19
   com=/blank/
   cylinder  13 1  0.301   31.16  29.85
   cuboid    14 1  0.3805 -0.3805  0.3805 -0.3805  31.16 29.85
unit  20
   com=/left region of lower lattice plate/
   array  9  0.0  0.0  29.85
   cuboid    14 1  3.805 -8.761  28.596 -1.2  31.16 29.85
unit  21
   com=/right region of lower lattice plate/
   array  9  0.0  0.0  29.85
   cuboid    14 1  17.688 0.0  28.596 -1.2  31.16 29.85
unit  22
   com=/fuel pin between bottom of fuel region and lower lattice plate/
   cylinder  10 1  0.254   34.68    32.648
   cylinder  11 1  0.254   34.68    31.16
   cylinder  12 1  0.2921  34.68    31.16
   cuboid    13 1  0.3805 -0.3805  0.3805 -0.3805  34.68 31.16
unit  23
   com=/blank/
   cuboid    13 1  0.3805 -0.3805  0.3805 -0.3805  34.68 31.16
unit  24
   com=/left region between bottom of fuel region and lower lattice
plate/
   array  10  0.0  0.0  31.16
   cuboid    13 1  3.805 -8.761  28.596 -1.2  34.68 31.16
unit  25
   com=/right region between bottom of fuel region and lower lattice
plate/
   array  10  0.0  0.0  31.16
   cuboid    13 1  17.688 0.0  28.596 -1.2  34.68 31.16
unit  26
   com=/fuel pin between middle lattice plate and bottom of fuel region/
   cylinder   3 1  0.247   80.65   34.68
   cylinder   0 1  0.254   80.65   34.68
   cylinder  12 1  0.2921  80.65   34.68
   cuboid    13 1  0.3805 -0.3805  0.3805 -0.3805  80.65 34.68
unit  27
   com=/blank/
   cuboid    13 1  0.3805 -0.3805  0.3805 -0.3805  80.65 34.68
unit  28
   com=/left region between middle lattice plate and bottom of fuel
region/
   array  11  0.0  0.0  34.68
   cuboid    13 1  3.805 -8.761  28.596 -1.2  80.65 34.68
unit  29
   com=/right region between middle lattice plate and bottom of fuel
region/
   array  11  0.0  0.0  34.68
   cuboid   500 1  4.05021  0.0  27.396   0.0     80.65 34.68
   cuboid    13 1  17.688 0.0  28.596 -1.2  80.65 34.68
unit  30
  com=/fuel pin within middle lattice plate/
   cylinder   3 1  0.247   81.96  80.65
   cylinder   0 1  0.254   81.96  80.65
   cylinder  12 1  0.2921  81.96  80.65
   cylinder  13 1  0.301   81.96  80.65
   cuboid    14 1  0.3805 -0.3805  0.3805 -0.3805  81.96 80.65
unit  31
   com=/left region of middle lattice plate/
   array  12  0.0  0.0  80.65
   cuboid    14 1  3.805 -8.761  28.596 -1.2  81.96 80.65
unit  32
   com=/right region of middle lattice plate/
   array  12  0.0  0.0  80.65
   cuboid   500 1  4.05021  0.0  27.396   0.0     81.96 80.65
   cuboid    14 1  17.688 0.0  28.596 -1.2  81.96 80.65
unit  33
   com=/fuel pin between top of fuel region and middle lattice plate/
   cylinder   3 1  0.247   126.12  81.96
   cylinder   0 1  0.254   126.12  81.96
   cylinder  12 1  0.2921  126.12  81.96
   cuboid    13 1  0.3805 -0.3805  0.3805 -0.3805  126.12 81.96
unit  34
   com=/blank/
   cuboid    13 1  0.3805 -0.3805  0.3805 -0.3805  126.12 81.96
unit  35
   com=/left region between top of fuel region and middle lattice plate/
   array  13  0.0  0.0  81.96
   cuboid    13 1  3.805 -8.761  28.596 -1.2  126.12 81.96
unit  36
   com=/right region between top of fuel region and middle lattice
plate/
   array  13  0.0  0.0  81.96
   cuboid   500 1  4.05021  0.0  27.396   0.0     126.12 81.96
   cuboid    13 1  17.688 0.0  28.596 -1.2  126.12 81.96
unit  37
   com=/fuel pin between upper lattice plate and top of fuel region/
   cylinder  10 1  0.254   128.152  126.12
   cylinder  11 1  0.254   131.45   126.12
   cylinder  12 1  0.2921  131.45   126.12
   cuboid    13 1  0.3805 -0.3805  0.3805 -0.3805  131.45 126.12
unit  38
   com=/blank/
   cuboid    13 1  0.3805 -0.3805  0.3805 -0.3805  131.45 126.12
unit  39
   com=/left region between upper lattice plate and top of fuel region/
   array  14  0.0  0.0  126.12
   cuboid    13 1  3.805 -8.761  28.596 -1.2  131.45 126.12
unit  40
   com=/right region between upper lattice plate and top of fuel region/
```

```
   array  14  0.0  0.0  126.12
   cuboid    13 1  17.688 0.0  28.596 -1.2  131.45 126.12
unit  41
   com=/fuel pin between water level and upper lattice plate/
   cylinder  11 1  0.254   142.63   132.76
   cylinder   0 1  0.254   146.7    132.76
   cylinder  12 1  0.2921  146.7    132.76
   cuboid    13 1  0.3805 -0.3805  0.3805 -0.3805  146.7 132.76
unit  42
   com=/blank/
   cuboid    13 1  0.3805 -0.3805  0.3805 -0.3805  146.7 132.76
unit  43
   com=/left region between water level and upper lattice plate/
   array  15  0.0  0.0  132.76
   cuboid    13 1  3.805 -8.761  28.596 -1.2  146.7 132.76
unit  44
   com=/right region between water level and upper lattice plate/
   array  15  0.0  0.0  132.76
   cuboid    13 1  17.688 0.0  28.596 -1.2  146.7 132.76
unit  45
   com=/left system of type 3.1 fuels/
   array  16  0.0  0.0  14.61
unit  46
   com=/right system of type 3.1 fuels/
   array  17  0.0  0.0  14.61
'
global unit  47
   com=/whole system/
   array  18  -25.8835  -3.8635  14.61
   replicate 15 1  5r0  5.08  1
   cylinder  13 1  56.0   146.7  0.95
   cylinder  16 1  56.31  146.7  0.0
   cuboid     0 1  57.0 -57.0  57.0 -57.0  147.0 0.0
end geom
'
read array
'***** type 3.2 fuel pin array
com=/27x36 fuel pins array between lower lattice plate and base plate/
ara=1 nux=27 nuy=36 nuz=1 fill f1 end fill
com=/27x36 fuel pins array within lower lattice plate/
ara=2 nux=27 nuy=36 nuz=1 fill f3 end fill
com=/27x36 fuel pins array between middle and lower lattice plate/
ara=3 nux=27 nuy=36 nuz=1 fill f5 end fill
com=/27x36 fuel pins array within middle lattice plate/
ara=4 nux=27 nuy=36 nuz=1 fill f7 end fill
com=/27x36 fuel pins array between upper and middle lattice plate/
ara=5 nux=27 nuy=36 nuz=1 fill f9 end fill
com=/27x36 fuel pins array between water level and upper lattice plate/
ara=6 nux=27 nuy=36 nuz=1 fill f11 end fill
com=/whole system of type 3.2 fuels from pin bottom to water level/
ara=7 nux=1 nuy=1 nuz=7 fill 2 4 6 8 10 4 12 end fill
'***** type 3.1 fuel pin array
com=/2x18 fuel pins array between lower lattice plate and base plate/
ara=8 nux=5 nuy=36 nuz=1 fill  15 14 15 14 15  5r15 17q10 end fill
com=/2x18 fuel pins array within lower lattice plate/
ara=9 nux=5 nuy=36 nuz=1 fill  19 18 19 18 19  5r19 17q10 end fill
com=/2x18 fuel pins array between fuel bottom and lower lattice plate/
ara=10 nux=5 nuy=36 nuz=1 fill  23 22 23 22 23  5r23 17q10 end fill
com=/2x18 fuel pins array between middle lattice plate and fuel bottom/
ara=11 nux=5 nuy=36 nuz=1 fill  27 26 27 26 27  5r27 17q10 end fill
com=/2x18 fuel pins array within middle lattice plate/
ara=12 nux=5 nuy=36 nuz=1 fill  19 30 19 30 19  5r19 17q10 end fill
com=/2x18 fuel pins array between fuel top and middle lattice plate/
ara=13 nux=5 nuy=36 nuz=1 fill  34 33 34 33 34  5r34 17q10 end fill
com=/2x18 fuel pins array between upper lattice plate and fuel top/
ara=14 nux=5 nuy=36 nuz=1 fill  38 37 38 37 38  5r38 17q10 end fill
com=/2x18 fuel pins array between water level and upper lattice plate/
ara=15 nux=5 nuy=36 nuz=1 fill  42 41 42 41 42  5r42 17q10 end fill
'
com=/left system of type 3.1 fuels/
ara=16 nux=1 nuy=1 nuz=9 fill  16 20 24 28 31 35 39 20 43 end fill
com=/right system of type 3.1 fuels/
ara=17 nux=1 nuy=1 nuz=9 fill  17 21 25 29 32 36 40 21 44 end fill
'
com=/whole system/
ara=18 nux=3 nuy=1 nuz=1 fill  45 13 46 end fill
end array
'
read plot
ttl='x-y slice at z=81'
xul=0.0   yul=58.0 zul=81.0
xlr=58.0  ylr=0.0  zlr=81.0
uax=1.0 vax=0.0  wax=0.0
udn=0.0 vdn=-1.0 wdn=0.0
nax=130 nch='013uiswpac#'end
'
ttl='x-y slice at z=81'
xul=6.0   yul=27.0  zul=81.0
xlr=12.0  ylr=22.0  zlr=81.0  end
'
ttl='x-y slice at z=90 (full array)'
xul=-19.0 yul=26.0 zul=90.0
xlr=14.0  ylr=-5.0 zlr=90.0  end
'
ttl='x-z slice at y=24.199'
xul=6.0   yul=24.199  zul=147.0
xlr=12.0  ylr=24.199  zlr=-1.0
uax=1.0 vax=0.0  wax=0.0
udn=0.0 vdn=0.0  wdn=-1.0 end
end plot
end data
end
```

p5803x68r

```
#csas2x
exp.no 68r pitch=1.537 (fuel region = pin array + mix 500 with lattice
plate)
44group                     latticecell
pu-238         1  den=9.830 0.000111 293 end
pu-239         1  den=9.830 0.171251 293 end
pu-240         1  den=9.830 0.023150 293 end
pu-241         1  den=9.830 0.001821 293 end
am-241         1  den=9.830 0.001652 293 end
pu-242         1  den=9.830 0.000381 293 end
u-235          1  den=9.830 0.004853 293 end
u-238          1  den=9.830 0.678638 293 end
```

