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# Validation and Comparison of KENO V.a and KENO-VI


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# ABSTRACT

This report documents the validation and comparison of KENO V.a and KENO-VI using the SCALE 27-group ENDF/B-IV and 238-group ENDF/B-V cross-section libraries against critical experiments. Experiments considered were primarily high- or low-enriched uranium systems. The results indicate that KENO V.a and KENO-VI Monte Carlo Criticality Programs accurately calculate a broad range of critical experiments. A number of the calculations showed a positive or negative bias in excess of 1½% in k-effective ($k_{eff}$). Classes of criticals that show a bias include 3% enriched green blocks, highly-enriched uranyl fluoride slab arrays, and highly-enriched uranyl nitrate arrays. If these biases are properly taken into account, KENO V.a and KENO-VI can be used with confidence for the design and criticality safety analysis of uranium-containing systems. KENO V.a and KENO-VI calculate the same $k_{eff}$ for a system within statistics and thus may be used interchangeably as long as the geometry of the problem can be modeled.

# 1. INTRODUCTION

The intent of this study is to validate the KENO V.a[1] and KENO-VI[2] Monte Carlo criticality programs against critical experiments. KENO V.a and KENO-VI are part of the SCALE computer code system.[3] The sequences being validated are for KENO V.a the CSAS25 sequence of CSAS and for KENO-VI the CSAS26 sequence of CSAS6. Both are documented in the SCALE manual.[3] The 27-group ENDF/B-IV and 238-group ENDF/B-V libraries were used for both the KENO V.a and KENO-VI calculations. Comparisons of KENO V.a and KENO-VI results, both 27- and 238-group, are reported in Section 4.

ANSI Standard ANS-8.1[4] requires that calculational methods used for criticality safety be validated and any bias be determined by correlating the results of critical experiments with calculations. It is essential that the computational methods used for nuclear criticality safety purposes be sufficiently accurate so that one can be confident of subcriticality when adequate safety margins are applied. It is also important that the applied safety margins not be unduly conservative.

The purpose of this report is to validate the use of KENO-VI for several types of applications. This validation is based primarily on uranium experiments.[5-9] Low-enriched (< 5% $^{235}$U) and highly-enriched (~ 90% $^{235}$U) experiments from ORNL/TM-238[10] were selected to validate and compare KENO V.a and KENO-VI. These experiments include various solution systems, varying fuel density systems, and uranium oxide and metal systems.

# 2. DESCRIPTION OF THE CODE PACKAGE

## 2.1. CSAS25 and CSAS26 Sequences

The CSAS25 and CSAS26 control sequences in SCALE allow simplified data input to the functional modules (i.e., BONAMI, NITAWL and KENO V.a / KENO-VI, respectively). These sequences will calculate atomic densities for both mixtures and standard solutions. They also generate input data for BONAMI and NITAWL, allowing various options for treatment of the cross sections in the resonance region for both homogeneous and heterogeneous systems.

## 2.2. Resonance Processing

BONAMI and NITAWL perform resonance processing in the SCALE sequences. Both of these codes are able to process resolved and unresolved resonance data using different methods discussed in the following sections. A common characteristic of both modules is that neither BONAMI nor NITAWL treat resonance overlap or resonance interference. Several system characteristics may cause problems with the resonance treatments. One such problem, resonance overlap, which occurs when two nuclides in a mixture have resonances at the same or nearly the same energies, as discussed in Sect. M7.A of the SCALE manual. When resonance overlap is ignored, the flux used to shield the cross section is incorrect and thus the group cross section can be in error. Another form of improper resonance processing can occur when the same resonance nuclide appears in different regions (mixtures) of a geometry specification, because SCALE currently only processes one region at a time. Again, because an incorrect flux is used to shield the cross sections, the group cross sections can be in error. An example of this is in a dissolver where a fuel lump is surrounded by fissile solution containing the same resonance absorbers.

Resonance interference is similar to resonance overlap. When two resonances are close together, the higher-energy resonance affects the flux shape in the lower-energy resonance, because the flux does not recover to the asymptotic slowing-down flux form over the lower-energy resonance. Resonance interference can occur between resonances of different nuclides or two closely spaced resonances of the same nuclide. The limitations and approximations used in BONAMI and NITAWL will be discussed below.

NITAWL performs temperature broadening during resonance processing. If temperature data are included in the library, BONAMI performs temperature broadening at the user-specified problem temperature during resonance processing. Starting with SCALE 4.3, NITAWL also performs a temperature interpolation of thermal-scattering data on the master library.

## 2.3. BONAMI

The BONAMI module self-shields cross sections with Bondarenko data using the shielding-factor methodology. Nuclides with Bondarenko data carry an infinite dilute cross section on the master library and tables of dilution-dependent shielding factors. BONAMI performs an iteration for each nuclide and each energy group that has shielding factors. Convergence is achieved when the shielded total cross section changes by less than some $\varepsilon$ for all nuclides, groups, and zones. In this manner, the problem-dependent self-shielded cross sections for each nuclide and group are determined while accounting for interactions. When CSAS calls BONAMI, heterogenous geometry effects are accounted for in the escape cross section that is passed to BONAMI.

The escape cross section is determined based on the system geometry specified in the cross-section processing portion of the SCALE input. The geometry type, materials, characteristic dimensions, and the Dancoff factor are all used to determine an escape cross section that has units equivalent to a macroscopic cross-section. The escape cross section is added to other cross sections to account for geometry effects. This method allows all nuclides to be processed by BONAMI as infinite homogeneous media in the CSAS sequences.

The performance of data shielded by the Bondarenko method depends on the adequacy of the approximations used to generate the Bondarenko data. The typical approach is to use the narrow resonance approximation to generate these data, which is adequate for a broad range of applications. When a resonance is not narrow relative to the slowing down in the system, the narrow resonance approximation breaks down and the resonance corrections for the cross sections can be in error. This breakdown has been observed for libraries that use the Bondarenko method to shield the low-energy resolved resonances for $^{238}$U for systems with low hydrogen moderation[11] and for many nuclides when the principal moderator is an intermediate-mass nuclide. The solution to this type of breakdown is to either carry sufficient cross-section energy groups to march across the resonance and/or to use more appropriate flux-generating methods to compute the Bondarenko factors. This problem does not occur in the SCALE END/B-IV and ENDF/B-V libraries because Bondarenko data are only used in the unresolved resonance range.

## 2.4. NITAWL

The NITAWL-II module shields cross sections with resonance data utilizing the Nordheim integral transport method. In the SCALE implementation, the infinite-dilute multi-group cross sections are adjusted by a correction value determined by NITAWL. The correction is calculated by first determining the infinite dilute contribution of each resonance to the group cross section and then by calculating what the contribution would be if the resonance was shielded for the specific problem. The geometry type, materials, characteristic dimensions, and Dancoff factor are all passed to NITAWL for determining the details of the approximations used to self-shield the cross sections. NITAWL uses two internal moderators when reconstructing the shielded flux. The slowing-down mass and scatter cross section for the principal material (first moderator) mixed with the fuel are used explicitly. The remaining materials (second moderator) are treated using an averaged slowing-down mass and scatter cross section.

A fundamental assumption of the Nordheim method is that resonances are widely spaced, both within a particular nuclide and between nuclides. If this assumption is not correct, the flux used to construct the resonance contribution to the group cross section is incorrect. Breakdowns have been observed when NITAWL was used to self-shield cross sections of fissile nuclides with overlapping resonances in dissolver-type systems[12] and in systems with intermediate-mass moderators and intermediate-mass resonance materials.

## 2.5. KENO V.a

KENO V.a is a Monte Carlo criticality program that includes an enhanced geometry package that allows modeling of a wide variety of complex three-dimensional geometries. The geometry package allows nested arrays and "holes" to be placed in the geometry model. The code allows the use of reflector options, including mirror reflection, periodic reflection, and differential albedo reflection. Automated biasing provides the capability to use reflector region weighting functions that are based on one-dimensional adjoint calculations for common reflector materials. The reflector options simplify geometry data input and/or reduce the running time of a specific problem. The CSAS control module handles cross-section input and atom density input. Most of the major KENO parameters have defaults that work for a wide variety of problems, but which can be overridden by the analyst.

## 2.6. KENO-VI

KENO-VI is an extension of the KENO V.a Monte Carlo criticality program. KENO-VI contains features currently in KENO V.a plus a more complex geometry package. The geometry package in KENO-VI is capable of modeling any volume that can be constructed using quadratic equations. In addition, such features as geometry intersections, body rotation, hexagonal arrays, and array boundaries have been included to make the code more flexible. These features allow the user to readily solve large geometrically complex problems whose computer storage requirements and geometric complexity preclude solution by the previous versions of KENO.

A set of 13 predefined geometry shapes has been incorporated into KENO-VI. Additional volumes can be constructed using the QUADRATIC geometry card that allows the user to specify any volume that can be modeled using quadratic equations. The ability to intersect the volumes makes it possible to exactly model such things as pipe intersections, which was previously impossible in KENO V.a. The ability to rotate bodies means volumes no longer must be positioned parallel to a major axis. Hexagonal arrays were added to simplify the construction of triangular pitch arrays. The use of array boundaries makes it possible to fill a noncuboidal volume with an array, specifying the boundary where a particle leaves and enters the array.

KENO-VI is primarily an eigenvalue *k*-effective code. Other calculated quantities include lifetime, generation time, energy-dependent leakages, energy- and region-dependent absorptions, fissions, fluxes, and fission densities.

KENO-VI retains the KENO V.a features such as flexible data input, the capability of supergrouping energy-dependent data, a $P_n$ scattering model in the cross sections, a procedure for matching lethargy boundaries between albedos and cross sections to extend the usefulness of the albedo feature, and restart capabilities. However, due to the increased flexibility in the geometric modeling capabilities, KENO-VI usually requires more CPU time than KENO V.a to solve the same problem.

## 2.7. The 27-Group Neutron Cross-Section Library

The 27-group ENDF/B-IV library is the broad-group companion library to the 218-group ENDF/B-IV library. The 218-group library was flux collapsed using MALOCS and the MT 1099 flux file carried with the fine-group cross sections. (This flux file is the energy group representation of the original weighting spectrum used to generate the 218-group cross sections from ENDF/B-IV data.) Because of the $1/(E\sigma_t)$ weighting in the resolved resonance range, the broad-group library calculates many systems nearly as well as the fine-group library does. Trends and biases in the 218-group library are preserved in the 27-group library. The library has 14 fast groups and 13 thermal groups (below 3 eV). The group structure was chosen to match the 16-group Hansen-Roach structure with two additional fast groups and nine additional thermal groups. The additional groups were chosen such that, for the systems considered, the broad-group calculations meet an acceptance criterion of $\Delta k/k < 0.3\%$ when compared with the reference 218-group calculation using the XSDRNPM code. This criterion was relaxed to 1% for $^{238}U$ in systems where the median fission energy was > 1 eV and < 100 eV. The resonance data and the thermal-scattering data carried with the 27-group library and the 218-group library are the same and are processed by NITAWL-II. This library was conceived as a general purpose criticality analysis library, with a special interest in applicability to shipping cask analysis and thermal neutron systems.

The 27-group library has been extensively validated against critical experiments.[7, 10, 13-21] Areas of validation include highly-enriched uranium metal, compound and solution systems, moderated low-enriched uranium, heterogeneous and homogeneous systems, and plutonium metal and solution systems.

## 2.8. The 238-Group Neutron Cross-Section Library

The 238-group ENDF/B-V library[22] is a general purpose criticality analysis library, and the most complete library available in SCALE. This library is also known as the LAW (**L**ibrary to **A**nalyze Radioactive **W**aste) Library. It was initially released in version 4.3 of SCALE. The library contains data for all nuclides (more than 300) available in ENDF/B-V processed by the AMPX-77 system.[23] It also contains data for ENDF/B-VI evaluations of $^{14}N$, $^{15}N$, $^{16}O$, $^{154}Eu$, and $^{155}Eu$. The library has 148 fast groups and 90 thermal groups (below 3 eV).

Most resonance nuclides in the 238-group ENDF/B-V library have resonance data (to be processed by NITAWL-II) in the resolved resonance range and Bondarenko factors (to be processed by BONAMI) for the unresolved range. This library contains resolved resonance data for *s*-wave, *p*-wave, and *d*-wave resonances (R = 0, R = 1, and R = 2, respectively). These data can have a significant effect on results for undermoderated, intermediate-energy problems. Resonance structures in several light-to-intermediate mass nonresonance ENDF nuclides (i.e., $^{7}Li$, $^{19}F$, $^{27}Al$, $^{28}Si$) are accounted for using Bondarenko shielding factors. These structures can also be important in intermediate-energy problems. The $^{235}U$ ENDF/B-V data result in slightly too much fission, while the $^{238}U$ data result in slightly too much capture. Although better than the ENDF/B-IV data, the thermal-plutonium data still appear to have problems.

All nuclides in the 238-group LAW Library use the same weighting spectrum, consisting of

1. Maxwellian spectrum (peak at 300 K) from $10^{-5}$ to 0.125 eV,

2. a 1/E spectrum from 0.125 eV to 67.4 keV,

3. a fission spectrum (effective temperature at 1.273 MeV) from 67.4 keV to 10 MeV, and

4. a 1/E spectrum from 10 to 20 MeV.

The use of this spectrum (as opposed to the $1/(E\sigma\ t)$ spectrum used to generate the 218-group library) makes it difficult to collapse a general-purpose broad-group library that is valid over a wide range of problems.

All nuclides use a $P_5$ Legendre expansion to fit the elastic and discrete-level inelastic scattering processes in the fast range, thereby making the library suitable for both reactor and shielding applications. A $P_3$ fit was used for thermal scattering. Thermal scattering kernels are provided at temperatures (K) as presented in Table M4.2.7 (Sect. M4) of the SCALE manual. All other scattering processes use $P_0$ fits.

# 3. CALCULATIONAL PROCEDURE

In the validation and comparison process, many of the available options in CSAS25, CSAS26, KENO V.a and KENO-VI were exercised. These options include the automatic atomic density generation features, the various treatments in NITAWL, and the geometry options in KENO V.a and KENO-VI. The majority of the calculations are repeat calculations, which were modeled by different people at different times. Usually there are multiple ways that a problem may be specified, all of which are equally correct. The original input data were left substantially unchanged in the KENO V.a models. In the original input data, most problems were run for 203 generations of 600 neutrons per generation; therefore, the KENO-VI problems were run in a similar manner. KENO V.a and KENO-VI defaults have now been changed to 1000 neutrons per generation. Complete listings of the input data for KENO V.a and KENO-VI using the 238-group library are given in Appendices A and B, respectively.

With KENO V.a and KENO-VI, there is no single $k_{eff}$ that is "the answer" for the problem. The code starts with an initial neutron distribution and calculates the effective multiplication for a generation of neutrons. The next generation uses a starting distribution based on the fission points of the previous generation and calculates the effective multiplication for the current generation. Since 203 generations were run, there are 203 different answers. In the ideal situation, once the source has converged and the original (and usually arbitrary) starting distribution has decayed, the difference in the batch-to-batch $k_{eff}$ may be attributed to the statistical nature of the Monte Carlo calculation, and the "best" answer should be the average of the remaining calculations. The common practice in KENO V.a and KENO-VI is to tabulate the average $k_{eff}$ as a function of the number of generations skipped. Judgment is then required in determining the answer. Many calculations do not approach the ideal situation. For example, undersampling may exist where the number of neutrons per generation is not sufficient to sustain a proper source distribution, or the number of generations is insufficient to converge the source distribution. In order to remove the element of judgment from the interpretation of the results and to mechanize the process of validating and comparing results to previous validation, the average $k_{eff}$ by generation skipped with the lowest calculated standard deviation is reported here. This number appears as the "final value" in the plot of the average $k_{eff}$ by generation skipped in the KENO V.a and KENO-VI output.

# 4. PROBLEM DESCRIPTIONS AND RESULTS

Brief problem descriptions and results are presented in Tables 1–6. Low-enrichment results are presented in Tables 1–3 while high-enrichment results are presented in Tables 4–6.

The experimental models used to generate Table 1 are from low-enriched uranium experiments obtained from ref. 9. These include experiments for homogeneous single-unit criticals, both reflected and unreflected, as well as heterogeneous uranium metal cylinders in water. The fissile compounds considered were $UO_2F_2$, U metal, and $U_3O_8$, all at 4.89% $^{235}U$ enrichment. The moderating materials were water, stereotex, and $UO_2F_2$ solution.

The experimental models used to generate Table 2 are from low-enriched uranium experiments. These 3.85% enriched uranium metal cylinders and annuli in water were obtained from ref. 24. The critical experiments were modeled in detail from descriptions in the experiment logbook.

Table 3 includes models from ref. 8. These experiments are single-unit criticals both reflected and unreflected, at several enrichments ranging from 1.4 to 4.98%. The first part of the table includes $UF_4$/paraffin-moderated systems and $UO_2F_2$ solution systems at various moderation levels. The remainder of the table is 4.46% enriched damp oxide experiments performed at Rocky Flats.

Highly-enriched uranium experiments from ref. 9 were used to generate Table 4. These are $UO_2F_2$ and $UO_2(NO_3)_2$ solution systems. Both single-unit and array systems were analyzed under a variety of reflection conditions including unreflected, fully water reflected, concrete reflected, and Plexiglas reflected.

Table 5 includes experiments from ref. 7. Single-unit reflected and unreflected systems for uranium metal, uranium alloy, $UO_2F_2$ solution and $UO_2(NO_3)_2$ solutions were considered. Calculations were performed on arrays, including (1) arrays of metal units with and without interstitial moderation, (2) arrays of $UO_2F_2$ slab systems, and (3) arrays of 5-liter containers of $UO_2(NO_3)_2$ having varying thickness of paraffin and/or Plexiglas.

Table 6 contains the experimental models and results from the eta experiments performed at Y-12.[25-26] These experiments are $UO_2(NO_3)_2$ solution experiments in simple unreflected geometry. The systems are typically very dilute. The experiments included boron poisoned solutions and $^{233}U$ systems.

Table 1. KENO V.a and KENO-VI comparison
Calculated $k_{eff}$ for low enriched homogeneous and heterogeneous uranium systems

| | | | $k_{eff} \pm \sigma$ | | | |
|---|---|---|---|---|---|---|
| | | | 27 group | | 238 group | |
| Case | Experimental description | Ref. | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| CAA01 | Experiment 1A. 401 – 4.89% U rods, 0.762-cm diam, 30-cm long, 1.3-cm pitch, $H_2O$ moderated and reflected | 27 | 0.992 ± 0.003 | 0.989 ± 0.002 | 0.988 ±. 0.003 | 0.991 ± 0.002 |
| CAA04 | Experiment 6A. 203 – 4.89% U rods, 0.762-cm diam, 30-cm long, 2.05-cm pitch, $H_2O$ moderated and reflected | 27 | 0.991 ± 0.003 | 0.991 ± 0.002 | 0.992 ± 0.003 | 0.992 ± 0.002 |
| CAA06 | Experiment 14A. 398 – 4.89% U rods, 0.762-cm diam, 30-cm long, 1.3-cm pitch, $H_2O$ top reflector, Plexiglas bottom reflector, Pb reflected 1 face | 27 | 0.996 ± 0.003 | 0.997 ± 0.002 | 0.998 ± 0.003 | 0.996 ± 0.002 |
| CAA08 | Experiment 28A. 255 – 4.89% U rods, 0.762-cm diam, 30-cm long, 1.3-cm pitch, $H_2O$ moderated, $H_2O$ top reflector, Plexiglas bottom reflector, Pb reflected 4 faces | 27 | 0.995 ± 0.002 | 0.997 ± 0.002 | 0.993 ± 0.002 | 0.992 ± 0.003 |
| CAA10 | Experiment 30C. 494 – 4.89% U rods, 0.762-cm diam, 30-cm long, 1.3-cm pitch, $H_2O$ moderated, $H_2O$ top reflector, Plexiglas bottom reflector, Pb reflected 4 faces, boral in row 6 | 27 | 1.001 ± 0.003 | 1.001 ± 0.002 | 1.002 ± 0.002 | 1.001 ± 0.002 |
| CAA11 | Experiment 31C. 494 – 4.89% U rods, 0.762-cm diam, 30-cm long, 1.3-cm pitch, $H_2O$ moderated, $H_2O$ top reflector, Plexiglas bottom reflector, Pb reflected 4 faces, Cd in row 6 | 27 | 0.998 ± 0.003 | 0.997 ± 0.002 | 0.997 ± 0.003 | 0.997 ± 0.002 |

Table 1 (continued)
Calculated $k_{eff}$ for low enriched homogeneous and heterogeneous uranium systems

| | | | $k_{eff} \pm \sigma$ | | | |
|---|---|---|---|---|---|---|
| | | | 27 group | | 238 group | |
| Case | Experimental description | Ref. | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| CAA14 | Experiment 36S, $9 \times 10$ array of 4.89% U rods in ~300 g U/l $UO_2F_2$ solution, 0.762-cm diam, 2.453-cm pitch in 95.88-cm-diam tank | 27 | 0.988 ± 0.002 | 0.989 ± 0.002 | 0.990 ± 0.002 | 0.990 ± 0.002 |
| CAA16 | Experiment 42S. $6 \times 7$ array of 4.89% U rods in ~300 g U/l $UO_2F_2$ solution, 1.31-cm diam, 3.40-cm pitch, in 95.88-cm diam tank | 27 | 0.987 ± 0.002 | 0.989 ± 0.003 | 0.991 ± 0.002 | 0.987 ± 0.003 |
| CAA17 | Experiment 44S. $6 \times 7$ array of 4.89% U rods in ~300 g U/l $UO_2F_2$ solution, 1.31-cm diam, 3.94-cm pitch, in 95.88-cm diam tank | 27 | 0.990 ± 0.002 | 0.990 ± 0.002 | 0.989 ± 0.002 | 0.992 ± 0.002 |
| CAA20 | 4.89% $U_3O_8$ – Stereotex blocks 40.6 g U-235/l (H/X = 395.0), unreflected | 28 | 1.000 ± 0.003 | 1.000 ± 0.004 | 1.002 ± 0.002 | 1.003 ± 0.003 |
| CAA22 | 4.89% $U_3O_8$ – Stereotex blocks 33.3 g U-235/l (H/X = 503.6), unreflected | 28 | 0.997 ± 0.002 | 0.997 ± 0.002 | 0.994 ± 0.002 | 1.000 ± 0.002 |
| CAA25 | 4.89% $U_3O_8$ – Stereotex blocks 40.6 g U-235/l (H/X = 396.7), paraffin top reflector, $H_2O$ reflected bottom and sides | 28 | 0.990 ± 0.003 | 0.993 ± 0.002 | 0.997 ± 0.003 | 0.995 ± 0.002 |
| CAA27 | 4.89% $U_3O_8$ – Stereotex blocks 81.1 g U-235/l (H/X = 146.8), paraffin top reflector, $H_2O$ reflected bottom and sides | 28 | 0.991 ± 0.003 | 0.990 ± 0.002 | 0.990 ± 0.003 | 0.989 ± 0.003 |
| CAA29 | 4.89% $U_3O_8$ – Stereotex blocks 33.3 g U-235/l (H/X = 504.1), paraffin top reflector, $H_2O$ reflected bottom and sides | 28 | 0.995 ± 0.002 | 0.998 ± 0.002 | 0.998 ± 0.002 | 0.998 ± 0.002 |

Table 1 (continued)
Calculated $k_{eff}$ for low enriched homogeneous and heterogeneous uranium systems

| Case | Experimental description | Ref. | $k_{eff} \pm \sigma$ 27 group KENO V.a | 27 group KENO-VI | 238 group KENO V.a | 238 group KENO-VI |
|---|---|---|---|---|---|---|
| CAA30 | 4.89% $UO_2F_2$ – solution 42.54 g U-235/l (H/X = 524), in a 20-in.-diam SS cylinder, unreflected | 28 | 0.989 ± 0.003 | 0.990 ± 0.003 | 0.995 ± 0.002 | 0.994 ± 0.003 |
| CAA33 | 4.89% $UO_2F_2$ – solution 24.04 g U-235/l (H/X = 1002), in a 27.3-in. diam aluminum sphere, unreflected | 28 | 0.988 ± 0.002 | 0.991 ± 0.002 | 0.992 ± 0.002 | 0.996 ± 0.002 |
| CAA35 | 4.89% $UO_2F_2$ – solution 42.54 g U-235/l (H/X = 524), in a 15-in.-diam SS cylinder, $H_2O$ reflected | 28 | 1.002 ± 0.003 | 0.999 ± 0.003 | 0.998 ± 0.003 | 1.002 ± 0.003 |
| CAA37 | 4.89% $UO_2F_2$ – solution 31.79 g U-235/l (H/X = 735), in a 15-in.-diam SS cylinder, $H_2O$ reflected | 28 | 0.997 ± 0.002 | 0.997 ± 0.002 | 1.001 ± 0.002 | 1.000 ± 0.002 |
| CAA39 | 4.89% $UO_2F_2$ – solution 24.22 g U-235/l (H/X = 994), in a 20-in.-diam SS cylinder, $H_2O$ reflected | 28 | 0.996 ± 0.002 | 0.996 ± 0.002 | 1.001 ± 0.001 | 0.998 ± 0.002 |

Table 2. KENO V.a and KENO-VI comparison

Calculated $k_{eff}$ for large diameter low enriched uranium cylinders in various lattice arrangements

| Case | Experimental description | Ref. | $k_{eff} \pm \sigma$ 27 group KENO V.a | 27 group KENO-VI | 238 group KENO V.a | 238 group KENO-VI |
|---|---|---|---|---|---|---|
| CAB01 | (EBJ.1) lattice 2. 15-3.85% U rods, 7.2 in. diam × 30 in. long in square lattice, 7.2 in. center-to-center, 77.8 cm water height | 29 | 1.003 ± 0.002 | 0.999 ± 0.002 | 1.000 ± 0.002 | 0.996 ± 0.002 |
| CAB07 | (EBJ.4) lattice 3. 16-3.85% U rods, 7.2 in. diam × 30 in. long in triangular lattice, 7.45 in. center-to-center, 53.1 cm water height | 29 | 0.992 ± 0.002 | 0.991 ± 0.002 | 0.984 ± 0.002 | 0.985 ± 0.002 |
| CAB10 | (EBJ.8) lattice 5. 6-3.85% U rods, 7.2 in. OD × 2.6 in. ID × 30 in. long in square lattice, 7.95 in. center-to-center, 91.4 cm water height (2 subcritical) | 29 | 1.008 ± 0.002 | 1.013 ± 0.002 | 0.995 ± 0.002 | 0.997 ± 0.003 |
| CAB12 | (EBJ.10) lattice 14. 20-3.85% U rods, 7.2 in. OD × 2.6 in. ID × 30 in. long in square lattice, 9.07 in. center-to-center, 79 cm water height | 29 | 1.007 ± 0.002 | 1.006 ± 0.002 | 0.997 ± 0.002 | 0.998 ± 0.002 |
| CAB13 | (EBJ.13) lattice 9. 15-3.85% U rods, 2.5 in. diam × 30 in. long in square lattice, 3.25 in. center-to-center, 64.8 cm water height | 29 | 1.006 ± 0.002 | 1.008 ± 0.002 | 1.003 ± 0.002 | 0.996 ± 0.002 |
| CAB15 | (EBJ.13) lattice 9. 15-3.85% U rods, 2.5 in. diam × 30 in. long in square lattice, 3.25 in. center-to-center, 64.8 cm water height | 29 | 1.007 ± 0.002 | 1.009 ± 0.002 | 0.991 ± 0.002 | 0.990 ± 0.002 |

Table 2 (continued)
Calculated $k_{eff}$ for large diameter low enriched uranium cylinders in various lattice arrangements

| Case | Experimental description | Ref. | $k_{eff} \pm \sigma$ 27 group KENO V.a | $k_{eff} \pm \sigma$ 27 group KENO-VI | $k_{eff} \pm \sigma$ 238 group KENO V.a | $k_{eff} \pm \sigma$ 238 group KENO-VI |
|---|---|---|---|---|---|---|
| CAB16 | (EBJ.14) lattice 2. 23-3.85% U rods, 2.5 in. diam × 30 in. long in square lattice 4.00 in. center-to-center, 68.9 cm water height | 29 | 1.000 ± 0.002 | 0.999 ± 0.002 | 0.992 ± 0.002 | 0.990 ± 0.002 |

Table 3. KENO V.a and KENO-VI comparison
Calculated $k_{eff}$ for low enriched homogeneous uranium systems

| Case | Experimental description | Ref. | $k_{eff} \pm \sigma$ 27 group KENO V.a | 27 group KENO-VI | 238 group KENO V.a | 238 group KENO-VI |
|---|---|---|---|---|---|---|
| CAS04 | An unreflected rectangular parallelepiped of homogeneous U(1.4) $F_4$ and paraffin with an H/U-235 atomic ratio of 421.8; 93.1 cm × 93.0 cm × 123.8 cm | 30 | 0.987 ±. 0.002 | 0.988 ±. 0.002 | 0.993 ± 0.002 | 0.993 ± 0.002 |
| CAS05 | An unreflected rectangular parallelepiped of homogeneous U(1.4) $F_4$ and paraffin with an H/U-235 atomic ratio of 421.8; 100.0 cm × 99.9 cm × 103.1 cm | 30 | 0.989 ± 0.002 | 0.986 ± 0.002 | 0.992 ± 0.002 | 0.991 ± 0.002 |
| CAS06 | An unreflected rectangular parallelepiped of homogeneous U(1.4)$F_4$ and paraffin with an H/U-235 atomic ratio of 421.8; 130.7 cm × 130.6 cm × 74.2 cm | 30 | 0.985 ± 0.002 | 0.985 ± 0.002 | 0.994 ± 0.002 | 0.992 ± 0.002 |
| CAS11 | A reflected rectangular parallelepiped of homogeneous U(2) $F_4$ and paraffin with an H/U-235 atomic ratio of 421.8 | 31 | 0.994 ± 0.003 | 0.995 ± 0.003 | 1.001 ± 0.002 | 1.000 ± 0.003 |
| CAS12 | An unreflected rectangular parallelepiped of homogeneous U(2)$F_4$ and paraffin with an H/U-235 atomic ratio of 195.2; 71.47 cm × 71.47 cm × 94.14 cm | 31 | 0.992 ± 0.002 | 0.996 ± 0.002 | 0.995 ± 0.002 | 0.995 ± 0.002 |

Table 3 (continued)
Calculated $k_{eff}$ for low enriched homogeneous uranium systems

| | | | $k_{eff} \pm \sigma$ | | | |
|---|---|---|---|---|---|---|
| | | | 27 group | | 238 group | |
| Case | Experimental description | Ref. | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| CAS14 | An unreflected rectangular parallelepiped of homogeneous U(2) $F_4$ and paraffin with an H/U-235 atomic ratio of 293.9; 56.22 cm × 56.22 cm × 122.47 cm | 31 | 0.997 ± 0.002 | 0.997 ± 0.002 | 1.000 ± 0.002 | 1.002 ± 0.002 |
| CAS15 | An unreflected rectangular parallelepiped of homogeneous U(2) $F_4$ and paraffin with an H/U-235 atomic ratio of 406.3; 53.67 cm × 53.67 cm × 54.29 cm, reflected with 15.2 cm of paraffin on top and sides and 15.2 cm of Plexiglas on the bottom | 31 | 0.995 ± 0.002 | 0.998 ± 0.002 | 0.999 ± 0.002 | 1.003 ± 0.002 |
| CAS16 | A reflected rectangular parallelepiped of homogeneous U(2) $F_4$ and paraffin with an H/U-235 atomic ratio of 495.9; 46.00 cm × 46.00 cm × 96.57 cm, reflected with 15.2 cm of paraffin on top and sides and 15.2 cm of Plexiglas on the bottom | 31 | 0.997 ± 0.002 | 0.999 ± 0.002 | 0.994 ± 0.002 | 0.999 ± 0.002 |
| CAS19 | A reflected rectangular parallelepiped of homogeneous U(2)$F_4$ and paraffin with an H/U-235 atomic ratio of 971.7; 76.51 cm × 76.44 cm × 82.42 cm, reflected with 5.2 cm of polyethylene on top and sides and 15.2 cm of Plexiglas on the bottom | 31 | 0.988 ± 0.002 | 0.986 ± 0.002 | 0.997 ± 0.002 | 0.997 ± 0.002 |

Table 3 (continued)
Calculated $k_{eff}$ for low enriched homogeneous uranium systems

| Case | Experimental description | Ref. | $k_{eff} \pm \sigma$ 27 group KENO V.a | 27 group KENO-VI | 238 group KENO V.a | 238 group KENO-VI |
|---|---|---|---|---|---|---|
| CAS20 | An unreflected rectangular parallelepiped of homogeneous U(2)$F_4$ and paraffin with an H/U-235 atomic ratio of 971.7; 81.45 cm × 86.70 cm × 88.22 cm | 31 | 0.987 ± 0.002 | 0.981 ± 0.002 | 0.991 ± 0.002 | 0.991 ± 0.002 |
| CAS22 | A reflected rectangular parallelepiped of homogeneous U(3)$F_4$ and paraffin with an H/U-235 atomic ratio of 133.4, 43.47 cm × 43.47 cm × 86.39 cm, reflected with 15.2 cm of paraffin on top and sides and 15.2 cm of Plexiglas on the bottom | 31 | 1.007 ± 0.002 | 1.009 ± 0.002 | 1.001 ± 0.002 | 1.015 ± 0.002 |
| CAS24 | A reflected rectangular parallelepiped of homogeneous U(3)$F_4$ and paraffin with an H/U-235 atomic ratio of 133.4; 56.25 cm × 56.25 cm × 43.41 cm, reflected with 15.2 cm of paraffin on top and sides and 15.2 cm of Plexiglas on the bottom | 31 | 1.008 ± 0.003 | 1.011 ± 0.003 | 1.011 ± 0.002 | 1.012 ± 0.002 |
| CAS26 | An unreflected rectangular parallelepiped of homogeneous U(3)$F_4$ and paraffin with an H/U-235 atomic ratio of 133.4; 56.47 cm × 56.47 cm × 86.64 cm | 31 | 1.014 ± 0.003 | 1.012 ± 0.003 | 1.013 ± 0.002 | 1.013 ± 0.002 |

Table 3 (continued)
Calculated $k_{eff}$ for low enriched homogeneous uranium systems

| | | | $k_{eff} \pm \sigma$ | | | |
|---|---|---|---|---|---|---|
| | | | 27 group | | 238 group | |
| Case | Experimental description | Ref. | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| CAS28 | An unreflected rectangular parallelepiped of homogeneous U(3) $F_4$ and paraffin with an H/U-235 atomic ratio of 133.4; 61.4 cm × 61.4 cm × 66.0 cm | 31 | 1.006 ± 0.002 | 1.009 ± 0.002 | 1.014 ± 0.002 | 1.014 ± 0.002 |
| CAS30 | An unreflected rectangular parallelepiped of homogeneous U(3)$F_4$ and paraffin with an H/U-235 atomic ratio of 276.9; 40.90 cm × 40.93 cm × 116.80 cm | 31 | 1.010 ± 0.003 | 1.010 ± 0.002 | 1.016 ± 0.003 | 1.016 ± 0.003 |
| CAS33 | A composite cadmium/steel/water side reflected stainless steel cylinder of 0.079 cm wall thickness and 19.545 cm IR filled to a height of 54.45 cm with (4.98)$O_2F_2$ solution at an H/U-235 atomic ratio of 488 | 31 | 1.000 ± 0.003 | 1.000 ± 0.003 | 1.001 ± 0.002 | 1.007 ± 0.002 |
| CAS36 | An unreflected stainless steel cylinder of 0.07874 cm wall thickness and a 19.55 cm IR filled to a height of 101.7 cm with U(4.98)$O_2F_2$ solution at an H/U-235 atomic ratio of 496 | 33 | 0.993 ± 0.003 | 1.004 ± 0.003 | 0.998 ± 0.003 | 0.994 ± 0.003 |
| CAR01 | Experiment 1. 4.46% enriched $U_3O_8$ H/U = 0.77, 42 fuel cans with 2.44 cm interstitial moderation, plastic reflected | 34 | 1.010 ± 0.002 | 1.016 ± 0.004 | 1.016 ± 0.002 | 1.015 ± 0.002 |

Table 3 (continued)
Calculated $k_{eff}$ for low enriched homogeneous uranium systems

| Case | Experimental description | Ref. | $k_{eff} \pm \sigma$ 27 group KENO V.a | $k_{eff} \pm \sigma$ 27 group KENO-VI | $k_{eff} \pm \sigma$ 238 group KENO V.a | $k_{eff} \pm \sigma$ 238 group KENO-VI |
|---|---|---|---|---|---|---|
| CAR05 | Experiment 2. 4.46% enriched $U_3O_8$ H/U = 0.77, 98 fuel cans with 0.929 cm interstitial moderation, concrete reflected | 34 | 1.003 ± 0.002 | 0.999 ± 0.003 | 0.999 ± 0.002 | 1.003 ± 0.003 |
| CAR11 | Experiment A. 4.46% enriched $U_3O_8$ H/U = 1.25, 38 fuel cans with 2.44 cm interstitial moderation, plastic reflected | 36 | 1.011 ± 0.003 | 1.010 ± 0.004 | 1.009 ± 0.002 | 1.015 ± 0.002 |
| CAR13 | Experiment C. 4.46% enriched $U_3O_8$ H/U = 1.25, 80 fuel cans with 0.929 cm interstitial moderation, plastic reflected | 36 | 1.014 ± 0.003 | 1.014 ± 0.004 | 1.017 ± 0.003 | 1.019 ± 0.003 |
| CAR15 | 4.46% enriched $U_3O_8$ H/U = 1.255, driven by high concentration (12,400 kg 351.65 g U/l), 93.17% enriched $UO_2(NO_3)_2$, 119 + 2S fuel cans, plastic reflected | 36 | 0.994 ± 0.003 | 1.003 ± 0.003 | 0.994 ± 0.003 | 1.001 ± 0.003 |
| CAR20 | Experiment E. 4.46% enriched $U_3O_8$ H/U = 2.03, driven by 93.12% enriched hollow uranium metal sphere (12.786 kg), 120 + 4S fuel cans, plastic reflected | 37 | 0.991 ± 0.003 | 1.000 ± 0.002 | 0.997 ± 0.002 | 0.999 ± 0.002 |

Table 4. KENO V.a and KENO-VI comparison
Calculated $k_{eff}$ for highly enriched uranium solution systems

| Case | Experimental description | Ref. | $k_{eff} \pm \sigma$ | | | |
|---|---|---|---|---|---|---|
| | | | 27 group | | 238 group | |
| | | | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| CAA01 | U(93.2) $O_2F_2$ solution sphere, H/X = 1112, unreflected | 38 | 1.004 ± 0.002 | 1.002 ± 0.002 | 1.006 ± 0.002 | 1.007 ± 0.002 |
| CAA04 | U(93.2) $O_2F_2$ solution sphere, H/X = 76.1, $H_2O$ reflected | 38 | 1.004 ± 0.003 | 1.007 ± 0.003 | 1.004 ± 0.003 | 1.007 ± 0.003 |
| CAA07 | U(93.2) $O_2F_2$ solution sphere, H/X = 268.8, $H_2O$ reflected | 39 | 1.008 ± 0.003 | 1.008 ± 0.003 | 1.001 ± 0.004 | 1.001 ± 0.003 |
| CAA10 | U(93.2) $O_2F_2$ solution sphere, H/X = 239.3, $H_2O$ reflected | 39 | 1.028 ± 0.003 | 1.028 ± 0.003 | 1.017 ± 0.003 | 1.021 ± 0.003 |
| CAA13 | U(93.2) $O_2(NO_3)_2$ solution 357.71 g U/l, 28.01 cm diam cylinder, unreflected | 40 | 1.016 ± 0.003 | 1.010 ± 0.003 | 1.003 ± 0.001 | 1.007 ± 0.003 |
| CAA16 | U(93.2) $O_2(NO_3)_2$ solution 357.71 g U/l, 28.01 cm diam cylinder, unreflected | 40 | 1.004 ± 0.003 | 0.998 ± 0.003 | 1.000 ± 0.003 | 0.995 ± 0.003 |
| CAA19 | U(93.2) $O_2(NO_3)_2$ solution 144.38 g U/l, 33.01 cm diam cylinder, concrete reflected | 40 | 1.013 ± 0.002 | 1.010 ± 0.004 | 1.006 ± 0.003 | 1.000 ± 0.003 |
| CAA22 | U(93.2) $O_2(NO_3)_2$ solution 334.77 g U/l, 33.01 cm diam cylinder, concrete reflected | 40 | 1.006 ± 0.003 | 1.006 ± 0.004 | 0.998 ± 0.003 | 1.002 ± 0.003 |
| CAA25 | U(93.2) $O_2(NO_3)_2$ solution 147.66 g U/l, 33.01 cm diam cylinder, Plexiglas reflected | 40 | 1.004 ± 0.003 | 1.002 ± 0.003 | 1.000 ± 0.003 | 1.000 ± 0.003 |
| CAA28 | U(93.2) $O_2(NO_3)_2$ solution 345.33 g U/l, 33.01 cm diam cylinder, concrete reflected | 40 | 1.008 ± 0.003 | 1.011 ± 0.003 | 1.005 ± 0.003 | 1.000 ± 0.003 |

Table 4 (continued)
Calculated $k_{eff}$ for highly enriched uranium solution systems

| | | | $k_{eff} \pm \sigma$ | | | |
|---|---|---|---|---|---|---|
| | | | 27 group | | 238 group | |
| Case | Experimental description | Ref. | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| CAA30 | U(93.2) $O_2(NO_3)_2$ solution 364.11 g U/l, 21.12 cm diam cylinder, in a 4 × 4 array, concrete reflected | 40 | 1.009 ± 0.003 | 1.001 ± 0.003 | 1.000 ± 0.003 | 0.998 ± 0.003 |
| CAA32 | U(93.2) $O_2(NO_3)_2$ solution 76.09 g U/l, 21.12 cm diam cylinder, in a 2 × 2 array, concrete reflected | 40 | 1.011 ± 0.003 | 1.012 ± 0.003 | 1.007 ± 0.003 | 1.008 ± 0.003 |
| CAA34 | U(93.2) $O_2(NO_3)_2$ solution 364.11 g U/l, 21.12 cm diam cylinder, in a 2 × 2 array, concrete reflected | 40 | 1.003 ± 0.003 | 0.996 ± 0.003 | 0.991 ± 0.003 | 0.993 ± 0.003 |
| CAA36 | U(93.2) $O_2(NO_3)_2$ solution 359.55 g U/l, 16.12 cm diam cylinder, in a 2 × 4 array, concrete reflected | 40 | 1.011 ± 0.002 | 1.009 ± 0.003 | 1.010 ± 0.003 | 1.011 ± 0.003 |
| CAA38 | U(93.2) $O_2(NO_3)_2$ solution 76.09 g U/l, 21.12 cm diam cylinder, in a 2 × 2 array, concrete reflected | 40 | 0.998 ± 0.003 | 1.000 ± 0.003 | 0.999 ± 0.002 | 0.994 ± 0.003 |
| CAA40 | U(93.2) $O_2(NO_3)_2$ solution 355.94 g U/l, 16.12 cm diam cylinder, in a 4 × 4 array, Plexiglas reflected | 40 | 1.001 ± 0.003 | 1.001 ± 0.003 | 0.999 ± 0.003 | 0.995 ± 0.003 |
| CAA42 | U(93.2) $O_2(NO_3)_2$ solution 355.94 g U/l, 21.12 cm diam cylinder, in a 2 × 2 array, Plexiglas reflected | 40 | 1.009 ± 0.003 | 1.001 ± 0.004 | 0.999 ± 0.002 | 1.007 ± 0.003 |

Table 5. KENO V.a and KENO-VI comparison
Calculated $k_{eff}$ highly enriched uranium metal and solution systems

| Case | Experimental description | Ref. | $k_{eff} \pm \sigma$ | | | |
|---|---|---|---|---|---|---|
| | | | 27 group | | 238 group | |
| | | | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| CAS01 | 93.8% U metal sphere, unreflected (GODIVA) | 41 | 1.003 ± 0.003 | 0.999 ± 0.003 | 0.991 ± 0.002 | 0.990 ± 0.002 |
| CAS05 | 93.2% $UO_2F_2$ solution, 19.992 g U/l, in Al sphere, unreflected | 38 | 1.001 ± 0.002 | 1.001 ± 0.002 | 1.006 ± 0.002 | 1.002 ± 0.002 |
| CAS07 | 93.5% U metal hemispherical shell, $H_2O$ reflected | 42 | 1.009 ± 0.002 | 1.012 ± 0.003 | 1.006 ± 0.002 | 1.005 ± 0.002 |
| CAS09 | 94% U metal cuboid, natural U reflected | 42 | 1.008 ± 0.002 | 1.011 ± 0.002 | 1.000 ± 0.002 | 0.999 ± 0.002 |
| CAS11 | 93.1% U metal hemispherical shell, steel center and oil reflected | 43 | 1.007 ± 0.002 | 1.004 ± 0.002 | 0.994 ± 0.002 | 0.995 ± 0.003 |
| CAS03 | 93.172% $UO_2(NO_3)_2$ solution, 346.7 g U/l, in SS cylinder, unreflected | 48 | 1.016 ± 0.003 | 1.011 ± 0.003 | 1.006 ± 0.004 | 1.013 ± 0.003 |
| CAS25 | 93.2% U metal cylinders, $2 \times 2 \times 2$ array, each unit in the array is a smaller cylinder capped on each end by a larger cylinder, unreflected | 44 | 1.002 ± 0.002 | 1.003 ± 0.002 | 0.996 ± 0.002 | 0.992 ± 0.003 |
| CAS29 | 92.6% $UO_2(NO_3)_2$ solution, 415 g U/l, in Plexiglas cylinders, $3 \times 3 \times 3$ array, unreflected | 45 | 0.994 ± 0.003 | 0.992 ± 0.003 | 0.991 ± 0.003 | 0.989 ± 0.003 |

Table 5 (continued)
Calculated $k_{eff}$ for highly enriched uranium metal and solution systems

| Case | Experimental description | Ref. | $k_{eff} \pm \sigma$ 27 group KENO V.a | 27 group KENO-VI | 238 group KENO V.a | 238 group KENO-VI |
|---|---|---|---|---|---|---|
| CAS13 | 92.6% $UO_2(NO_3)_2$ solution, 63.3 g U/l, in Plexiglas cylinders, 3 × 3 × 3 array, unreflected | 45 | 0.988 ± 0.003 | 0.991 ± 0.003 | 0.992 ± 0.003 | 0.991 ± 0.003 |
| CAS15 | 93.2% U metal cylinders, 2 × 2 × 2 array, graphite moderated and polyethylene reflected | 46 | 1.002 ± 0.002 | 1.002 ± 0.002 | 0.993 ± 0.002 | 0.994 ± 0.002 |
| CAS17 | 92.6% $UO_2(NO_3)_2$ solution, 415 g U/l, in Plexiglas cylinders, 3 × 3 × 3 array, paraffin reflected | 45 | 1.019 ± 0.003 | 1.020 ± 0.003 | 1.016 ± 0.003 | 1.019 ± 0.003 |
| CAS19 | 93.1% $UO_2(NO_3)_2$ solution, 450.8 g U/l, in SS containers, square central column with 8 perpendicular cylindrical arms unreflected | 48, 49 | 1.036 ± 0.003 | 1.035 ± 0.003 | 1.023 ± 0.003 | 1.028 ± 0.003 |
| CAS21 | 93.17% $UO_2(NO_3)_2$ solution, 364.1 g U/l, in Al cylinders, 4 × 4 array, concrete reflected | 40 | 1.024 ± 0.003 | 1.024 ± 0.003 | 1.020 ± 0.003 | 1.020 ± 0.003 |
| CAS33 | Problem S333SP1R 93.2% $UO_2F_2$ solution 81.8 g U/l, in Al slabs, 3 7.62 cm slabs in 3 × 1 array, 2.54 cm separation, $H_2O$ reflected | 49 | 1.003 ± 0.002 | 0.998 ± 0.003 | 0.993 ± 0.003 | 1.000 ± 0.003 |

Table 5 (continued)
Calculated $k_{eff}$ highly enriched uranium metal and solution systems

| Case | Experimental description | Ref. | $k_{eff} \pm \sigma$ 27 group KENO V.a | 27 group KENO-VI | 238 group KENO V.a | 238 group KENO-VI |
|---|---|---|---|---|---|---|
| CAS39 | Problem S333SP5R 93.2% $UO_2F_2$ solution 81.8 g U/l, in Al slabs, 3 7.62 cm slabs in 3 × 1 array, 13.97 cm separation, $H_2O$ reflected | 49 | 0.999 ± 0.003 | 1.006 ± 0.003 | 1.005 ± 0.003 | 0.998 ± 0.002 |
| CAS41 | Problem S36SP15 93.2% $UO_2F_2$ solution 81.8 g U/l, in Al slabs, 7.62 cm and 14.834 cm slabs in 2 × 1 array, 38.1 cm separation, unreflected | 49 | 0.976 ± 0.003 | 0.980 ± 0.003 | 0.973 ± 0.003 | 0.979 ± 0.003 |
| CAS45 | Problem S363SPO 93.2% $UO_2F_2$ solution 81.8 g U/l, in Al slabs, 7.62 cm and 14.834 cm slabs in 3 × 1 array, 0 cm separation, unreflected | 49 | 0.988 ± 0.003 | 0.983 ± 0.003 | 0.979 ± 0.003 | 0.984 ± 0.003 |
| CAS47 | Problem S363SP20 93.2% $UO_2F_2$ solution 81.8 g U/l, in Al slabs, 7.62 cm and 14.834 cm slabs in 2 × 1 array, 38.1 cm separation, unreflected | 49 | 0.977 ± 0.003 | 0.976 ± 0.003 | 0.978 ± 0.003 | 0.974 ± 0.003 |
| CAS49 | Problem S63SP12 93.2% $UO_2F_2$ solution 81.8 g U/l, in Al slabs, one slab is made up from two 7.62 cm slabs snugly fit together, the other is 7.62 cm, 2 × 1 array, 30.48 cm separation, unreflected | 49 | 0.986 ± 0.003 | 0.983 ± 0.003 | 0.987 ± 0.003 | 0.982 ± 0.003 |

Table 5 (continued)
Calculated $k_{eff}$ highly enriched uranium metal and solution systems

| | | | $k_{eff} \pm \sigma$ | | | |
|---|---|---|---|---|---|---|
| | | | 27 group | | 238 group | |
| Case | Experimental description | Ref. | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| CAS51 | Problem S63SP30 93.2% $UO_2F_2$ solution 81.8 g U/l, in Al slabs, one slab is made up from two 7.62 cm slabs snugly fit together, the other is 7.62 cm, 2 × 1 array, 76.2 cm separation, unreflected | 49 | 0.981 ± 0.003 | 0.985 ± 0.003 | 0.977 ± 0.003 | 0.982 ± 0.003 |
| CAS58 | Problem S63SP6 93.2% $UO_2F_2$ solution 81.8 g U/l, in Al slabs, one slab is 14.834 and the other is made of from two 7.62 cm slabs snugly fit together 2 × 1 array, 15.24 cm separation, unreflected | 49 | 0.983 ± 0.003 | 0.982 ± 0.003 | 0.983 ± 0.003 | 0.978 ± 0.003 |
| CAS57 | Problem S66SP48 93.2% $UO_2F_2$ solution 81.8 g U/l, in Al slabs, one slab is 14.834 and the other is made of from two 7.62 cm slabs snugly fit together 2 × 1 array, 121.92 cm separation, unreflected | 49 | 0.984 ± 0.003 | 0.987 ± 0.003 | 0.986 ± 0.003 | 0.980 ± 0.003 |
| CAS91 | Problem U6B271F. 92.6% $UO_2(NO_3)_2$ solution, 63.3 g U/l, in Plexiglas cylinders, 3 × 3 × 3 array, unreflected, walls, floor, and tank in experiment room included | 45 | 1.008 ± 0.003 | 1.007 ± 0.003 | 1.003 ± 0.004 | 1.000 ± 0.003 |
| CAS61 | Problem U2B81F. 92.6% $UO_2(NO_3)_2$ solution, 279 g U/l, in Plexiglas cylinders, 2 × 2 × 2 array, unreflected, walls, floor, and tank in experiment room included | 45 | 1.007 ± 0.003 | 1.006 ± 0.003 | 1.001 ± 0.003 | 0.997 ± 0.003 |

Table 5 (continued)
Calculated $k_{eff}$ highly enriched uranium metal and solution systems

| | | | $k_{eff} \pm \sigma$ | | | |
|---|---|---|---|---|---|---|
| | | | 27 group | | 238 group | |
| Case | Experimental description | Ref. | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| CAS63 | Problem U4B271F. 92.6% $UO_2(NO_3)_2$ solution, 415 g U/l, in Plexiglas cylinders, 3 × 3 × 3 array, unreflected, walls, floor, and tank in experiment room included | 45 | 0.998 ± 0.003 | 1.001 ± 0.003 | 0.991 ± 0.003 | 0.990 ± 0.004 |
| CAS90 | Problem U4U2B27. 92.6% $UO_2(NO_3)_2$ solution, 63.3 g U/l, in Plexiglas cylinders, 3 × 3 × 3 array, unreflected, walls, floor, and tank in experiment room included | 45 | 1.001 ± 0.003 | 1.000 ± 0.003 | 0.999 ± 0.003 | 0.995 ± 0.003 |
| CAS67 | Problem U4R27B1F. 92.6% $UO_2(NO_3)_2$ solution, 415 g U/l, in Plexiglas cylinders, 3 × 3 × 3 array, reflected, 15.24 cm paraffin on bottom, 2.54 cm Plexiglas on other faces. | 45 | 1.018 ± 0.003 | 1.017 ± 0.003 | 1.004 ± 0.003 | 1.005 ± 0.003 |
| CAS71 | Problem U4R27F1F. 92.6% $UO_2(NO_3)_2$ solution, 415 g U/l, in Plexiglas cylinders, 3 × 3 × 3 array, reflected, 15.24 cm paraffin on bottom, 7.62 cm paraffin on other faces. | 45 | 1.031 ± 0.003 | 1.034 ± 0.003 | 1.023 ± 0.003 | 1.027 ± 0.003 |
| CAS73 | Problem U4R27H1F. 92.6% $UO_2(NO_3)_2$ solution, 415 g U/l, in Plexiglas cylinders, 3 × 3× 3 array, reflected, 1.27 cm paraffin all faces | 45 | 1.009 ± 0.003 | 1.008 ± 0.003 | 1.002 ± 0.003 | 1.004 ± 0.003 |

Table 5 (continued)
Calculated $k_{eff}$ highly enriched uranium metal and solution systems

| Case | Experimental description | Ref. | $k_{eff} \pm \sigma$ 27 group KENO V.a | 27 group KENO-VI | 238 group KENO V.a | 238 group KENO-VI |
|---|---|---|---|---|---|---|
| CAS76 | Problem U4R27H1F. 92.6% $UO_2(NO_3)_2$ solution, 415 g U/l, in Plexiglas cylinders, 2 × 2 × 2 array, reflected, 15.24 cm paraffin on bottom, 1.27 cm Plexiglas on other faces | 45 | 1.019 ± 0.004 | 1.008 ± 0.003 | 1.005 ± 0.003 | 1.004 ± 0.003 |
| CAS79 | Problem U4R8D1F. 92.6% $UO_2(NO_3)_2$ solution, 415 g U/l, in Plexiglas cylinders, 2 × 2 × 2 array, reflected, 15.24 cm paraffin on bottom, 2.54 cm Plexiglas on other faces | 45 | 1.012 ± 0.003 | 1.012 ± 0.003 | 1.012 ± 0.003 | 1.007 ± 0.003 |
| CAS81 | Problem U4R28F1F. 92.6% $UO_2(NO_3)_2$ solution, 415 g U/l, in Plexiglas cylinders, 2 × 2 × 2 array, reflected, 15.24 cm paraffin on bottom, 6.35 cm Plexiglas on other faces | 45 | 1.022 ± 0.003 | 1.028 ± 0.003 | 1.012 ± 0.003 | 1.019 ± 0.003 |
| CAS84 | Problem U4R8I1F. 92.6% $UO_2(NO_3)_2$ solution, 415 g U/l, in Plexiglas cylinders, 2 × 2 × 2 array, reflected, 15.24 cm paraffin on bottom, 7.62 cm Plexiglas on other faces | 45 | 1.022 ± 0.004 | 1.022 ± 0.003 | 1.013 ± 0.003 | 1.009 ± 0.003 |
| CAS86 | Problem U4R8K1F. 92.6% $UO_2(NO_3)_2$ solution, 415 g U/l, in Plexiglas cylinders, 2 × 2 × 2 array, reflected, 1.27 cm paraffin on all faces | 45 | 1.012 ± 0.003 | 1.011 ± 0.003 | 1.004 ± 0.003 | 1.009 ± 0.003 |

Table 5 (continued)
Calculated $k_{eff}$ highly enriched uranium metal and solution systems

| | | | $k_{eff} \pm \sigma$ | | | |
|---|---|---|---|---|---|---|
| | | | 27 group | | 238 group | |
| Case | Experimental description | Ref. | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| CAS88 | Problem U4R8N1F. 92.6% $UO_2(NO_3)_2$ solution, 415 g U/l, in Plexiglas cylinders, $2 \times 2 \times 2$ array, reflected, 7.62 cm paraffin on all faces | 45 | 1.016 ± 0.003 | 1.023 ± 0.003 | 1.013 ± 0.004 | 1.012 ± 0.003 |

Table 6. KENO V.a and KENO-VI comparison
Calculated $k_{eff}$ for highly enriched uranium solution systems

| Case | Experimental description | Ref. | $k_{eff} \pm \sigma$ 27 group KENO V.a | 27 group KENO-VI | 238 group KENO V.a | 238 group KENO-VI |
|---|---|---|---|---|---|---|
| CAS01 | Experiment 1. $U(93.2)\ O_2(NO_3)_2$ H/X = 1378 in 27.24-in. diam sphere | 25, 26 | 0.999 ± 0.002 | 0.997 ± 0.002 | 0.996 ± 0.002 | 1.003 ± 0.002 |
| CAS02 | Experiment 2. $U(93.2)\ O_2(NO_3)_2$ H/X = 1177, B poisoned, in 27.24-in. diam sphere | 25, 26 | 0.998 ± 0.002 | 1.001 ± 0.002 | 1.003± 0.002 | 0.998 ± 0.002 |
| CAS03 | Experiment 3. $U(93.2)\ O_2(NO_3)_2$ H/X = 1033, B poisoned, in 27.24-in. diam sphere | 25, 26 | 0.996 ± 0.002 | 0.993 ± 0.002 | 0.993 ± 0.002 | 0.993 ± 0.002 |
| CAS04 | Experiment 4. $U(93.2)\ O_2(NO_3)_2$ H/X = 972, B poisoned, in 27.24-in. diam sphere | 25, 26 | 0.995 ± 0.002 | 0.998 ± 0.002 | 0.998 ± 0.002 | 1.000 ± 0.002 |
| CAS05 | Experiment 5. $U\text{-}233\ O_2(NO_3)_2$ H/X = 1533, in 27.24-in. diam sphere | 25, 26 | 0.998 ± 0.002 | 1.003 ± 0.002 | 0.995 ± 0.002 | 0.999 ± 0.002 |
| CAS06 | Experiment 6. $U\text{-}233\ O_2(NO_3)_2$ H/X = 1470, B poisoned, in 27.24-in. diam sphere | 25, 26 | 1.002 ± 0.002 | 0.999 ± 0.002 | 0.996 ± 0.002 | 0.994 ± 0.002 |
| CAS07 | Experiment 7. $U\text{-}233\ O_2(NO_3)_2$ H/X = 1417, B poisoned, in 27.24-in. diam sphere | 25, 26 | 1.002 ± 0.002 | 0.999 ± 0.002 | 0.997 ± 0.002 | 0.995 ± 0.002 |
| CAS08 | Experiment 8. $U\text{-}233\ O_2(NO_3)_2$ H/X = 1368, B poisoned, in 27.24-in. diam sphere | 25, 26 | 1.003 ± 0.002 | 1.003 ± 0.002 | 0.993 ± 0.002 | 0.991 ± 0.002 |
| CAS09 | Experiment 9. $U\text{-}233\ O_2(NO_3)_2$ H/X = 1308, B poisoned, in 27.24-in. diam sphere | 25, 26 | 1.005 ± 0.002 | 1.006 ± 0.002 | 1.000 ± 0.002 | 0.996 ± 0.002 |

Table 6 (continued)
Calculated $k_{eff}$ for highly enriched uranium solution systems

| Case | Experimental description | Ref. | $k_{eff} \pm \sigma$ 27 group KENO V.a | 27 group KENO-VI | 238 group KENO V.a | 238 group KENO-VI |
|---|---|---|---|---|---|---|
| CAS10 | Experiment 10. U(93.2) $O_2(NO_3)_2$ H/X = 1835, in 48.04-in. diam sphere | 25, 26 | 0.998 ± 0.002 | 0.995 ± 0.001 | 1.000 ± 0.002 | 0.998 ± 0.001 |
| CAS11 | Experiment 11. U-233 $O_2(NO_3)_2$ H/X = 1986, in 48.04-in. diam sphere | 25, 26 | 0.994 ± 0.002 | 1.000 ± 0.001 | 0.996 ± 0.002 | 0.994 ± 0.001 |
| CAS12 | Experiment 12. U(93.2) $O_2(NO_3)_2$ H/X = 1604, in 60.92-in. diam cylinder | 25, 26 | 0.991 ± 0.002 | 0.992 ± 0.002 | 0.996 ± 0.001 | 0.994 ± 0.002 |
| CAS13 | Experiment 13. U(93.2) $O_2(NO_3)_2$ H/X = 1634, in 60.92-in. diam cylinder | 25, 26 | 0.994 ± 0.002 | 0.992 ± 0.001 | 0.999 ± 0.002 | 0.995 ± 0.002 |
| CAS14 | Experiment 14. U(93.2) $O_2(NO_3)_2$ H/X = 1821, in 60.92-in. diam cylinder | 25, 26 | 0.999 ± 0.001 | 0.997 ± 0.001 | 0.997± 0.002 | 1.000 ± 0.001 |
| CAS15 | Experiment 15. U(93.2) $O_2(NO_3)_2$ H/X = 1905, in 60.92-in. diam cylinder | 25, 26 | 0.999 ± 0.001 | 0.999 ± 0.001 | 0.999 ± 0.002 | 1.002 ± 0.001 |
| CAS16 | Experiment 16. U(93.2) $O_2(NO_3)_2$ H/X = 1981, in 60.92-in. diam cylinder | 25, 26 | 0.996 ± 0.001 | 0.995 ± 0.001 | 0.996 ± 0.001 | 1.003 ± 0.001 |
| CAS17 | Experiment 17. U-233 $O_2(NO_3)_2$ H/X = 1819, in 60.92-in. diam cylinder | 25, 26 | 0.993 ± 0.001 | 0.992 ± 0.002 | 0.993 ± 0.001 | 0.991 ± 0.002 |
| CAS18 | Experiment 18. U-233 $O_2(NO_3)_2$ H/X = 1900, in 60.92-in. diam cylinder | 25, 26 | 0.996 ± 0.001 | 0.996 ± 0.001 | 0.995 ± 0.001 | 0.997 ± 0.001 |

Table 6 (continued)
Calculated $k_{eff}$ for highly enriched uranium solution systems

| | | | $k_{eff} \pm \sigma$ | | | |
|---|---|---|---|---|---|---|
| | | | 27 group | | 238 group | |
| Case | Experimental description | Ref. | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| CAS19 | Experiment 19. U-233 $O_2(NO_3)_2$ H/X = 1996, in 60.92-in. diam cylinder | 25, 26 | 0.994 ± 0.002 | 0.994 ± 0.001 | 0.995 ± 0.001 | 0.997 ± 0.001 |
| CAS20 | Experiment 20. U-233 $O_2(NO_3)_2$ H/X = 2106, in 60.92-in. diam cylinder | 25, 26 | 0.992 ± 0.002 | 0.993 ± 0.001 | 0.995 ± 0.001 | 0.994 ± 0.002 |
| CAS21 | Experiment 21. U(93.2) $O_2(NO_3)_2$ H/X = 1955, in 107.7-in. diam cylinder | 25, 26 | 0.993 ± 0.001 | 0.996 ± 0.001 | 0.997 ± 0.001 | 1.002 ± 0.001 |
| CAS22 | Experiment 22. U(93.2) $O_2(NO_3)_2$ H/X = 2004, in 107.7-in. diam cylinder | 25, 26 | 0.995 ± 0.001 | 0.994 ± 0.001 | 0.999 ± 0.001 | 0.999 ± 0.001 |
| CAS23 | Experiment 23. U(93.2) $O_2(NO_3)_2$ H/X = 2052, in 107.7-in. diam cylinder | 25, 26 | 0.996 ± 0.001 | 0.996 ± 0.001 | 0.999 ± 0.001 | 1.000 ± 0.001 |

# 5. DISCUSSION OF RESULTS

Table 7 gives the mean, median, minimum, and maximum *k*-effectives for each table of results. The deviations for the mean values are the root mean square of each table. The mean values of $k_{eff}$ are in excellent agreement with the experiments.

The spread in data, however, indicates that there may be problems with certain types of calculations. The low-enriched uranium systems reported in Table 3 and the highly-enriched uranium systems in Table 5 show a wide spread in the data. This could be caused by the detail of the descriptions of the experiments.

Figures 1–6 are plots of calculated $k_{eff}$ values for each case from Tables 1–6. These plots show the comparisons between KENO-VI and KENO V.a using both the 27- and 238-group cross-section libraries.

Figures 7–10 show the calculated value of $k_{eff}$ as a function of the assay for low-enriched and high-enriched experiments. Figures 7 and 8 show the comparison of 27- and 238-group cross sections for low-enrichment experiments using KENO V.a and KENO-VI, respectively. Figures 9 and 10 show the same comparison for high-enrichment experiments.

Figure 11 shows the comparison of KENO V.a and KENO-VI for low-enrichment experiments using 238-group cross sections. Figure 12 shows the same comparison for high-enrichment experiments.

Figures 13–19 are plots of $k_{eff}$ versus energy of average lethargy causing fission (EALF) for each table of results. Table 5 was split into two portions because of the large range in EALF. Figure 17 presents the EALF for the uranium metal systems of Table 5 while Figure 18 presents the EALF for the uranium solutions for Table 5. These plots do not show a trend in the results.