```
o              1  den=9.830 0.118143 293 end
pu-238         2  den=9.830 0.000111 293 end
pu-239         2  den=9.830 0.171251 293 end
pu-240         2  den=9.830 0.023150 293 end
pu-241         2  den=9.830 0.001821 293 end
am-241         2  den=9.830 0.001652 293 end
pu-242         2  den=9.830 0.000381 293 end
u-235          2  den=9.830 0.004853 293 end
u-238          2  den=9.830 0.678638 293 end
o              2  den=9.830 0.118143 293 end
ss316          5  1.0 293 end
h2o            6  1.0 293 end
'
uo2            10  den=10.42 1.0 293 end
'inconel       11
ni             11  den=8.30 0.73 end
cr             11  den=8.30 0.15 end
fe             11  den=8.30 0.07 end
ti             11  den=8.30 0.025 end
si             11  den=8.30 0.025 end
ss316          12  1.0 293 end
h2o            13  1.0 293 end
poly(h2o)      14  den=0.904 end
plexiglass     15  1.0 293 end
carbonsteel    16  1.0 293 end
al             17  1.0 293 end
end comp
squarepitch 1.537 .49403 1  6  .5842 5  .508 0  end
more data  res=2  cylinder  0.247  dan(2)=3.98261-2  end more
'======================== keno data ============================
exp. no 68r pitch=1.537 (fuel region = pin array + mix 500 with lattice
plate)
read parm run=yes plt=yes npg=600 gen=405 nsk=5 nub=yes res=205 wrs=34
tme=60 end parm
read geom
'
unit  1
com=/region under bottom of fuel pin/
cuboid    15 1  25.4 -25.4  25.7 -3.5  14.61 9.53
cylinder  13 1  56.0   14.61  0.95
cylinder  16 1  56.31  14.61  0.0
cuboid     0 1  57.0 -57.0  57.0  -57.0  14.61 0.0
unit  2
com=/fuel pin between lower lattice plate and base plate/
cylinder  11 1  0.254   29.85    18.67
cylinder  12 1  0.2921  29.85    14.61
cuboid    13 1  0.7685  -0.7685  0.7685 -0.7685  29.85 14.61
unit  3
com=/region between lower lattice plate and base plate/
array  1  -9.222  0.0  14.61
cylinder  13 1  56.0   29.85  14.61
cylinder  16 1  56.31  29.85  14.61
cuboid     0 1  57.0 -57.0  57.0  -57.0  29.85 14.61
unit  4
com=/fuel pin within lower lattice plate/
cylinder  11 1  0.254   31.16  29.85
cylinder  12 1  0.2921  31.16  29.85
cylinder  13 1  0.301   31.16  29.85
cuboid    14 1  0.7685  -0.7685  0.7685 -0.7685  31.16 29.85
unit  5
com=/region of lower lattice plate/
array  2  -9.222  0.0  29.85
cuboid    14 1  25.4 -25.4  25.7 -3.5  31.16 29.85
cylinder  13 1  56.0   31.16  29.85
cylinder  16 1  56.31  31.16  29.85
cuboid     0 1  57.0 -57.0  57.0  -57.0  31.16 29.85
unit  6
com=/fuel pin between bottom of fuel region and lower lattice plate/
cylinder  10 1  0.254   35.18    33.148
cylinder  11 1  0.254   35.18    31.16
cylinder  12 1  0.2921  35.18    31.16
cuboid    13 1  0.7685  -0.7685  0.7685 -0.7685  35.18 31.16
unit  7
com=/region between bottom of fuel region and lower lattice plate/
array  3  -9.222  0.0  31.16
cylinder  13 1  56.0   35.18  31.16
cylinder  16 1  56.31  35.18  31.16
cuboid     0 1  57.0 -57.0  57.0  -57.0  35.18 31.16
unit  8
com=/fuel pin between middle latice plate and bottom of fuel region/
cylinder   2 1  0.247   80.65   35.18
cylinder   0 1  0.254   80.65   35.18
cylinder  12 1  0.2921  80.65   35.18
cuboid    13 1  0.7685  -0.7685  0.7685 -0.7685  80.65 35.18
unit  9
com=/region between middle latice plate and bototm of fuel region/
array  4  -9.222  0.0  35.18
cuboid   500 1  11.2406 -9.222  23.055 0.0  80.65 35.18
cylinder  13 1  56.0   80.65  35.18
cylinder  16 1  56.31  80.65  35.18
cuboid     0 1  57.0 -57.0  57.0  -57.0  80.65 35.18
unit  10
com=/fuel pin within middle lattice plate/
cylinder   2 1  0.247   81.96  80.65
cylinder   0 1  0.254   81.96  80.65
cylinder  12 1  0.2921  81.96  80.65
cylinder  13 1  0.301   81.96  80.65
cuboid    14 1  0.7685  -0.7685  0.7685 -0.7685  81.96 80.65
unit  11
com=/region of middle lattice plate/
array  5  -9.222  0.0  80.65
cuboid   500 1  11.2406 -9.222  23.055 0.0  81.96 80.65
cuboid    14 1  25.4 -25.4  25.7 -3.5  81.96 80.65
cylinder  13 1  56.0   81.96  80.65
cylinder  16 1  56.31  81.96  80.65
cuboid     0 1  57.0 -57.0  57.0  -57.0  81.96 80.65
unit  12
com=/fuel pin between top of fuel region and middle latice plate/
cylinder   2 1  0.247   126.62  81.96
cylinder   0 1  0.254   126.62  81.96
cylinder  12 1  0.2921  126.62  81.96
cuboid    13 1  0.7685  -0.7685  0.7685 -0.7685  126.62 81.96
unit  13
com=/region between top of fuel region and midle lattice plate/
array  6  -9.222  0.0  81.96
cuboid   500 1  11.2406 -9.222  23.055 0.0  126.62 81.96
cylinder  13 1  56.0   126.62  81.96
cylinder  16 1  56.31  126.62  81.96
```

```
cuboid     0 1  57.0 -57.0  57.0  -57.0  126.62 81.96
unit  14
com=/fuel pin between upper lattice plate and top of fuel region/
cylinder  10 1  0.254   128.652  126.62
cylinder  11 1  0.254   131.45   126.62
cylinder  12 1  0.2921  131.45   126.62
cuboid    13 1  0.7685  -0.7685  0.7685 -0.7685  131.45 126.62
unit  15
com=/region between upper lattice plate and top of fuel region/
array  7  -9.222  0.0  126.62
cylinder  13 1  56.0   131.45  126.62
cylinder  16 1  56.31  131.45  126.62
cuboid     0 1  57.0 -57.0  57.0  -57.0  131.45 126.62
unit  16
com=/fuel pin between water level and upper lattice plate/
cylinder  11 1  0.254   143.13   132.76
cylinder   0 1  0.254   146.7    132.76
cylinder  12 1  0.2921  146.7    132.76
cuboid    13 1  0.7685  -0.7685  0.7685 -0.7685  146.7 132.76
unit  17
com=/region between water level and upper lattice plate/
array  8  -9.222  0.0  132.76
cylinder  13 1  56.0   146.7   132.76
cylinder  16 1  56.31  146.7   132.76
cuboid     0 1  57.0 -57.0  57.0  -57.0  146.7 132.76
'
global
unit  20
com=/whole system/
array  10  -57.0  -57.0  0.0
'
end geom
read array
com=/14x15 fuel pin array between lower lattice plate and base plate/
ara=1 nux=14 nuy=15 nuz=1 fill f2 end fill
com=/14x15 fuel pin array with lower lattice plate/
ara=2 nux=14 nuy=15 nuz=1 fill f4 end fill
com=/14x15 fuel pin array between fuel bottom and lower lattice plate/
ara=3 nux=14 nuy=15 nuz=1 fill f6 end fill
com=/13x15 fuel pin array between middle latice plate and fuel bottom/
ara=4 nux=13 nuy=15 nuz=1 fill f8 end fill
com=/13x15 fuel pin array with middle lattice plate/
ara=5 nux=13 nuy=15 nuz=1 fill f10 end fill
com=/13x15 fuel pin array between fuel top and midle lattice plate/
ara=6 nux=13 nuy=15 nuz=1 fill f12 end fill
com=/14x15 fuel pin array between upper lattice plate and fuel top/
ara=7 nux=14 nuy=15 nuz=1 fill f14 end fill
com=/14x15 fuel pin array between water level and upper lattice plate/
ara=8 nux=14 nuy=15 nuz=1 fill f16 end fill
com=/whole system/
ara=10 nux=1 nuy=1 nuz=10 fill 1 3 5 7 9 11 13 15 5 17 end fill
end array
'
read plot
ttl='x-y slice at z=15'
xul=6.0   yul=24.0 zul=15.0
xlr=12.0  ylr=18.0 zlr=15.0
uax=1.0 vax=0.0  wax=0.0
udn=0.0 vdn=-1.0 wdn=0.0
nax=130 nch='0fniswpac*'end
ttl='x-y slice at z=40'
xul=6.0   yul=24.0 zul=40.0
xlr=12.0  ylr=18.0 zlr=40.0  end
ttl='x-y slice at z=81'
xul=6.0   yul=24.0 zul=81.0
xlr=12.0  ylr=18.0 zlr=81.0  end
ttl='x-y slice at z=90 (full array)'
xul=-10   yul=24.0 zul=90.0
xlr=12.0  ylr=0.0 zlr=90.0  end
ttl='x-y slice at z=132'
xul=6.0   yul=24.0 zul=132.0
xlr=12.0  ylr=18.0 zlr=132.0  end
end plot
end data
end
```

cr1071as

```
=csas25
rocky flats criticals nureg/cr-1071 experiment number 1 (symmslabcell)
' 42 fuel cans 2.43 cm moderator    h/u=0.77
44group      latticecell
u3o8  1 den=4.54 1 293.0 92234 0.03 92235 4.48 92236 0.09 92238 95.4
                 end
h2o   1 den=.09316 end
arbm-baggie  1.596-2 3 0 0 0  6012 84.9  1001 14.01 8016 1.20 1  end
arbm-al1100 2.713 4 0 0 1 13027 99.33 26000 0.42 29000 0.12
                          14000 0.1                          2   end
arbm-tape(vinyl) 1.374-2 7 0 0 0  6012 45.91 1001 5.92 8016 10.82
            17000 25.73 20000 6.9 22000 1.6 82000 1.1 2           end

arbm-tape(mylar) 1.832-2 3 0 0 0  6012 65.50 1001 6.83 8016 27.02 2  end
arbm-moderator  1.185 3 0 0 0  6012 59.49 1001 7.83 8016 32.48 3 end
arbm-plex(reg)  1.185 3 0 0 0  6012 59.59 1001 7.84 8016 32.23 4
                .9935   end
arbm-plex(paper) .766 3 0 0 0  6012 42.17 1001 6.48 8016 49.5 4
                .0049     end
arbm-plex(glue) .728 3 0 0 0   6012 86.29 1001 11.67 8016 1.20 4
                .0016     end
arbm-plex(tris) 1.284 8 0 0 1 6012 52.03 1001 7.16 7014 0.16 8016 29.82
            15031 1.02 17000 1.81 35079 3.55 35081 3.55 5 .9935  end
arbm-plex(paper) .766 3 0 0 0  6012 42.17 1001 6.48 8016 49.5 5
                .0049     end
arbm-plex(glue)  .728 3 0 0 0  6012 86.29 1001 11.67 8016 1.20 5
                .0016     end
arbm-filler  1.185 3 0 0 0  6012 59.49 1001 7.83 8016 32.48 6 1.0 end
end comp
symmslabcell 17.67 14.92 1 3 15.24 2 end

rocky flats criticals nureg/cr-1071 experiment number 1
' 42 fuel cans 2.43 cm moderator
read parm  run=yes npg=600 gen=805 nsk=5 wrs=34 res=205
nub=yes fdn=yes plt=yes tme=180
end parm
read geom
'unit  1
'com='fuel box 15.24 cm on a side with .16 cm walls '
```