Table 7. Average calculated $k_{eff}$ value by table

Table = 1

| Total Cases | | 27 group | | 238 group | |
|---|---|---|---|---|---|
| | | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| 19 | | | | | |
| | Mean $k_{eff}$ | 0.994 ± 0.005 | 0.994 ± 0.004 | 0.995 ± 0.005 | 0.996 ± 0.005 |
| | Median $k_{eff}$ | 0.995 ± 0.002 | 0.993 ± 0.002 | 0.995 ± 0.002 | 0.996 ± 0.002 |
| | Minimum $k_{eff}$ | 0.987 ± 0.002 | 0.989 ± 0.002 | 0.988 ± 0.003 | 0.989 ± 0.003 |
| | Maximum $k_{eff}$ | 1.002 ± 0.003 | 1.001 ± 0.002 | 1.002 ± 0.002 | 1.003 ± 0.003 |

Table = 2

| Total Cases | | 27 group | | 238 group | |
|---|---|---|---|---|---|
| | | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| 7 | | | | | |
| | Mean $k_{eff}$ | 1.003 ± 0.006 | 1.004 ± 0.008 | 0.995 ± 0.007 | 0.993 ± 0.005 |
| | Median $k_{eff}$ | 1.006 ± 0.002 | 1.006 ± 0.002 | 0.995 ± 0.002 | 0.996 ± 0.002 |
| | Minimum $k_{eff}$ | 0.992 ± 0.002 | 0.991 ± 0.002 | 0.984 ± 0.002 | 0.985 ± 0.002 |
| | Maximum $k_{eff}$ | 1.008 ± 0.003 | 1.013 ± 0.002 | 1.003 ± 0.002 | 0.998 ± 0.003 |

Table = 3

| Total Cases | | 27 group | | 238 group | |
|---|---|---|---|---|---|
| | | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| 23 | | | | | |
| | Mean $k_{eff}$ | 0.999 ± 0.010 | 1.000 ± 0.009 | 1.002 ± 0.002 | 1.003 ± 0.009 |
| | Median $k_{eff}$ | 0.997 ± 0.002 | 0.999 ± 0.002 | 0.999 ± 0.003 | 1.001 ± 0.003 |
| | Minimum $k_{eff}$ | 0.985 ± 0.002 | 0.981 ± 0.002 | 0.986 ± 0.003 | 0.990 ± 0.003 |
| | Maximum $k_{eff}$ | 1.014 ± 0.003 | 1.016 ± 0.004 | 1.017 ± 0.003 | 1.019 ± 0.003 |

Table 7 (continued)

| Table = 4 | | | | | |
|---|---|---|---|---|---|
| | | 27 group | | 238 group | |
| Total Cases | | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| 17 | | | | | |
| | Mean $k_{eff}$ | 1.009 ± 0.007 | 1.006 ± 0.007 | 1.002 ± 0.007 | 1.003 ± 0.007 |
| | Median $k_{eff}$ | 1.008 ± 0.003 | 1.005 ± 0.003 | 1.000 ± 0.003 | 1.001 ± 0.003 |
| | Minimum $k_{eff}$ | 0.998 ± 0.003 | 0.996 ± 0.003 | 0.991 ± 0.003 | 0.993 ± 0.003 |
| | Maximum $k_{eff}$ | 1.028 ± 0.003 | 1.028 ± 0.004 | 1.017 ± 0.003 | 1.021 ± 0.003 |

| Table = 5 | | | | | |
|---|---|---|---|---|---|
| | | 27 group | | 238 group | |
| Total Cases | | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| 35 | | | | | |
| | Mean $k_{eff}$ | 1.005 ± 0.015 | 1.005 ± 0.015 | 0.999 ± 0.013 | 1.004 ± 0.014 |
| | Median $k_{eff}$ | 1.007 ± 0.002 | 1.006 ± 0.003 | 1.001 ± 0.003 | 0.998 ± 0.002 |
| | Minimum $k_{eff}$ | 0.976 ± 0.003 | 0.980 ± 0.003 | 0.973 ± 0.003 | 0.974 ± 0.003 |
| | Maximum $k_{eff}$ | 1.036 ± 0.003 | 1.035 ± 0.004 | 1.023 ± 0.003 | 1.028 ± 0.003 |

| Table = 6 | | | | | |
|---|---|---|---|---|---|
| | | 27 group | | 238 group | |
| Total Cases | | KENO V.a | KENO-VI | KENO V.a | KENO-VI |
| 23 | | | | | |
| | Mean $k_{eff}$ | 0.997 ± 0.004 | 0.997 ± 0.004 | 0.997 ± 0.003 | 0.997 ± 0.004 |
| | Median $k_{eff}$ | 0.996 ± 0.002 | 0.996 ± 0.001 | 0.996 ± 0.001 | 0.997 ± 0.001 |
| | Minimum $k_{eff}$ | 1.005 ± 0.002 | 1.006 ± 0.002 | 1.003 ± 0.002 | 1.003 ± 0.002 |
| | Maximum $k_{eff}$ | 1.005 ± 0.002 | 1.006 ± 0.002 | 1.003 ± 0.002 | 1.003 ± 0.002 |

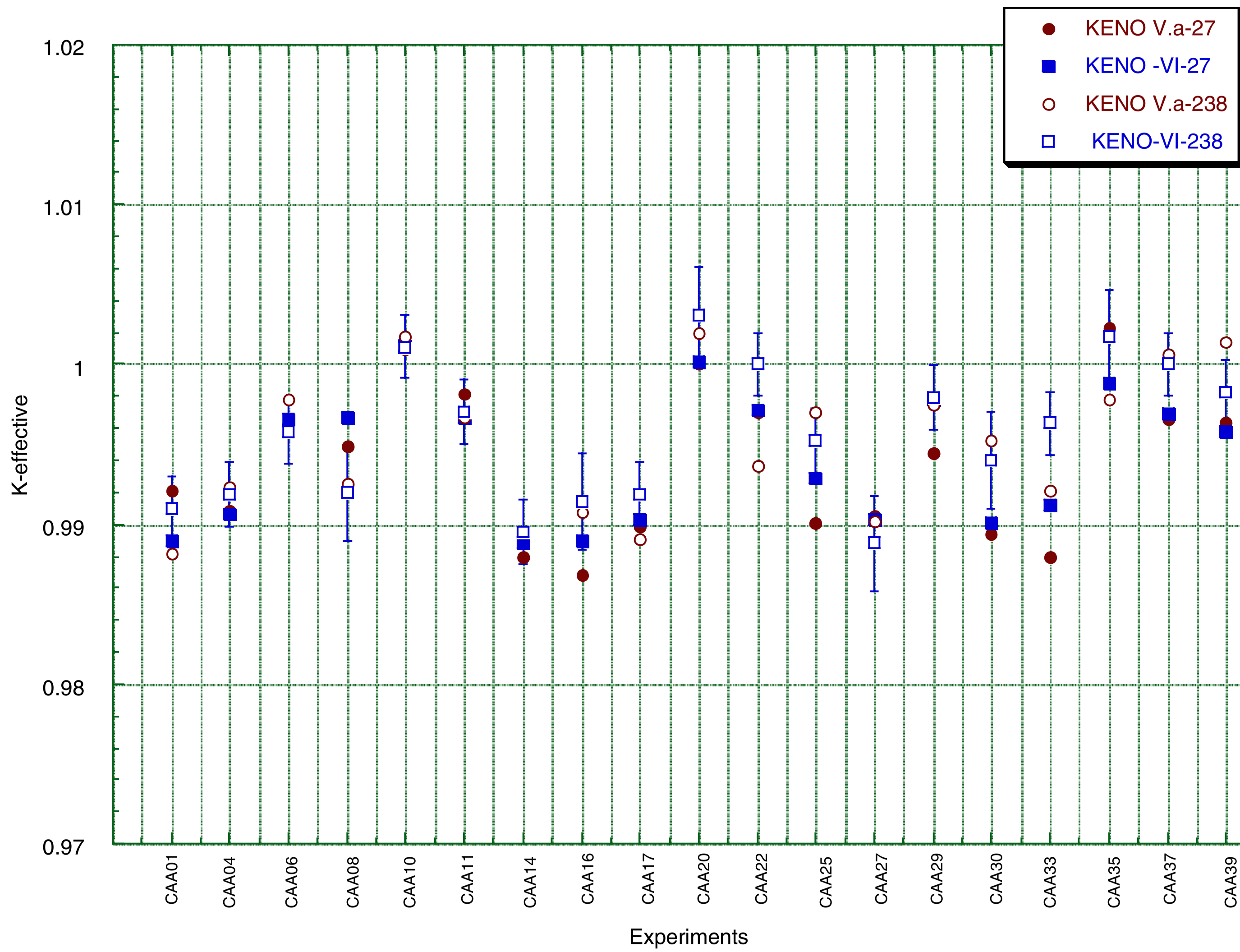


**Figure 1. Calculated K-effective values from Table 1.**

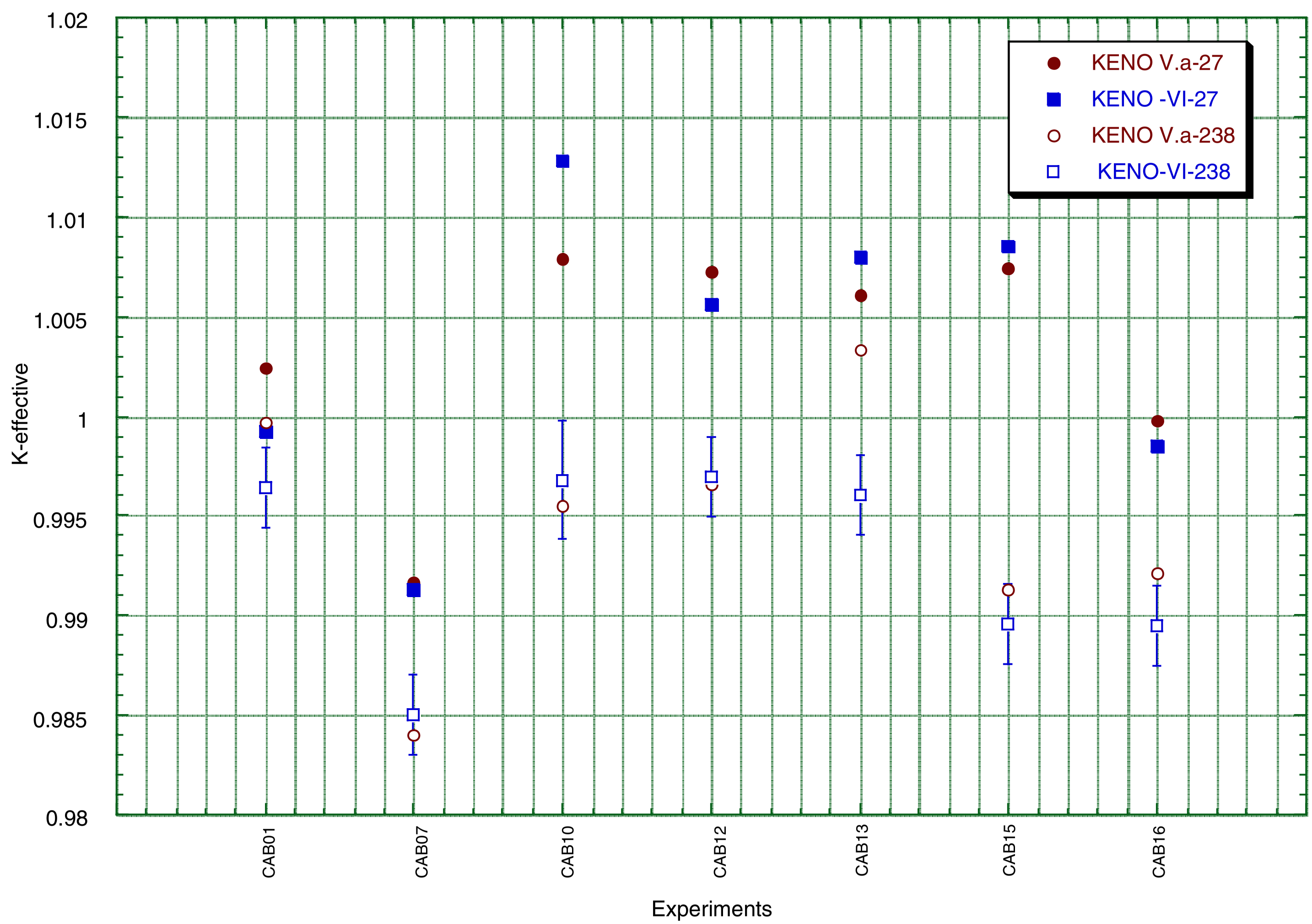


**Figure 2. Calculated K-effective values from Table 2.**

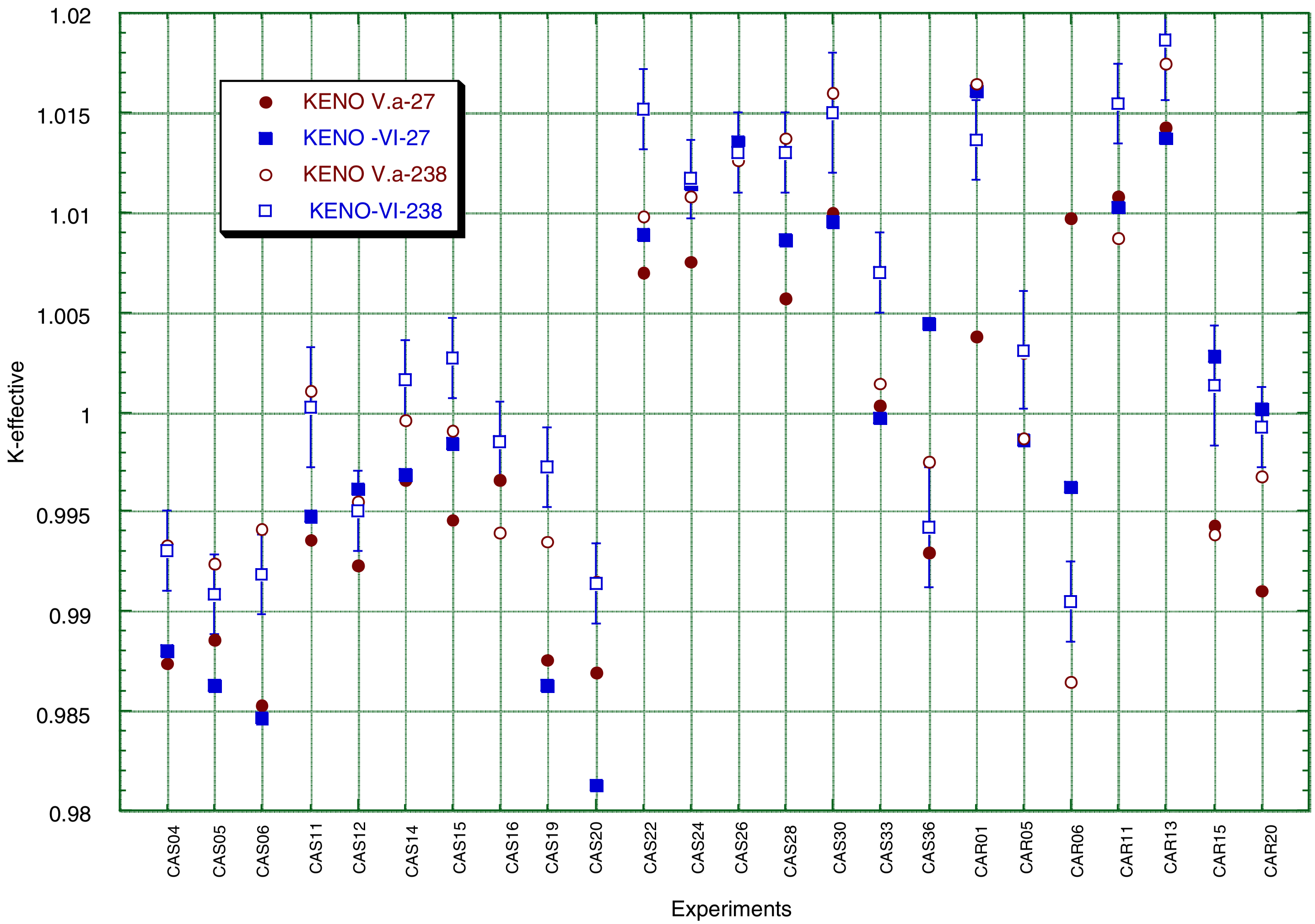


**Figure 3. Calculated K-effective values from Table 3.**

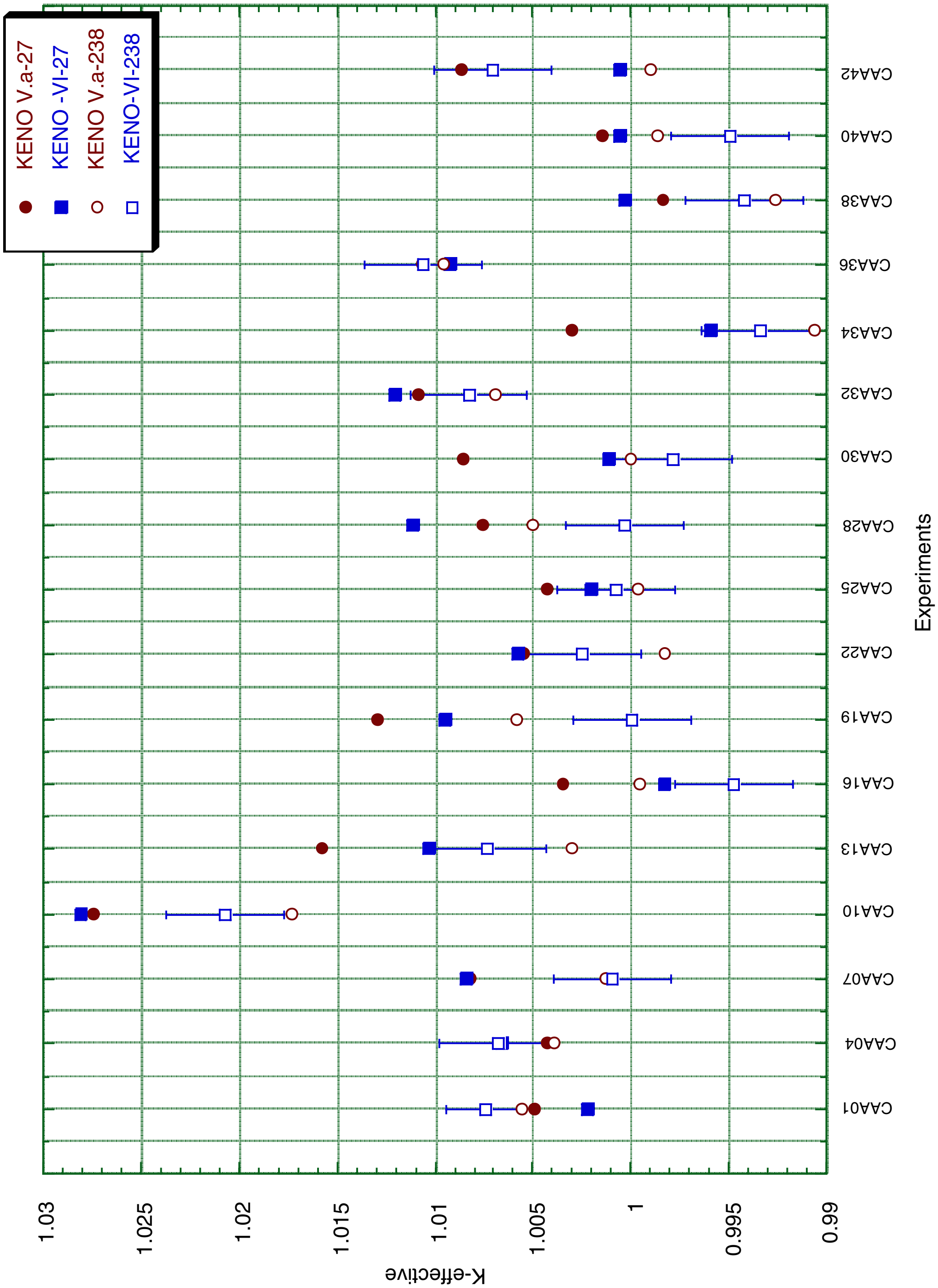


**Figure 4. Calculated K-effective values from Table 4.**

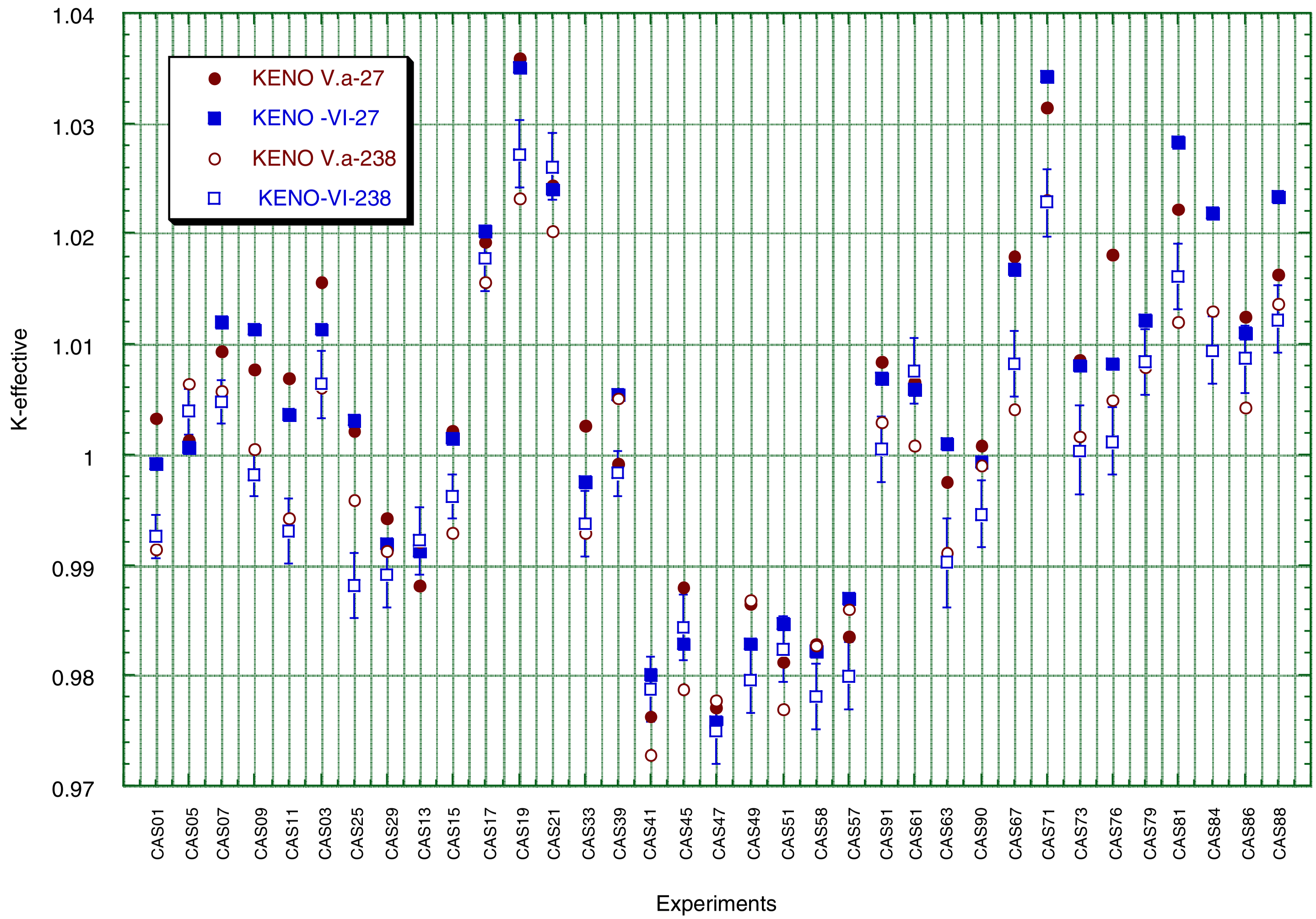


**Figure 5. Calculated K-effective values from Table 5.**

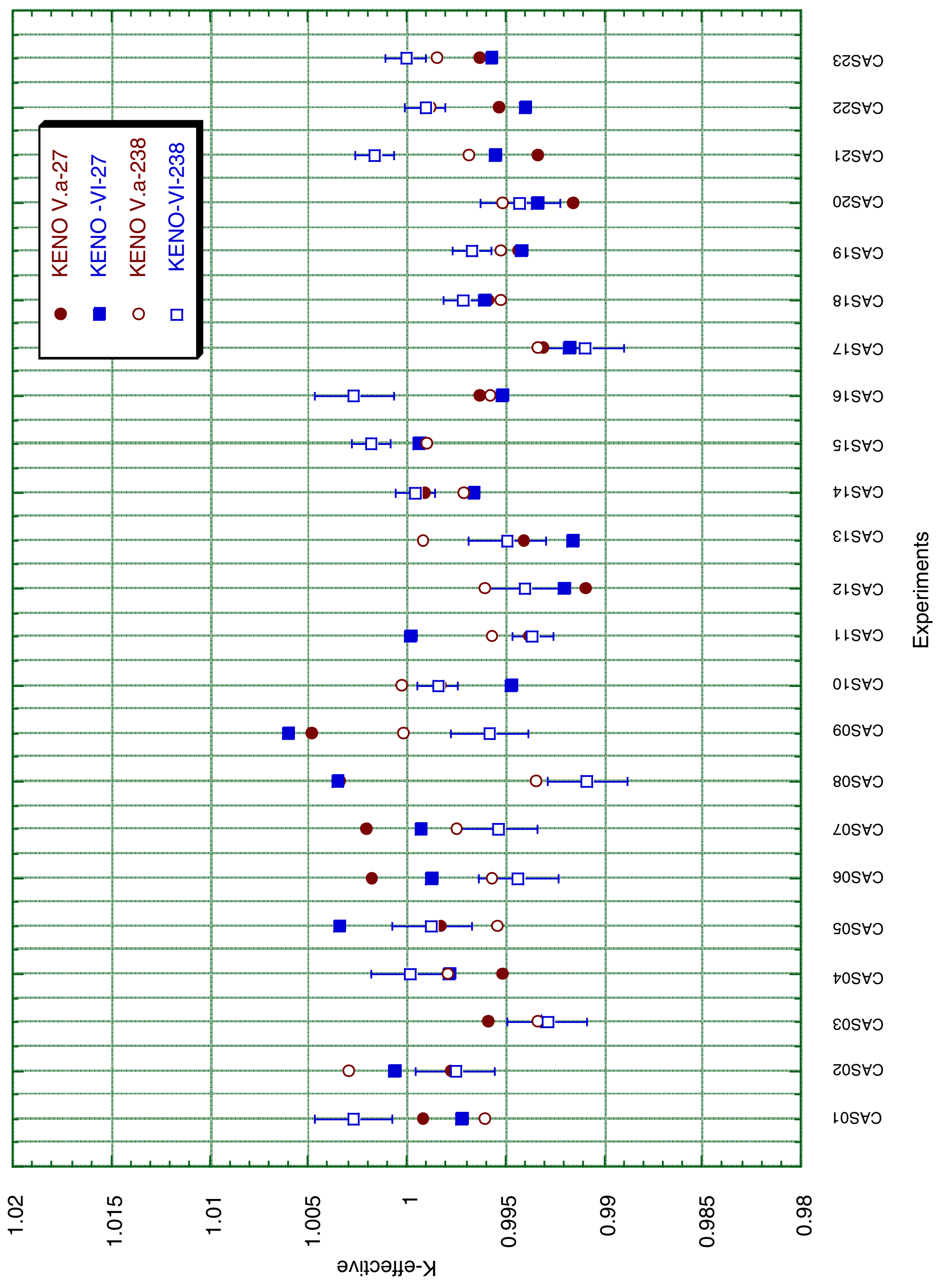


**Figure 6. Calculated K-effective values from Table 6.**

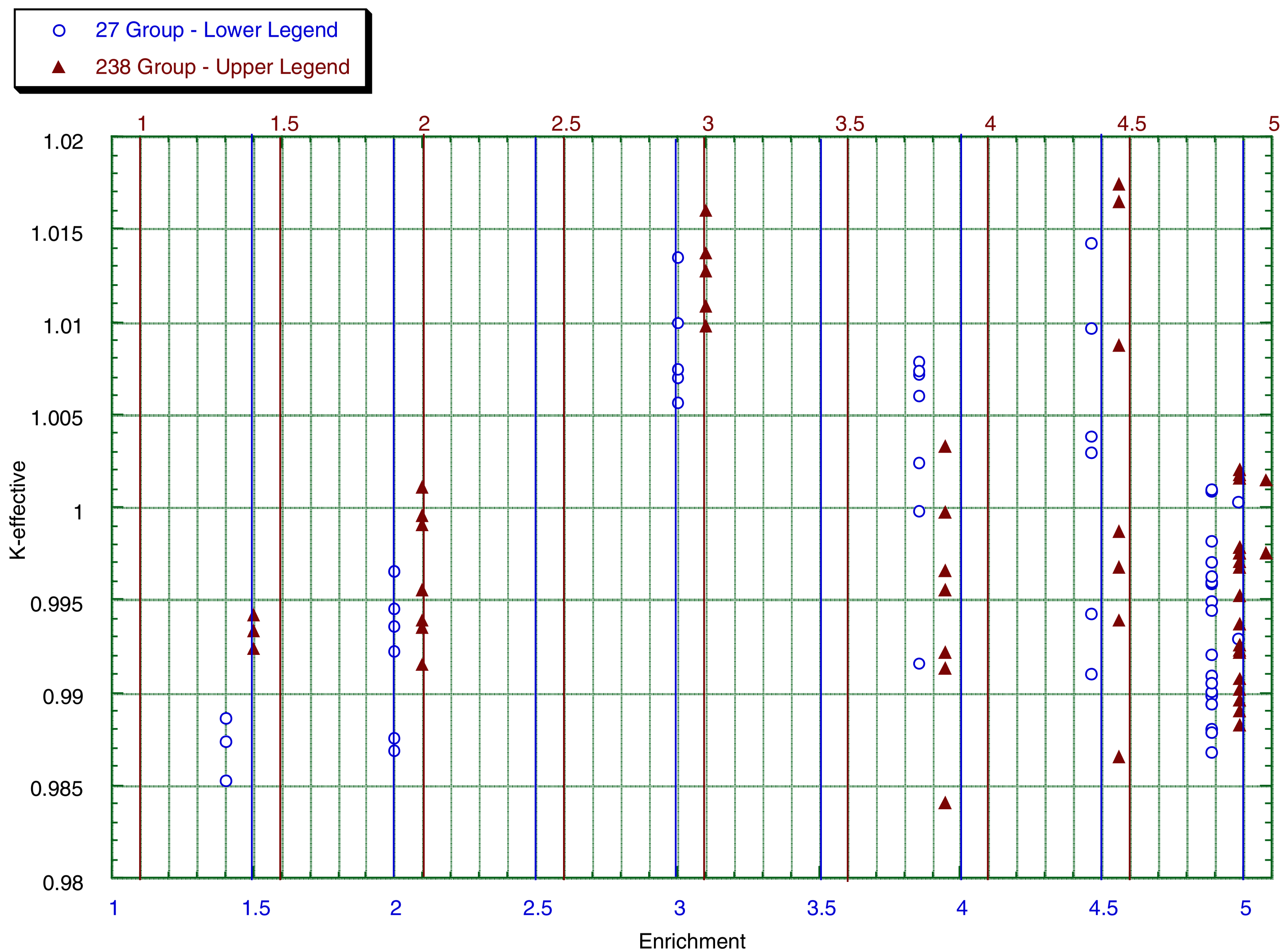


**Figure 7. KENO V.a k-effective vs. enrichment level low enrichment experiments.**

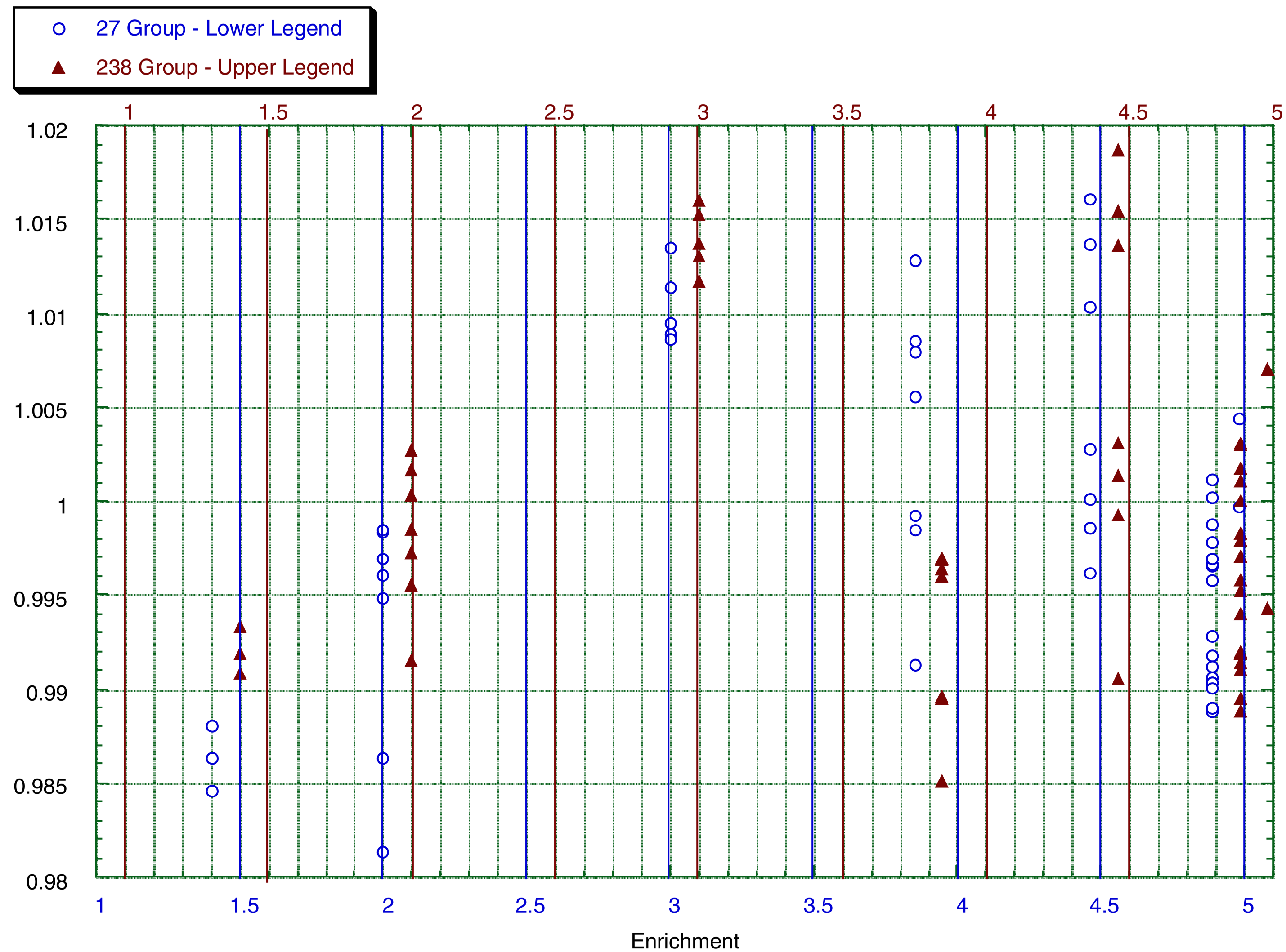


**Figure 8. KENO-VI k-effective vs. enrichment level low enrichment experiments.**

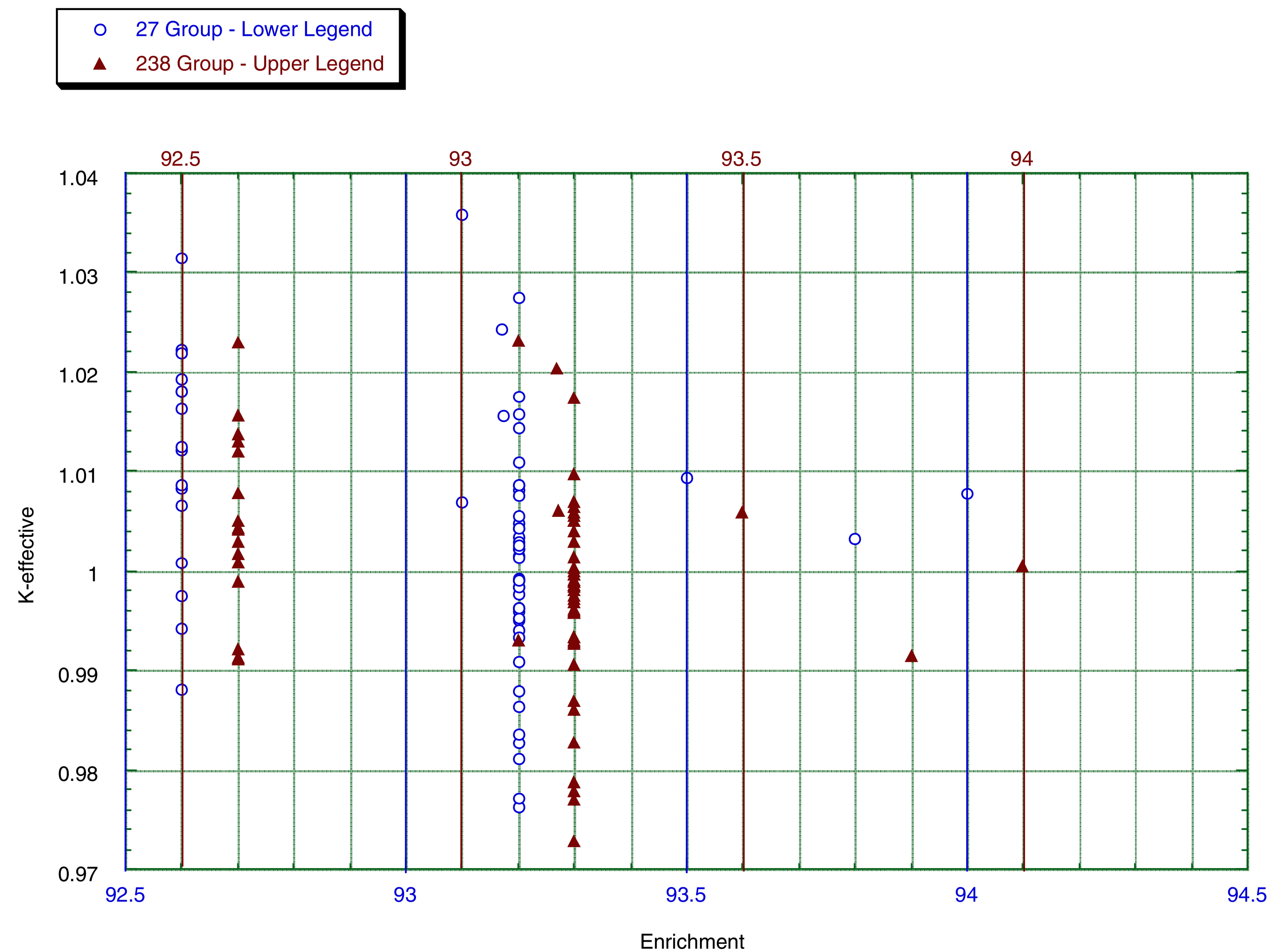


Figure 9. KENO V.a k-effective vs. enrichment level high enrichment experiments.