```
'cuboid  1 1 6p7.46
'cuboid  2 1 6p7.62

unit  51
com='fuel box with moderator +x,+y,+z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 1.215 0.0 1.215 0.0 1.215 0.0 1
unit  52
com='fuel box with moderator -x,+y,+z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 0.0 1.215  1.215 0.0 1.215 0.0 1
unit  53
com='fuel box with moderator +x,+y,-y,+z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 1.215 0.0 2r1.215 1.215 0.0 1
unit  54
com='fuel box with moderator -x,+y,-y,+z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 0.0 1.215  2r1.215 1.215 0.0 1
unit  55
com='fuel box with moderator +x,-y,+z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 1.215 0.0 0.0 1.215 1.215 0.0 1
unit  56
com='fuel box with moderator -x,-y,+z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 0.0 1.215 0.0 1.215 1.215 0.0 1
unit  57
com='fuel box with moderator +x,+y,+z,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 1.215 0.0 1.215 0.0 2r1.215 1
unit  58
com='fuel box with moderator -x,+y,+z,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 0.0 1.215 1.215 0.0 2r1.215  1
unit  59
com='fuel box with moderator +x,+y,-y,+z,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 1.215 0.0 4r1.215     1
unit  60
com='fuel box with moderator -x,+y,-y,+z,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 0.0 5r1.215  1
unit  61
com='fuel box with moderator +x,-y,+z,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 1.215 0.0 0.0 1.215 2r1.215  1
unit  62
com='fuel box with moderator -x,-y,+z,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 0.0 1.215 0.0 1.215 2r1.215  1
unit  63
com='fuel box with moderator -x,+y,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 0.0 1.215 1.215 0.0 0.0 1.215  1
unit  64
com='fuel box with moderator +x,+y,-y,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 1.215 0.0 2r1.215 0.0 1.215  1
unit  65
com='fuel box with moderator -x,+y,-y,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 0.0 1.215 2r1.215 0.0 1.215  1
unit  66
com='fuel box with moderator -x,-y,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 0.0 1.215 0.0 1.215 0.0 1.215  1
unit  67
com='fuel box with moderator +x,+y,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 1.215 0.0 1.215 0.0 0.0 1.215  1
unit  68
com='fuel box with moderator +x,-y,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
replicate  3 1 1.215 0.0 0.0 1.215 0.0 1.215  1
unit  69
com='empty fuel location edge'
cuboid  0 1 6p8.2275
unit  70
com='empty fuel location middle'
cuboid  0 1 2p8.2275 2p8.835 2p8.2275

unit  11
com='north split table core'
array 1 3*0.0
cuboid 0 1 32.91 -.59 68.25 0.0  50.58 0.0
replicate 6 1 0 4.9 8.5 0.0 7.3 26.1 1
replicate 0 1 0 0.6 .75 3*0 1
unit  12
com='south split table core'
array 2 3*0.0
cuboid 0 1 33.5  0.0  68.25 0.0  50.58 0.0
replicate 6 1 12.2 0 8.5 0.0 7.3 26.1 1
replicate 0 1 1.3  0 .75 3*0 1
unit  21
com='north bottom reflector '
cuboid  3 1 7.4   0.0 2p64.05 2p12.60
cuboid  5 1 39.0  0.0 2p64.05 2p12.60
```

```
unit  22
com='north top reflector '
cuboid  3 1 7.4   0.0 2p64.05 2p12.00
cuboid  5 1 39.0  0.0 2p64.05 2p12.00
unit  23
com='north side reflector '
cuboid  3 1 7.4   0.0 2p12.65 57.88 -26.1
cuboid  5 1 39.0  0.0 2p12.65 57.88 -26.1
unit  24
com='south bottom reflector with tris'
cuboid  0 1 10.2  0.0 2p2.55  2p12.60
cuboid  5 1 47.0  0.0 2p64.05 2p12.60
unit  25
com='south top reflector with tris'
cuboid  0 1 10.2  0.0 2p2.55  2p12.00
cuboid  5 1 47.0  0.0 2p64.05 2p12.00
unit  26
com='south side reflector with tris'
cuboid  5 1 47.0  0.0 2p12.65 57.88 -26.1
unit  31
com='north array core+side'
array 3 3*0.0
unit  32
com='south array core+side'
array 4 3*0.0
unit  33
com='north array'
array 5 3*0.0
replicate 4 1 0 25.2 4r0.0 1
replicate 3 1 1.23 0 4r0.0 1
unit  34
com='south array'
array 6 3*0.0
replicate 5 1 26.5   5r0.0 1
replicate 3 1 0 1.23 4r0.0 1
replicate 0 1 0 .31  4r0.0 1
global
unit  35
com='total'
array 7 3*0.0
end geometry
read array
ara=1  nux=2 nuy=4 nuz=3
com='north split table core'
fill 51 52 53 54 1q2   55 56  57 58 59 60 1q2  61 62
     69 63 64 65 1q2   69 66  end fill
ara=2  nux=2 nuy=4 nuz=3
com='south split table core'
fill 51 52 53 54 1q2   55 56  57 58 59 60 1q2  61 62
     67 69 64 70 1q2   68 69   end fill
ara=3  nux=1 nuy=3 nuz=1
com='north core with side wall'
fill 23 11 23 end fill
ara=4  nux=1 nuy=3 nuz=1
com='south core with side wall'
fill 26 12 26 end fill
ara=5  nux=1 nuy=1 nuz=3
com='north assembly'
fill 21 31 22 end fill
ara=6  nux=1 nuy=1 nuz=3
com='south assembly'
fill 24 32 25 end fill
ara=7  nux=2 nuy=1 nuz=1
com='total'
fill  33 34     end fill
end array
read plot ttl='xz slice of rfp1 showing material regions'
xul=-2  yul=64.05 zul=136
xlr=137 ylr=64.05 zlr=-2
uax=1  wdn=-1 nax=130  nch=' 1*345.'end
ttl='xy slice of rfp1 showing material regions'
xul=23  yul=98  zul=95
xlr=115 ylr=24 zlr=95
uax=1  vdn=-1 nax=130  nch=' 1*345.'end
ttl='yz slice of north core second row'
xul=40  yul=24   zul=110
xlr=40  ylr=70 zlr=50
vax=1  wdn=-1 nax=130  nch=' 1*345.'end
ttl='yz slice of south core second row'
xul=85 yul=24   zul=105
xlr=85 ylr=98   zlr=50
vax=1  wdn=-1 nax=130  nch=' 1*345.'
end plot
end data
end
```

cr1653as

```
=csas25
rocky flats criticals nureg/cr-1653 experiment number 1 (symmslabcell)
' 38 fuel cans 2.43 cm moderator   h/u=1.25
44group      latticecell
u3o8  1 den=4.54 1 293.0 92234 0.03 92235 4.48 92236 0.09 92238 95.4
                end
h2o   1 den=.16060 end
arbm-baggie  1.596-2 3 0 0 0  6012 84.9  1001 14.01 8016 1.20 1  end
arbm-al1100 2.713 4 0 0 1 13027 99.33 26000 0.42 29000 0.12
                          14000 0.1                          2   end
arbm-tape(vinyl) 1.374-2 7 0 0 0  6012 45.91 1001 5.92 8016 10.82
            17000 25.73 20000 6.9 22000 1.6 82000 1.1 2           end
arbm-tape(mylar) 1.832-2 3 0 0 0  6012 65.50 1001 6.83 8016 27.02 2  end
arbm-moderator  1.185 3 0 0 0  6012 59.49 1001 7.83 8016 32.48 3 end
arbm-plex(reg)  1.185 3 0 0 0  6012 59.59 1001 7.84 8016 32.23 4
                .9935   end
arbm-plex(paper) .766 3 0 0 0  6012 42.17 1001 6.48 8016 49.5 4
                .0049     end
arbm-plex(glue) .728 3 0 0 0   6012 86.29 1001 11.67 8016 1.20 4
                .0016     end
arbm-plex(tris) 1.284 8 0 0 1 6012 52.03 1001 7.16 7014 0.16 8016 29.82
            15031 1.02 17000 1.81 35079 3.55 35081 3.55 5 .9935  end
arbm-plex(paper) .766 3 0 0 0  6012 42.17 1001 6.48 8016 49.5 5
                .0049     end
arbm-plex(glue)  .728 3 0 0 0  6012 86.29 1001 11.67 8016 1.20 5
                .0016     end
arbm-filler  1.185 3 0 0 0  6012 59.49 1001 7.83 8016 32.48 6 1.0 end
end comp
symmslabcell 17.67 14.92 1 3 15.24 2 end
```

```
rocky flats criticals nureg/cr-1071 experiment number 1
' 42 fuel cans 2.43 cm moderator
read parm  run=yes npg=600 gen=805 nsk=5 wrs=34 res=205
nub=yes fdn=yes plt=yes tme=120