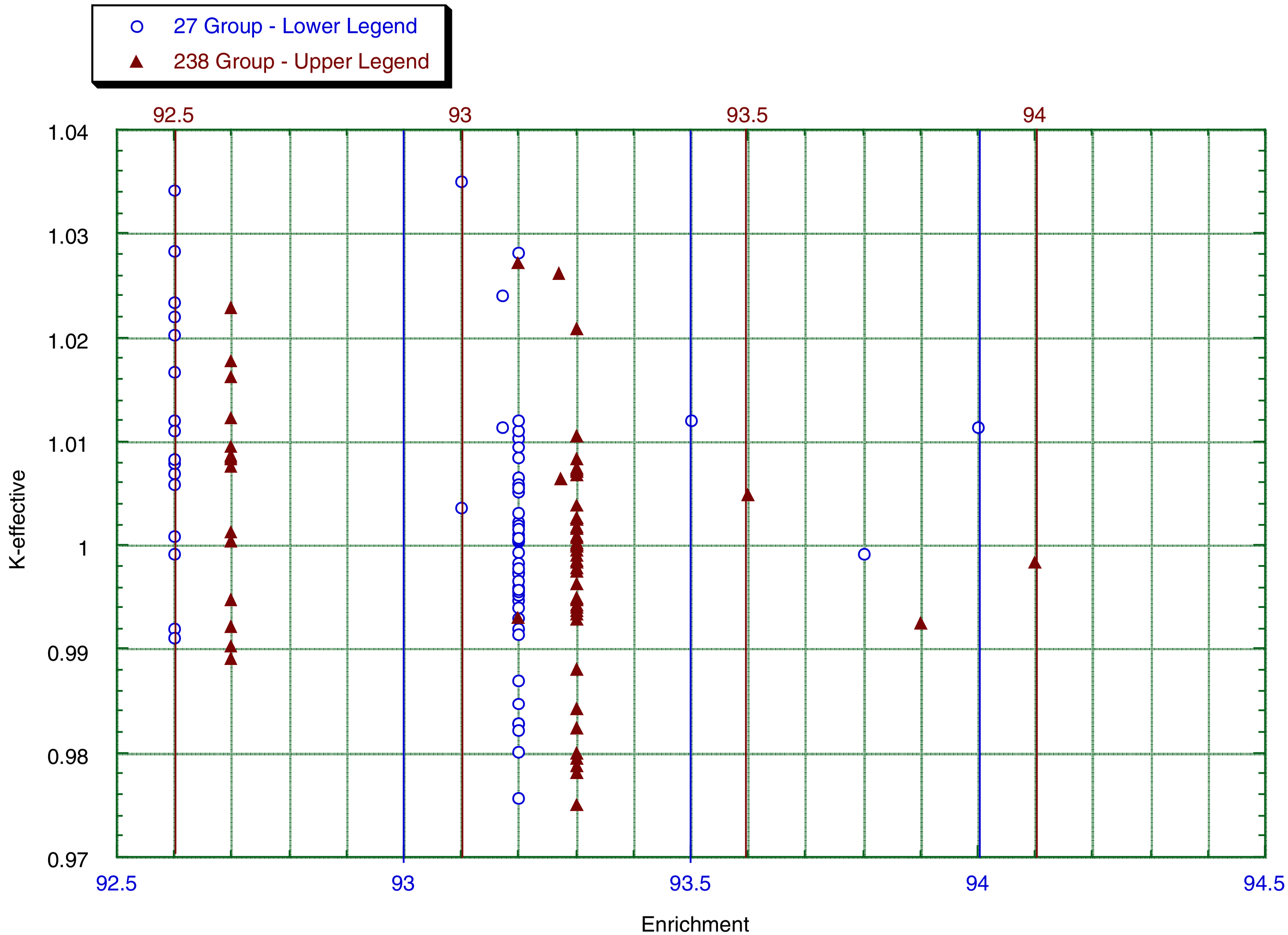


**Figure 10. KENO-VI k-effective vs. enrichment level high enrichment experiments.**

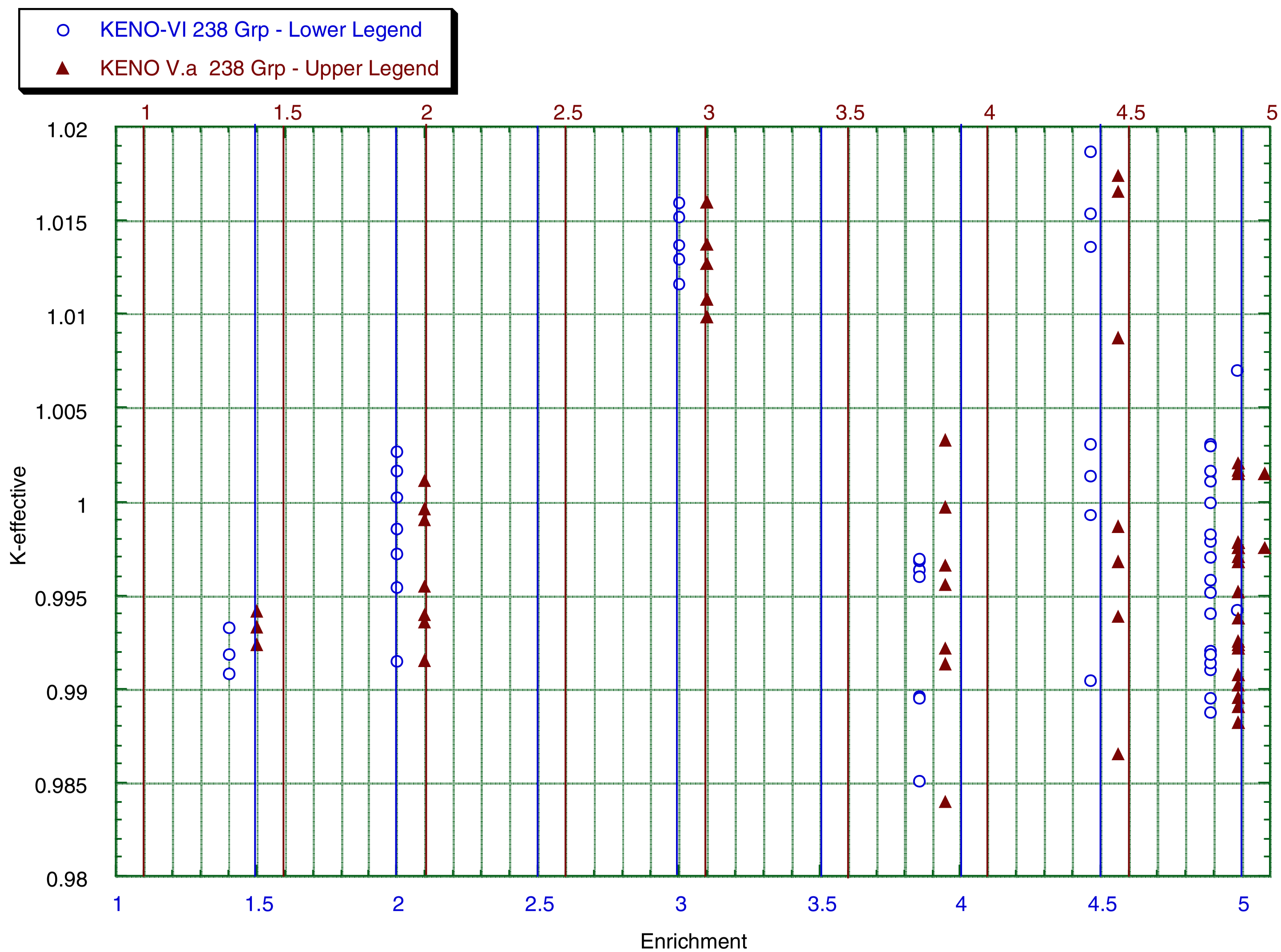


Figure 11. KENO V.a and KENO-VI (238 group) k-effective vs. enrichment level low enrichment experiments.

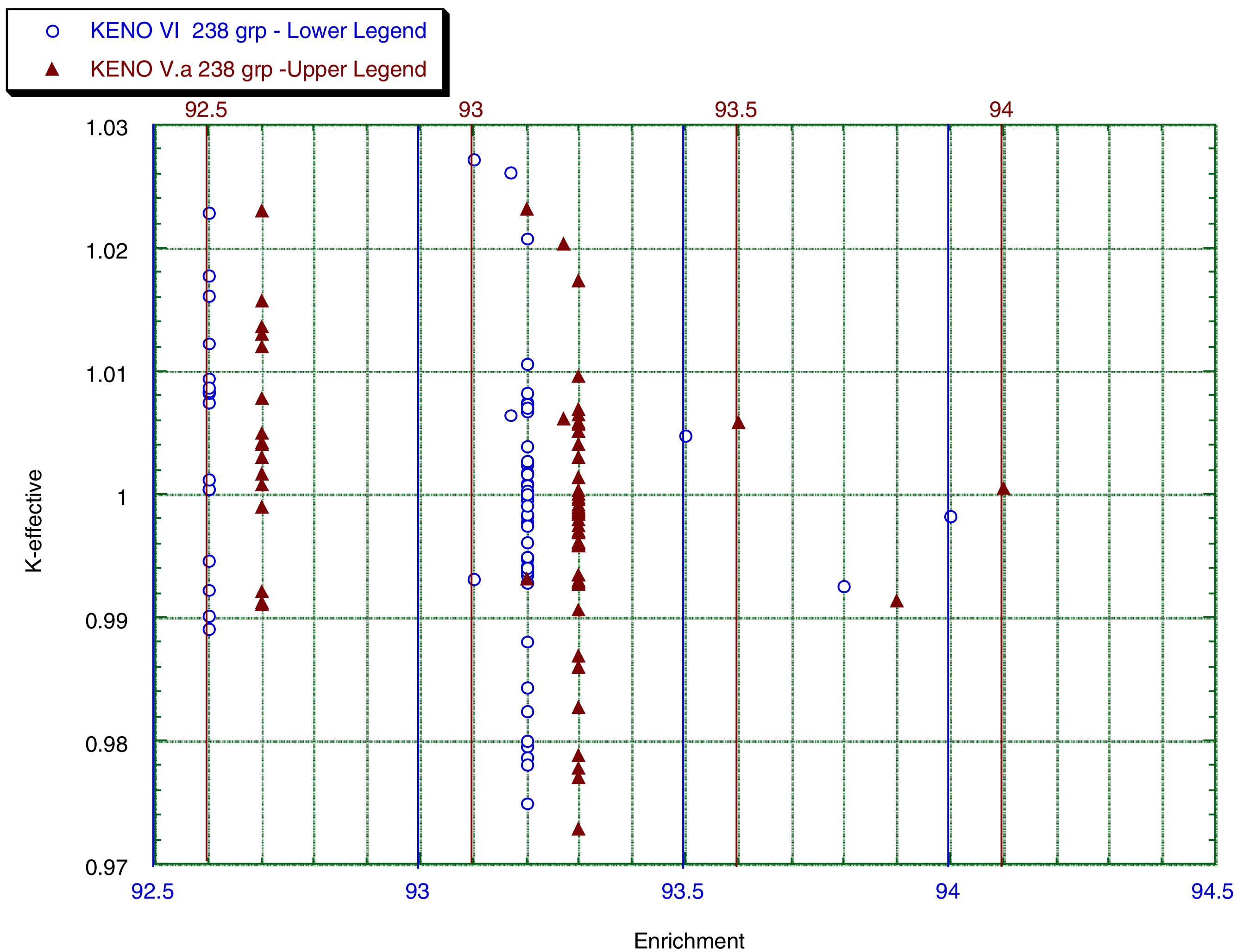


**Figure 12. KENO V.a and KENO-VI (238 group) k-effective vs. enrichment level high enrichment experiments.**

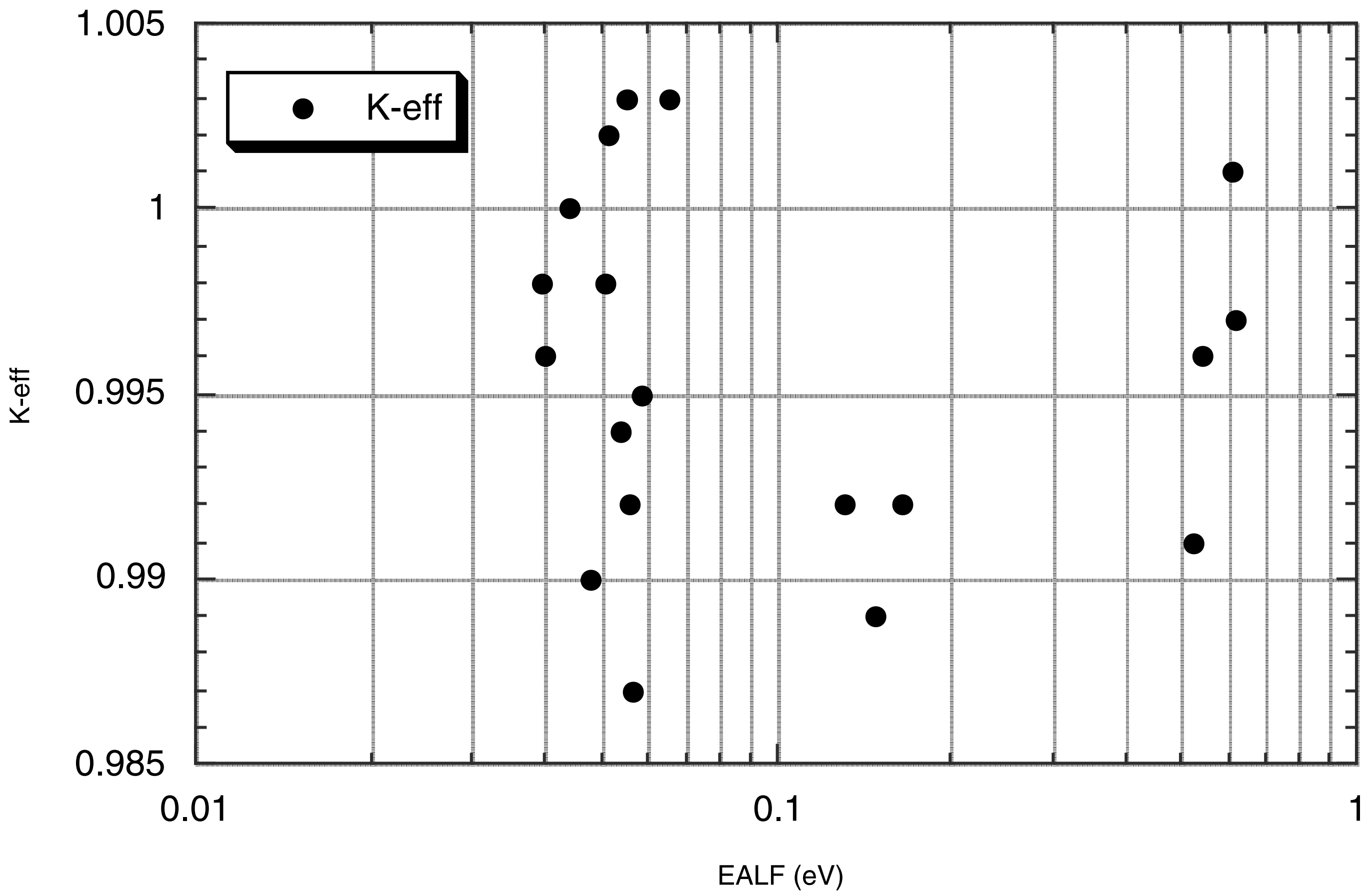


**Figure 13. KENO-VI 238-group results for low enriched homogeneous and heterogeneous systems (Table 1).**

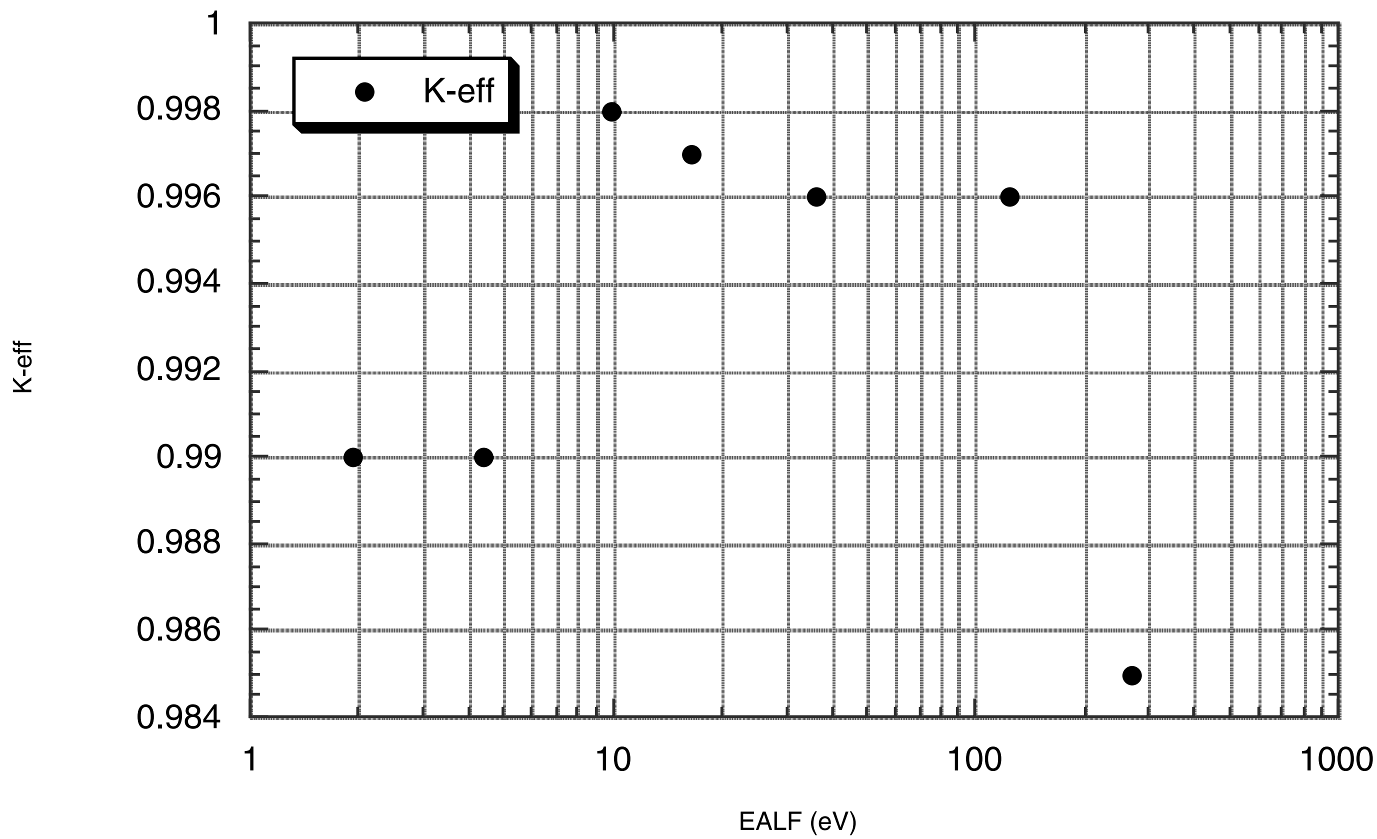


**Figure 14. KENO-VI 238-group results for large diameter low enriched uranium cylinders in various lattice arrangements (Table 2).**

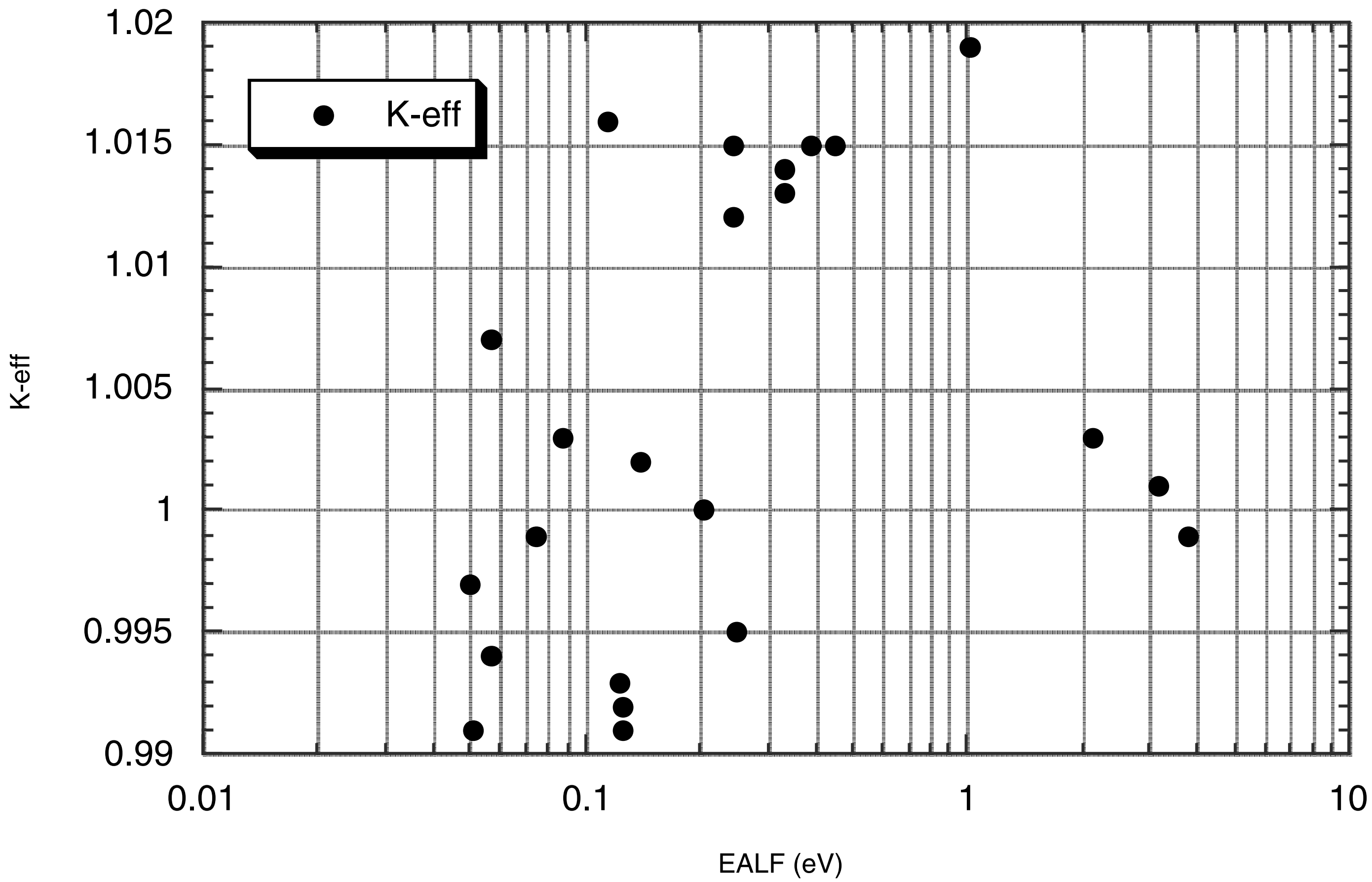


**Figure 15. KENO-VI 238-group results for low enriched homogeneous uranium systems (Table 3).**

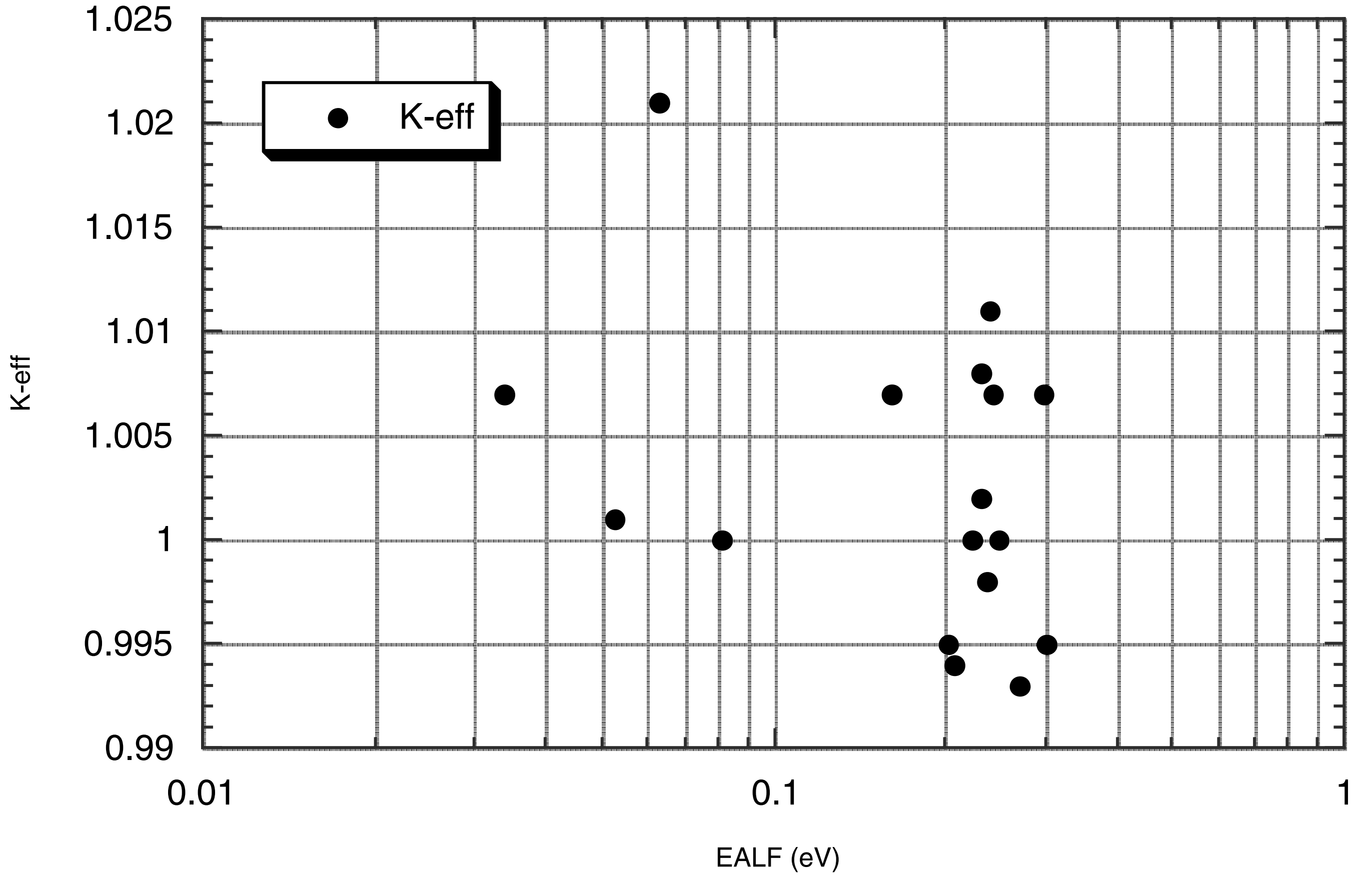


**Figure 16. KENO-VI 238-group results for highly enriched uranium solutions (Table 4).**

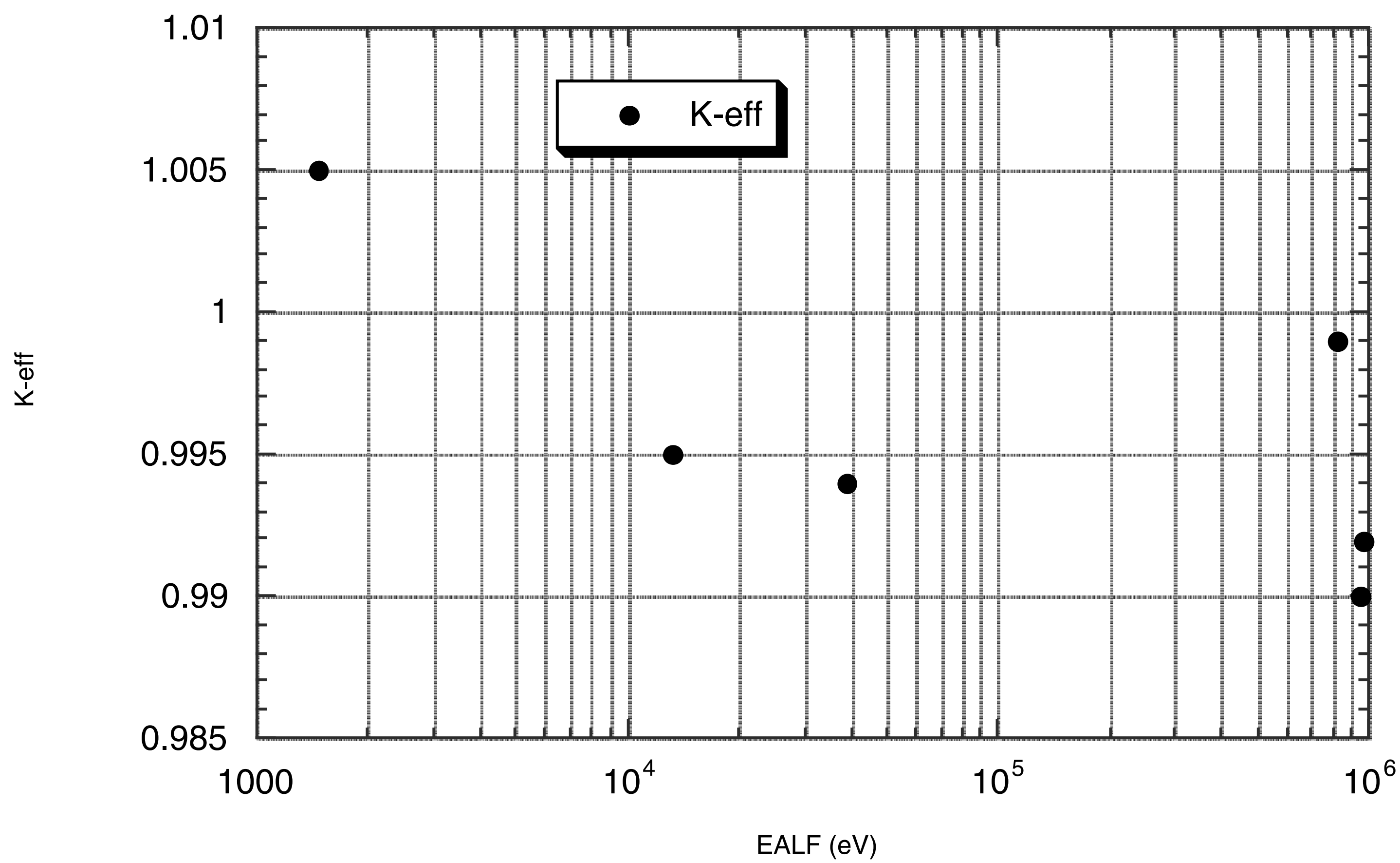


**Figure 17. KENO-VI 238-group results for highly enriched uranium metal systems (Table 5) .**

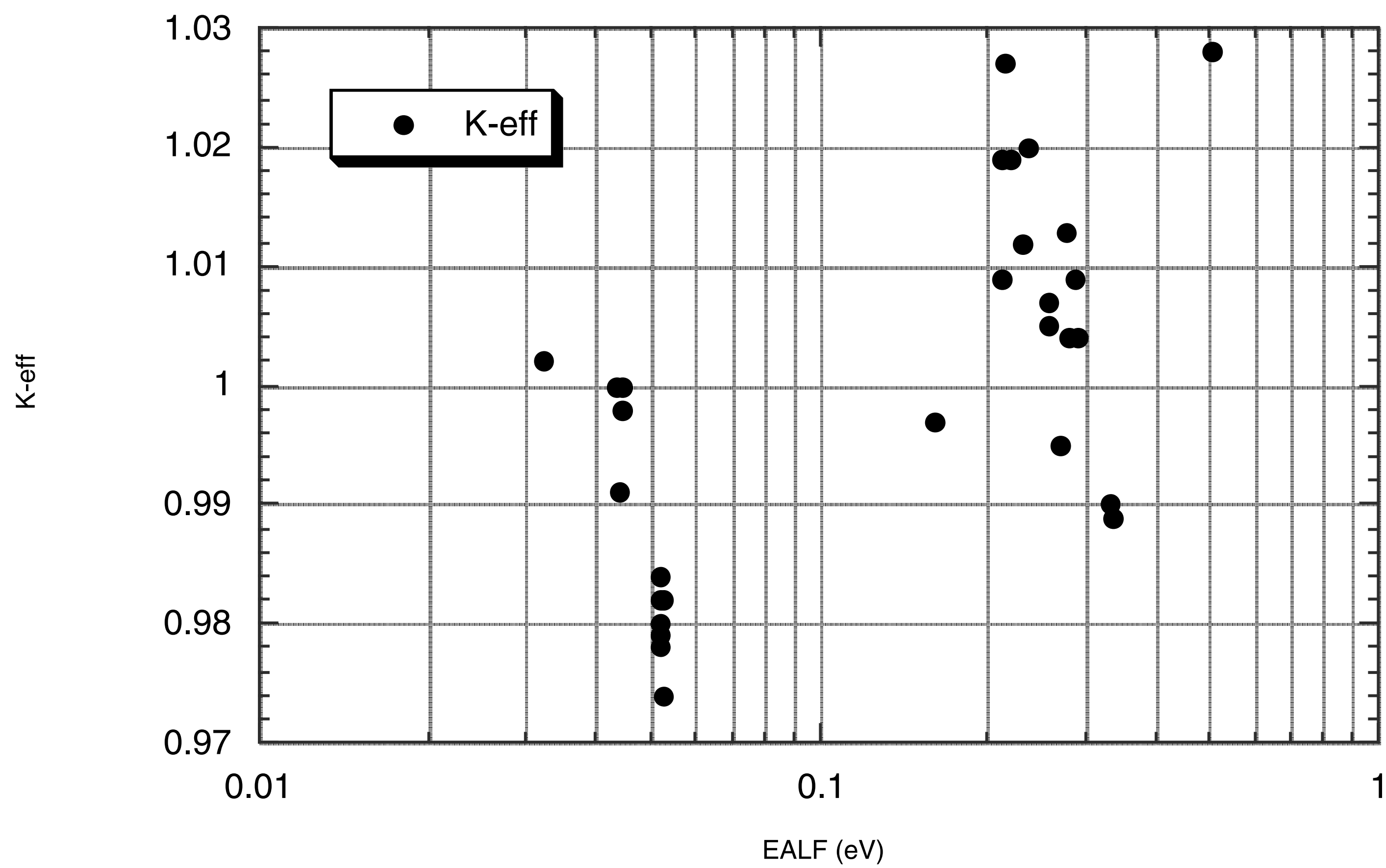


**Figure 18. KENO-VI 238 group results for highly enriched uranium solution systems (Table 5).**

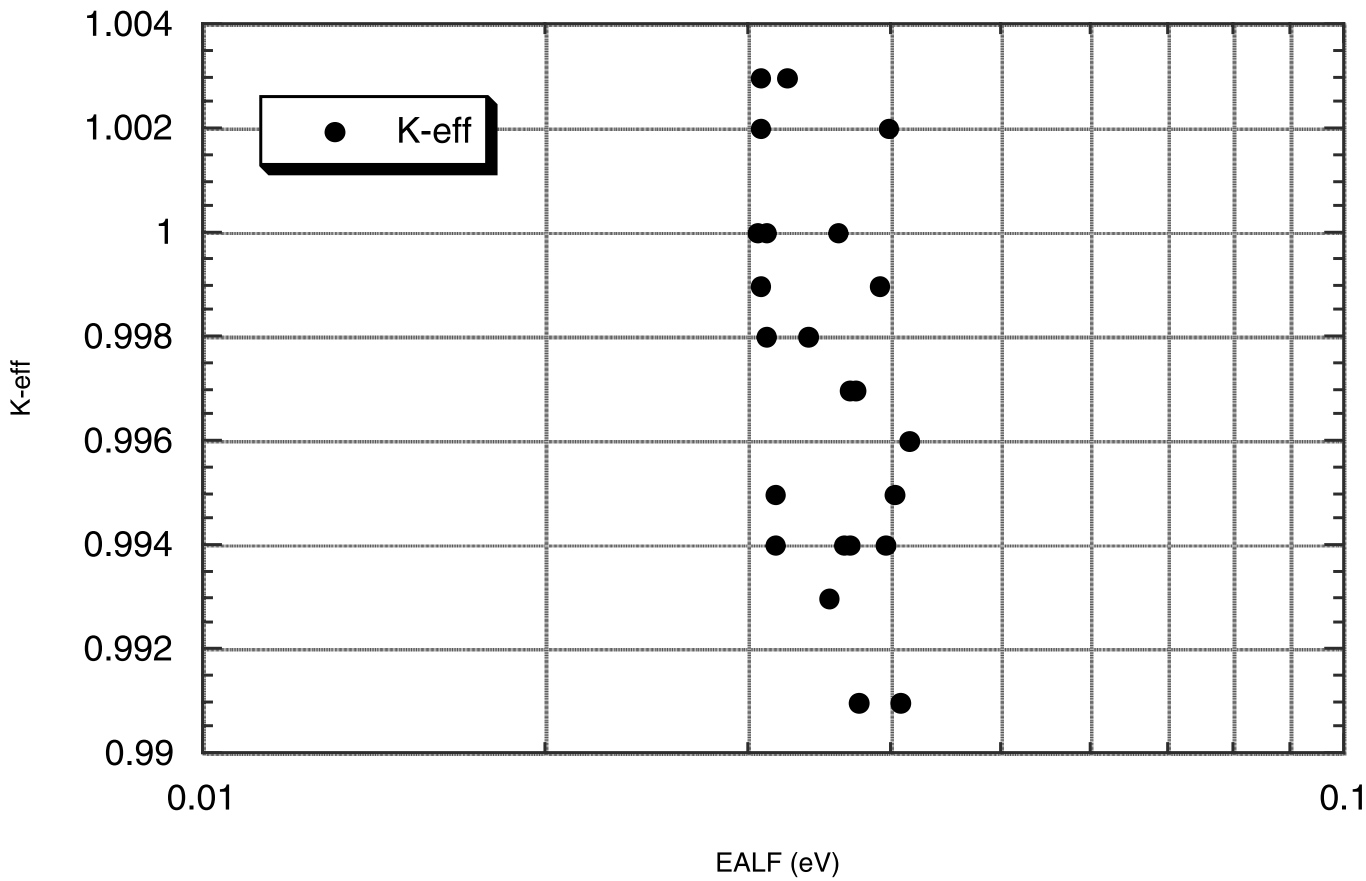


Figure 19. KENO-VI 238-group results for highly enriched uranium solution systems (Table 6).