end parm
read geom
unit  1
com='fuel box 15.24 cm on a side with .16 cm walls '
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
unit  2
com='x-face interstitial moderator'
cuboid  3 1 2p1.215 4p7.62
unit  3
com='y-face interstitial moderator'
cuboid  3 1 2p7.62 2p1.215 2p7.62
unit  4
com='z-face interstitial moderator'
cuboid  3 1 4p7.62 2p1.215
unit  5
com='more x-face moderator'
cuboid  3 1 4p1.215 2p7.62
unit  6
com='more y-face moderator'
cuboid  3 1 2p7.62 4p1.215
unit  7
com='more z-face moderator'
cuboid  3 1 2p1.215 2p7.62 2p1.215
unit  8
com='last of interstitial moderator'
cuboid  3 1 6p1.215
unit  51
com='empty fuel location'
cuboid  0 1 6p7.620
unit  52
com='x-face moderator void'
cuboid  0 1 2p1.215 4p7.62
unit  53
com='y-face moderator void'
cuboid  0 1 2p7.62 2p1.215 2p7.62
unit  11
com='north split table core'
array 1 3*0.0
cuboid 0 1 32.91 -.59 69.0  0.0  50.58 0.0
replicate 6 1 0 4.9 8.5 0.0 7.3 26.1 1
replicate 0 1 0 0.6  4*0 1
unit  12
com='south split table core'
array 2 3*0.0
cuboid 0 1 33.6  0.0  69.0  0.0  50.58 0.0
replicate 6 1 12.2 0 8.5 0.0 7.3 26.1 1
replicate 0 1 1.3  0  4*0 1
unit  21
com='north bottom reflector '
cuboid  3 1 7.4   0.0 2p64.05 2p12.60
cuboid  5 1 39.0  0.0 2p64.05 2p12.60
unit  22
com='north top reflector '
cuboid  3 1 7.4   0.0 2p64.05 2p12.00
cuboid  5 1 39.0  0.0 2p64.05 2p12.00
unit  23
com='north side reflector '
cuboid  3 1 7.4   0.0 2p12.65 57.88 -26.1
cuboid  5 1 39.0  0.0 2p12.65 57.88 -26.1
unit  24
com='south bottom reflector with tris'
cuboid  0 1 10.2  0.0 2p2.55  2p12.60
cuboid  5 1 47.1  0.0 2p64.05 2p12.60
unit  25
com='south top reflector with tris'
cuboid  0 1 10.2  0.0 2p2.55  2p12.00
cuboid  5 1 47.1  0.0 2p64.05 2p12.00
unit  26
com='south side reflector with tris'
cuboid  5 1 47.1  0.0 2p12.65 57.88 -26.1
unit  31
com='north array core+side'
array 3 3*0.0
unit  32
com='south array core+side'
array 4 3*0.0
unit  33
com='north array'
array 5 3*0.0
replicate 4 1 0 25.2 4r0.0 1
replicate 3 1 1.23 0 4r0.0 1
unit  34
com='south array'
array 6 3*0.0
replicate 0 1 0.5    5r0.0 1
replicate 5 1 26.5   5r0.0 1
replicate 3 1 0 1.23 4r0.0 1
replicate 0 1 0 1.26 4r0.0 1
global
unit  35
com='total'
array 7 3*0.0
end geometry
read array
ara=1  nux=3 nuy=7 nuz=5
com='north split table core'
fill  1 2 1 3 5 3 2q6 1 2 1
      4 7 4 6 8 6 2q6 4 7 4
      1q42
      51 2 1 53 5 3 2q6 51 52 51  end fill
ara=2  nux=3 nuy=7 nuz=5
com='south split table core'
fill  1 2 1 3 5 3 2q6 1 2 1
      4 7 4 6 8 6 2q6 4 7 4
      1q42
      1 2 51 3 5 53 2q6 51 52 51 end fill
ara=3  nux=1 nuy=3 nuz=1
com='north core with side wall'
fill 23 11 23 end fill
ara=4  nux=1 nuy=3 nuz=1
com='south core with side wall'
fill 26 12 26 end fill
```

```
ara=5  nux=1 nuy=1 nuz=3
com='north assembly'
fill 21 31 22 end fill
ara=6  nux=1 nuy=1 nuz=3
com='south assembly'
fill 24 32 25 end fill
ara=7  nux=2 nuy=1 nuz=1
com='total'
fill  33 34     end fill
end array
read plot ttl='xz slice of rfp1 showing material regions'
xul=-2  yul=64.05 zul=136
xlr=137 ylr=64.05 zlr=-2
uax=1  wdn=-1 nax=130  nch=' 1*345.'end
ttl='xy slice of rfp1 showing material regions'
xul=23  yul=98  zul=95
xlr=115 ylr=24 zlr=95
uax=1  vdn=-1 nax=130  nch=' 1*345.'end
ttl='yz slice of north core second row'
xul=50  yul=20   zul=105
xlr=50  ylr=98 zlr=50
vax=1  wdn=-1 nax=130  nch=' 1*345.'end
ttl='yz slice of south core second row'
xul=70 yul=20   zul=105
xlr=70 ylr=98   zlr=50
vax=1  wdn=-1 nax=130  nch=' 1*345.'
end plot
end data
end
```

cr1653b

```
=csas25
rocky flats criticals nureg/cr-1653 experiment number 1 (44 group)
' 120 fuel cans 2.43 cm moderator   h/u=1.25
44group      infhommedium
u3o8  1 den=4.54 1 293.0 92234 0.03 92235 4.48 92236 0.09 92238 95.4
                  end
h2o   1 den=.16060 end
arbm-baggie  1.596-2 3 0 0 0  6012 84.9  1001 14.01 8016 1.20 1  end
arbm-al1100 2.713 4 0 0 1 13027 99.33 26000 0.42 29000 0.12
                         14000 0.1                      2   end
arbm-tape(vinyl) 1.374-2 7 0 0 0  6012 45.91 1001 5.92 8016 10.82
             17000 25.73 20000 6.9 22000 1.6 82000 1.1 2           end
arbm-tape(mylar) 1.832-2 3 0 0 0  6012 65.50 1001 6.83 8016 27.02 2  end
arbm-moderator  1.185 3 0 0 0  6012 59.49 1001 7.83 8016 32.48 3 end
arbm-plex(reg)  1.185 3 0 0 0  6012 59.59 1001 7.84 8016 32.23 4
                .9935   end
arbm-plex(paper) .766 3 0 0 0  6012 42.17 1001 6.48 8016 49.5 4
                .0049     end
arbm-plex(glue) .728 3 0 0 0   6012 86.29 1001 11.67 8016 1.20 4
                .0016     end
arbm-plex(tris) 1.284 8 0 0 1 6012 52.03 1001 7.16 7014 0.16 8016 29.82
             15031 1.02 17000 1.81 35079 3.55 35081 3.55 5 .9935  end
arbm-plex(paper) .766 3 0 0 0  6012 42.17 1001 6.48 8016 49.5 5
                .0049     end
arbm-plex(glue)  .728 3 0 0 0  6012 86.29 1001 11.67 8016 1.20 5
                .0016     end
arbm-filler  1.185 3 0 0 0  6012 59.49 1001 7.83 8016 32.48 6 1.0 end
arbm-al1100  1.0 3 0 0 1 13027 99.18 26000 0.5 29000 0.2 7 2.715  end
solnuo2(no3)2  8 86.60 0.143 1.0 293.0 92234 1.01  92235 93.15
   92236 0.43  92238 5.41   end
ss304  9 1.0 end
end comp
rocky flats criticals nureg/cr-1071 experiment number 1 (44 group)
' 42 fuel cans 2.43 cm moderator
read parm  run=yes npg=600 gen=805 nsk=5 wrs=34 res=205
nub=yes fdn=yes plt=yes tme=120
end parm
read geom
unit  1
com='fuel box 15.24 cm on a side with .16 cm walls '
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
cuboid  0 1 6p7.65
unit  2
com='middle of special box'
cuboid  0 1 9.79  0.0 2p1.875      2p7.46
cuboid  2 1 9.95  0.0 2p2.035      2p7.46
cuboid  1 1 14.92 0.0 4p7.46
cuboid  2 1 15.08 0.0 2p7.62 2p7.46
unit  3
com='front of special box'
cuboid  0 1 0.16 0 2p1.876        2p7.62
cuboid  2 1 0.16 0 4p7.62
unit  9
com='top and bottom of special box'
cuboid  0 1 9.79 0 2p1.876        2p0.08
cuboid  2 1 15.08 0 2p7.62  2p0.08
unit  4
com='north core solution driver'
cuboid  8 1 2p7.5 2p14.88 3.332 -7.5
cuboid  0 1 2p7.5 2p14.88 2p7.5
cuboid  9 1 2p7.65 2p15.03 2p7.65
cuboid  0 1 2p7.65 2p15.30 2p7.65
unit  5
com='south core solution driver'
cuboid  8 1 2p7.5 2p14.935 3.292 -7.5
cuboid  0 1 2p7.5 2p14.935 2p7.5
cuboid  9 1 2p7.65 2p15.085 2p7.65
cuboid  0 1 2p7.65 2p15.30  2p7.65
unit  6
com='aluminum weight distribution plate for fuel box'
cuboid  7 1 4p7.65  0.16 0.0
unit  7
com='aluminum weight distribution plate for special box'
cuboid  0 1  9.95 -0.03 2p1.875    2p0.08
cuboid  7 1 15.27 -0.03 2p7.65     2p0.08
unit  8
com='special box'
array 9 3*0.0
cuboid 0 1 15.27 -0.03 15.27 -0.03 15.27 -0.03
unit  10
com='main part of special box'
array 1  3*0.0
unit  51
com='combination of two regular fuel boxes'
```

```
array 11 3*0.0
unit  52
com='combination of regular fuel box and special fuel box'
array 12 3*0.0
unit  53
com='combination of two regular weight distribution plates'
array 13 3*0.0
unit  54
com='combination of regular and special weight distribution plates'
array 14 3*0.0
unit  11
com='north split table core'
array 2 3*0.0
cuboid 0 1 30.6 -1.4  77.5  0.0  83.6  0.0
unit  12
com='south split table core'
array 3 3*0.0
cuboid 0 1 47.9  0.0  77.5  0.0  83.6  0.0
unit  21
com='north bottom reflector '
cuboid  5 1 32.0  0.0 2p64.05 2p12.60
unit  22
com='north top reflector '
cuboid  5 1 32.0  0.0 2p64.05 2p12.00
unit  23
com='north side reflector '
cuboid  5 1 32.0  0.0 2p12.65 83.6  0.0
unit  24
com='south bottom reflector with tris'
cuboid  0 1 10.2  0.0 2p2.55  2p12.60
cuboid  5 1 47.9  0.0 2p64.05 2p12.60
unit  25
com='south top reflector with tris'
cuboid  0 1 10.2  0.0 2p2.55  2p12.00
cuboid  5 1 47.9  0.0 2p64.05 2p12.00
unit  26
com='south side reflector with tris'
cuboid  5 1 10.2  0.0 2p2.55  83.6  0.0
cuboid  5 1 47.9  0.0 2p12.65 83.6  0.0
unit  31
com='north array core+side'
array 4 3*0.0
unit  32
com='south array core+side'
array 5 3*0.0
unit  33
com='north array'
array 6 3*0.0
replicate 4 1 0 25.2 4r0.0 1
unit  34
com='south array'
array 7 3*0.0
replicate 0 1 0.6    5r0.0 1
replicate 5 1 26.5   5r0.0 1
replicate 0 1 0 0.57 4r0.0 1
global
unit  35
com='total'
array 8 3*0.0
end geometry
read array
ara=9  nux=2 nuy=1 nuz=1
com='special box  '
fill 3 10     end fill
ara=1  nux=1 nuy=1 nuz=3
com='main part of special box  '
fill 9 2 9    end fill
ara=2  nux=2 nuy=4 nuz=9
com='north split table core'
fill  2r1 2r51 4r1 2r6 2r53 4r6  1q16
      2r1  51 4  4r1 2r6 2r53 4r6
      2r1  2r51 4r1 2r6 2r53 4r6
      2r1  2r51 4r1               end fill
ara=3  nux=3 nuy=4 nuz=9
com='south split table core'
fill  3r1 3r51     6r1 3r6 3r53    6r6  1q24
      3r1  5  2r51 6r1 3r6 54 2r53 6r6
      3r1  52 2r51 6r1 3r6 54 2r53 6r6
      3r1  52 2r51 6r1               end fill
ara=4  nux=1 nuy=3 nuz=1
com='north core with side wall'
fill 23 11 23 end fill
ara=5  nux=1 nuy=3 nuz=1
com='south core with side wall'
fill 26 12 26 end fill
ara=6  nux=1 nuy=1 nuz=3
com='north assembly'
fill 21 31 22 end fill
ara=7  nux=1 nuy=1 nuz=3
com='south assembly'
fill 24 32 25 end fill
ara=8  nux=2 nuy=1 nuz=1
com='total'
fill  33 34     end fill
ara=11  nux=1 nuy=2 nuz=1
com='combination of two fuel boxes'
fill  1 1  end fill
ara=12  nux=1 nuy=2 nuz=1
com='combination of regular and special fuel boxes'
fill  1 8  end fill
ara=13  nux=1 nuy=2 nuz=1
com='combination of two weight distribution plates'
fill  6 6    end fill
ara=14  nux=1 nuy=2 nuz=1
com='combination of regular and special weight distribution plates'
fill  6 7    end fill
end array
read plot ttl='xz slice of rfp1 showing material regions'
xul=-2  yul=64.05 zul=136
xlr=137 ylr=64.05 zlr=-2
uax=1  wdn=-1 nax=130  nch=' 1*345.'end
ttl='xy slice of rfp1 showing material regions'
xul=23  yul=110 zul=95
xlr=115 ylr=20 zlr=95
uax=1  vdn=-1 nax=130  nch=' 1*345.'end
ttl='yz slice of north core second row'
xul=50  yul=24   zul=110
xlr=50  ylr=110 zlr=24
```