# 6. CONCLUSIONS

The KENO V.a and KENO-VI criticality codes accurately calculate a broad range of critical experiments. All KENO V.a and KENO-VI results using the same cross-section library agree within statistical uncertainties. In review, a number of the calculations show a positive or negative bias in excess of 1½% in $k_{eff}$. Classes of criticals that show a bias include 3% enriched green blocks, highly-enriched uranyl fluoride slab arrays, and highly enriched uranyl nitrate arrays. The consistency of the results for two different Monte Carlo codes using two different cross-section libraries is the basis for a high level of confidence in the analytical methods. The implication is that these biases are due to poor performance of the cross sections and/or inadequate descriptions of the experiments. If these biases are properly taken into account, the KENO V.a and KENO-VI codes can be used with great confidence for the design and criticality safety analysis of uranium-containing systems. Note that only a fraction of the available options and geometry types have been exercised. It must be emphasized that the calculated $k_{eff}$ value from KENO V.a and KENO-VI is an estimate of the eigenvalue of the system and has an associated degree of uncertainty due to the statistical nature of the code. Several suggestions are offered to the users of these codes.

1. Never base the design or safety of a system on a single calculation. Make at least two calculations in which the random sequence is somehow changed (starting random number, slight change in starting distribution, geometry or materials, etc.) to ensure that the calculated $k_{eff}$ is a reasonable estimate of the calculational mean for the system.

2. Substantial efforts may be required to ensure that the problem has converged to a reasonable estimate of the true $k_{eff}$ of the system. Undersampling (insufficient neutrons per generation) or problems with convergence of the source distribution (insufficient generations or a very poor initial starting distribution) commonly occur.

3. Only validated options, geometry types, and materials should be used for the criticality safety design of a system. Biases should be based upon validation calculations of critical experiments with similar characteristics (e.g., geometry, materials, spectrum) to the systems being analyzed.

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# APPENDIX A

# KENO V.a INPUT DATA USED FOR VALIDATION CASES LISTED IN TABLES 1–6 (238 group)

# APPENDIX A

# KENO V.A INPUT DATA USED FOR VALIDATION CASES LISTED IN TABLES 1–6 (238 GROUP)

Input data for the validation appears in the same order as listed in Tables 1–6 of Section 1 of this report.

Table A.1. Table 1 input data

```
=csas25
libby exp. 4.89% rods 30 cm long, .762 cm diam, 1.3 cm pitch
238groupndf5 latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
h2o        2 1 end
plexiglass  3 1 end
end comp
squarepitch  1.3 .762 1 2 end
libby exp. 4.89% rods 30 cm long, .762cm diam, 1.3cm pitch
read param npg=2000  nub=yes fdn=yes end param
read geom
unit 1
cylinder  1 1 .381 5.08 0
cuboid    2 1 4p.65 5.08 0
unit 2
cylinder  1 1 .381 1.27 0
cuboid    3 1 4p.65 1.27 0
unit 3
cylinder  1 1 .381 17.935 0
cuboid    2 1 4p.65 17.935 0
unit 4
cylinder  1 1 .381 .635 0
cuboid    3 1 4p.65 .635 0
unit 5
cuboid    2 1 4p.65 5.08 0
unit 6
cylinder  2 1 .381 1.27 0
cuboid    3 1 4p.65 1.27 0
unit 7
cuboid    2 1 4p.65 17.935 0
unit 8
cylinder  2 1 .381 .635 0
cuboid    3 1 4p.65 .635 0
core      0 1 3r0
reflector  3 1 5r0 3.81 1
reflector  2 2 5r3 0 1
reflector  2 3 5r3 2.19 1
reflector  2 4 4r3 3.2 3 1
reflector  2 5 4r3 0 3   2
end geom
read array nux=20 nuy=21 nuz=5 fill
19r5 401r1  19r6 401r2  19r7 401r3 19r8 401r4 19r5 401r1
end fill end array
read bias id=500 2 6 end bias
end data
end


=csas25
libby exp. 4.89 rods 30 cm long, .762 cm diam, 2.05 cm pitch
238groupndf5  latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
h2o        2 1 end
plexiglass  3 1 end
end comp
squarepitch  2.05 .762 1 2 end
libby h2o refl. case 6a
read param npg=2000  nub=yes fdn=yes end param
read geom
```

```
unit 1
cylinder  1 1 .381 30 0
cuboid    2 1 4p1.025 30 0
unit 2
cuboid    2 1 4p1.025 30 0
core      0 1 3r0
reflector  2 2 6r3 3
reflector  2 5 4r3 .3 3 1
reflector  2 6 4r3 0 3 1
end geom
read array nux=14 nuy=15 nuz=1 fill
7r1 7r2 f1
end fill end array
read bias id=500 2 6 end bias
end data
end


=csas25
libby exp. 4.89% rods 30 cm long, .762 cm diam, 1.3 cm pitch
238groupndf5  latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
h2o        2 1 end
plexiglass  3 1 end
pb   4 1 end
end comp
squarepitch  1.3 .762 1 2 end
libby h2o refl. case 14a pb 1 face
read param npg=2000  nub=yes plt=no fdn=yes end param
read geom
unit 1
cylinder  1 1 .381 30 0
cuboid    2 1 4p.65 30 0
unit 2
cuboid    2 1 4p.65 30 0
unit 3
array 1 3r0
reflector  2 2 2r3 0 3 2r0 2
reflector  2 4 2r1.32 0 1.32 2r0 1
unit 4
cuboid  4 1 2p20.32 2p10.16 25.4 0
reflector  2 2 4r0 1.425 0 1
reflector  3 2 5r0 3.175 1
array 2 3r0
reflector  2 4 2r1.68 0 1.68 2r0 1
reflector  2 5 2r3 0 3 2r0 2
reflector  2 2 4r0 3 0 1
reflector  2 3 4r0 2.1 0 1
reflector  3 2 5r0 3 4
reflector  3 6 5r0 1.97 1
end geom
read array ara=1 nux=20 nuy=20 nuz=1 fill
18r1 2r2 f1
end fill
ara=2 nux=1 nuy=2 nuz=1 fill 3 4
end fill end array
read bias id=500 2 6 end bias
read plot ttl='14a x-y' pic=mix
xul=-7.8 yul=53.8 zul=15  xlr=48.8 ylr=-7.8 zlr=15
uax=1 vdn=-1 nax=125 end
ttl='14a x-y' pic=wts end
ttl='14a y-z' pic=mix
xul=20 yul=-7.8 zul=35.5  xlr=20 ylr=53.8 zlr=-14.1
```

```
vax=1 wdn=-1 uax=0 vdn=0 nax=125 end
ttl='14a y-z' pic=wts end
end plot
end data
end


=csas25
libby exp. 4.89% rods 30 cm long, .762 cm diam, 1.3 cm pitch
238groupndf5  latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
h2o        2 1 end
plexiglass  3 1 end
pb   4 1 end
end comp
squarepitch  1.3 .762 1 2 end
libby h2o refl. case 26a pb 4 faces
read param npg=2000   nub=yes plt=no fdn=yes end param
read geom
unit 1
cylinder  1 1 .381 30 0
cuboid    2 1 4p.65 30 0
unit 2
cuboid    2 1 4p.65 30 0
unit 3
array 1 3r0
reflector  2 1 .62 .62 .62 4.52 2r0 1
unit 4
cuboid  4 1 2p10.16 2p15.57 25.4 0
reflector  2 2 4r0 1.425 0 1
reflector  3 2 5r0 3.175 1
unit 5
array 2 3r0
unit 6
cuboid  4 1 2p35.89 2p10.16 25.4 0
reflector  2 2 4r0 1.425 0 1
reflector  3 2 5r0 3.175 1
array 3 3r0
reflector 2 2 4r0 3 0 2
reflector 2 4 4r0 1.95 0 1
reflector 3 2 5r0 3 4
reflector 3 6 5r0 1.97 1
end geom
read array ara=1 nux=23 nuy=20 nuz=1 fill
3r2 2r1 2 5q3 2r1  q23  23r2  q69  2 1 2 2r1 2 5q3 2r1
2r1 2 6q3 2r1  23r2  2r1 2 6q3 2r1  q23  23r2  2q69
2r1 2 6q3 2r1  q23
end fill
ara=2 nux=3 nuy=1 nuz=1 fill 4 3 4 end fill
ara=3 nux=1 nuy=3 nuz=1 fill 6 5 6
end fill end array
read bias id=500 2 6 end bias
read plot ttl=' x-y' pic=mix
xul=0 yul=72 zul=15  xlr=72 ylr=0 zlr=15
uax=1 vdn=-1 nax=125 end
ttl=' x-y' pic=wts end
ttl=' y-z' pic=mix
xul=33 yul=0 zul=40  xlr=33 ylr=72 zlr=-14.1
vax=1 wdn=-1 uax=0 vdn=0 nax=125 end
ttl=' y-z' pic=wts end
end plot
end data
end
```

```
=csas25
libby exp. 4.89% rods 30 cm long, .762 cm diam, 1.3 cm pitch
238groupndf5  latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
h2o        2 1 end
plexiglass  3 1 end
pb   4 1 end
b-10  5 0 4.617-3 end
b-11  5 0 1.872-2 end
c     5 0 5.750-3 end
al    5 0 4.765-2 end
end comp
squarepitch  1.3 .762 1 2 end
libby h2o refl. case 30c pb 4 faces, boral plate 6th row
read param npg=2000  nub=yes pgm=yes  plt=no fdn=yes end param
read geom
unit 1
cylinder  1 1 .381 30 0
cuboid    2 1 4p.65 30 0
unit 2
cuboid    2 1 4p.65 30 0
unit 3
array 1 3r0
reflector  2 1 2r.62 0 .62 2r0 1
unit 7
array 4 3r0
reflector  2 1 3r.62 0 2r0 1
unit 8
cuboid  5 1 2p15.57 2p.3175 25.4 0
reflector  2 1 2r0 2r.3325 1.425 3.175 1
unit 4
cuboid  4 1 2p10.16 2p15.57 25.4 0
reflector  2 2 4r0 1.425 0 1
reflector  3 2 5r0 3.175 1
unit 9
array 5 3r0
unit 5
array 2 3r0
unit 6
cuboid  4 1 2p35.89 2p10.16 25.4 0
reflector  2 2 4r0 1.425 0 1
reflector  3 2 5r0 3.175 1
array 3 3r0
reflector  2 2 4r0 3 0 1
reflector  2 3 4r0 1.8 0 1
reflector  3 2 5r0 3 4
reflector  3 6 5r0 1.97 1
end geom
read array ara=1 nux=23 nuy=17 nuz=1 fill
2r2 19r1 2r2  2 21r1 2  f1
end fill
ara=4 nux=23 nuy=5 nuz=1 fill
69r1 2 21r1 2  2r2 19r1 2r2
end fill
ara=5 nux=1 nuy=3 nuz=1 fill 3 8 7 end fill
ara=2 nux=3 nuy=1 nuz=1 fill 4 9 4 end fill
ara=3 nux=1 nuy=3 nuz=1 fill 6 5 6
end fill end array
read bias id=500 2 6 end bias
read plot ttl=' x-y' pic=mix
xul=0 yul=72 zul=15  xlr=72 ylr=0 zlr=15
```

```
uax=1 vdn=-1 nax=125 end
ttl=' x-y' pic=wts end
ttl=' y-z' pic=mix
xul=33 yul=0 zul=40  xlr=33 ylr=72 zlr=-14.1
'following card left out'
vax=1 wdn=-1 uax=0 vdn=0 nax=125 end
ttl=' y-z' pic=wts end
end plot
end data
end


=csas25
libby exp. 4.89% rods 30 cm long, .762 cm diam, 1.3 cm pitch
238groupndf5  latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
h2o        2 1 end
plexiglass  3 1 end
pb   4 1 end
cd  5 1 end
end comp
squarepitch  1.3 .762 1 2 end
libby h2o refl. case 31c pb 4 faces, cd plate 6th row
read param npg=2000  nub=yes plt=no fdn=yes end param
read geom
unit 1
cylinder  1 1 .381 30 0
cuboid    2 1 4p.65 30 0
unit 2
cuboid    2 1 4p.65 30 0
unit 3
array 1 3r0
reflector  2 1 2r.62 0 .62 2r0 1
unit 7
array 4 3r0
reflector  2 1 3r.62 0 2r0 1
unit 8
cuboid  5 1 2p15.57 2p.04445 25.4 0
reflector  2 1 2r0 2r.60555 1.425 3.175 1
unit 4
cuboid  4 1 2p10.16 2p15.57 25.4 0
reflector  2 2 4r0 1.425 0 1
reflector  3 2 5r0 3.175 1
unit 9
array 5 3r0
unit 5
array 2 3r0
unit 6
cuboid  4 1 2p35.89 2p10.16 25.4 0
reflector  2 2 4r0 1.425 0 1
reflector  3 2 5r0 3.175 1
array 3 3r0
reflector  2 2 4r0 .5 0 1
reflector  3 2 5r0 3 4
reflector  3 6 5r0 1.97 1
end geom
read array ara=1 nux=23 nuy=17 nuz=1 fill
11r1 12r2   f1
end fill
ara=4 nux=23 nuy=5 nuz=1 fill
f1
end fill
ara=5 nux=1 nuy=3 nuz=1 fill 3 8 7 end fill
```

```
ara=2 nux=3 nuy=1 nuz=1 fill 4 9 4 end fill
ara=3 nux=1 nuy=3 nuz=1 fill 6 5 6
end fill end array
read bias id=500 2 6 end bias
read plot ttl=' x-y' pic=mix
xul=0 yul=72 zul=15  xlr=72 ylr=0 zlr=15
uax=1 vdn=-1 nax=125 end
ttl=' x-y' pic=wts end
ttl=' y-z' pic=mix
xul=33 yul=0 zul=40  xlr=33 ylr=72 zlr=-14.1
vax=1 wdn=-1 uax=0 vdn=0 nax=125 end
ttl=' y-z' pic=wts end
end plot
end data
end
1


=csas25
libby exp. 4.89% rods 30 cm long, .762 cm diam, 3.25 cm pitch in uo2f2 soln
238groupndf5  latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
solnuo2f2  2 301.16 0 1 293 92235 4.89 92238 95.11 end
plexiglass  3 1 end
al  4 1 end
solnuo2f2  5 301.16 0 1 293 92235 4.89 92238 95.11 end
end comp
squarepitch  3.25 .762 1 2 end
libby rods in uo2f2 soln case 36s
read param npg=2000  far=yes  nub=yes fdn=yes end param
read geom
unit 1
cylinder  1 1 .381 5.08 0
cuboid    5 1 4p1.625 5.08 0
unit 2
cylinder  1 1 .381 1.27 0
cuboid    3 1 4p1.625 1.27 0
unit 3
cylinder  1 1 .381 17.935 0
cuboid    5 1 4p1.625 17.935 0
unit 4
cylinder  1 1 .381 .635 0
cuboid    3 1 4p1.625 .635 0
unit 5
cuboid    2 1 4p1.625 5.08 0
unit 6
cylinder  2 1 .381 1.27 0
cuboid    3 1 4p1.625 1.27 0
unit 7
cuboid    2 1 4p1.625 17.935 0
unit 8
cylinder  2 1 .381 .635 0
cuboid    3 1 4p1.625 .635 0
core      0 1 -14.625 -16.25 0
reflector  3 1 5r0 3.81 1
cylinder  5 1 47.94 38.52 -10.16
cylinder  4 1 48.26 38.52 -10.48
end geom
read array nux=9 nuy=10 nuz=5 fill
90r1 90r2 90r3 90r4 90r1
end fill end array
end data
end
```

```
=csas25
libby exp. 4.89% rods 30 cm long, 1.31 cm diam, 3.40 cm pitch in uo2f2 soln
238groupndf5  latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
solnuo2f2  2 300.24 0 1 293 92235 4.89 92238 95.11 end
plexiglass  3 1 end
al  4 1 end
solnuo2f2  5 300.24 0 1 293 92235 4.89 92238 95.11 end
end comp
squarepitch  3.40 1.31 1 2 end
libby rods in uo2f2 soln case 42s
read param npg=2000  far=yes  nub=yes fdn=yes end param
read geom
unit 1
cylinder  1 1 .655 5.08 0
cuboid    5 1 4p1.70 5.08 0
unit 2
cylinder  1 1 .655 1.27 0
cuboid    3 1 4p1.70 1.27 0
unit 3
cylinder  1 1 .655 17.935 0
cuboid    5 1 4p1.70 17.935 0
unit 4
cylinder  1 1 .655 .635 0
cuboid    3 1 4p1.70 .635 0
unit 5
cuboid    2 1 4p1.70 5.08 0
unit 6
cylinder  2 1 .655 1.27 0
cuboid    3 1 4p1.70 1.27 0
unit 7
cuboid    2 1 4p1.70 17.935 0
unit 8
cylinder  2 1 .655 .635 0
cuboid    3 1 4p1.70 .635 0
core      0 1 -10.2 -11.9 0
reflector  3 1 5r0 3.81 1
cylinder  5 1 47.94 39.1 -10.16
cylinder  4 1 48.26 39.1 -10.48
end geom
read array nux=6 nuy=7 nuz=5 fill
42r1 42r2 42r3 42r4 42r1
end fill end array
end data
end


=csas25
libby exp. 4.89% rods 30 cm long, 1.31 cm diam, 3.940 cm pitch in uo2f2 soln
238groupndf5  latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
solnuo2f2  2 300.24 0 1 293 92235 4.89 92238 95.11 end
plexiglass  3 1 end
al  4 1 end
solnuo2f2  5 300.24 0 1 293 92235 4.89 92238 95.11 end
end comp
squarepitch  3.94 1.31 1 2 end
libby rods in uo2f2 soln case 44s
read param npg=2000  far=yes  nub=yes fdn=yes end param
read geom
unit 1
cylinder  1 1 .655 5.08 0
```

```
cuboid    5 1 4p1.97 5.08 0
unit 2
cylinder  1 1 .655 1.27 0
cuboid    3 1 4p1.97 1.27 0
unit 3
cylinder  1 1 .655 17.935 0
cuboid    5 1 4p1.97 17.935 0
unit 4
cylinder  1 1 .655 .635 0
cuboid    3 1 4p1.97 .635 0
unit 5
cuboid    2 1 4p1.97 5.08 0
unit 6
cylinder  2 1 .655 1.27 0
cuboid    3 1 4p1.97 1.27 0
unit 7
cuboid    2 1 4p1.97 17.935 0
unit 8
cylinder  2 1 .655 .635 0
cuboid    3 1 4p1.97 .635 0
core      0 1 -11.82 -13.79 0
reflector  3 1 5r0 3.81 1
cylinder  5 1 47.94 39.25 -10.16
cylinder  4 1 48.26 39.25 -10.48
end geom
read array nux=6 nuy=7 nuz=5 fill
42r1 42r2 42r3 42r4 42r1
end fill end array
end data
end


=csas25
4.89% green blocks h/u-235=395.0 40.6 g u-235/l
238groupndf5  multiregion
u-234  1 0 4.3000-7 end
u-235  1 0 1.0402-4 end
u-238  1 0 1.9972-3 end
h      1 0 4.1088-2 end
c      1 0 2.1291-2 end
o      1 0 7.8456-3 end
al     2 1 end
end comp
spherical  end
1 28 noextermod  end zone
4.89% green blocks unreflected case 2
read param npg=2000  nub=yes fdn=yes end param
read geom
cuboid  1 1 50.8 0 60.96 0 60.452 0
end geom
end data
end


=csas25
4.89% green blocks h/u-235=503.5 33.3 g u-235/l
238groupndf5  multiregion
u-234  1 0 3.5000-7 end
u-235  1 0 8.5320-5 end
u-238  1 0 1.6381-3 end
h      1 0 4.2959-2 end
c      1 0 2.2261-2 end
o      1 0 6.9399-3 end
```

```
al     2 1 end
end comp
spherical  end
1 36 noextermod  end zone
4.89% green blocks unreflected case 4
read param npg=2000  nub=yes fdn=yes end param
read geom
cuboid  1 1 60.96 0 60.96 0 52.832 0
end geom
end data
end


=csas25
4.89% green blocks h/u-235=199.3 64.9 g u-235/l
238groupndf5  multiregion
u-234  1 0 6.8000-7 end
u-235  1 0 1.6628-4 end
u-238  1 0 3.1926-3 end
h      1 0 3.3140-2 end
c      1 0 1.7173-2 end
o      1 0 1.0766-2 end
al     2 1 end
h2o    3 1 end
para(h2o)  4 1 end
end comp
spherical  end
1 22 oneextermod 3 40 noextermod  end zone
4.89% green blocks reflected case 1
read param npg=2000  nub=yes fdn=yes end param
read geom
unit 1
cube  1 1 2p10.16
unit 2
cuboid  1 1 4p10.16  2p8.763
core    0 1 3r0.
reflector  4 8 4r0 3.048 0 5
reflector  3 2 4r3 0 3 6
end geom
read array nux=2 nuy=2 nuz=3 fill 8r1 4r2 end fill end array
read bias id=500 2 7 id=400 8 12 end bias
end data
end


=csas25
4.89 green blocks h/u-235=396.7 40.6 g u-235/l
238groupndf5  multiregion
u-234  1 0 4.3000-7 end
u-235  1 0 1.0402-4 end
u-238  1 0 1.9972-3 end
h      1 0 4.1265-2 end
c      1 0 2.1383-2 end
o      1 0 7.8552-3 end
al     2 1 end
h2o    3 1 end
para(h2o)  4 1 end
end comp
spherical  end
1 20 oneextermod 3 38 noextermod  end zone
4.89% green blocks reflected case 3
read param npg=2000  nub=yes fdn=yes end param
read geom
```

```
cuboid  1 1 40.64 0 40.64 0 57.658 0
reflector  4 8 4r0 3.048 0 5
reflector  3 2 4r3 0 3 6
end geom
read bias id=500 2 7 id=400 8 12 end bias
end data
end


=csas25
4.89% green blocks h/u-235=146.8 81.1 g u-235/l
238groupndf5  multiregion
u-234  1 0 8.5000-7 end
u-235  1 0 2.0779-4 end
u-238  1 0 3.9896-3 end
h      1 0 3.0504-2 end
c      1 0 1.5807-2 end
o      1 0 1.2859-2 end
al     2 1 end
h2o    3 1 end
para(h2o)  4 1 end
end comp
spherical  end
1 22 oneextermod 3 40 noextermod  end zone
4.89% green blocks reflected case 5
read param npg=2000  nub=yes fdn=yes end param
read geom
cuboid  1 1 50.8 0 50.8 0 42.164 0
reflector  4 8 4r0 3.048 0 5
reflector  3 2 4r3 0 3 6
end geom
read bias id=500 2 7 id=400 8 12 end bias
end data
end


=csas25
4.89% green blocks h/u-235=504.1 33.3 g u-235/l
238groupndf5  multiregion
u-234  1 0 3.5000-7 end
u-235  1 0 8.5320-5 end
u-238  1 0 1.6381-3 end
h      1 0 4.3010-2 end
c      1 0 2.2287-2 end
o      1 0 6.9427-3 end
al     2 1 end
h2o    3 1 end
para(h2o)  4 1 end
end comp
spherical  end
1 29 oneextermod 3 47 noextermod  end zone
4.89% green blocks reflected case 7
read param npg=2000  nub=yes fdn=yes end param
read geom
cuboid  1 1 50.8 0 50.8 0 41.148 0
reflector  4 8 4r0 3.048 0 5
reflector  3 2 4r3 0 3 6
end geom
read bias id=500 2 7 id=400 8 12 end bias
end data
end
```

```
=csas25
4.89% uo2f2 h/u-235=524
238groupndf5  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 npg=2000  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
```

```
=csas25
4.89% uo2f2 h/u-235=1002
238groupndf5  multiregion
solnuo2f2  1 491.6 0 1 293 92234 .02 92235 4.89
92238 95.09 end
al        2 1 end
end comp
spherical end
1 34.6 noextermod  2 34.76 noextermod end zone
4.89% uo2f2 27.3 in diam al sphere bare 4
read param npg=2000  nub=yes fdn=yes end param
read geom
hemisphe-z  1 1 34.6   chord 30.
sphere      0 1 34.6
sphere      2 1 34.759
end geom
end data
end
```

```
=csas25
4.89% uo2f2 h/u-235=524
238groupndf5  multiregion
solnuo2f2  1 869.9 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 19 oneextermod 2 19.2 noextermod 3 37.2 noextermod end zone
4.89% uo2f2 15 in diam ss cyl refl 1
read param npg=2000  nub=yes fdn=yes end param
read geom
cylinder  1 1 19.05 50.37 0
cylinder  2 1 19.209 50.529 -.159
reflector 3 2 3r3 6
end geom
read bias id=500 2 7 end bias
end data
end
```

```
=csas25
4.89% uo2f2 h/u-235=735
238groupndf5  multiregion
solnuo2f2  1 650.1 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 19 oneextermod 2 19.2 noextermod 3 37.2 noextermod end zone
4.89% uo2f2 15 in diam ss cyl refl 3
read param npg=2000  nub=yes fdn=yes end param
read geom
cylinder  1 1 19.05 153.01 0
cylinder  2 1 19.209 153.169 -.159
reflector 3 2 3r3 6
end geom
read bias id=500 2 7 end bias
end data
end


=csas25
4.89% uo2f2 h/u-235=994
238groupndf5  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 npg=2000  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
```

Table A.2. Table 2 input data

```
=csas25
case ebj.1 u(3.85) 15 @ 7.2"/0"/0"/77.8cm, square
238groupndf5 infhommedium
' u(3.85) metal
u-235        1 0.  1.8643e-3 end
u-238        1 0.  4.5971e-2 end
' full density water moderator/reflector
h2o          2 1.0           end
' fir timber model
c            3 0.  1.06802e-2 end
h            3 0.  2.21713e-2 end
o            3 0.  1.10850e-2 end
' steel for grating, tank walls and floor
carbonsteel  4 1.0           end
' stainless steel lining for tank
ss304        5 1.0           end
end comp
case ebj.1 u(3.85) 15 @ 7.2"/0"/0"/77.8cm, square
read parm
npg=2000  plt=no fdn=yes nub=yes tme=90 tba=2
end parm
read geom
unit 1
com=* fir timber 7.25" x 72" x 7.25" *
cuboid 3 1 182.88 0. 18.415 0. 18.415 0.
unit 2
com=* water gap 3.5" x 72" x 7.25" between timbers *
cuboid 2 1 182.88 0. 8.89 0. 18.415 0.
unit 3
com=* array of timbers 72" x 72" x 7.25" *
array 1 3*0.0
replicate 2 1 2r0. 2r0.3175 2r0. 1
unit 4
com=* section of steel grating *
cuboid 4 1 2.778125 .238125 .396875 -.396875 3.175 2.38125
cuboid 2 1 2.778125 .238125 4.524375 -4.524375 3.175 0.
cuboid 4 1 3.01625 0. 4.524375 -4.524375 3.175 0.
unit 5
com=* array of steel grating *
array 2 3*0.0
replicate 2 1 4r0.9525 2r0.0 1
unit 6
com=* u(3.85) annulus with insert *
cylinder 1 1 3.175 76.2 0.
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p9.144 76.2 0.
unit 7
com=* water cuboid to complete annuli array *
cuboid 2 1 4p9.144 76.2 0.
unit 8
com=* array of 15 annuli with u(3.85) inserts *
array 3 3*0.0
replicate 2 1 4r54.864 1.6 0. 1
core 4 1 -91.44 -91.44 0.
replicate 2 1 4r30.48 2r0. 1
replicate 5 1 5r0.0 0.1905 1
replicate 4 1 5r0.0 2.54 1
end geom
```

```
read array
ara=1 nux=1 nuy=13 nuz=1
fill 1 2 5q2 1 end fill
ara=2 nux=60 nuy=20 nuz=1
fill f4 end fill
ara=3 nux=4 nuy=4 nuz=1
loop 6  1 4 1  1 4 1  1 1 1
     7  4 4 1  1 1 1  1 1 1 end loop
gbl=4
ara=4 nux=1 nuy=1 nuz=3
fill 3 5 8 end fill
end array
read start
xsm=-36.576 xsp=36.576 ysm=-36.576 ysp=36.576 zsm=21.59 zsp=97.79
end start
read plot
ttl="plan view 1/6 scale of core, z=midlevel of annuli/inserts"
xul=-91.44 yul=91.44 zul=59.69
xlr=91.44 ylr=-91.44 zlr=59.69
uax=1. vdn=-1. dlx=1.524 nch=* u.wgsc* end
ttl="plan view 1/6 scale of core, z=midlevel of grating"
xul=-91.44 yul=91.44 zul=20.0025
xlr=91.44 ylr=-91.44 zlr=20.0025
uax=1. vdn=-1. dlx=1.524 nch=* u.wgsc* end
ttl="plan view 1/6 scale of core, z=midlevel of fir timbers"
xul=-91.44 yul=91.44 zul=9.2075
xlr=91.44 ylr=-91.44 zlr=9.2075
uax=1. vdn=-1. dlx=1.524 nch=* u.wgsc* end
ttl="plan view 1/10 scale of mockup, z=midlevel of u units"
xul=-121.92 yul=121.92 zul=59.69
xlr=121.92 ylr=-121.92 zlr=59.69
uax=1. vdn=-1. dlx=2.54 nch=* u.wgsc* end
ttl="plan view 2x scale of single u unit, z=midlevel of unit"
xul=0. yul=18.288 zul=59.69
xlr=18.288 ylr=0. zlr=59.69
uax=1. vdn=-1. dlx=0.127 nch=* u.wgsc* end
ttl="cross section of core 1/6 scale,y=9.144"
xul=-91.44 yul=9.144 zul=102.
xlr=91.44 ylr=9.144 zlr=0.
uax=1. wdn=-1. dlx=1.524 nch=* u.wgsc* end
ttl="cross section of mockup 1/10 scale,y=9.144"
xul=-121.92 yul=9.144 zul=105.
xlr=121.92 ylr=9.144 zlr=-65.
uax=1. wdn=-1. dlx=2.54 nch=* u.wgsc* end
ttl="cross section of grating/fir timbers, full scale"
xul=0. yul=0. zul=24.13
xlr=25.4 ylr=0. zlr=-3.0
uax=1. wdn=-1. dlx=.254 nch=* u.wgsc* end
ttl="plan view of grating thru tiebars, full scale"
xul=0. yul=25.4 zul=21.193
xlr=25.4 ylr=0. zlr=21.193
uax=1. vdn=-1. dlx=.254 nch=* u.wgsc* end
ttl="plan view of grating @ grating midlevel, full scale"
xul=0. yul=25.4 zul=20.0025
xlr=25.4 ylr=0. zlr=20.0025
uax=1. vdn=-1. dlx=.254 nch=* u.wgsc* end
ttl="plan view of timbers @ timber midlevel, full scale"
xul=0. yul=25.4 zul=9.2075
xlr=25.4 ylr=-25.4 zlr=9.2075
uax=1. vdn=-1. dlx=.254 nch=* u.wgsc* end
end plot
end data
end
```

```
=csas25
case ebj.4 u(3.85) 16 @ 7.2"/0"/0.25"/79.3cm, triangular
238groupndf5 infhommedium
' u(3.85) metal
u-235        1 0.  1.8643e-3 end
u-238        1 0.  4.5971e-2 end
' full density water moderator/reflector
h2o          2 1.0           end
' fir timber model
c            3 0.  1.06802e-2 end
h            3 0.  2.21713e-2 end
o            3 0.  1.10850e-2 end
' steel for grating, tank walls and floor
carbonsteel  4 1.0           end
' stainless steel lining for tank
ss304        5 1.0           end
end comp
case ebj.4 u(3.85) 16 @ 7.2"/0"/0.25"/79.3cm, triangular
read parm
tba=3 npg=2000  nub=yes plt=no fdn=yes tme=90
end parm
read geom
unit 1
com=* fir timber 7.25" x 72" x 7.25" *
cuboid 3 1 182.88 0. 18.415 0. 18.415 0.
unit 2
com=* water gap 3.5" x 72" x 7.25" between timbers *
cuboid 2 1 182.88 0. 8.89 0. 18.415 0.
unit 3
com=* array of timbers 72" x 72" x 7.25" *
array 1 3*0.0
replicate 2 1 2r0. 2r0.3175 2r0. 1
unit 4
com=* section of steel grating *
cuboid 4 1 2.778125 .238125 .396875 -.396875 3.175 2.38125
cuboid 2 1 2.778125 .238125 4.524375 -4.524375 3.175 0.
cuboid 4 1 3.01625 0. 4.524375 -4.524375 3.175 0.
unit 5
com=* array of steel grating *
array 2 3*0.0
replicate 2 1 4r0.9525 2r0.0 1
unit 6
com=* u(3.85) annulus with insert *
cylinder 1 1 3.175 76.2 0.
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
unit 7
com=* array of 16 annuli with u(3.85) inserts *
cuboid 2 1 4p91.44 79.3 0.
hole 6   0.0      0.0    0.0
hole 6 -18.923    0.0    0.0
hole 6  -9.4615  16.3878 0.0
hole 6   9.4615  16.3878 0.0
hole 6  18.923    0.0    0.0
hole 6   9.4615 -16.3878 0.0
hole 6  -9.4615 -16.3878 0.0
hole 6 -28.3845  16.3878 0.0
hole 6 -18.923   32.7756 0.0
hole 6   0.0     32.7756 0.0
hole 6  28.3845  16.3878 0.0
hole 6  37.846    0.0    0.0
```

```
hole 6  28.3845 -16.3878 0.0
hole 6   0.0    -32.7756 0.0
hole 6 -18.923  -32.7756 0.0
hole 6 -28.3845 -16.3878 0.0
core 3 1 -91.44 -91.44 0.
replicate 2 1 4r30.48 2r0. 1
replicate 5 1 5r0.0 0.1905 1
replicate 4 1 5r0.0 2.54 1
end geom
read array
ara=1 nux=1 nuy=13 nuz=1
fill 1 2 5q2 1 end fill
ara=2 nux=60 nuy=20 nuz=1
fill f4 end fill
gbl=3
ara=3 nux=1 nuy=1 nuz=3
fill 3 5 7 end fill
end array
read start
nst=1
xsm=-37.5285 xsp=46.99
ysm=-41.9196 ysp=41.9196
zsm= 21.59   zsp=97.79
end start
read plot
ttl="plan view 1/6 scale of core, z=midlevel of annuli/inserts"
xul=-91.44 yul=91.44 zul=59.69
xlr=91.44 ylr=-91.44 zlr=59.69
uax=1. vdn=-1. dlx=1.524 nch=* u.wgsc* end
ttl="plan view 1/6 scale of core, z=midlevel of grating"
xul=-91.44 yul=91.44 zul=20.0025
xlr=91.44 ylr=-91.44 zlr=20.0025
uax=1. vdn=-1. dlx=1.524 nch=* u.wgsc* end
ttl="plan view 1/6 scale of core, z=midlevel of fir timbers"
xul=-91.44 yul=91.44 zul=9.2075
xlr=91.44 ylr=-91.44 zlr=9.2075
uax=1. vdn=-1. dlx=1.524 nch=* u.wgsc* end
ttl="plan view 1/10 scale of mockup, z=midlevel of u units"
xul=-121.92 yul=121.92 zul=59.69
xlr=121.92 ylr=-121.92 zlr=59.69
uax=1. vdn=-1. dlx=2.54 nch=* u.wgsc* end
ttl="plan view full scale of single u unit, z=midlevel of unit"
xul=-16.75 yul=16.75 zul=59.69
xlr=16.75 ylr=-16.75 zlr=59.69
uax=1. vdn=-1. dlx=0.254 nch=* u.wgsc* end
ttl="cross section of core 1/6 scale,y=0.0"
xul=-91.44 yul=0.0 zul=102.
xlr=91.44 ylr=0.0 zlr=0.
uax=1. wdn=-1. dlx=1.524 nch=* u.wgsc* end
ttl="cross section of mockup 1/10 scale,y=0.0"
xul=-121.92 yul=0.0 zul=105.
xlr=121.92 ylr=0.0 zlr=-65.
uax=1. wdn=-1. dlx=2.54 nch=* u.wgsc* end
ttl="cross section of grating/fir timbers, full scale"
xul=0. yul=0. zul=24.13
xlr=25.4 ylr=0. zlr=-3.0
uax=1. wdn=-1. dlx=.254 nch=* u.wgsc* end
ttl="plan view of grating thru tiebars, full scale"
xul=0. yul=25.4 zul=21.193
xlr=25.4 ylr=0. zlr=21.193
uax=1. vdn=-1. dlx=.254 nch=* u.wgsc* end
ttl="plan view of grating @ grating midlevel, full scale"
xul=0. yul=25.4 zul=20.0025
```

```
xlr=25.4 ylr=0. zlr=20.0025
uax=1. vdn=-1. dlx=.254 nch=* u.wgsc* end
ttl="plan view of timbers @ timber midlevel, full scale"
xul=0. yul=25.4 zul=9.2075
xlr=25.4 ylr=-25.4 zlr=9.2075
uax=1. vdn=-1. dlx=.254 nch=* u.wgsc* end
end plot
end data
end


=csas25
case ebj.8 u(3.85) 6 @ 7.2"/2.6"/0.75"/91.4cm, square
238groupndf5 infhommedium
' u(3.85) metal
u-235        1 0.  1.8643e-3 end
u-238        1 0.  4.5971e-2 end
' full density water moderator/reflector
h2o          2 1.0           end
' fir timber model
c            3 0.  1.06802e-2 end
h            3 0.  2.21713e-2 end
o            3 0.  1.10850e-2 end
' steel for grating, tank walls and floor
carbonsteel  4 1.0           end
' stainless steel lining for tank
ss304        5 1.0           end
end comp
case ebj.8 u(3.85) 6 @ 7.2"/2.6"/0.75"/91.4cm, square
read parm
npg=2000  nub=yes plt=no fdn=yes tme=90 tba=2
end parm
read geom
unit 1
com=* fir timber 7.25" x 72" x 7.25" *
cuboid 3 1 182.88 0. 18.415 0. 18.415 0.
unit 2
com=* water gap 3.5" x 72" x 7.25" between timbers *
cuboid 2 1 182.88 0. 8.89 0. 18.415 0.
unit 3
com=* array of timbers 72" x 72" x 7.25" *
array 1 3*0.0
replicate 2 1 2r0. 2r0.3175 2r0. 1
replicate 2 1 4r30.48 2r0. 1
unit 4
com=* section of steel grating *
cuboid 4 1 2.778125 .238125 .396875 -.396875 3.175 2.38125
cuboid 2 1 2.778125 .238125 4.524375 -4.524375 3.175 0.
cuboid 4 1 3.01625 0. 4.524375 -4.524375 3.175 0.
unit 5
com=* array of steel grating *
array 2 3*0.0
replicate 2 1 4r0.9525 2r0.0 1
replicate 2 1 4r30.48 2r0. 1
unit 6
com=* u(3.85) annulus, h=76.2, submerged, on corner *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 4.614139 76.2 0.
cylinder 1 1 5.628264 76.2 0.
cylinder 1 1 6.485710 76.2 0.
cylinder 1 1 7.242341 76.2 0.
cylinder 1 1 7.927079 76.2 0.
cylinder 1 1 8.557199 76.2 0.
```

```
cylinder 1 1 9.144000 76.2 0.
cuboid 2 1 4p10.0965 91.4 0.
unit 7
com=* u(3.85) annulus, h=76.2, submerged, on side *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 4.614139 76.2 0.
cylinder 1 1 5.628264 76.2 0.
cylinder 1 1 6.485710 76.2 0.
cylinder 1 1 7.242341 76.2 0.
cylinder 1 1 7.927079 76.2 0.
cylinder 1 1 8.557199 76.2 0.
cylinder 1 1 9.144000 76.2 0.
cuboid 2 1 4p10.0965 91.4 0.
unit 8
com=* array of 6 annuli, h=76.2, submerged *
array 3 3*0.0
replicate 2 1 2r61.1505 2r71.247 2r0. 1
replicate 2 1 4r30.48 2r0. 1
core 4 1 -121.92 -121.92 0.
replicate 5 1 5r0.0 0.1905 1
replicate 4 1 5r0.0 2.54 1
end geom
read array
ara=1 nux=1 nuy=13 nuz=1
fill 1 2 5q2 1 end fill
ara=2 nux=60 nuy=20 nuz=1
fill f4 end fill
ara=3 nux=3 nuy=2 nuz=1
fill 6 7 6 6 7 6 end fill
gbl=4
ara=4 nux=1 nuy=1 nuz=3
fill 3 5 8 end fill
end array
read start
nst=1
xsm=-30.2895 xsp=30.2895
ysm=-20.193 ysp=20.193
zsm=21.59 zsp=97.79
end start
read plot
ttl="plan view 1/6 scale of core, z=midlevel of annuli/inserts"
xul=-91.44 yul=91.44 zul=59.69
xlr=91.44 ylr=-91.44 zlr=59.69
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of grating"
xul=-91.44 yul=91.44 zul=20.0025
xlr=91.44 ylr=-91.44 zlr=20.0025
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of fir timbers"
xul=-91.44 yul=91.44 zul=9.2075
xlr=91.44 ylr=-91.44 zlr=9.2075
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/10 scale of mockup, z=midlevel of u units"
xul=-135. yul=135. zul=59.69
xlr=135. ylr=-135. zlr=59.69
uax=1. vdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="plan view 2x scale of single u unit, z=midlevel of unit"
xul=0.0 yul=20.193 zul=59.69
xlr=20.193 ylr=0.0 zlr=59.69
uax=1. vdn=-1. dlx=0.127 nch=* u.wgs* end
ttl="cross section of core 1/6 scale,y=10.0965"
xul=-91.44 yul=10.0965 zul=125.
xlr=91.44 ylr=10.0965 zlr=-10.
```

```
uax=1. wdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="cross section of mockup 1/10 scale,y=10.0965"
xul=-135. yul=10.0965 zul=125.
xlr=135. ylr=10.0965 zlr=-10.
uax=1. wdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="cross section of grating/fir timbers, full scale"
xul=0. yul=0. zul=24.13
xlr=25.4 ylr=0. zlr=-3.0
uax=1. wdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating thru tiebars, full scale"
xul=0. yul=25.4 zul=21.193
xlr=25.4 ylr=0. zlr=21.193
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating @ grating midlevel, full scale"
xul=0. yul=25.4 zul=20.0025
xlr=25.4 ylr=0. zlr=20.0025
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of timbers @ timber midlevel, full scale"
xul=0. yul=25.4 zul=9.2075
xlr=25.4 ylr=-25.4 zlr=9.2075
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="cross section of central unit, full scale,y=10.0965"
xul=-10.0965 yul=10.0965 zul=125.
xlr=10.0965 ylr=10.0965 zlr=-10.
uax=1. wdn=-1. dlx=.254 nch=* u.wgs* end
end plot
end data
end
```

```
=csas25
case ebj.10 u(3.85) 20 @ 7.2"/2.6"/1.87"/79.0cm, square
238groupndf5 infhommedium
' u(3.85) metal
u-235        1 0.  1.8643e-3 end
u-238        1 0.  4.5971e-2 end
' full density water moderator/reflector
h2o          2 1.0           end
' fir timber model
c            3 0.  1.06802e-2 end
h            3 0.  2.21713e-2 end
o            3 0.  1.10850e-2 end
' steel for grating, tank walls and floor
carbonsteel  4 1.0           end
' stainless steel lining for tank
ss304        5 1.0           end
end comp
case ebj.10 u(3.85) 20 @ 7.2"/2.6"/1.87"/79.0cm, square
read parm
npg=2000  nub=yes plt=no fdn=yes tme=90 tba=2
end parm
read geom
unit 1
com=* fir timber 7.25" x 72" x 7.25" *
cuboid 3 1 182.88 0. 18.415 0. 18.415 0.
unit 2
com=* water gap 3.5" x 72" x 7.25" between timbers *
cuboid 2 1 182.88 0. 8.89 0. 18.415 0.
unit 3
com=* array of timbers 72" x 72" x 7.25" *
array 1 3*0.0
replicate 2 1 2r0. 2r0.3175 2r0. 1
replicate 2 1 4r30.48 2r0. 1
```

```
unit 4
com=* section of steel grating *
cuboid 4 1 2.778125 .238125 .396875 -.396875 3.175 2.38125
cuboid 2 1 2.778125 .238125 4.524375 -4.524375 3.175 0.
cuboid 4 1 3.01625 0. 4.524375 -4.524375 3.175 0.
unit 5
com=* array of steel grating *
array 2 3*0.0
replicate 2 1 4r0.9525 2r0.0 1
replicate 2 1 4r30.48 2r0. 1
unit 6
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 7
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 8
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 9
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 10
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 11
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 12
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 13
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 14
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 15
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 16
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
```

```
unit 17
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 18
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 19
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 20
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 21
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 22
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 23
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 24
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 25
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 2 1 3.302 76.2 0.
cylinder 1 1 9.144 76.2 0.
cuboid 2 1 4p11.5189 79.0 0.
unit 26
com=* water cuboid to complete array *
cuboid 2 1 4p11.5189 79.0 0.
unit 27
com=* array of 20 annuli, h=76.2, submerged *
array 3 3*0.0
replicate 2 1 4r33.8455 2r0. 1
replicate 2 1 4r30.48 2r0. 1
core 4 1 -121.92 -121.92 0.
replicate 5 1 5r0.0 0.1905 1
replicate 4 1 5r0.0 2.54 1
end geom
read array
ara=1 nux=1 nuy=13 nuz=1
fill 1 2 5q2 1 end fill
ara=2 nux=60 nuy=20 nuz=1
fill f4 end fill
ara=3 nux=5 nuy=5 nuz=1
```

```
fill 26 26 6 7 26 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
26 23 24 25 26 end fill
gbl=4
ara=4 nux=1 nuy=1 nuz=3
fill 3 5 27 end fill
end array
read start
nst=1
xsm=-57.5945 xsp=57.5945
ysm=-57.5945 ysp=57.5945
zsm=21.59 zsp=97.79
end start
read plot
ttl="plan view 1/6 scale of core, z=midlevel of annuli/inserts"
xul=-91.44 yul=91.44 zul=59.69
xlr=91.44 ylr=-91.44 zlr=59.69
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of grating"
xul=-91.44 yul=91.44 zul=20.0025
xlr=91.44 ylr=-91.44 zlr=20.0025
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of fir timbers"
xul=-91.44 yul=91.44 zul=9.2075
xlr=91.44 ylr=-91.44 zlr=9.2075
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/10 scale of mockup, z=midlevel of u units"
xul=-135. yul=135. zul=59.69
xlr=135. ylr=-135. zlr=59.69
uax=1. vdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="plan view 2x scale of single u unit, z=midlevel of unit"
xul=-11.5189 yul=11.5189 zul=59.69
xlr=11.5189 ylr=-11.5189 zlr=59.69
uax=1. vdn=-1. dlx=0.127 nch=* u.wgs* end
ttl="cross section of core 1/6 scale,y=0.0"
xul=-91.44 yul=0.0 zul=110.
xlr=91.44 ylr=0.0 zlr=-10.
uax=1. wdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="cross section of mockup 1/10 scale,y=0.0"
xul=-135. yul=0.0 zul=125.
xlr=135. ylr=0.0 zlr=-10.
uax=1. wdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="cross section of grating/fir timbers, full scale"
xul=0. yul=0. zul=24.13
xlr=25.4 ylr=0. zlr=-3.0
uax=1. wdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating thru tiebars, full scale"
xul=0. yul=25.4 zul=21.193
xlr=25.4 ylr=0. zlr=21.193
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating @ grating midlevel, full scale"
xul=0. yul=25.4 zul=20.0025
xlr=25.4 ylr=0. zlr=20.0025
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of timbers @ timber midlevel, full scale"
xul=0. yul=25.4 zul=9.2075
xlr=25.4 ylr=-25.4 zlr=9.2075
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="cross section of central unit, full scale,y=0.0"
xul=-11.5189 yul=0.0 zul=110.
xlr=11.5189 ylr=0.0 zlr=-10.
uax=1. wdn=-1. dlx=.254 nch=* u.wgs* end
end plot
end data
```

```
end


=csas25
case ebj.11 u(3.85) 8 @ 7.2"/2.6"/0.0"/72.5cm, square
238groupndf5 infhommedium
' u(3.85) metal
u-235        1 0.  1.8643e-3 end
u-238        1 0.  4.5971e-2 end
' full density water moderator/reflector
h2o          2 1.0           end
' fir timber model
c            3 0.  1.06802e-2 end
h            3 0.  2.21713e-2 end
o            3 0.  1.10850e-2 end
' steel for grating, tank walls and floor
carbonsteel  4 1.0           end
' stainless steel lining for tank
ss304        5 1.0           end
end comp
case ebj.11 u(3.85) 8 @ 7.2"/2.6"/0.0"/72.5cm, square
read parm
npg=2000  nub=yes plt=no fdn=yes tme=90 tba=2
end parm
read geom
unit 1
com=* fir timber 7.25" x 72" x 7.25" *
cuboid 3 1 182.88 0. 18.415 0. 18.415 0.
unit 2
com=* water gap 3.5" x 72" x 7.25" between timbers *
cuboid 2 1 182.88 0. 8.89 0. 18.415 0.
unit 3
com=* array of timbers 72" x 72" x 7.25" *
array 1 3*0.0
replicate 2 1 2r0. 2r0.3175 2r0. 1
replicate 2 1 4r30.48 2r0. 1
unit 4
com=* section of steel grating *
cuboid 4 1 2.778125 .238125 .396875 -.396875 3.175 2.38125
cuboid 2 1 2.778125 .238125 4.524375 -4.524375 3.175 0.
cuboid 4 1 3.01625 0. 4.524375 -4.524375 3.175 0.
unit 5
com=* array of steel grating *
array 2 3*0.0
replicate 2 1 4r0.9525 2r0.0 1
replicate 2 1 4r30.48 2r0. 1
unit 6
com=* u(3.85) annulus, h=72.5, submerged, on corner *
cylinder 2 1 3.302 72.5 0.
cylinder 1 1 4.614139 72.5 0.
cylinder 1 1 5.628264 72.5 0.
cylinder 1 1 6.485710 72.5 0.
cylinder 1 1 7.242341 72.5 0.
cylinder 1 1 7.927079 72.5 0.
cylinder 1 1 8.557199 72.5 0.
cylinder 1 1 9.144000 72.5 0.
cuboid 2 1 4p9.144 72.5 0.
unit 7
com=* u(3.85) annulus, h=72.5, submerged, on side *
cylinder 2 1 3.302 72.5 0.
cylinder 1 1 4.614139 72.5 0.
cylinder 1 1 5.628264 72.5 0.
cylinder 1 1 6.485710 72.5 0.
```

```
cylinder 1 1 7.242341 72.5 0.
cylinder 1 1 7.927079 72.5 0.
cylinder 1 1 8.557199 72.5 0.
cylinder 1 1 9.144000 72.5 0.
cuboid 2 1 4p9.144 72.5 0.
unit 8
com=* u(3.85) annulus, h=3.7, dry, on corner *
cylinder 0 1 3.302 3.7 0.
cylinder 1 1 4.614139 3.7 0.
cylinder 1 1 5.628264 3.7 0.
cylinder 1 1 6.485710 3.7 0.
cylinder 1 1 7.242341 3.7 0.
cylinder 1 1 7.927079 3.7 0.
cylinder 1 1 8.557199 3.7 0.
cylinder 1 1 9.144000 3.7 0.
cuboid 0 1 4p9.144 3.7 0.
unit 9
com=* u(3.85) annulus, h=3.7, dry, on side *
cylinder 0 1 3.302 3.7 0.
cylinder 1 1 4.614139 3.7 0.
cylinder 1 1 5.628264 3.7 0.
cylinder 1 1 6.485710 3.7 0.
cylinder 1 1 7.242341 3.7 0.
cylinder 1 1 7.927079 3.7 0.
cylinder 1 1 8.557199 3.7 0.
cylinder 1 1 9.144000 3.7 0.
cuboid 0 1 4p9.144 3.7 0.
unit 10
com=* array of 8 annuli, h=72.5, submerged *
array 3 3*0.0
replicate 2 1 2r54.864 2r73.152 2r0. 1
replicate 2 1 4r30.48 2r0. 1
unit 11
com=* array of 8 annuli, h=3.7, dry *
array 4 3*0.0
replicate 0 1 2r54.864 2r73.152 2r0. 1
replicate 0 1 4r30.48 2r0. 1
core 5 1 -121.92 -121.92 0.
replicate 5 1 5r0.0 0.1905 1
replicate 4 1 5r0.0 2.54 1
end geom
read array
ara=1 nux=1 nuy=13 nuz=1
fill 1 2 5q2 1 end fill
ara=2 nux=60 nuy=20 nuz=1
fill f4 end fill
ara=3 nux=4 nuy=2 nuz=1
fill 6 7 7 6 6 7 7 6 end fill
ara=4 nux=4 nuy=2 nuz=1
fill 8 9 9 8 8 9 9 8 end fill
gbl=5
ara=5 nux=1 nuy=1 nuz=4
fill 3 5 10 11 end fill
end array
'read start
'nst=1
'xsm=-36.576 xsp=36.576
'ysm=-18.288 ysp=18.288
'zsm=21.59 zsp=94.09
'end start
read plot
ttl="plan view 1/6 scale of core, z=midlevel of annuli/inserts"
xul=-91.44 yul=91.44 zul=59.69
```

```
xlr=91.44 ylr=-91.44 zlr=59.69
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of grating"
xul=-91.44 yul=91.44 zul=20.0025
xlr=91.44 ylr=-91.44 zlr=20.0025
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of fir timbers"
xul=-91.44 yul=91.44 zul=9.2075
xlr=91.44 ylr=-91.44 zlr=9.2075
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/10 scale of mockup, z=midlevel of u units"
xul=-135. yul=135. zul=59.69
xlr=135. ylr=-135. zlr=59.69
uax=1. vdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="plan view 2x scale of single u unit, z=midlevel of unit"
xul=0.0 yul=18.288 zul=59.69
xlr=18.288 ylr=0. zlr=59.69
uax=1. vdn=-1. dlx=0.127 nch=* u.wgs* end
ttl="cross section of core 1/6 scale,y=9.144"
xul=-91.44 yul=9.144 zul=110.
xlr=91.44 ylr=9.144 zlr=-10.
uax=1. wdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="cross section of mockup 1/10 scale,y=9.144"
xul=-135. yul=9.144 zul=125.
xlr=135. ylr=9.144 zlr=-10.
uax=1. wdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="cross section of grating/fir timbers, full scale"
xul=0. yul=0. zul=24.13
xlr=25.4 ylr=0. zlr=-3.0
uax=1. wdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating thru tiebars, full scale"
xul=0. yul=25.4 zul=21.193
xlr=25.4 ylr=0. zlr=21.193
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating @ grating midlevel, full scale"
xul=0. yul=25.4 zul=20.0025
xlr=25.4 ylr=0. zlr=20.0025
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of timbers @ timber midlevel, full scale"
xul=0. yul=25.4 zul=9.2075
xlr=25.4 ylr=-25.4 zlr=9.2075
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="cross section of central unit, full scale,y=9.144"
xul=0.0 yul=9.144 zul=110.
xlr=18.288 ylr=9.144 zlr=-10.
uax=1. wdn=-1. dlx=.254 nch=* u.wgs* end
end plot
end data
end


=csas25
case ebj.13 u(3.85) 15 @ 2.5"/0.0"/0.75"/64.8cm, square
238groupndf5 infhommedium
' u(3.85) metal
u-235        1 0.  1.8643e-3 end
u-238        1 0.  4.5971e-2 end
' full density water moderator/reflector
h2o          2 1.0           end
' fir timber model
c            3 0.  1.06802e-2 end
h            3 0.  2.21713e-2 end
o            3 0.  1.10850e-2 end
```

```
' steel for grating, tank walls and floor
carbonsteel  4 1.0           end
' stainless steel lining for tank
ss304        5 1.0           end
end comp
case ebj.13 u(3.85) 15 @ 2.5"/0.0"/0.75"/64.8cm, square
read parm
npg=2000  nub=yes plt=no fdn=yes tme=90 tba=2
end parm
read geom
unit 1
com=* fir timber 7.25" x 72" x 7.25" *
cuboid 3 1 182.88 0. 18.415 0. 18.415 0.
unit 2
com=* water gap 3.5" x 72" x 7.25" between timbers *
cuboid 2 1 182.88 0. 8.89 0. 18.415 0.
unit 3
com=* array of timbers 72" x 72" x 7.25" *
array 1 3*0.0
replicate 2 1 2r0. 2r0.3175 2r0. 1
replicate 2 1 4r30.48 2r0. 1
unit 4
com=* section of steel grating *
cuboid 4 1 2.778125 .238125 .396875 -.396875 3.175 2.38125
cuboid 2 1 2.778125 .238125 4.524375 -4.524375 3.175 0.
cuboid 4 1 3.01625 0. 4.524375 -4.524375 3.175 0.
unit 5
com=* array of steel grating *
array 2 3*0.0
replicate 2 1 4r0.9525 2r0.0 1
replicate 2 1 4r30.48 2r0. 1
unit 6
com=* u(3.85) rod, h=64.8, submerged *
cylinder 1 1 1.419903 64.8 0.
cylinder 1 1 2.008046 64.8 0.
cylinder 1 1 2.459344 64.8 0.
cylinder 1 1 2.839806 64.8 0.
cylinder 1 1 3.175000 64.8 0.
cuboid 2 1 4p4.1275 64.8 0.
unit 7
com=* water cuboid to complete array 3 *
cuboid 2 1 4p4.1275 64.8 0.
unit 8
com=* u(3.85) rod, h=11.4, dry *
cylinder 1 1 1.419903 11.4 0.
cylinder 1 1 2.008046 11.4 0.
cylinder 1 1 2.459344 11.4 0.
cylinder 1 1 2.839806 11.4 0.
cylinder 1 1 3.175000 11.4 0.
cuboid 0 1 4p4.1275 11.4 0.
unit 9
com=* void cuboid to complete array 4 *
cuboid 0 1 4p4.1275 11.4 0.
unit 10
com=* u(3.85) rod array, h=64.8, submerged *
array 3 3*0.0
replicate 2 1 4r74.93 2r0. 1
replicate 2 1 4r30.48 2r0. 1
unit 11
com=* array of 15 rods, h=11.4, dry *
array 4 3*0.0
replicate 0 1 4r74.93 2r0. 1
replicate 0 1 4r30.48 2r0. 1
```

```
core 5 1 -121.92 -121.92 0.
replicate 5 1 5r0.0 0.1905 1
replicate 4 1 5r0.0 2.54 1
end geom
read array
ara=1 nux=1 nuy=13 nuz=1
fill 1 2 5q2 1 end fill
ara=2 nux=60 nuy=20 nuz=1
fill f4 end fill
ara=3 nux=4 nuy=4 nuz=1
fill 3r6 7 12r6 end fill
ara=4 nux=4 nuy=4 nuz=1
fill 3r8 9 12r8 end fill
gbl=5
ara=5 nux=1 nuy=1 nuz=4
fill 3 5 10 11 end fill
end array
read start
nst=1
xsm=-16.51 xsp=16.51
ysm=-16.51 ysp=16.51
zsm=21.59 zsp=86.39
end start
read plot
ttl="plan view 1/6 scale of core, z=midlevel of annuli/inserts"
xul=-91.44 yul=91.44 zul=59.69
xlr=91.44 ylr=-91.44 zlr=59.69
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view full scale of array, z=midlevel of units"
xul=-16.51 yul=16.51 zul=59.69
xlr=16.51 ylr=-16.51 zlr=59.69
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of grating"
xul=-91.44 yul=91.44 zul=20.0025
xlr=91.44 ylr=-91.44 zlr=20.0025
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of fir timbers"
xul=-91.44 yul=91.44 zul=9.2075
xlr=91.44 ylr=-91.44 zlr=9.2075
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/10 scale of mockup, z=midlevel of u units"
xul=-135. yul=135. zul=59.69
xlr=135. ylr=-135. zlr=59.69
uax=1. vdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="plan view 2x scale of single u unit, z=midlevel of unit"
xul=0.0 yul=8.255 zul=59.69
xlr=8.255 ylr=0.0 zlr=59.69
uax=1. vdn=-1. dlx=0.127 nch=* u.wgs* end
ttl="cross section of core 1/6 scale,y=4.1275"
xul=-91.44 yul=4.1275 zul=110.
xlr=91.44 ylr=4.1275 zlr=-10.
uax=1. wdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="cross section of mockup 1/10 scale,y=4.1275"
xul=-135. yul=4.1275 zul=125.
xlr=135. ylr=4.1275 zlr=-10.
uax=1. wdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="cross section of grating/fir timbers, full scale"
xul=0. yul=0. zul=24.13
xlr=25.4 ylr=0. zlr=-3.0
uax=1. wdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating thru tiebars, full scale"
xul=0. yul=25.4 zul=21.193
xlr=25.4 ylr=0. zlr=21.193
```

```
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating @ grating midlevel, full scale"
xul=0. yul=25.4 zul=20.0025
xlr=25.4 ylr=0. zlr=20.0025
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of timbers @ timber midlevel, full scale"
xul=0. yul=25.4 zul=9.2075
xlr=25.4 ylr=-25.4 zlr=9.2075
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="cross section of central unit, 2x scale,y=4.1275"
xul=0.0 yul=4.1275 zul=110.
xlr=8.255 ylr=4.1275 zlr=-10.
uax=1. wdn=-1. dlx=.127 nch=* u.wgs* end
end plot
end data
end


=csas25
case ebj.14 u(3.85) 23 @ 2.5"/0.0"/1.50"/68.9cm, square
238groupndf5 infhommedium
' u(3.85) metal
u-235        1 0.  1.8643e-3 end
u-238        1 0.  4.5971e-2 end
' full density water moderator/reflector
h2o          2 1.0           end
' fir timber model
c            3 0.  1.06802e-2 end
h            3 0.  2.21713e-2 end
o            3 0.  1.10850e-2 end
' steel for grating, tank walls and floor
carbonsteel  4 1.0           end
' stainless steel lining for tank
ss304        5 1.0           end
end comp
case ebj.14 u(3.85) 23 @ 2.5"/0.0"/1.50"/68.9cm, square
read parm
npg=2000  nub=yes plt=no fdn=yes tme=90 tba=2
end parm
read geom
unit 1
com=* fir timber 7.25" x 72" x 7.25" *
cuboid 3 1 182.88 0. 18.415 0. 18.415 0.
unit 2
com=* water gap 3.5" x 72" x 7.25" between timbers *
cuboid 2 1 182.88 0. 8.89 0. 18.415 0.
unit 3
com=* array of timbers 72" x 72" x 7.25" *
array 1 3*0.0
replicate 2 1 2r0. 2r0.3175 2r0. 1
replicate 2 1 4r30.48 2r0. 1
unit 4
com=* section of steel grating *
cuboid 4 1 2.778125 .238125 .396875 -.396875 3.175 2.38125
cuboid 2 1 2.778125 .238125 4.524375 -4.524375 3.175 0.
cuboid 4 1 3.01625 0. 4.524375 -4.524375 3.175 0.
unit 5
com=* array of steel grating *
array 2 3*0.0
replicate 2 1 4r0.9525 2r0.0 1
replicate 2 1 4r30.48 2r0. 1
unit 6
com=* u(3.85) rod, h=68.9, submerged *
```

```
cylinder 1 1 1.419903 68.9 0.
cylinder 1 1 2.008046 68.9 0.
cylinder 1 1 2.459344 68.9 0.
cylinder 1 1 2.839806 68.9 0.
cylinder 1 1 3.175000 68.9 0.
cuboid 2 1 4p5.08 68.9 0.
unit 7
com=* water cuboid to complete array 3 *
cuboid 2 1 4p5.08 68.9 0.
unit 8
com=* u(3.85) rod, h=7.3, dry *
cylinder 1 1 1.419903 7.3 0.
cylinder 1 1 2.008046 7.3 0.
cylinder 1 1 2.459344 7.3 0.
cylinder 1 1 2.839806 7.3 0.
cylinder 1 1 3.175000 7.3 0.
cuboid 0 1 4p5.08 7.3 0.
unit 9
com=* void cuboid to complete array 4 *
cuboid 0 1 4p5.08 7.3 0.
unit 10
com=* u(3.85) rod array, h=68.9, submerged *
array 3 3*0.0
replicate 2 1 4r66.04 2r0. 1
replicate 2 1 4r30.48 2r0. 1
unit 11
com=* array of 22 u(3.85) rods, h=7.3, dry *
array 4 3*0.0
replicate 0 1 4r66.04 2r0. 1
replicate 0 1 4r30.48 2r0. 1
core 5 1 -121.92 -121.92 0.
replicate 5 1 5r0.0 0.1905 1
replicate 4 1 5r0.0 2.54 1
end geom
read array
ara=1 nux=1 nuy=13 nuz=1
fill 1 2 5q2 1 end fill
ara=2 nux=60 nuy=20 nuz=1
fill f4 end fill
ara=3 nux=5 nuy=5 nuz=1
fill 3r6 2r7 20r6 end fill
ara=4 nux=5 nuy=5 nuz=1
fill 3r8 2r9 20r8 end fill
gbl=5
ara=5 nux=1 nuy=1 nuz=4
fill 3 5 10 11 end fill
end array
read start
nst=1
xsm=-25.4 xsp=25.4
ysm=-25.4 ysp=25.4
zsm=21.59 zsp=90.49
end start
read plot
ttl="plan view 1/6 scale of core, z=midlevel of annuli/inserts"
xul=-91.44 yul=91.44 zul=59.69
xlr=91.44 ylr=-91.44 zlr=59.69
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view of array, full scale"
xul=-25.4 yul=25.4 zul=59.69
xlr=25.4 ylr=-25.4 zlr=59.69
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of grating"
```

```
xul=-91.44 yul=91.44 zul=20.0025
xlr=91.44 ylr=-91.44 zlr=20.0025
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of fir timbers"
xul=-91.44 yul=91.44 zul=9.2075
xlr=91.44 ylr=-91.44 zlr=9.2075
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/10 scale of mockup, z=midlevel of u units"
xul=-135. yul=135. zul=59.69
xlr=135. ylr=-135. zlr=59.69
uax=1. vdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="plan view 2x scale of single u unit, z=midlevel of unit"
xul=-5.08 yul=5.08 zul=59.69
xlr=5.08 ylr=-5.08 zlr=59.69
uax=1. vdn=-1. dlx=0.127 nch=* u.wgs* end
ttl="cross section of core 1/6 scale,y=0.0"
xul=-91.44 yul=0.0 zul=110.
xlr=91.44 ylr=0.0 zlr=-10.
uax=1. wdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="cross section of mockup 1/10 scale,y=0.0"
xul=-135. yul=0.0 zul=125.
xlr=135. ylr=0.0 zlr=-10.
uax=1. wdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="cross section of grating/fir timbers, full scale"
xul=0. yul=0. zul=24.13
xlr=25.4 ylr=0. zlr=-3.0
uax=1. wdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating thru tiebars, full scale"
xul=0. yul=25.4 zul=21.193
xlr=25.4 ylr=0. zlr=21.193
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating @ grating midlevel, full scale"
xul=0. yul=25.4 zul=20.0025
xlr=25.4 ylr=0. zlr=20.0025
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of timbers @ timber midlevel, full scale"
xul=0. yul=25.4 zul=9.2075
xlr=25.4 ylr=-25.4 zlr=9.2075
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="cross section of central unit, 2x scale,y=0.0"
xul=-5.08 yul=0.0 zul=110.
xlr=5.08 ylr=0.0 zlr=-10.
uax=1. wdn=-1. dlx=.127 nch=* u.wgs* end
end plot
end data
end
```