```
vax=1  wdn=-1 nax=130  nch=' 1*345.'end
ttl='yz slice of south core second row'
xul=60 yul=24   zul=110
xlr=60 ylr=110  zlr=24
vax=1  wdn=-1 nax=130  nch=' 1*345.'
end plot
end data
end
```

cr2500s

```
=csas25
rocky flats criticals nureg/cr-2500 experiment number 1 (symmslabcell)
' 30 fuel cans 2.43 cm moderator  h/u=2.03
44group      latticecell
u3o8  1 den=4.54 1 293.0 92234 0.03 92235 4.48 92236 0.09 92238 95.4
                end
h2o   1 den=.27248 end
arbm-baggie  1.596-2 3 0 0 0  6012 84.9   1001 14.01 8016 1.20 1   end
arbm-al1100 2.713 4 0 0 1 13027 99.33 26000 0.42 29000 0.12
                          14000 0.1                          2   end
arbm-tape(vinyl) 1.374-2 7 0 0 0  6012 45.91 1001 5.92 8016 10.82
            17000 25.73 20000 6.9 22000 1.6 82000 1.1 2           end
arbm-tape(mylar) 2.748-2 3 0 0 0  6012 65.50 1001 6.83 8016 27.02 2  end
arbm-moderator  1.185 3 0 0 0  6012 59.49 1001 7.83 8016 32.48 3 end
arbm-plex(reg)  1.185 3 0 0 0  6012 59.59 1001 7.84 8016 32.23 4
               .9935   end
arbm-plex(paper) .766 3 0 0 0  6012 42.17 1001 6.48 8016 49.5 4
               .0049     end
arbm-plex(glue) .728 3 0 0 0   6012 86.29 1001 11.67 8016 1.20 4
               .0016     end
arbm-plex(tris) 1.284 8 0 0 1 6012 52.03 1001 7.16 7014 0.16 8016 29.82
            15031 1.02 17000 1.81 35079 3.55 35081 3.55 5 .9935  end
arbm-plex(paper) .766 3 0 0 0  6012 42.17 1001 6.48 8016 49.5 5
               .0049     end
arbm-plex(glue)  .728 3 0 0 0  6012 86.29 1001 11.67 8016 1.20 5
               .0016     end
arbm-filler  1.185 3 0 0 0  6012 59.49 1001 7.83 8016 32.48 6 1.0 end
end comp
symmslabcell 17.67 14.92 1 3 15.24 2 end
rocky flats criticals nureg/cr-2500 experiment number 1
' 30 fuel cans 2.43 cm moderator
read parm  run=yes npg=600 gen=805 nsk=5 wrs=34 res=205
nub=yes fdn=yes plt=yes tme=120
end parm
read geom
unit  1
com='fuel box 15.24 cm on a side with .16 cm walls '
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
unit  2
com='x-face interstitial moderator'
cuboid  3 1 2p1.215 4p7.62
unit  3
com='y-face interstitial moderator'
cuboid  3 1 2p7.62 2p1.215 2p7.62
unit  4
com='z-face interstitial moderator'
cuboid  3 1 4p7.62 2p1.215
unit  5
com='more x-face moderator'
cuboid  3 1 4p1.215 2p7.62
unit  6
com='more y-face moderator'
cuboid  3 1 2p7.62 4p1.215
unit  7
com='more z-face moderator'
cuboid  3 1 2p1.215 2p7.62 2p1.215
unit  8
com='last of interstitial moderator'
cuboid  3 1 6p1.215
unit  51
com='empty fuel location'
cuboid  0 1 6p7.620
unit  53
com='y-face moderator void'
cuboid  0 1 2p7.62 2p1.215 2p7.62
unit  11
com='north split table core'
array 1 3*0.0
cuboid 0 1 32.91 -.59 77.50 0.0  50.58 0.0
replicate 6 1 4*0 2.42 30.0 1
replicate 0 1 0 0 0 0 0.3 0 1
unit  12
com='south split table core'
array 2 3*0.0
cuboid 0 1 33.5  0.0  77.50 0.0  50.58 0.0
replicate 6 1 13.5 3*0 2.42 30.0 1
replicate 0 1 0 0 0 0 0.3 0 1
unit  21
com='north bottom reflector '
cuboid  3 1 1.90  0.0 2p64.05 2p12.60
cuboid  5 1 33.50 0.0 2p64.05 2p12.60
unit  22
com='north top reflector '
cuboid  3 1 1.90  0.0 2p64.05 2p12.00
cuboid  5 1 33.50 0.0 2p64.05 2p12.00
unit  23
com='north side reflector '
cuboid  3 1 1.90  0.0 2p12.65 53.3 -30.0
cuboid  5 1 33.50 0.0 2p12.65 53.3 -30.0
unit  24
com='south bottom reflector with tris'
cuboid  0 1 10.2  0.0 2p2.55  2p12.60
cuboid  5 1 47.0  0.0 2p64.05 2p12.60
unit  25
com='south top reflector with tris'
cuboid  0 1 10.2  0.0 2p2.55  2p12.00
cuboid  5 1 47.0  0.0 2p64.05 2p12.00
unit  26
com='south side reflector with tris'
cuboid  5 1 47.0  0.0 2p12.65 53.3 -30.0
unit  31
com='north array core+side'
array 3 3*0.0
unit  32
com='south array core+side'
```

```
array 4 3*0.0
unit  33
com='north array'
array 5 3*0.0
replicate 4 1 0 25.2 4r0.0 1
replicate 3 1 1.23 0 4r0.0 1
unit  34
com='south array'
array 6 3*0.0
replicate 5 1 26.5   5r0.0 1
replicate 3 1 0 1.23 4r0.0 1
replicate 0 1 0 .57  4r0.0 1
global
unit  35
com='total'
array 7 3*0.0
end geometry
read array
ara=1  nux=3 nuy=5 nuz=5
com='north split table core'
fill  1 2 1 3 5 3 1q6 1 2 1
      4 7 4 6 8 6 1q6 4 7 4
      1q30
      51 2 1 53 5 3 1q6 51 2 1  end fill
ara=2  nux=3 nuy=5 nuz=5
com='south split table core'
fill  1 2 1 3 5 3 1q6 1 2 1
      4 7 4 6 8 6 1q6 4 7 4
      1q30
      1 2 51 3 5 53 1q6 1 2 51 end fill
ara=3  nux=1 nuy=3 nuz=1
com='north core with side wall'
fill 23 11 23 end fill
ara=4  nux=1 nuy=3 nuz=1
com='south core with side wall'
fill 26 12 26 end fill
ara=5  nux=1 nuy=1 nuz=3
com='north assembly'
fill 21 31 22 end fill
ara=6  nux=1 nuy=1 nuz=3
com='south assembly'
fill 24 32 25 end fill
ara=7  nux=2 nuy=1 nuz=1
com='total'
fill  33 34     end fill
end array
read plot ttl='xz slice of rfp1 showing material regions'
xul=-2  yul=64.05 zul=136
xlr=137 ylr=64.05 zlr=-2
uax=1  wdn=-1 nax=130  nch=' 1*345.'end
ttl='xy slice of rfp1 showing material regions'
xul=-2  yul=105 zul=95
xlr=137 ylr=20 zlr=95
uax=1  vdn=-1 nax=130  nch=' 1*345.'end
ttl='yz slice of north core second row'
xul=40  yul=-2   zul=110
xlr=40  ylr=137 zlr=50
vax=1  wdn=-1 nax=130  nch=' 1*345.'end
ttl='yz slice of south core second row'
xul=85 yul=-2   zul=110
xlr=85 ylr=137  zlr=50
vax=1  wdn=-1 nax=130  nch=' 1*345.'
end plot
end data
end
```


ydr14un2

```
=csas25
raffety and milhalczo u(2)f4-2 unreflected (case 14)
44group      infhommedium
u-235  1 0 1.3303e-4 end
u-238  1 0 6.4370e-3 end
h      1 0 3.9097e-2 end
c      1 0 1.8797e-2 end
f      1 0 2.6280e-2 end
end comp
raffety and malhalczo u(2)f4-2 unreflected (case 14)
read param gen=405 npg=600 nsk=5 wrs=34
           res=205 nub=yes fdn=yes end param
read geom
cuboid  1 1 28.11 -28.11 28.11 -28.11 61.235 -61.235
end geom
end data
end
```

ydr14pl2

```
#csas25
raffety and malhalczo u(2)f4-3 reflected (case 15)
44group      infhommedium
u-235  1 0 1.1191e-4 end
u-238  1 0 5.4152e-3 end
h      1 0 4.5472e-2 end
c      1 0 2.1861e-2 end
f      1 0 2.2109e-2 end
para(h2o) 2 1.0 end
plexiglass  3 0.918 end
al          3 0.062 end
end comp
raffety and malhalczo u(2)f4-3 reflected (case 15)
read param gen=405 npg=600 nsk=5 wrs=34
           res=205 nub=yes fdn=yes end param
read geom
unit  1
cuboid  1 1 4p26.835 2p27.145
replicate  2 2 5*3.048 0.0 5
unit  2
cuboid  1 1 4p26.835 2p0.0
replicate  3 2 4*3.048 0.0 3.048 5
end geom
read array
nux=1  nuy=1  nuz=2 fill 2 1 end fill
end array
read bias id=400  2 6 end bias
```

```
end data
end
```

ydr14pl3

```
#csas25
raffety and milhalczo u(3)f4-1 reflected (case 22)
44group      infhommedium
u-235  1 0 2.3494e-4 end
u-238  1 0 7.4999e-3 end
h      1 0 3.1341e-2 end
c      1 0 1.5067e-2 end
f      1 0 3.0939e-2 end
para(h2o) 2 1.0 end
plexiglass  3 0.918 end
al          3 0.062 end
end comp
raffety and malhalczo u(3)f4-1 reflected (case 22)
read param gen=405 npg=600 nsk=5 wrs=34
     plt=yes res=205 nub=yes fdn=yes end param
read geom
unit  1
cuboid  1 1 2p21.735 2p21.735 2p43.1950
replicate  2 2 5*3.048 0.0 5
unit  2
cuboid  1 1 2p21.735 2p21.735 2p0.0
replicate  3 2 4*3.048 0.0 3.048 5
end geom
read array
nux=1  nuy=1  nuz=2  fill 2 1  end fill
end array
read bias id=400  2 6 end bias
read plot ttl='xz slice of case 22 showing biasing regions'
xul=-1  yul=20  zul=99
xlr=79  ylr=20  zlr=-3
uax=1  wdn=-1 nax=130  nch='0123456'
pic=wts
end plot
end data
end
```

ydr14un3

```
=csas25
raffety and milhalczo u(3)f4-1 unreflected (case 26)
44group      infhommedium
u-235  1 0 2.3494e-4 end
u-238  1 0 7.4999e-3 end
h      1 0 3.1341e-2 end
c      1 0 1.5067e-2 end
f      1 0 3.0939e-2 end
end comp
raffety and malhalczo u(3)f4-1 unreflected (case 26)
read param gen=405 npg=600 nsk=5 wrs=34
res=205 nub=yes fdn=yes rnd=5D306CBF6558 end param
read geom
cuboid  1 1 28.235 -28.235 28.235 -28.235 43.32 -43.32
end geom
end data
end
```

or260901

```
=csas25
uo2f2 soln h/u-235=1112 bare sphere case 1
44group      multiregion
solnuo2f2  1  25.132  0 den=1.03     1  293
             92234 1.14  92235 93.20  92238 5.66  end
al     2 1 end
end comp
spherical end
1 27.9 noextermod  2 28.10 noextermod  end zone
uo2f2 soln h/u-235=1112 bare sphere case 1
read param gen=405 npg=600 nsk=5 wrs=34
           res=205 nub=yes fdn=yes end param
read geom
sphere  1 1 27.9
sphere  2 1 28.1
end geom
end data
end
```

or260906

```
=csas25
uo2f2 soln h/u-235=1270 h2o refl sphere case 6
44group  multiregion
solnuo2f2  1  22.042  0 den=1.03     1  293
             92235 93.18 92234  0.98  92236 .50  92238 5.36  end
al     2 1 end
h2o    3 1 end
end comp
spherical end
1 27.9 oneextermod  2 28.10 noextermod  3 46.10 noextermod end zone
uo2f2 soln h/u-235=1270 h2o refl sphere case 6
read param gen=405 npg=600 nsk=5 wrs=34 tme=60
           res=205 nub=yes fdn=yes end param
read geom
sphere  1 1 27.9
sphere  2 1 28.1
reflector  3 2 3 6
end geom
read bias id=500 2 7 end bias
end data
end
```

rfp2710u

```
=csas25
rocky flats uo2(no3)2 soln 142.92 g u/l
44group      multiregion
```

```
solnuo2(no3)2  1 142.92 0.283 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
end comp
cylindrical end
1 14 noextermod  2 14.3 noextermod end zone
rocky flats uo2(no3)2 soln 28.01 cm d1am bare 1
read param gen=405 npg=600 nsk=5 wrs=34
           res=205 nub=yes fdn=yes end param
read geom
cylinder  1 1 14.005 33.55 0
cylinder  2 1 14.325 33.55 -.64
end geom
end data
end
```

rfp2710r

```
=csas25
rocky flats uo2(no3)2 soln 345.33 g u/l
44group  multiregion
solnuo2(no3)2  1 345.33 .534 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
plexiglass  3 1 end
h    4  den=1.286 .0718  end
c    4  den=1.286 .5268  end
o    4  den=1.286 .2940  end
p    4  den=1.286 .0154  end
cl   4  den=1.286 .0163  end
bromine 4 den=1.286 .0650  end
end comp
cylindrical end
1 16.5 noextermod  2 16.8 noextermod end zone
rocky flats uo2(no3)2 soln 33.01 cm d1am refl 12 plexiglass refl
read param gen=405 npg=600 nsk=5 wrs=34 tme=60
           res=205 nub=yes fdn=yes end param
read geom
cylinder  1 1 16.505 17.2 0
cylinder  2 1 16.825 17.2 -.64
cuboid    0 1 105.2 -17.7 17.3 -105.6 122.26 -.64
reflector 3 2 4r2.971 2r0  7
reflector 4 2 5r0 2.971    7
reflector 4 2 4r0 2.886 0  7
end geom
read bias id=400 2 8 end bias
end data
end
```

or2968s1

```
#csas25
4.89% uo2f2 h/u-235=524
44group      multiregion
solnuo2f2  1 869.9 0 1 293 92234 .02 92235 4.89
92238 95.09 end
ss304     2 1 end
end comp
cylindrical end
1 25.4 noextermod  2 25.56 noextermod end zone
4.89% uo2f2 20 in diam ss cyl bare 1
read param gen=405 npg=600 nsk=5 wrs=34
           res=205 nub=yes fdn=yes end param
read geom
cylinder  1 1 25.4 38.66 0
cylinder  2 1 25.559 38.66 -.159
end geom
end data
end
```

or2968al

```
#csas25
4.89% uo2f2 h/u-235=524
44group      multiregion
solnuo2f2  1 869.9 0 1 293 92234 .02 92235 4.89
92238 95.09 end
al        2 1 end
h2o       3 1 end
end comp
cylindrical end
1 25.4 oneextermod 2 25.56 noextermod 3 43.56 noextermod end zone
4.89% uo2f2 20x20 in al box refl 2
read param gen=805 npg=600 nsk=5 wrs=34 tme=120
           res=205 nub=yes fdn=yes end param
read geom
cuboid  1 1 4p25.25 25.4 0
cuboid  2 1 4p25.409 25.559 -.159
reflector 3 2 6r3       6
end geom
read bias id=500 2  7 end bias
end data
end
```

or2968s2

```
#csas25
4.89% uo2f2 h/u-235=994
44group      multiregion
solnuo2f2  1 495.3 0 1 293 92234 .02 92235 4.89
92238 95.09 end
ss304     2 1 end
h2o       3 1 end
end comp
cylindrical end
1 25.4 oneextermod 2 25.56 noextermod 3 43.56 noextermod end zone
4.89% uo2f2 20 in diam ss cyl refl 5
read param gen=805 npg=600 nsk=5 wrs=34 tme=120
           res=205 nub=yes fdn=yes end param
read geom
cylinder  1 1 25.4 85.72 0
cylinder  2 1 25.559 85.879 -.159
reflector 3 2 3r3   6
end geom
```

```
read bias id=500 2  7 end bias
end data
end
```

p6838

```
=csas25
'
' problem id ttc-5
'
' 4.31% u-235 enriched uo2 rods, 1.415 cm diam. al clad, 1.283 cm id,
' 1.415 cm od. uo2 91.44 cm long, rod 96.52 cm long. h2o moderated and
' reflected.
' 4 14x14 clusters, 2 14x14 clusters w/36 locations without fuel,
' 1 14x14 center cluster w/34 locations without fuel and w/2 guide tubes
' reference: pnl-6838
' scale module: csas25
'
1.891 cm pitch lattice cell,4.306 wt% enriched fuel.
44group latticecell
uo2  1 0.9489 293 92235 4.306 92238 95.694 end
al   2             end al
h2o  3             end h2o
arbmpolyprop 0.90 2 0 1 1 6012 3    1001 6           4 end
arbmrubber  1.321 6 0 0 0 6012 58.0 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 5 end
arbmalb2    2.64  2 1 0 1 5000 3.41  13027 96.59
         6  1.0 293  5010 98.71  5011 1.29  end
h2o   7            end
plexiglass  8 den=1.185  end
h2o   9            end
end comp
squarepitch  1.891 1.265  1 3 1.415 2 1.283 0 end
ttc-5 pnl-6838 1264 fuel rods 4.31wt%u235 uo2
read parm plt=yes run=yes gen=405 npg=600 nsk=5 tme=150
wrs=34 res=205 nub=yes  end parm
read geom
unit 1
cylinder  5 1  .6415     1.23  0.0
cylinder  2 1  .7075     1.23  0.0
cuboid    4 1  4p.9455   1.23  0.0
unit 2
cylinder  1 1  .6325    68.58  0.0
cylinder  0 1  .6415    68.58  0.0
cylinder  5 1  .6415    68.58 -1.31
cylinder  2 1  .7075    68.58 -1.31
cuboid    3 1  4p.9455  68.58 -1.31
unit 3
cylinder  1 1  .6325     1.23  0.0
cylinder  0 1  .6415     1.23  0.0
cylinder  2 1  .7075     1.23  0.0
cuboid    4 1  4p.9455   1.23  0.0
unit 4
cylinder  1 1  .6325    21.63  0.0
cylinder  0 1  .6415    21.63  0.0
cylinder  5 1  .6415    24.17  0.0
cylinder  2 1  .7075    24.17  0.0
cuboid    3 1  4p.9455  24.17  0.0
unit 5
cylinder  3 1  .6415     1.23  0.0
cylinder  2 1  .7075     1.23  0.0
cuboid    4 1  4p.9455   1.23  0.0
unit 6
cylinder  3 1  .6415    68.58 -1.31
cylinder  2 1  .7075    68.58 -1.31
cuboid    3 1  4p.9455  68.58 -1.31
unit 7
cylinder  3 1  .6415    24.17  0.0
cylinder  2 1  .7075    24.17  0.0
cuboid    3 1  4p.9455  24.17  0.0

unit 8
cylinder  3 1  .7075     1.23  0.0
cuboid    4 1  4p.9455   1.23  0.0
unit 9
cuboid    3 1  4p.9455  68.58 -1.31
unit 10
cuboid    3 1  4p.9455  24.17  0.0


unit 11
com='fuel rod'
array 1   3*0.0
unit 12
com='guide tube'
array 2   3*0.0
unit 13
com='unfilled spot'
array 3   3*0.0

unit 14
com='14x14 array'
array 4   2*-13.237 0.
replicate 3 1  4r0.0065  2r0.0  1
replicate 6 1  4r0.384   2r0.0  1
replicate 7 1  4r2.475   2r0.0  1

unit 15
com='14x14 array with 36 missing (on right of center array)'
array 5   2*-13.237 0.
replicate 3 1  4r0.0065  2r0.0  1
replicate 6 1  4r0.384   2r0.0  1
replicate 7 1  4r2.475   2r0.0  1

unit 16
com='14x14 array with 34 missing and 2 guide tubes (center array)'
array 6   2*-13.237 0.
replicate 3 1  4r0.0065  2r0.0  1
replicate 6 1  4r0.384   2r0.0  1
replicate 7 1  4r2.475   2r0.0  1

unit 20
com='14x14 array with 36 missing (on left of center array)'
array 7   2*-13.237 0.
replicate 3 1  4r0.0065  2r0.0  1
replicate 6 1  4r0.384   2r0.0  1
replicate 7 1  4r2.475   2r0.0  1
```