Table A.3. Table 3 input data

```
=CSAS25
ROCKY FLATS CRITICALS NUREG/CR-1071 EXPERIMENT NUMBER 1 (27 GROUP)
' 48 FUEL CANS 2.44 CM MODERATOR GEE.HU77.DATA(OPT1)
238groupndf5  latticecell
u3o8  1 5.4078e-1 293.0 92234 0.03 92235 4.46 92236 0.08 92238 95.43 end
h2o   1 8.9514e-2 end
arbm-baggie  1.0 3 0 0 0 1001 14.01 6012 84.79 8016 1.20 1 1.9134e-2
   end
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 2 9.5390e-1
   end
arbm-tape(vinyl)  1.0 7 0 0 0 1001 5.92 6012 47.93 8016 10.82 17000
   25.73 20000 6.9 22000 1.6 82000 1.1 2 1.1115e-2 end
arbm-tape(mylar)  1.0 3 0 0 0 1001 6.83 6012 66.15 8016 27.02 2
   1.7491e-2 end
arbm-moderator  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 3 end
arbm-plex(reg)  1.0 3 0 0 0 1001 7.84 6012 59.93 8016 32.23 4
   1.1773 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 4
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 4
   1.1648e-3 end
arbm-plex(tris)  1.0 8 0 0 1 1001 7.16 6012 52.93 7014 0.16 8016 29.82
   15031 1.02 17000 1.81 35079 4.260 35081 2.840 5 1.2757 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 5
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 5
   1.1648e-3 end
arbm-filler  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 6 .88 end
' this material is actually moderator adjusted for the volume
' fraction of the void filled between core and reflector.
end comp
SPHTRIANGP  19.9462 18.5857 1 3 18.9579 2 END
ROCKY FLATS CRITICALS NUREG/CR-1071 EXPERIMENT NUMBER 1 (27 GROUP)
' 48 FUEL CANS 2.44 CM MODERATOR GEE.HU77.DATA(OPT1)
READ PARM  RUN=YES NPG=600
NUB=YES FDN=YES PLT=NO
END PARM
READ GEOM
UNIT  1
COM='FUEL BOX 15.28 CM ON A SIDE WITH .15 CM WALLS .05CM STACKING VOID'
CUBOID  1 1 6P7.49
CUBOID  2 1 6P7.64
CUBOID  0 1 6P7.6650
UNIT  2
COM='X-FACE INTERSTITIAL MODERATOR'
CUBOID  3 1 2P1.2200 4P7.665
UNIT  3
COM='Y-FACE INTERSTITIAL MODERATOR'
CUBOID  3 1 2P7.665 2P1.2200 2P7.665
UNIT  4
COM='Z-FACE INTERSTITIAL MODERATOR'
CUBOID  3 1 4P7.665 2P1.2200
UNIT  5
COM='MORE X-FACE MODERATOR'
CUBOID  3 1 4P1.2200 2P7.665
UNIT  6
COM='MORE Y-FACE MODERATOR'
CUBOID  3 1 2P7.665 4P1.2200
UNIT  7
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COM='MORE Z-FACE MODERATOR'
CUBOID  3 1 2P1.2200 2P7.665 2P1.2200
UNIT  8
COM='LAST OF INTERSTITIAL MODERATOR'
CUBOID  3 1 6P1.2200
UNIT  9
COM='NORTH SPLIT TABLE CORE'
ARRAY 1 3*0.0
UNIT  10
COM='SOUTH SPLIT TABLE CORE'
ARRAY 2 3*0.0
UNIT  11
COM='PLEXIGLASS REFLECTOR SHEET WITHOUT TRIS, NORTH BOTTOM REFLECTOR'
CUBOID  4 1 2P16.5500 2P38.7500 2P0.6150
UNIT  12
COM='PLEXIGLASS REFLECTOR SHEET WITH TRIS, NORTH BOTTOM REFLECTOR'
CUBOID  5 1 2P16.5500 2P38.7500 2P0.6150
UNIT  13
COM='UPPER PORTION NORTH BOTTOM REFLECTOR WITH TRIS'
CUBOID  5 1 2P16.550 2P38.75 2P8.24
UNIT  14
COM='LOWER PORTION NORTH BOTTOM REFLECTOR WITH TRIS'
CUBOID  5 1 2P16.550 2P38.75 2P3.69
UNIT  15
COM='NORTH BOTTOM REFLECTOR INCLUDES REGULAR AND TRIS'
ARRAY 3 3*0.0
UNIT  16
COM='PLEXIGLAS SHEET BOTTOM SOUTH REFLECTOR WITHOUT TRIS'
CUBOID  0 1 2P5.1 2P2.55 2P0.615
CUBOID  4 1 44.3 -5.1 2P38.75  2P0.615
UNIT  17
COM='PLEXIGLAS SHEET BOTTOM SOUTH REFLECTOR WITH TRIS'
CUBOID  0 1 2P5.1 2P2.55 2P0.615
CUBOID  5 1 44.3 -5.1 2P38.75 2P0.6150
UNIT  18
COM='LOWER PORTION SOUTH BOTTOM REFLECTOR WITH TRIS'
CUBOID  0 1 2P5.1 2P2.55 2P8.855
CUBOID  5 1 44.3 -5.1 2P38.75 2P8.855
UNIT  19
COM='SOUTH BOTTOM REFLECTOR WITH REGULAR AND TRIS'
ARRAY 4 3*0.0
UNIT  20
COM='EAST AND WEST REFLECTORS FOR NORTH REFLECTOR WITH TRIS'
CUBOID  5 1 2P16.550 2P12.65 2P54.2825
UNIT  21
COM='ARRAY FOR EAST AND WEST REFLECTORS FOR NORTH REFLECTOR'
ARRAY 5 3*0.0
UNIT  22
COM='EAST AND WEST REFLECTORS FOR SOUTH REFLECTOR WITH TRIS'
CUBOID  5 1 2P24.700 2P12.65 2P54.2825
UNIT  23
COM='ARRAY FOR EAST AND WEST REFLECTORS FOR SOUTH REFLECTOR'
ARRAY 6 3*0.0
UNIT  24
COM='NORTH TOP REFLECTOR WITH TRIS'
CUBOID  5 1 2P29.100 2P64.05 2P12.15
UNIT  25
COM='ARRAY FOR NORTH TOP REFLECTOR'
ARRAY 7 3*0.0
UNIT  26
COM='SOUTH TOP REFLECTOR WITH TRIS'
CUBOID  0 1 2P5.1 2P2.55 2P12.15
CUBOID  5 1 69.4 -5.1 2P64.05 2P12.15
```

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UNIT  27
COM='ARRAY FOR SOUTH TOP REFLECTOR'
ARRAY 8 3*0.0
UNIT  28
COM='NORTH END REFLECTOR 9.8CM PORTION WITHOUT TRIS'
CUBOID  4 1 2P4.9000 2P64.0500 2P54.2825
UNIT  29
COM='NORTH END RELFECTOR 5.2 CM PORTION WITH TRIS'
CUBOID  5 1 2P2.6 2P64.0500 2P54.2825
UNIT  30
COM='NORTH END RELFECTOR 10.1 CM PORTION WITHOUT TRIS'
CUBOID  4 1 2P5.05 2P64.05 2P54.2825
UNIT  31
COM='ARRAY FOR NORTH END REFLECTOR'
ARRAY 9 3*0.0
UNIT  32
COM='SOUTH END REFLECTOR'
CUBOID  5 1 2P12.55 2P64.05 2P54.2825
UNIT  33
COM='ARRAY FOR SOUTH END REFLECTOR'
ARRAY 10 3*0.0
UNIT  34
COM='BOTTOM MODERATING PLASTIC NORTH CORE'
CUBOID  6 1 2P16.550 2P38.7500 2P13.0500
UNIT  35
COM='TOP MODERATING PLASTIC NORTH CORE'
CUBOID  6 1 2P16.550 2P38.7500 2P3.2525
UNIT  36
ARRAY 11 3*0.0
UNIT  37
ARRAY 12 3*0.0
UNIT  38
COM='NORTH CORE WITH BOTTOM REFLECTOR'
ARRAY 13 3* 0.0
UNIT  39
COM='NORTH CORE WITH EAST AND WEST REFLECTOR'
ARRAY 14 3*0.0
UNIT  40
COM='NORTH CORE WITH END REFLECTOR'
ARRAY 15 3*0.0
UNIT  41
COM='NORTH SPLIT TABLE FACEPLATE'
CUBOID  3 1 2P0.6150 2P64.0500 2P66.4325
UNIT  42
COM='NORTH CORE WITH TOP REFLECTOR'
ARRAY 16 3*0.0
UNIT  43
COM='NORTH CORE WITH FACEPLATE'
ARRAY 17 3*0.0
UNIT  44
COM='12.95 CM THICK MODERATOR SOUTH CORE'
CUBOID  6 1 2P23.924 2P6.475 2P40.183
UNIT  45
COM='2.95 THICK MODERATOR SOUTH CORE'
CUBOID  6 1 2P23.924 2P38.5285 2P1.475
UNIT  46
COM='COMBINATION OF CORE WITH 12.95 THICK MODERATOR'
ARRAY 18 3*0.0
UNIT  47
COM='COMBINATION OF CORE WITH 2.95 THICK MODERATOR'
ARRAY 19 3*0.0
UNIT  48
COM='SOUTH CORE WITH EAST WEST REFLECTORS'
```

```
ARRAY 20 3*0.0
UNIT  49
COM='SOUTH CORE WITH EAST WEST REFLECTORS'
ARRAY 21 3*0.0
UNIT  50
COM='SOUTH CORE END REFLECTOR'
ARRAY 22 3*0.0
UNIT  51
COM='FACEPLATE FOR SOUTH SPLIT TABLE'
CUBOID  3 1 2P0.4620  2P64.0500 2P66.4325
UNIT  52
COM='SOUTH CORE WITH TOP REFLECTOR'
ARRAY 23 3*0.0
UNIT  53
COM='SOUTH CORE WITH FACEPLATE'
ARRAY 24 3*0.0
UNIT  54
COM='AIR GAP'
CUBOID  0 1 2P0.1550 2P64.0500 2P66.4325
GLOBAL
UNIT  55
COM='TOTAL'
ARRAY 25 3*0.0
UNIT  56
COM='EMPTY FUEL LOCATION'
CUBOID  0 1 6P7.6650
UNIT  57
COM='SIDE MODERATOR'
CUBOID  6 1 2P16.550 2P4.4300 2P25.4350
UNIT  58
COM='END MODERATOR'
CUBOID  6 1 2P8.1500 2P38.7500 2P25.4350
UNIT  59
COM='SOUTH CORE BOTTOM MODERATING PLASTIC'
CUBOID  6 1 2P24.7000 2P38.7500 2P13.0500
UNIT  60
COM='SOUTH CORE TOP MODERATING PLASTIC'
CUBOID  6 1 2P24.7000 2P38.7500 2P3.2525
UNIT  61
COM='Y-FACE MODERATOR VOID'
CUBOID  0 1 2P7.665 2P1.2200 2P7.665
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
      56 2 1 3 5 3 1 2 1 3 5 3 1Q6 56 2 1  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 56 3 5 61 2Q6 1 2 56 END FILL
ARA=3  NUX=1 NUY=1 NUZ=3
COM='NORTH BOTTOM REFLECTOR'
FILL  14 11 13  END FILL
ARA=4  NUX=1 NUY=1 NUZ=7
COM='SOUTH BOTTOM REFLECTOR'
FILL  18 16 17 16 16 17 17  END FILL
ARA=5  NUX=1 NUY=1 NUZ=1
COM='EAST AND WEST WALLS OF NORTH REFLECTOR'
```

```
FILL  20 END FILL
ARA=6  NUX=1 NUY=1 NUZ=1
COM='EAST AND WEST WALLS OF SOUTH REFLECTOR'
FILL  22  END FILL
ARA=7  NUX=1 NUY=1 NUZ=1
COM='ARRAY FOR NORTH TOP REFLECTOR'
FILL  24  END FILL
ARA=8  NUX=1 NUY=1 NUZ=1
COM='ARRAY FOR SOUTH TOP REFLECTOR'
FILL  26 END FILL
ARA=9  NUX=3 NUY=1 NUZ=1
COM='ARRAY FOR NORTH END REFLECTOR'
FILL  28 29 30  END FILL
ARA=10  NUX=1 NUY=1 NUZ=1
COM='ARRAY FOR SOUTH END REFLECTOR'
FILL  32  END FILL
ARA=11  NUX=1 NUY=2 NUZ=1
COM='COMBINARION OF CORE WITH SIDE MODERATOR'
FILL  9 57  END FILL
ARA=12 NUX=1 NUY=1 NUZ=3
COM='COMBINATION OF PREVIOUS ARRAY WITH TOP AND BOTTOM MODERATOR'
FILL  34 36 35  END FILL
ARA=13  NUX=1 NUY=1 NUZ=2
COM='COMBINATION OF NORTH CORE WITH BOTTOM REFLECTOR'
FILL  15 37  END FILL
ARA=14  NUX=1 NUY=3 NUZ=1
COM='NORTH CORE WITH SIDE REFLECTORS'
FILL  21 38 21  END FILL
ARA=15  NUX=2 NUY=1 NUZ=1
COM='NORTH CORE WITH END REFLECTOR'
FILL  31 39  END FILL
ARA=16  NUX=1 NUY=1 NUZ=2
COM='NORTH CORE WITH TOP REFLECTOR'
FILL  40 25  END FILL
ARA=17  NUX=2 NUY=1 NUZ=1
COM='NORTH CORE WITH FACEPLATE'
FILL  42 41  END FILL
ARA=18  NUX=1 NUY=2 NUZ=1
COM='COMBINATION OF S. CORE WITH SIDE MODERATOR'
FILL  10 57  END FILL
ARA=19  NUX=2 NUY=1 NUZ=1
COM='COMBINATION OF CORE WITH END MODERATOR'
FILL  46 58  END FILL
ARA=20  NUX=1 NUY=1 NUZ=4
COM='SOUTH CORE WITH BOTTOM MODERATOR AND REFLECTOR'
FILL  19 59 47 60  END FILL
ARA=21 NUX=1 NUY=3 NUZ=1
COM='SOUTH CORE WITH EAST WEST REFLECTORS'
FILL  23 48 23  END FILL
ARA=22 NUX=2 NUY=1 NUZ=1
COM='SOUTH CORE WITH END REFLECTOR'
FILL  49 33  END FILL
ARA=23  NUX=1 NUY=1 NUZ=2
COM='COMBINATION OF CORE WITH TOP REFLECTOR'
FILL  50 27  END FILL
ARA=24  NUX=2 NUY=1 NUZ=1
COM='SOUTH CORE WITH FACEPLATE'
FILL  51 52  END FILL
ARA=25  NUX=3 NUY=1 NUZ=1
COM='TOTAL'
FILL  43 54 53  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='0123456'END
TTL='YZ SLICE OF NORTH CORE SECOND ROW'
XUL=28  YUL=-2   ZUL=136
XLR=28  YLR=136 ZLR=-2
VAX=1  WDN=-1 NAX=130  NCH='0123456'END
TTL='YZ SLICE OF SOUTH CORE SECOND ROW'
XUL=80 YUL=-2   ZUL=136
XLR=80 YLR=136  ZLR=-2
VAX=1  WDN=-1 NAX=130  NCH='0123456'
END PLOT
END DATA
END


=csas25
rocky flats criticals nureg/cr-1071 experiment number 15 (27 group)
238groupndf5  latticecell
u3o8  1 5.4078e-1 293.0 92234 0.03 92235 4.46 92236 0.08 92238 95.43 end
h2o   1 8.9514e-2 end
arbm-baggie  1.0 3 0 0 0 1001 14.01 6012 84.79 8016 1.20 1 1.9134e-2
   end
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 2 9.5390e-1
   end
arbm-tape(vinyl)  1.0 7 0 0 0 1001 5.92 6012 47.93 8016 10.82 17000
   25.73 20000 6.9 22000 1.6 82000 1.1 2 1.1115e-2 end
arbm-tape(mylar)  1.0 3 0 0 0 1001 6.83 6012 66.15 8016 27.02 2
   1.7491e-2 end
arbm-moderator  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 3 end
h2o   4.0  1.0-15 end
rfconcrete   5  1.0 end
end comp
sphtriangp  19.0000 18.5857 1 3 18.9579 2 end
rocky flats criticals nureg/cr-1071 experiment number 15 (27 group)
read parm  run=yes npg=2000 plt=no
fdn=yes nub=yes
end parm
read geom
unit  1
com='fuel box 15.28 cm on a side with .15 cm walls .05cm stacking void'
cuboid  1 1 6p7.49
cuboid  2 1 6p7.64
cuboid  0 1 6p7.6650
unit  2
com='x-face interstitial moderator'
cuboid  3 1 2p0.4645 4p7.665
unit  3
com='y-face interstitial moderator'
cuboid  3 1 2p7.665 2p0.4645 2p7.665
unit  4
com='z-face interstitial moderator'
cuboid  3 1 4p7.665 2p0.4645
unit  5
com='more x-face moderator'
cuboid  3 1 4p0.4645 2p7.665
unit  6
com='more y-face moderator'
cuboid  3 1 2p7.665 4p0.4645
unit  7
com='more z-face moderator'
cuboid  3 1 2p0.4645 2p7.665 2p0.4645
unit  8
```

```
com='last of interstitial moderator'
cuboid  3 1 6p0.4645
unit  9
com='north split table core'
array 1 -31.589 2*0.0
cuboid  5 1 0.0 -31.589 76.207 0.0  80.366 -25.5
cuboid  0 1 0.0 -32.3   77.5   0.0  83.2   -25.5
cuboid  5 1 0.0 -57.8  103.0 -25.5 108.7   -25.5
unit  10
com='south split table core'
array 2 3*0.0
cuboid  5 1 47.848 0.0  76.207 0.0  80.366 -25.5
hole   11 0.0 38.75 -25.5
cuboid  0 1 47.848 0.0  77.5   0.0  83.2   -25.5
cuboid  5 1 47.848 0.0 103.0 -25.5 108.7   -25.5
hole   11 0.0 38.75  83.2
cuboid  0 1 48.848 0.0 103.0 -25.5 108.7   -25.5
cuboid  5 1 74.348 0.0 103.0 -25.5 108.7   -25.5
unit  11
cuboid  0 1 10.2 0.0 2p2.55 25.5 0.0
unit  12
com='north split table faceplate'
cuboid  3 1 2p0.0001 2p64.2500 2p67.1
unit  13
com='faceplate for south split table'
cuboid  3 1 2p0.4620  2p64.2500 2p67.1
unit  14
com='air gap'
cuboid  0 1 2p0.2850 2p64.2500 2p67.1
global
unit  15
com='total'
array 3 3*0.0
unit  56
com='empty fuel location'
cuboid  0 1 6p7.6650
unit  61
com='y-face moderator void'
cuboid  0 1 2p7.665 2p0.4645 2p7.665
end geometry
read array
ara=1  nux=3 nuy=7 nuz=9
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
      3q42
      1 2 1 3 5 3 2q6 1 2 1  end fill
ara=2  nux=5 nuy=7 nuz=9
com='south split table core'
fill  1 2 1 2 1 3 5 3 5 3 2q10 1 2 1 2 1
      4 7 4 7 4 6 8 6 8 6 2q10 4 7 4 7 4
      3q70
      1 2 1 2 1 3 5 3 5 3
      56 2 1 2 1 61 5 3 5 3
      56 2 1 2 1 3 5 3 5 3
      1 2 1 2 1               end fill
ara=3  nux=5 nuy=1 nuz=1
com='total'
fill  9 12 14 13 10  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='0123456'end
ttl='yz slice of north core second row'
xul=28  yul=-2   zul=136
xlr=28  ylr=136 zlr=-2
vax=1  wdn=-1 nax=130  nch='0123456'end
ttl='yz slice of south core second row'
xul=80 yul=-2   zul=136
xlr=80 ylr=136  zlr=-2
vax=1  wdn=-1 nax=130  nch='0123456'
end plot
read start  nst=1
xsm=15 xsp=122 ysm=15 ysp=122 zsm=30 zsp=122  end start
end data
end


=csas25
rocky flats criticals nureg/cr-0674 experiment number ? (27 group model)
' fuel cube 15.28 cm, u(4.46)3o8 @ h/u=0.77, hi enriched sphere driven
238groupndf5  infhommedium
u3o8  1 5.4078e-1 293.0 92234 0.03 92235 4.46 92236 0.08 92238 95.43 end
h2o   1 8.9514e-2 end
arbm-baggie  1.0 3 0 0 0 1001 14.01 6012 84.79 8016 1.20 1 1.9134e-2
   end
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 2 9.5390e-1
   end
arbm-tape(vinyl)  1.0 7 0 0 0 1001 5.92 6012 47.93 8016 10.82 17000
   25.73 20000 6.9 22000 1.6 82000 1.1 2 1.1115e-2 end
arbm-tape(mylar)  1.0 3 0 0 0 1001 6.83 6012 66.15 8016 27.02 2
   1.7491e-2 end
arbm-moderator  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 3 end
arbm-plex(reg)  1.0 3 0 0 0 1001 7.84 6012 59.93 8016 32.23 4
   1.1773 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 4
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 4
   1.1648e-3 end
arbm-plex(tris)  1.0 8 0 0 1 1001 7.16 6012 52.93 7014 0.16 8016 29.82
   15031 1.02 17000 1.81 35079 4.260 35081 2.840 5 1.2757 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 5
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 5
   1.1648e-3 end
arbm-filler  1.185 3 0 0 0 1001 7.83 6012 59.69  8016 32.48 6 0.7 end
' this material is actually moderator adjusted for the volume
' fraction of the void filled between core and reflector.
arbm-al1100  1.0 3 0 0 1 13027 99.3  26000 0.5 29000 0.2 7 2.715  end
uranium  8 0.9516 293.0 92234 1.0 92235 93.19 92236 0.4 92238  5.41 end
arbm-pj  0.816 2 0 0 0 1001 85.1 6012 14.9 8 0.0041  end
ss304  9 1.0 end
end comp
rocky flats criticals nureg/cr-0674 experiment number ? (27 group model)
' fuel cube 15.28 cm, u(4.46)3o8 @ h/u=0.77, hi enriched sphere driven
read parm  npg=2000 nub=yes fdn=yes plt=no  end parm
read geom
unit  1
com='fuel box with void and part of al box'
cuboid  0 1 9.80  0.0 3.75   0.0   14.98 0.0
cuboid  2 1 9.95  0.0 3.90  -0.15  14.98 0.0
cuboid  1 1 14.98 0.0 9.365 -5.615 14.98 0.0
unit  2
com='front of fuel box'
cuboid  2 1 0.15 0.0  5.615 0.0 14.98 0.0
```

```
cuboid  0 1 0.15 0.0  9.365 0.0 14.98 0.0
cuboid  2 1 0.15 0.0 14.98  0.0 14.98 0.0
unit  3
com='rear of fuel box'
cuboid  2 1 0.15 0.0 14.98  0.0 14.98 0.0
unit  4
com='array to assemble part of box'
array 26 3*0
unit  5
com='top and bottom of box'
cuboid  0 1  9.80 0.0 3.750  0.0   0.15 0.0
cuboid  2 1 15.28 0.0 9.365 -5.615 0.15 0.0
global
unit  6
com='array to assemble top and bottom'
array 27 3*0
cuboid  2 1 15.28   0.0   15.13  -0.15  15.28   0.0
cuboid  0 1 15.305 -0.025 15.155 -0.175 15.305 -0.025
unit  7
com='fuel box 15.28 cm on a side with .15 cm walls .05cm stacking void'
cuboid  1 1 6p7.49
cuboid  2 1 6p7.64
cuboid  0 1 6p7.6650
unit  8
com='box for driver'
cylinder  9 1 0.3175 2p7.32
hemisphe+x  8 1 7.334  chord 6.818
cuboid  0 1 8.512 -6.818 2p7.665 2p7.665
hole  37 0.0 0.0 -7.665
unit  34
com='aluminum weight distribution plate for special box'
cuboid  0 1  9.80 0.0 3.750  0.0   0.16 0.0
cuboid  7 1 15.33 0.0 9.54 -5.79 0.16 0.0
unit  35
com='aluminum weight distribution plate for boxes'
cuboid  7 1  4p7.665 0.16 0.0
unit  37
com='driver mount'
cylinder  9 1 1.56 0.33099 0.0
unit  9
com='north split table core'
array 1 3*0.0
cuboid  0 1 30.66 -0.94 77.5 0.0 83.475 0.0
unit  10
com='south split table core'
array 2 3*0.0
cuboid  0 1 49.4 0.0 77.5 0.0 83.475 0.0
unit  11
com='plexiglass reflector sheet without tris, north bottom reflector'
cuboid  4 1 2p15.8000 2p38.7500 2p0.6150
unit  12
com='plexiglass reflector sheet with tris, north bottom reflector'
cuboid  5 1 2p15.8000 2p38.7500 2p0.6150
unit  13
com='upper portion north bottom reflector with tris'
cuboid  5 1 2p15.8 2p38.75 2p8.24
unit  14
com='lower portion north bottom reflector with tris'
cuboid  5 1 2p15.8 2p38.75 2p3.69
unit  15
com='north bottom reflector includes regular and tris'
array 3 3*0.0
unit  16
```

```
com='plexiglas sheet bottom south reflector without tris'
cuboid  0 1 2p5.1 2p2.5 2p0.6150
cuboid  4 1 44.3 -5.1 2p38.75  2p0.615
unit  17
com='plexiglas sheet bottom south reflector with tris'
cuboid  0 1 2p5.1 2p2.5 2p0.6150
cuboid  5 1 44.3 -5.1 2p38.75 2p0.6150
unit  18
com='lower portion south bottom reflector with tris'
cuboid  0 1 2p5.1 2p2.5 2p8.855
cuboid  5 1 44.3 -5.1 2p38.75 2p8.855
unit  19
com='south bottom reflector with regular and tris'
array 4 3*0.0
unit  20
com='east and west reflectors for north reflector with tris'
cuboid  5 1 2p15.8 2p12.65 2p54.2825
unit  21
com='array for east and west reflectors for north reflector'
array 5 3*0.0
unit  22
com='east and west reflectors for south reflector with tris'
cuboid  5 1 2p24.700 2p12.65 2p54.2825
unit  23
com='array for east and west reflectors for south reflector'
array 6 3*0.0
unit  24
com='north top reflector with tris'
cuboid  5 1 2p28.35 2p64.05 2p12.15
unit  25
com='array for north top reflector'
array 7 3*0.0
unit  26
com='south top reflector with tris'
cuboid  0 1 2p5.1 2p2.5 2p12.15
cuboid  5 1 69.4 -5.1 2p64.05 2p12.15
unit  27
com='array for south top reflector'
array 8 3*0.0
unit  28
com='north end reflector 9.8cm portion without tris'
cuboid  4 1 2p4.9000 2p64.0500 2p54.2825
unit  29
com='north end relfector 5.2 cm portion with tris'
cuboid  5 1 2p2.6 2p64.0500 2p54.2825
unit  30
com='north end relfector 10.1 cm portion without tris'
cuboid  4 1 2p5.05 2p64.05 2p54.2825
unit  31
com='array for north end reflector'
array 9 3*0.0
unit  32
com='south end reflector'
cuboid  5 1 2p12.55 2p64.05 2p54.2825
unit  33
com='array for south end reflector'
array 10 3*0.0
unit  38
com='north core with bottom reflector'
array 13 3* 0.0
unit  39
com='north core with east and west reflector'
array 14 3*0.0
```

```
unit  40
com='north core with end reflector'
array 15 3*0.0
unit  42
com='north core with top reflector'
array 16 3*0.0
unit  48
com='south core with bottom reflectors'
array 20 3*0.0
unit  49
com='south core with east west reflectors'
array 21 3*0.0
unit  50
com='south core end reflector'
array 22 3*0.0
unit  52
com='south core with top reflector'
array 23 3*0.0
unit  54
com='air gap'
hemisphe-x  8 1 7.334  chord -6.818
cuboid  0 1 -6.818 -7.619 64.475 -63.625 69.13 -63.735
global
unit  55
com='total'
array 25 3*0.0
end geometry
read array
ara=1  nux=2 nuy=5 nuz=9
com='north split table core'
fill  10r7
      10r35
      10r7
      10r35
      10r7
      10r35
      10r7
      10r35
      10r7   end fill
ara=2  nux=3 nuy=5 nuz=9
com='south split table core'
fill  6r7 6 8r7
      6r35 34 8r35
      6r7 6 8r7
      6r35 34 8r35
      6r7 8 8r7
      6r35 34 8r35
      6r7 6 8r7
      6r35 34 8r35
      6r7 6 8r7  end fill
ara=3  nux=1 nuy=1 nuz=3
com='north bottom reflector'
fill  14 11 13  end fill
ara=4  nux=1 nuy=1 nuz=7
com='south bottom reflector'
fill  18 16 17 16 16 17 17  end fill
ara=5  nux=1 nuy=1 nuz=1
com='east and west walls of north reflector'
fill  20 end fill
ara=6  nux=1 nuy=1 nuz=1
com='east and west walls of south reflector'
fill  22  end fill
ara=7  nux=1 nuy=1 nuz=1
```

```
com='array for north top reflector'
fill  24  end fill
ara=8  nux=1 nuy=1 nuz=1
com='array for south top reflector'
fill  26 end fill
ara=9  nux=3 nuy=1 nuz=1
com='array for north end reflector'
fill  28 29 30  end fill
ara=10  nux=1 nuy=1 nuz=1
com='array for south end reflector'
fill  32  end fill
ara=13  nux=1 nuy=1 nuz=2
com='combination of north core with bottom reflector'
fill  15 9  end fill
ara=14  nux=1 nuy=3 nuz=1
com='north core with side reflectors'
fill  21 38 21  end fill
ara=15  nux=2 nuy=1 nuz=1
com='north core with end reflector'
fill  31 39  end fill
ara=16  nux=1 nuy=1 nuz=2
com='north core with top reflector'
fill  40 25  end fill
ara=20  nux=1 nuy=1 nuz=2
com='south core with bottom reflector'
fill  19 10  end fill
ara=21 nux=1 nuy=3 nuz=1
com='south core with east west reflectors'
fill  23 48 23  end fill
ara=22 nux=2 nuy=1 nuz=1
com='south core with end reflector'
fill  49 33  end fill
ara=23  nux=1 nuy=1 nuz=2
com='combination of core with top reflector'
fill  50 27  end fill
ara=25  nux=3 nuy=1 nuz=1
com='total'
fill  42 54 52  end fill
ara=26  nux=3 nuy=1 nuz=1
com='assembly of fuel box front and rear'
fill  2 1 3  end fill
ara=27  nux=1 nuy=1 nuz=3
com='assembly of fuel box top and bottom'
fill  5 4 5  end fill
end array
read plot ttl='yz slice of south core first row'
xul=64.319 yul=55.625 zul=71.735
xlr=64.319 ylr=71.625 zlr=55.735
vax=1  wdn=-1 nax=130  nch='012345678'end
ttl='xz slice of sphere cuboid'
xul=56.0 yul=63.625 zul=71.735
xlr=72.0 ylr=63.625 zlr=55.735
uax=1  wdn=-1 nax=130  nch='012345678'
end plot
' read start  nst=6 tfx=65 tfy=63.625 tfz=63.735 lnu=300  end start
read start  nst=1 xsm=56.981 xsp=71.649 ysm=56.219 ysp=70.959
  zsm=56.401 zsp=71.069   end start
end data
end
```

```
=csas25
rocky flats criticals nureg/cr-0674 experiment number ? (27 group model)
' fuel cube 15.28 cm, u(4.46)3o8 @ h/u=0.77, low conc. solution driven
238groupndf5  infhommedium
u3o8  1 5.4078e-1 293.0 92234 0.03 92235 4.46 92236 0.08 92238 95.43 end
h2o   1 8.9514e-2 end
arbm-baggie  1.0 3 0 0 0 1001 14.01 6012 84.79 8016 1.20 1 1.9134e-2
   end
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 2 9.5390e-1
   end
arbm-tape(vinyl)  1.0 7 0 0 0 1001 5.92 6012 47.93 8016 10.82 17000
   25.73 20000 6.9 22000 1.6 82000 1.1 2 1.1115e-2 end
arbm-tape(mylar)  1.0 3 0 0 0 1001 6.83 6012 66.15 8016 27.02 2
   1.7491e-2 end
arbm-moderator  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 3 end
arbm-plex(reg)  1.0 3 0 0 0 1001 7.84 6012 59.93 8016 32.23 4
   1.1773 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 4
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 4
   1.1648e-3 end
arbm-plex(tris)  1.0 8 0 0 1 1001 7.16 6012 52.93 7014 0.16 8016 29.82
   15031 1.02 17000 1.81 35079 4.260 35081 2.840 5 1.2757 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 5
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 5
   1.1648e-3 end
arbm-filler  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 6 0.7 end
' this material is actually moderator adjusted for the volume
' fraction of the void filled between core and reflector.
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 7 2.715  end
solnuo2(no3)2  8 86.42 0.149 1.0 293.0 92234 1.022 92235 93.172
   92236 0.434 92238 5.372  end
ss304  9 1.0 end
end comp
rocky flats criticals nureg/cr-0674 experiment number ? (27 group model)
' fuel cube 15.28 cm, u(4.46)3o8 @ h/u=0.77, low conc. solution driven
read parm  npg=2000 nub=yes fdn=yes plt=no  end parm
read geom
unit  1
com='fuel box with void and part of al box'
cuboid  0 1 9.80  0.0 3.75   0.0   14.98 0.0
cuboid  2 1 9.95  0.0 3.90  -0.15  14.98 0.0
cuboid  1 1 14.98 0.0 9.365 -5.615 14.98 0.0
unit  2
com='front of fuel box'
cuboid  2 1 0.15 0.0  5.615 0.0 14.98 0.0
cuboid  0 1 0.15 0.0  9.365 0.0 14.98 0.0
cuboid  2 1 0.15 0.0 14.98  0.0 14.98 0.0
unit  3
com='rear of fuel box'
cuboid  2 1 0.15 0.0 14.98  0.0 14.98 0.0
unit  4
com='array to assemble part of box'
array 26 3*0
unit  5
com='top and bottom of box'
cuboid  0 1  9.80 0.0 3.750  0.0   0.15 0.0
cuboid  2 1 15.28 0.0 9.365 -5.615 0.15 0.0
global
unit  6
com='array to assemble top and bottom'
array 27 3*0
```

```
cuboid  2 1 15.28   0.0   15.13  -0.15  15.28   0.0
cuboid  0 1 15.305 -0.025 15.155 -0.175 15.305 -0.025
unit  7
com='fuel box 15.28 cm on a side with .15 cm walls .05cm stacking void'
cuboid  1 1 6p7.49
cuboid  2 1 6p7.64
cuboid  0 1 6p7.6650
unit  34
com='aluminum weight distribution plate for special box'
cuboid  0 1  9.80 0.0 3.750  0.0   0.16 0.0
cuboid  7 1 15.33 0.0 9.54 -5.79 0.16 0.0
unit  35
com='aluminum weight distribution plate for boxes'
cuboid  7 1  4p7.665 0.16 0.0
unit  9
com='north split table core'
array 1 3*0.0
cuboid  0 1 30.66 -0.94 77.5 0.0 83.475 0.0
unit  10
com='south split table core'
array 2 3*0.0
cuboid  0 1 49.4 0.0 77.5 0.0 83.475 0.0
unit  11
com='plexiglass reflector sheet without tris, north bottom reflector'
cuboid  4 1 2p15.8000 2p38.7500 2p0.6150
unit  12
com='plexiglass reflector sheet with tris, north bottom reflector'
cuboid  5 1 2p15.8000 2p38.7500 2p0.6150
unit  13
com='upper portion north bottom reflector with tris'
cuboid  5 1 2p15.8 2p38.75 2p8.24
unit  14
com='lower portion north bottom reflector with tris'
cuboid  5 1 2p15.8 2p38.75 2p3.69
unit  15
com='north bottom reflector includes regular and tris'
array 3 3*0.0
unit  16
com='plexiglas sheet bottom south reflector without tris'
cuboid  0 1 2p5.1 2p2.5 2p0.6150
cuboid  4 1 44.3 -5.1 2p38.75  2p0.615
unit  17
com='plexiglas sheet bottom south reflector with tris'
cuboid  0 1 2p5.1 2p2.5 2p0.6150
cuboid  5 1 44.3 -5.1 2p38.75 2p0.6150
unit  18
com='lower portion south bottom reflector with tris'
cuboid  0 1 2p5.1 2p2.5 2p8.855
cuboid  5 1 44.3 -5.1 2p38.75 2p8.855
unit  19
com='south bottom reflector with regular and tris'
array 4 3*0.0
unit  20
com='east and west reflectors for north reflector with tris'
cuboid  5 1 2p15.8 2p12.65 2p54.2825
unit  21
com='array for east and west reflectors for north reflector'
array 5 3*0.0
unit  22
com='east and west reflectors for south reflector with tris'
cuboid  5 1 2p24.700 2p12.65 2p54.2825
unit  23
com='array for east and west reflectors for south reflector'
```