```
unit 17
com='water block separator'
cuboid    7 1  16.1025 0.0     32.205  0.0     96.52  0.0

unit 18
com='2 full assemblies '
array  8   3*0.0

unit 19
com='3 middle assemblies'
array  9   3*0.0

global unit 21
array  10  3*0.0
replicate 8 1 5r0.0 5.08 1
reflector 9 2    6r3 5
reflector 9 7    4r3 2r0 5

end geom

read bias id=500 2 11 end bias

read array
com='fuel rod'   ara=1 nux=1  nuy=1  nuz=4   fill 1 2 3 4    end fill
com='guide tube' ara=2 nux=1  nuy=1  nuz=4   fill 5 6 5 7    end fill
com='unfilled'   ara=3 nux=1  nuy=1  nuz=4   fill 8 9 8 10   end fill
com='full array' ara=4 nux=14 nuy=14 nuz=1   fill f11        end fill
ara=5 nux=14 nuy=14 nuz=1   fill 16r11 13 11 5q2 5q28 28r11  end fill
ara=6 nux=14 nuy=14 nuz=1   fill 15r11 13 11 5q2 11 2q28
                                 15r11 13 11 13 11 12 11 13 11 12 11 13
                                 17r11 13 11 5q2 11 1q28 28r11 end fill
ara=7 nux=14 nuy=14 nuz=1   fill 15r11 13 11 5q2 11 5q28 28r11 end fill
ara=8 nux=4  nuy=1  nuz=1   fill 17 14 14 17  end fill
ara=9 nux=3  nuy=1  nuz=1   fill 20 16 15     end fill
ara=10 nux=1 nuy=3  nuz=1   fill 18 19 18     end fill
end array
read plot
ttl='x-y slice of ttc-5 at z=1.'
xul=0.0    yul=97.0   zul=1.
xlr=97.0   ylr=0.0    zlr=1.
uax=1 vdn=-1 nax=260  nch=' 12 456789'  end
ttl='x-y slice of ttc-5 at z=2.'
xul=0.0    yul=97.0   zul=2.
xlr=97.0   ylr=0.0    zlr=2.
uax=1 vdn=-1 nax=260  nch=' 12 456789'  end
ttl='x-y slice of ttc-5 at z=50.'
xul=0.0    yul=97.0   zul=50.
xlr=97.0   ylr=0.0    zlr=50.
uax=1 vdn=-1 nax=260  nch=' 12 456789'  end
ttl='x-y slice of ttc-5 at z=72.'
xul=0.0    yul=97.0   zul=72.
xlr=97.0   ylr=0.0    zlr=72.
uax=1 vdn=-1 nax=260  nch=' 12 456789'  end
ttl='x-y slice of ttc-5 at z=90.'
xul=0.0    yul=97.0   zul=90.
xlr=97.0   ylr=0.0    zlr=90.
uax=1 vdn=-1 nax=260  nch=' 12 456789'  end
ttl='x-y slice of ttc-5 at z=96.'
xul=0.0    yul=97.0   zul=96.
xlr=97.0   ylr=0.0    zlr=96.
uax=1 vdn=-1 nax=260  nch=' 12 456789'  end
end plot
end data
end
```

APPENDIX B

CONTENTS OF THE 44GROUPNDF5 LIBRARY

The table on the following pages lists the contents of the 44GROUPNDF5 library by SCALE cross-section identifier number. The following features of the library should be noted:

- The default neutron dose factor within material 900 is based on the ANSI/ANS 6.1.1-1977 standard. Dose factors based on the more recent ANSI/ANS-6.1.1-1991 standard are available within material 900 by specification of dose identifier number 9031. However, until uncertainties in dose measurement methods and inconsistencies with ICRP recommendations are resolved, use of ANSI-91 in design calculations is not recommended unless specifically required.

- Because of the significantly improved and conservative behavior of the ENDF/B-VI ^{16}O evaluation under conditions where higher-order scattering terms are important (e.g., high leakage geometries), this cross section has been included in 44GROUPNDF5 as the default for ^{16}O. The ENDF/B-V evaluation is available within the library as cross-section number 801601, and may be copied into an AMPX master format library and changed to cross-section number 8016 by AJAX for subsequent use in calculations.

- ENDF/B-VI evaluations of ^{14}N and ^{15}N are included in the 44GROUPNDF5 library; however, ENDF/B-V versions remain the default for these isotopes. The ENDF/B-VI-based nitrogen isotopes were processed using the same methods used for ^{16}O, and, like oxygen, were tested to see if significant differences between ENDF/B-V and ENDF/B-VI could be identified. No significant differences have been identified; however, because they had already been processed into AMPX master library format and were readily available, ENDF/B-VI ^{14}N and ^{15}N cross sections are included in the library as cross sections 701401 and 701501, respectively.

- ENDF/B-VI evaluations of ^{154}Eu and ^{155}Eu are also included in the library as default cross sections 63154 and 63155, respectively. The more recent ENDF/B-VI evaluations include resonance parameters not included in previous evaluations and yield energy-dependent cross sections significantly different from those obtained using ENDF/B-V cross sections. Comparisons of depletion/decay calculations to experimental isotopic measurements have indicated that the ENDF/B-VI europium evaluations are more accurate than those available in ENDF/B-V. However, as with ^{16}O, ENDF/B-V cross sections are available within the library, as isotopes 631541 and 631551.

Cross-section identifier	Description
900	Neutron dose factors
999	1/v Function
1001	H in Water
1002	^{2}H (D) IN D_2O
1003	^{3}H (T)
1801	H
1802	^{2}H (D)
1901	H in CH_2
2003	^{3}He
2004	^{4}He
3006	^{6}Li
3007	^{7}Li
4009	^{9}Be
4309	Be
5010	^{10}B
5011	^{11}B
6000	Graphite (96 angles)
6012	^{12}C
6312	Graphite
7014	^{14}N
7015	^{15}N
701401	^{14}N from Version 6 evaluation
701501	^{15}N from Version 6 evaluation
8016	^{16}O from Version 6 evaluation
801601	^{16}O
8017	^{17}O
9019	^{19}F
11023	^{23}Na
12000	Mg
13027	^{27}Al
14000	Si
15031	^{31}P
16000	S
16032	^{32}S
17000	Cl
19000	K
20000	Ca
22000	Ti
23000	V
24000	Cr
40000	Zr
40090	^{90}Zr
40091	^{91}Zr

Cross-section identifier	Description
24301	Cr (1/E σ_t)
24304	Cr (1/E σ_t - SS304)
25055	^{55}Mn
26000	Fe
26301	Fe (1/E σ_t)
26304	Fe (1/E σ_t - SS304)
27059	^{59}Co
28000	Ni
28301	Ni (1/E σ_t)
28304	Ni (1/E σ_t - SS304)
29000	Cu
31000	Ga
32072	^{72}Ge
32073	^{73}Ge
32074	^{74}Ge
32076	^{76}Ge
33075	^{75}As
34074	^{74}Se
34076	^{76}Se
34077	^{77}Se
34078	^{78}Se
34080	^{80}Se
34082	^{82}Se
35079	^{79}Br
35081	^{81}Br
36078	^{78}Kr
36080	^{80}Kr
36082	^{82}Kr
36083	^{83}Kr
36084	^{84}Kr
36085	^{85}Kr
36086	^{86}Kr
37085	^{85}Rb
37086	^{86}Rb
37087	^{87}Rb
38084	^{84}Sr
38086	^{86}Sr
38087	^{87}Sr
38088	^{88}Sr
38089	^{89}Sr
38090	^{90}Sr
39089	^{89}Y
39090	^{90}Y
39091	^{91}Y
48116	^{116}Cd
48601	^{115m}Cd
49113	^{113}In

Cross-section identifier	Description	Cross-section identifier	Description
40092	^{92}Zr	49115	^{115}In
40093	^{93}Zr	50112	^{112}Sn
40094	^{94}Zr	50114	^{114}Sn
40095	^{95}Zr	50115	^{115}Sn
40096	^{96}Zr	50116	^{116}Sn
41093	^{93}Nb	50117	^{117}Sn
41094	^{94}Nb	50118	^{118}Sn
41095	^{95}Nb	50119	^{119}Sn
42000	Mo	50120	^{120}Sn
42092	^{92}Mo	50122	^{122}Sn
42094	^{94}Mo	50123	^{123}Sn
42095	^{95}Mo	50124	^{124}Sn
42096	^{96}Mo	50125	^{125}Sn
42097	^{97}Mo	50126	^{126}Sn
42098	^{98}Mo	51121	^{121}Sb
42099	^{99}Mo	51123	^{123}Sb
42100	^{100}Mo	51124	^{124}Sb
43099	^{99}Tc	51125	^{125}Sb
44096	^{96}Ru	51126	^{126}Sb
44098	^{98}Ru	52120	^{120}Te
44099	^{99}Ru	52122	^{122}Te
44100	^{100}Ru	52123	^{123}Te
44101	^{101}Ru	52124	^{124}Te
44102	^{102}Ru	52125	^{125}Te
44103	^{103}Ru	52126	^{126}Te
44104	^{104}Ru	52128	^{128}Te
44105	^{105}Ru	52130	^{130}Te
44106	^{106}Ru	52132	^{132}Te
45103	^{103}Rh	52601	^{127m}Te
45105	^{105}Rh	52611	^{129m}Te
46102	^{102}Pd	53127	^{127}I
46104	^{104}Pd	53129	^{129}I
46105	^{105}Pd	53130	^{130}I
46106	^{106}Pd	53131	^{131}I
46107	^{107}Pd	53135	^{135}I
46108	^{108}Pd	54124	^{124}Xe
46110	^{110}Pd	54126	^{126}Xe
47107	^{107}Ag	54128	^{128}Xe
47109	^{109}Ag	54129	^{129}Xe
47111	^{111}Ag	54130	^{130}Xe
48000	Cd	54131	^{131}Xe
48106	^{106}Cd	54132	^{132}Xe
48108	^{108}Cd	54133	^{133}Xe
48110	^{110}Cd	54134	^{134}Xe
48111	^{111}Cd	54135	^{135}Xe
48112	^{112}Cd	54136	^{136}Xe
48113	^{113}Cd	55133	^{133}Cs
48114	^{114}Cd	55134	^{134}Cs

Cross-section identifier	Description	Cross-section identifier	Description
55135	^{135}Cs	63155	^{155}Eu from Version 6 evaluation
55136	^{136}Cs		
55137	^{137}Cs	64152	^{152}Gd
56134	^{134}Ba	64154	^{154}Gd
56135	^{135}Ba	64155	^{155}Gd
56136	^{136}Ba	64156	^{156}Gd
56137	^{137}Ba	64157	^{157}Gd
56138	^{138}Ba	64158	^{158}Gd
56140	^{140}Ba	64160	^{160}Gd
57139	^{139}La	65159	^{159}Tb
57140	^{140}La	65160	^{160}Tb
58140	^{140}Ce	66160	^{160}Dy
58141	^{141}Ce	66161	^{161}Dy
58142	^{142}Ce	66162	^{162}Dy
58143	^{143}Ce	66163	^{163}Dy
58144	^{144}Ce	66164	^{164}Dy
59141	^{141}Pr	67165	^{165}Ho
59142	^{142}Pr	68166	^{166}Er
59143	^{143}Pr	68167	^{167}Er
60142	^{142}Nd	71175	^{175}Lu
60143	^{143}Nd	71176	^{176}Lu
60144	^{144}Nd	72000	Hf
60145	^{145}Nd	72174	^{174}Hf
60146	^{146}Nd	72176	^{176}Hf
60147	^{147}Nd	72177	^{177}Hf
60148	^{148}Nd	72178	^{178}Hf
60150	^{150}Nd	72179	^{179}Hf
61147	^{147}Pm	72180	^{180}Hf
61148	^{148}Pm	73181	^{181}Ta
61149	^{149}Pm	73182	^{182}Ta
61151	^{151}Pm	74000	W
61548	^{148}Pm	74182	^{182}W
62144	^{144}Sm	74183	^{183}W
62147	^{147}Sm	74184	^{184}W
62148	^{148}Sm	74186	^{186}W
62149	^{149}Sm	75185	^{185}Re
62150	^{150}Sm	75187	^{187}Re
62151	^{151}Sm	79197	^{197}Au
62152	^{152}Sm	82000	Pb
62153	^{153}Sm	83209	^{209}Bi
62154	^{154}Sm	90230	^{230}Th
63000	Eu	90232	^{232}Th
63151	^{151}Eu	91231	^{231}Pa
63152	^{152}Eu	91233	^{233}Pa
63153	^{153}Eu	92232	^{232}U
631541	^{154}Eu from ENDF/B-V	92233	^{233}U
631551	^{155}Eu from ENDF/B-V	92234	^{234}U
63156	^{156}Eu	92235	^{235}U

Cross-section identifier	Description
63157	^{157}Eu
631541	^{154}Eu from Version 6 evaluation
93237	^{237}Np
93238	^{238}Np
94236	^{236}Pu
94237	^{237}Pu
94238	^{238}Pu
94239	^{239}Pu
94240	^{240}Pu
94241	^{241}Pu
94242	^{242}Pu
94243	^{243}Pu
94244	^{244}Pu
95241	^{241}Am
95242	^{242}Am
95243	^{243}Am
95601	^{242m}Am
96241	^{241}Cm
96242	^{242}Cm
96243	^{243}Cm
96244	^{244}Cm
96245	^{245}Cm
96246	^{246}Cm
96247	^{247}Cm
96248	^{248}Cm
97249	^{249}Bk
98249	^{249}Cf
98250	^{250}Cf
98251	^{251}Cf
98252	^{252}Cf
98253	^{253}Cf
99253	^{253}Es
92236	^{235}U
92237	^{237}U
92238	^{238}U

APPENDIX C

NEW RESONANCE DATA

ENDF/B-V cross-section evaluations include resolved resonance parameters for higher-order resonances than have historically been included in SCALE cross-section libraries. Although Level 0 (s-wave) resonances have always been available for resolved-resonance isotopes, the later ENDF releases have included Level 1 (p-wave), and in some cases Level 2 (d-wave), resonance parameters for a limited number of isotopes. The SCALE 44GROUPNDF5 cross-section library contains higher-order resonance data not available in earlier SCALE cross-section libraries. The isotopes and the corresponding resonance levels available in the 44GROUPNDF5 library are given in Table C.1 below.

Table C.1 44GROUPNDF5 isotopes with higher-order resonance data

Isotope	Cross-section identifier	Resonance levels
^{23}Na	11023	0, 1, 2
S	16000	0, 1, 2
Cr	24000	0, 1
Mn	25055	0, 1
Fe	26000	0, 1, 2
Ni	28000	0, 1
^{85}Rb	37085	0, 1
^{87}Rb	37087	0, 1
Zr	40000	0, 1, 2
^{90}Zr	40090	0, 1, 2
^{91}Zr	40091	0, 1
^{92}Zr	40092	0, 1
^{94}Zr	40094	0, 1
^{96}Zr	40096	0, 1
^{93}Nb	41093	0, 1
Mo	42000	0, 1
^{99}Tc	43099	0, 1
^{103}Rh	45103	0, 1
^{232}Th	90232	0, 1
^{238}U	92238	0, 1

However, SCALE versions 4.2 and earlier were designed to retrieve only Level 0 data during NITAWL resonance processing. Hence, these versions of SCALE are unable to access the higher-order resonances. Results presented in this report are based on a modified version of SCALE 4.2, in which CSAS and NITAWL modules have been updated to include Level 1 and 2 data processing for isotopes for which these data are available. These modifications will be included in future releases of SCALE. However, in order to provide a set of common reference values, calculations were repeated using the standard version of SCALE 4.2. Table C.2 compares k_{eff} values computed using Level 0 data only, relative to the results reported in the body of this report, based on Level 0, 1, and 2 resonance data. These results indicate that use of the higher-order resonance data results in an average increase in the value of k_{eff} by approximately 0.4%.

Table C.2 Comparison of results using L=0 and L=0, 1, and 2 resonance data

Case no.	Case designation	k_{eff} (L=0, 1 & 2 data)	k_{eff} (L=0 only)	Case % change	Case no.	Case designation	k_{eff} (L=0, 1 & 2 data)	k_{eff} (L=0 only)	Case % change
1	p2438x05	0.9947	0.9920	0.27%	41	bw1645so	0.9986	0.9913	0.74%
2	p2438x17	0.9974	0.9959	0.15%	42	bnw1810a	1.0008	0.9960	0.48%
3	p2438x28	1.0007	0.9941	0.66%	43	bnw1810b	0.9999	0.9958	0.41%
4	p2615x14	0.9966	0.9942	0.24%	44	bnw1810c	0.9958	0.9953	0.05%
5	p2615x23	0.9976	0.9945	0.31%	45	e196u6n	0.9936	0.9903	0.33%
6	p2615x31	0.9990	0.9937	0.53%	46	epru615b	1.0004	0.9934	0.70%
7	p2827u2a	1.0021	0.9948	0.73%	47	epru75	0.9966	0.9931	0.35%
8	p2827l2a	1.0029	0.9956	0.73%	48	epru75b	0.9986	0.9962	0.24%
9	p2827non	0.9946	0.9912	0.34%	49	e196u87c	0.9998	0.9946	0.52%
10	p2827u2b	1.0033	0.9999	0.34%	50	epru87b	1.0000	0.9972	0.28%
11	p2827l2b	1.0096	1.0069	0.27%	51	saxu56	0.9932	0.9960	-0.28%
12	p3314a	1.0038	0.9971	0.67%	52	saxu792	0.9995	0.9969	0.26%
13	p3314b	1.0001	0.9946	0.55%	53	w3269a	1.0063	0.9962	1.01%
14	p3602n2	0.9917	0.9923	-0.06%	54	w3269b	0.9983	0.9961	0.22%
15	p3602non	0.9981	0.9926	0.55%	55	w3269c	0.9939	0.9879	0.61%
16	p3602s4	0.9936	0.9970	-0.34%	56	ans33bp2	0.9987	0.9961	0.26%
17	p3602b4	0.9950	0.9926	0.24%	57	ans33bb2	1.0096	1.0050	0.46%
18	p3602c4	0.9979	0.9925	0.54%	58	ans33bh2	1.0129	1.0080	0.49%
19	p3926u2a	1.0020	0.992	1.01%	59	ans33h2	0.9983	0.9947	0.36%
20	p3926l2a	1.0010	0.9942	0.68%	60	epri70un	0.9991	0.9918	0.74%
21	p3926n2	0.9974	0.9897	0.78%	61	epri70b	1.0007	0.9951	0.56%
22	p3926u4a	1.0036	0.9952	0.84%	62	epri87un	1.0046	0.9993	0.53%
23	p3926l4a	1.0069	0.9992	0.77%	63	epri87b	1.0079	1.0054	0.25%
24	p3926nob	0.9988	0.9931	0.57%	64	epri99un	1.0059	1.0052	0.07%
25	p4267a	0.9975	0.9930	0.45%	65	epri99b	1.0111	1.0063	0.48%
26	p4267b	1.0037	0.9978	0.59%	66	saxton52	0.9985	0.9940	0.45%
27	p4267c	0.9994	0.9929	0.65%	67	saxton56	0.9993	0.9952	0.41%
28	p4267d	0.9945	0.9878	0.68%	68	saxtn56b	0.9986	0.9989	-0.03%
29	pnl194	1.0088	1.0088	0.00%	69	saxtn735	1.0034	0.9988	0.46%
30	ft214r	0.9955	0.9904	0.51%	70	saxtn792	1.0017	1.0014	0.03%
31	ft214v3	0.9967	0.9923	0.44%	71	saxtn104	1.0042	1.0039	0.03%
32	baw1231a	0.9962	0.9873	0.90%	73	p5803x21	1.0031	1.0037	-0.06%
33	baw1231b	0.9981	0.9886	0.96%	74	p5803x32	1.0068	1.0117	-0.48%
34	baw1273m	0.9980	0.9904	0.77%	75	p5803x43	1.0044	1.0047	-0.03%
35	baw1484a	0.9942	0.9886	0.57%	76	p5803x67	1.0009	0.9979	0.30%
36	baw1484b	0.9944	0.9878	0.67%	77	p5803x68r	1.0065	1.0075	-0.10%
37	baw1484c	0.9962	0.9917	0.45%					
38	baw1484d	0.9920	0.9874	0.47%					
39	baw1645t	1.0069	0.9886	1.85%					
40	baw1645s	1.0045	0.9873	1.74%					

Table C.2 (continued)

Case no.	Case designation	k_{eff} (L=0, 1 & 2 data)	k_{eff} (L=0 only)	% change	Case no.	Case designation	k_{eff} (L=0, 1 & 2 data)	k_{eff} (L=0 only)	% change
78	cr1071as	1.0207	1.0138	0.68%	87	or260906	1.0020	1.0012	0.08%
79	cr1653as	1.0146	1.0048	0.98%	88	rfp2710u	1.0052	1.0032	0.20%
80	cr1653b	1.0148	1.0077	0.70%	89	rfp2710r	1.0031	1.0034	-0.03%
81	cr2500s	1.0194	1.0137	0.56%	90	or2968s1	0.9909	0.9937	-0.28%
82	ydr14un2	1.0020	0.9944	0.76%	91	or2968al	1.0062	1.0064	-0.02%
83	ydr14pl2	1.0023	0.9992	0.31%	92	or2968s2	0.9990	1.0009	-0.19%
84	ydr14pl3	1.0180	1.0108	0.71%	93	p6838	0.9057	0.9018	0.43%
85	ydr14un3	1.0177	1.0095	0.81%		Average	1.0005	0.9962	0.43%
86	or260901	1.0077	1.0079	-0.02%		Maximum	1.0207	1.0138	
						Minimum	0.9057	0.9018	

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10. **SUPPLEMENTARY NOTES**

C. J. Withee, NRC Project Manager ***(Revised 2/18/2000)***

11. **ABSTRACT** *(200 words or less)*

This report is documents the validation of the recently developed 44-group ENDF/B-V based cross-section library (44GROUPNDF5). This cross-section set has been tested against its parent 238-group fine structure library (238GROUPNDF5) using a set of 33 benchmark problems in order to demonstrate that the collapsed set was an acceptable representation of 238GROUPNDF5. Validation of the library within the SCALE system was based on a comparison of calculated values of k_{eff} with that of 93 experiments. The experiments primarily consisted of various configurations of light-water-reactor-type fuel representative of transportation and storage conditions. Additional experiments were included to allow comparison with results obtained in earlier validation of the 27GROUPNDF4 library.

Results show that the broad 44-group structure is an acceptable representation of its parent 238-group library for thermal as well as hard fast spectrum systems. Accurate broad-group analyses of intermediate spectrum systems will require either a more detailed group structure in this energy range or a more appropriate collapsing spectrum. Further, validation calculations indicate that the 44-group library is an accurate tool in the prediction of criticality for arrays of light-water-reactor-type fuel assemblies as would be encountered in fresh or spent fuel transportation or storage environments.

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