```
array 6 3*0.0
unit  24
com='north top reflector with tris'
cuboid  5 1 2p28.35 2p64.05 2p12.15
unit  25
com='array for north top reflector'
array 7 3*0.0
unit  26
com='south top reflector with tris'
cuboid  0 1 2p5.1 2p2.5 2p12.15
cuboid  5 1 69.4 -5.1 2p64.05 2p12.15
unit  27
com='array for south top reflector'
array 8 3*0.0
unit  28
com='north end reflector 9.8cm portion without tris'
cuboid  4 1 2p4.9000 2p64.0500 2p54.2825
unit  29
com='north end relfector 5.2 cm portion with tris'
cuboid  5 1 2p2.6 2p64.0500 2p54.2825
unit  30
com='north end relfector 10.1 cm portion without tris'
cuboid  4 1 2p5.05 2p64.05 2p54.2825
unit  31
com='array for north end reflector'
array 9 3*0.0
unit  32
com='south end reflector'
cuboid  5 1 2p12.55 2p64.05 2p54.2825
unit  33
com='array for south end reflector'
array 10 3*0.0
unit  38
com='north core with bottom reflector'
array 13 3* 0.0
unit  39
com='north core with east and west reflector'
array 14 3*0.0
unit  40
com='north core with end reflector'
array 15 3*0.0
unit  42
com='north core with top reflector'
array 16 3*0.0
unit  48
com='south core with bottom reflectors'
array 20 3*0.0
unit  49
com='south core with east west reflectors'
array 21 3*0.0
unit  50
com='south core end reflector'
array 22 3*0.0
unit  52
com='south core with top reflector'
array 23 3*0.0
unit  54
com='air gap'
cuboid  0 1 0.912 0.0 64.475 -63.625 69.13 -63.735
global
unit  55
com='total'
array 25 3*0.0
```

```
unit  56
com='combination of two regular fuel boxes'
array 28 3*0.0
unit  57
com='combination of regular fuel box and special fuel box'
array 29 3*0.0
unit  58
com='combination of two regular weight distribution plates'
array 30 3*0.0
unit  59
com='combination of regular and special weight distribution plates'
array 31 3*0.0
unit  60
com='north core solution driver'
cuboid  8 1 2p7.5 2p14.9 5.374 -7.5
cuboid  0 1 2p7.5 2p14.9 2p7.5
cuboid  9 1 2p7.65 2p15.05 2p7.65
cuboid  0 1 2p7.665 2p15.33 2p7.665
unit  61
com='north core solution driver'
cuboid  8 1 2p7.5 2p14.9 5.328 -7.5
cuboid  0 1 2p7.5 2p14.9 2p7.5
cuboid  9 1 2p7.65 2p15.05 2p7.65
cuboid  0 1 2p7.665 2p15.33 2p7.665
end geometry
read array
ara=1  nux=2 nuy=4 nuz=9
com='north split table core'
fill   2r7  2r56  4r7
       2r35 2r58  4r35
       2r7  2r56  4r7
       2r35 2r58  4r35
       2r7  56 60 4r7
       2r35 2r58  4r35
       2r7  2r56  4r7
       2r35 2r58  4r35
       2r7  2r56  4r7
end fill
ara=2  nux=3 nuy=4 nuz=9
com='south split table core'
fill   3r7  3r56     6r7
       3r35 3r58     6r35
       3r7  3r56     6r7
       3r35 3r58     6r35
       3r7  61 56 56 6r7
       3r35 3r58     6r35
       3r7  57 56 56 6r7
       3r35 59 58 58 6r35
       3r7  57 56 56 6r7
end fill
ara=3  nux=1 nuy=1 nuz=3
com='north bottom reflector'
fill  14 11 13  end fill
ara=4  nux=1 nuy=1 nuz=7
com='south bottom reflector'
fill  18 16 17 16 16 17 17  end fill
ara=5  nux=1 nuy=1 nuz=1
com='east and west walls of north reflector'
fill  20 end fill
ara=6  nux=1 nuy=1 nuz=1
com='east and west walls of south reflector'
fill  22  end fill
ara=7  nux=1 nuy=1 nuz=1
```

```
com='array for north top reflector'
fill  24  end fill
ara=8  nux=1 nuy=1 nuz=1
com='array for south top reflector'
fill  26 end fill
ara=9  nux=3 nuy=1 nuz=1
com='array for north end reflector'
fill  28 29 30  end fill
ara=10  nux=1 nuy=1 nuz=1
com='array for south end reflector'
fill  32  end fill
ara=13  nux=1 nuy=1 nuz=2
com='combination of north core with bottom reflector'
fill  15 9  end fill
ara=14  nux=1 nuy=3 nuz=1
com='north core with side reflectors'
fill  21 38 21  end fill
ara=15  nux=2 nuy=1 nuz=1
com='north core with end reflector'
fill  31 39  end fill
ara=16  nux=1 nuy=1 nuz=2
com='north core with top reflector'
fill  40 25  end fill
ara=20  nux=1 nuy=1 nuz=2
com='south core with bottom reflector'
fill  19 10  end fill
ara=21 nux=1 nuy=3 nuz=1
com='south core with east west reflectors'
fill  23 48 23  end fill
ara=22 nux=2 nuy=1 nuz=1
com='south core with end reflector'
fill  49 33  end fill
ara=23  nux=1 nuy=1 nuz=2
com='combination of core with top reflector'
fill  50 27  end fill
ara=25  nux=3 nuy=1 nuz=1
com='total'
fill  42 54 52  end fill
ara=26  nux=3 nuy=1 nuz=1
com='assembly of fuel box front and rear'
fill  2 1 3  end fill
ara=27  nux=1 nuy=1 nuz=3
com='assembly of fuel box top and bottom'
fill  5 4 5  end fill
ara=28  nux=1 nuy=2 nuz=1
com='combination of two fuel boxes'
fill  7 7  end fill
ara=29  nux=1 nuy=2 nuz=1
com='combination of special and regular fuel boxes'
fill  7 6  end fill
ara=30  nux=1 nuy=2 nuz=1
com='combination of two weight distribution plates'
fill  35 35  end fill
ara=31  nux=1 nuy=2 nuz=1
com='combination of special and regular weight distribution plates'
fill  35 34  end fill
end array
read plot ttl='yz slice of south core first row'
xul=64.319 yul=40.000 zul=72.000
xlr=64.319 ylr=72.000 zlr=56.000
vax=1  wdn=-1 nax=130  nch='012345678'end
ttl='xz slice of sphere cuboid'
xul=56.0 yul=63.625 zul=71.735
```

```
xlr=72.0 ylr=63.625 zlr=55.735
uax=1  wdn=-1 nax=130  nch='012345678'
end plot
read start  nst=1 xsm=41.37 xsp=72.894 ysm=40.63 ysp=71.29
  zsm=56.071 zsp=71.4   end start
end data
end


=csas25      parm=size=500000
rocky flats criticals nureg/cr-1653 experiment a (27 group)
' 48 fuel cans 2.44 cm moderator gee.hu125.data(opt)
238groupndf5  latticecell
u3o8  1 5.4078e-1 293.0 92234 0.03 92235 4.46 92236 0.08 92238 95.43 end
h2o   1 1.5627e-1 end
arbm-baggie  1.0 3 0 0 0 1001 14.01 6012 84.9 8016 1.20 1 1.9134e-2
   end
arbm-al1100  1.0 3 0 0 1 13027 99.18 26000 0.5 29000 0.2 2 9.5390e-1
   end
arbm-tape(vinyl)  1.0 7 0 0 0 1001 5.92 6012 45.91 8016 10.82 17000
   25.73 20000 6.9 22000 1.6 82000 1.1 2 1.1115e-2 end
arbm-tape(mylar)  1.0 3 0 0 0 1001 6.83 6012 65.50 8016 27.02 2
   1.7491e-2 end
arbm-moderator  1.185 3 0 0 0 1001 7.83 6012 59.49 8016 32.48 3 end
arbm-plex(reg)  1.0 3 0 0 0 1001 7.84 6012 59.59 8016 32.23 4
   1.1773 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 49.5 4
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 86.29 8016 1.20 4
   1.1648e-3 end
arbm-plex(tris)  1.0 8 0 0 1 1001 7.16 6012 52.03 7014 0.16 8016 29.82
   15031 1.02 17000 1.81 35079 4.260 35081 2.840 5 1.2757 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 49.5 5
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 86.29 8016 1.20 5
   1.1648e-3 end
arbm-filler  1.185 3 0 0 0 1001 7.83 6012 59.49 8016 32.48 6 .888 end
' this material is actually moderator adjusted for the volume
' fraction of the void filled between core and reflector.
end comp
sphtriangp  19.9462 18.5857 1 3 18.9579 2 end
rocky flats criticals nureg/cr-1653 experiment a (27 group)
' 48 fuel cans 2.44 cm moderator gee.hu125.data(opt)
read parm  run=yes npg=2000 fdn=yes nub=yes plt=no  end parm
read geom
unit  1
com='fuel box 15.28 cm on a side with .15 cm walls .05cm stacking void'
cuboid  1 1 6p7.49
cuboid  2 1 6p7.64
cuboid  0 1 6p7.6650
unit  2
com='x-face interstitial moderator'
cuboid  3 1 2p1.2200 4p7.665
unit  3
com='y-face interstitial moderator'
cuboid  3 1 2p7.665 2p1.2200 2p7.665
unit  4
com='z-face interstitial moderator'
cuboid  3 1 4p7.665 2p1.2200
unit  5
com='more x-face moderator'
cuboid  3 1 4p1.2200 2p7.665
unit  6
```

```
com='more y-face moderator'
cuboid  3 1 2p7.665 4p1.2200
unit  7
com='more z-face moderator'
cuboid  3 1 2p1.2200 2p7.665 2p1.2200
unit  8
com='last of interstitial moderator'
cuboid  3 1 6p1.2200
unit  9
com='north split table core'
array 1 3*0.0
unit  10
com='south split table core'
array 2 3*0.0
unit  11
com='plexiglass reflector sheet without tris, north bottom reflector'
cuboid  4 1 2p16.5500 2p38.7500 2p0.6150
unit  12
com='plexiglass reflector sheet with tris, north bottom reflector'
cuboid  5 1 2p16.5500 2p38.7500 2p0.6150
unit  13
com='upper portion north bottom reflector with tris'
cuboid  5 1 2p16.550 2p38.75 2p8.24
unit  14
com='lower portion north bottom reflector with tris'
cuboid  5 1 2p16.550 2p38.75 2p3.69
unit  15
com='north bottom reflector includes regular and tris'
array 3 3*0.0
unit  16
com='plexiglas sheet bottom south reflector without tris'
cuboid  0 1 2p5.1 2p2.55 2p0.615
cuboid  4 1 44.3 -5.1 2p38.75  2p0.615
unit  17
com='plexiglas sheet bottom south reflector with tris'
cuboid  0 1 2p5.1 2p2.55 2p0.615
cuboid  5 1 44.3 -5.1 2p38.75 2p0.6150
unit  18
com='lower portion south bottom reflector with tris'
cuboid  0 1 2p5.1 2p2.55 2p8.855
cuboid  5 1 44.3 -5.1 2p38.75 2p8.855
unit  19
com='south bottom reflector with regular and tris'
array 4 3*0.0
unit  20
com='east and west reflectors for north reflector with tris'
cuboid  5 1 2p16.550 2p12.65 2p54.2825
unit  21
com='array for east and west reflectors for north reflector'
array 5 3*0.0
unit  22
com='east and west reflectors for south reflector with tris'
cuboid  5 1 2p24.700 2p12.65 2p54.2825
unit  23
com='array for east and west reflectors for south reflector'
array 6 3*0.0
unit  24
com='north top reflector with tris'
cuboid  5 1 2p29.100 2p64.05 2p12.15
unit  25
com='array for north top reflector'
array 7 3*0.0
unit  26
```

```
com='south top reflector with tris'
cuboid  0 1 2p5.1 2p2.55 2p12.15
cuboid  5 1 69.4 -5.1 2p64.05 2p12.15
unit  27
com='array for south top reflector'
array 8 3*0.0
unit  28
com='north end reflector 9.8cm portion without tris'
cuboid  4 1 2p4.9000 2p64.0500 2p54.2825
unit  29
com='north end relfector 5.2 cm portion with tris'
cuboid  5 1 2p2.6 2p64.0500 2p54.2825
unit  30
com='north end relfector 10.1 cm portion without tris'
cuboid  4 1 2p5.05 2p64.05 2p54.2825
unit  31
com='array for north end reflector'
array 9 3*0.0
unit  32
com='south end reflector'
cuboid  5 1 2p12.55 2p64.05 2p54.2825
unit  33
com='array for south end reflector'
array 10 3*0.0
unit  34
com='bottom moderating plastic north core'
cuboid  6 1 2p16.550 2p38.7500 2p13.0500
unit  35
com='top moderating plastic north core'
cuboid  6 1 2p16.550 2p38.7500 2p3.2525
unit  36
array 11 3*0.0
unit  37
array 12 3*0.0
unit  38
com='north core with bottom reflector'
array 13 3* 0.0
unit  39
com='north core with east and west reflector'
array 14 3*0.0
unit  40
com='north core with end reflector'
array 15 3*0.0
unit  41
com='north split table faceplate'
cuboid  3 1 2p0.6150 2p64.0500 2p66.4325
unit  42
com='north core with top reflector'
array 16 3*0.0
unit  43
com='north core with faceplate'
array 17 3*0.0
unit  44
com='12.95 cm thick moderator south core'
cuboid  6 1 2p23.924 2p6.475 2p40.183
unit  45
com='2.95 thick moderator south core'
cuboid  6 1 2p23.924 2p38.5285 2p1.475
unit  46
com='combination of core with 12.95 thick moderator'
array 18 3*0.0
unit  47
com='combination of core with 2.95 thick moderator'
```

```
array 19 3*0.0
unit  48
com='south core with east west reflectors'
array 20 3*0.0
unit  49
com='south core with east west reflectors'
array 21 3*0.0
unit  50
com='south core end reflector'
array 22 3*0.0
unit  51
com='faceplate for south split table'
cuboid  3 1 2p0.4620  2p64.0500 2p66.4325
unit  52
com='south core with top reflector'
array 23 3*0.0
unit  53
com='south core with faceplate'
array 24 3*0.0
unit  54
com='air gap'
cuboid  0 1 2p0.1550 2p64.0500 2p66.4325
global
unit  55
com='total'
array 25 3*0.0
unit  56
com='empty fuel location'
cuboid  0 1 6p7.6650
unit  57
com='side moderator'
cuboid  5 1 2p16.550 2p4.4300 2p25.4350
unit  58
com='end moderator'
cuboid  6 1 2p8.1500 2p38.7500 2p25.4350
unit  59
com='south core bottom moderating plastic'
cuboid  6 1 2p24.7000 2p38.7500 2p13.0500
unit  60
com='south core top moderating plastic'
cuboid  6 1 2p24.7000 2p38.7500 2p3.2525
unit  61
com='y-face moderator void'
cuboid  0 1 2p7.665 2p1.2200 2p7.665
unit  62
com='x-face moderator void'
cuboid  0 1 2p1.2200 4p7.665
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
      56 2 1 61 5 3 56 2 1 61 5 3 1q6 56 62 56  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 56 3 5 61 2q6 56 62 56  end fill
ara=3  nux=1 nuy=1 nuz=3
com='north bottom reflector'
```

```
fill  14 11 13  end fill
ara=4  nux=1 nuy=1 nuz=7
com='south bottom reflector'
fill  18 16 17 16 16 17 17  end fill
ara=5  nux=1 nuy=1 nuz=1
com='east and west walls of north reflector'
fill  20 end fill
ara=6  nux=1 nuy=1 nuz=1
com='east and west walls of south reflector'
fill  22  end fill
ara=7  nux=1 nuy=1 nuz=1
com='array for north top reflector'
fill  24  end fill
ara=8  nux=1 nuy=1 nuz=1
com='array for south top reflector'
fill  26 end fill
ara=9  nux=3 nuy=1 nuz=1
com='array for north end reflector'
fill  28 29 30  end fill
ara=10  nux=1 nuy=1 nuz=1
com='array for south end reflector'
fill  32  end fill
ara=11  nux=1 nuy=2 nuz=1
com='combinarion of core with side moderator'
fill  9 57  end fill
ara=12 nux=1 nuy=1 nuz=3
com='combination of previous array with top and bottom moderator'
fill  34 36 35  end fill
ara=13  nux=1 nuy=1 nuz=2
com='combination of north core with bottom reflector'
fill  15 37  end fill
ara=14  nux=1 nuy=3 nuz=1
com='north core with side reflectors'
fill  21 38 21  end fill
ara=15  nux=2 nuy=1 nuz=1
com='north core with end reflector'
fill  31 39  end fill
ara=16  nux=1 nuy=1 nuz=2
com='north core with top reflector'
fill  40 25  end fill
ara=17  nux=2 nuy=1 nuz=1
com='north core with faceplate'
fill  42 41  end fill
ara=18  nux=1 nuy=2 nuz=1
com='combination of s. core with side moderator'
fill  10 57  end fill
ara=19  nux=2 nuy=1 nuz=1
com='combination of core with end moderator'
fill  46 58  end fill
ara=20  nux=1 nuy=1 nuz=4
com='south core with bottom moderator and reflector'
fill  19 59 47 60  end fill
ara=21 nux=1 nuy=3 nuz=1
com='south core with east west reflectors'
fill  23 48 23  end fill
ara=22 nux=2 nuy=1 nuz=1
com='south core with end reflector'
fill  49 33  end fill
ara=23  nux=1 nuy=1 nuz=2
com='combination of core with top reflector'
fill  50 27  end fill
ara=24  nux=2 nuy=1 nuz=1
com='south core with faceplate'
```

```
fill  51 52  end fill
ara=25  nux=3 nuy=1 nuz=1
com='total'
fill  43 54 53  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='0123456'end
ttl='yz slice of north core first row'
xul=48  yul=-2   zul=136
xlr=48  ylr=136 zlr=-2
vax=1  wdn=-1 nax=130  nch='0123456'end
ttl='yz slice of north core second row'
xul=28  yul=-2   zul=136
xlr=28  ylr=136 zlr=-2
vax=1  wdn=-1 nax=130  nch='0123456'end
ttl='yz slice of south core first row'
xul=62 yul=-2   zul=136
xlr=62 ylr=136  zlr=-2
vax=1  wdn=-1 nax=130  nch='0123456'end
ttl='yz slice of south core second row'
xul=80 yul=-2   zul=136
xlr=80 ylr=136  zlr=-2
vax=1  wdn=-1 nax=130  nch='0123456'end
end plot
end data
end


=csas25
rocky flats criticals nureg/cr-1653 experiment c (27 group)
' 80 fuel cans 0.929 cm moderator gee.hu125.data(und2)
238groupndf5  latticecell
u3o8  1 5.4078e-1 293.0 92234 0.03 92235 4.46 92236 0.08 92238 95.43 end
h2o   1 1.5627e-1 end
arbm-baggie  1.0 3 0 0 0 1001 14.01 6012 84.79 8016 1.20 1 1.9134e-2
   end
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 2 9.5390e-1
   end
arbm-tape(vinyl)  1.0 7 0 0 0 1001 5.92 6012 47.93 8016 10.82 17000
   25.73 20000 6.9 22000 1.6 82000 1.1 2 1.1115e-2 end
arbm-tape(mylar)  1.0 3 0 0 0 1001 6.83 6012 66.15 8016 27.02 2
   1.7491e-2 end
arbm-moderator  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 3 end
arbm-plex(reg)  1.0 3 0 0 0 1001 7.84 6012 59.93 8016 32.23 4
   1.1773 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 4
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 4
   1.1648e-3 end
arbm-plex(tris)  1.0 8 0 0 1 1001 7.16 6012 52.93 7014 0.16 8016 29.82
   15031 1.02 17000 1.81 35079 4.260 35081 2.840 5 1.2757 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 5
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 5
   1.1648e-3 end
arbm-filler  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 6 .854 end
' this material is actually moderator adjusted for the volume
' fraction of the void filled between core and reflector.
end comp
sphtriangp  19.00 18.5857 1 3 18.9579 2 end
rocky flats criticals nureg/cr-1653 experiment c (27 group)
```

```
' 80 fuel cans 0.929 cm moderator gee.hu125.data(und2)
read parm  run=yes npg=2000 fdn=yes nub=yes plt=no  end parm
read geom
unit  1
com='fuel box 15.28 cm on a side with .15 cm walls .05cm stacking void'
cuboid  1 1 6p7.49
cuboid  2 1 6p7.64
cuboid  0 1 6p7.6650
unit  2
com='x-face interstitial moderator'
cuboid  3 1 2p0.4645 4p7.665
unit  3
com='y-face interstitial moderator'
cuboid  3 1 2p7.665 2p0.4645 2p7.665
unit  4
com='z-face interstitial moderator'
cuboid  3 1 4p7.665 2p0.4645
unit  5
com='more x-face moderator'
cuboid  3 1 4p0.4645 2p7.665
unit  6
com='more y-face moderator'
cuboid  3 1 2p7.665 4p0.4645
unit  7
com='more z-face moderator'
cuboid  3 1 2p0.4645 2p7.665 2p0.4645
unit  8
com='last of interstitial moderator'
cuboid  3 1 6p0.4645
unit  9
com='north split table core'
array 1 3*0.0
unit  10
com='south split table core'
array 2 3*0.0
unit  11
com='plexiglass reflector sheet without tris, north bottom reflector'
cuboid  4 1 2p15.8000 2p38.7500 2p0.6150
unit  12
com='plexiglass reflector sheet with tris, north bottom reflector'
cuboid  5 1 2p15.8000 2p38.7500 2p0.6150
unit  13
com='upper portion north bottom reflector with tris'
cuboid  5 1 2p15.8 2p38.75 2p8.24
unit  14
com='lower portion north bottom reflector with tris'
cuboid  5 1 2p15.8 2p38.75 2p3.69
unit  15
com='north bottom reflector includes regular and tris'
array 3 3*0.0
unit  16
com='plexiglas sheet bottom south reflector without tris'
cuboid  0 1 2p5.1 2p2.55 2p0.615
cuboid  4 1 44.3 -5.1 2p38.75  2p0.615
unit  17
com='plexiglas sheet bottom south reflector with tris'
cuboid  0 1 2p5.1 2p2.55 2p0.615
cuboid  5 1 44.3 -5.1 2p38.75 2p0.6150
unit  18
com='lower portion south bottom reflector with tris'
cuboid  0 1 2p5.1 2p2.55 2p8.855
cuboid  5 1 44.3 -5.1 2p38.75 2p8.855
unit  19
```

```
com='south bottom reflector with regular and tris'
array 4 3*0.0
unit  20
com='east and west reflectors for north reflector with tris'
cuboid  5 1 2p15.8 2p12.65 2p54.2825
unit  21
com='array for east and west reflectors for north reflector'
array 5 3*0.0
unit  22
com='east and west reflectors for south reflector with tris'
cuboid  5 1 2p24.700 2p12.65 2p54.2825
unit  23
com='array for east and west reflectors for south reflector'
array 6 3*0.0
unit  24
com='north top reflector with tris'
cuboid  5 1 2p28.35 2p64.05 2p12.15
unit  25
com='array for north top reflector'
array 7 3*0.0
unit  26
com='south top reflector with tris'
cuboid  0 1 2p5.1 2p2.55 2p12.15
cuboid  5 1 69.4 -5.1 2p64.05 2p12.15
unit  27
com='array for south top reflector'
array 8 3*0.0
unit  28
com='north end reflector 9.8cm portion without tris'
cuboid  4 1 2p4.9000 2p64.0500 2p54.2825
unit  29
com='north end relfector 5.2 cm portion with tris'
cuboid  5 1 2p2.6 2p64.0500 2p54.2825
unit  30
com='north end relfector 10.1 cm portion without tris'
cuboid  4 1 2p5.05 2p64.05 2p54.2825
unit  31
com='array for north end reflector'
array 9 3*0.0
unit  32
com='south end reflector'
cuboid  5 1 2p12.55 2p64.05 2p54.2825
unit  33
com='array for south end reflector'
array 10 3*0.0
unit  34
com='12.95 thick moderating plastic north core'
cuboid  6 1 2p15.7945 2p6.4750 2p32.0535
unit  35
com='2.95 thick moderating plastic north core'
cuboid  6 1 2p15.7945 2p38.5285 2p1.475
unit  36
array 11 3*0.0
unit  37
array 12 3*0.0
replicate  0 1 0.0 0.011 0.443 0.0 0.1590 0.0 1
unit  38
com='north core with bottom reflector'
array 13 3*0.0
unit  39
com='north core with east and west reflector'
array 14 3*0.0
unit  40
```

```
com='north core with end reflector'
array 15 3*0.0
unit  41
com='north split table faceplate'
cuboid  3 1 2p0.6150 2p64.0500 2p66.4325
unit  42
com='north core with top reflector'
array 16 3*0.0
unit  43
com='north core with faceplate'
array 17 3*0.0
unit  44
com='12.95 cm thick moderator south core'
cuboid  6 1 2p23.924 2p6.475 2p32.0535
unit  45
com='2.95 thick moderator south core'
cuboid  6 1 2p23.924 2p38.5285 2p1.475
unit  46
com='combination of core with 12.95 thick moderator'
array 18 3*0.0
unit  47
com='combination of core with 2.95 thick moderator'
array 19 3*0.0
replicate  0 1 1.552 0.0 0.4430 0.0 0.159 0.0 1
unit  48
com='south core with east west reflectors'
array 20 3*0.0
unit  49
com='south core with east west reflectors'
array 21 3*0.0
unit  50
com='south core end reflector'
array 22 3*0.0
unit  51
com='faceplate for south split table'
cuboid  3 1 2p0.4620  2p64.0500 2p66.4325
unit  52
com='south core with top reflector'
array 23 3*0.0
unit  53
com='south core with faceplate'
array 24 3*0.0
unit  54
com='air gap'
cuboid  0 1 2p0.7805 2p64.0500 2p66.4325
global
unit  55
com='total'
array 25 3*0.0
unit  56
com='north bottom moderator'
cuboid  6 1 2p15.8000 2p38.7500 2p8.1295
unit  57
com='bottom south moderator'
cuboid  6 1 2p24.700 2p38.75  2p8.1295
'unit  58
'com='south rear moderator'
'cuboid  3 1
end geometry
read array
ara=1  nux=3 nuy=7 nuz=7
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
      2q42
      1 2 1 3 5 3 2q6 1 2 1  end fill
ara=2  nux=5 nuy=7 nuz=7
com='south split table core'
fill  1 2 1 2 1 3 5 3 5 3 2q10 1 2 1 2 1
      4 7 4 7 4 6 8 6 8 6 2q10 4 7 4 7 4
      2q70
      1 2 1 2 1 3 5 3 5 3 2q10 1 2 1 2 1  end fill
ara=3  nux=1 nuy=1 nuz=4
com='north bottom moderator and reflector'
fill  14 11 13 56  end fill
ara=4  nux=1 nuy=1 nuz=8
com='south bottom moderator and reflector'
fill  18 16 17 16 16 17 17 57  end fill
ara=5  nux=1 nuy=1 nuz=1
com='east and west walls of north reflector'
fill  20 end fill
ara=6  nux=1 nuy=1 nuz=1
com='east and west walls of south reflector'
fill  22  end fill
ara=7  nux=1 nuy=1 nuz=1
com='array for north top reflector'
fill  24  end fill
ara=8  nux=1 nuy=1 nuz=1
com='array for south top reflector'
fill  26 end fill
ara=9  nux=3 nuy=1 nuz=1
com='array for north end reflector'
fill  28 29 30  end fill
ara=10  nux=1 nuy=1 nuz=1
com='array for south end reflector'
fill  32  end fill
ara=11  nux=1 nuy=2 nuz=1
com='combinarion of core with 12.95cm thick moderator'
fill  9 34  end fill
ara=12 nux=1 nuy=1 nuz=2
com='combination of previous array with 2.95cm thick moderator'
fill  36 35  end fill
ara=13  nux=1 nuy=1 nuz=2
com='combination of north core with bottom reflector'
fill  15 37  end fill
ara=14  nux=1 nuy=3 nuz=1
com='north core with side reflectors'
fill  21 38 21  end fill
ara=15  nux=2 nuy=1 nuz=1
com='north core with end reflector'
fill  31 39  end fill
ara=16  nux=1 nuy=1 nuz=2
com='north core with top reflector'
fill  40 25  end fill
ara=17  nux=2 nuy=1 nuz=1
com='north core with faceplate'
fill  42 41  end fill
ara=18  nux=1 nuy=2 nuz=1
com='combination of s. core with 12.95 cm thick moderator'
fill  10 44  end fill
ara=19  nux=1 nuy=1 nuz=2
com='combination of core with 2.95 cm thick moderator'
fill  46 45  end fill
ara=20  nux=1 nuy=1 nuz=2
com='south core with bottom reflector'
fill  19 47  end fill
```

```
ara=21 nux=1 nuy=3 nuz=1
com='south core with east west reflectors'
fill  23 48 23  end fill
ara=22 nux=2 nuy=1 nuz=1
com='south core with end reflector'
fill  49 33  end fill
ara=23  nux=1 nuy=1 nuz=2
com='combination of core with top reflector'
fill  50 27  end fill
ara=24  nux=2 nuy=1 nuz=1
com='south core with faceplate'
fill  51 52  end fill
ara=25  nux=3 nuy=1 nuz=1
com='total'
fill  43 54 53  end fill
end array
read plot ttl='xz slice of rfp3 showing material regions'
xul=-1  yul=64.05 zul=135
xlr=136 ylr=64.05 zlr=-2
uax=1  wdn=-1 nax=130  nch='0123456'end
ttl='yz slice of north core second row'
xul=28  yul=-2   zul=136
xlr=28  ylr=136 zlr=-2
vax=1  wdn=-1 nax=130  nch='0123456'end
ttl='yz slice of south core second row'
xul=80 yul=-2   zul=136
xlr=80 ylr=136  zlr=-2
vax=1  wdn=-1 nax=130  nch='0123456'
end plot
end data
end


=csas25
rocky flats criticals nureg/cr-1653 experiment number ? (27 group model)
' fuel cube 15.28 cm, u(4.46)3o8 @ h/u=1.25, hi conc. solution driven
238groupndf5  infhommedium
u3o8  1 5.4078e-1 293.0 92234 0.03 92235 4.46 92236 0.08 92238 95.43 end
h2o   1 1.5627e-1 end
arbm-baggie  1.0 3 0 0 0 1001 14.01 6012 84.79 8016 1.20 1 1.9134e-2
   end
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 2 9.5390e-120
   end
arbm-tape(vinyl)  1.0 7 0 0 0 1001 5.92 6012 47.93 8016 10.82 17000
   25.73 20000 6.9 22000 1.6 82000 1.1 2 1.1115e-2 end
arbm-tape(mylar)  1.0 3 0 0 0 1001 6.83 6012 66.15 8016 27.02 2
   1.7491e-2 end
arbm-moderator  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 3 end
arbm-plex(reg)  1.0 3 0 0 0 1001 7.84 6012 59.93 8016 32.23 4
   1.1773 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 4
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 4
   1.1648e-3 end
arbm-plex(tris)  1.0 8 0 0 1 1001 7.16 6012 52.93 7014 0.16 8016 29.82
   15031 1.02 17000 1.81 35079 4.260 35081 2.840 5 1.2757 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 5
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 5
   1.1648e-3 end
arbm-filler  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 6 0.7 end
' this material is actually moderator adjusted for the volume
' fraction of the void filled between core and reflector.
```

```
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 7 2.715  end
solnuo2(no3)2  8 351.18 0.549 1.0 293.0 92234 1.022 92235 93.172
   92236 0.434 92238 5.372  end
ss304  9 1.0 end
end comp
rocky flats criticals nureg/cr-1653 experiment number ? (27 group model)
' fuel cube 15.28 cm, u(4.46)3o8 @ h/u=1.25, hi conc. solution driven
read parm  npg=2000 nub=yes fdn=yes plt=no  end parm
read geom
unit  1
com='fuel box with void and part of al box'
cuboid  0 1 9.80  0.0 3.75   0.0   14.98 0.0
cuboid  2 1 9.95  0.0 3.90  -0.15  14.98 0.0
cuboid  1 1 14.98 0.0 9.365 -5.615 14.98 0.0
unit  2
com='front of fuel box'
cuboid  2 1 0.15 0.0  5.615 0.0 14.98 0.0
cuboid  0 1 0.15 0.0  9.365 0.0 14.98 0.0
cuboid  2 1 0.15 0.0 14.98  0.0 14.98 0.0
unit  3
com='rear of fuel box'
cuboid  2 1 0.15 0.0 14.98  0.0 14.98 0.0
unit  4
com='array to assemble part of box'
array 26 3*0
unit  5
com='top and bottom of box'
cuboid  0 1  9.80 0.0 3.750  0.0   0.15 0.0
cuboid  2 1 15.28 0.0 9.365 -5.615 0.15 0.0
global
unit  6
com='array to assemble top and bottom'
array 27 3*0
cuboid  2 1 15.28   0.0   15.13  -0.15  15.28   0.0
cuboid  0 1 15.305 -0.025 15.155 -0.175 15.305 -0.025
unit  7
com='fuel box 15.28 cm on a side with .15 cm walls .05cm stacking void'
cuboid  1 1 6p7.49
cuboid  2 1 6p7.64
cuboid  0 1 6p7.6650
unit  34
com='aluminum weight distribution plate for special box'
cuboid  0 1  9.80 0.0 3.750  0.0   0.16 0.0
cuboid  7 1 15.33 0.0 9.54 -5.79 0.16 0.0
unit  35
com='aluminum weight distribution plate for boxes'
cuboid  7 1  4p7.665 0.16 0.0
unit  9
com='north split table core'
array 1 3*0.0
cuboid  0 1 30.66 -0.94 77.5 0.0 83.475 0.0
unit  10
com='south split table core'
array 2 3*0.0
cuboid  0 1 49.4 0.0 77.5 0.0 83.475 0.0
unit  11
com='plexiglass reflector sheet without tris, north bottom reflector'
cuboid  4 1 2p15.8000 2p38.7500 2p0.6150
unit  12
com='plexiglass reflector sheet with tris, north bottom reflector'
cuboid  5 1 2p15.8000 2p38.7500 2p0.6150
unit  13
com='upper portion north bottom reflector with tris'
```

```
cuboid  5 1 2p15.8 2p38.75 2p8.24
unit  14
com='lower portion north bottom reflector with tris'
cuboid  5 1 2p15.8 2p38.75 2p3.69
unit  15
com='north bottom reflector includes regular and tris'
array 3 3*0.0
unit  16
com='plexiglas sheet bottom south reflector without tris'
cuboid  0 1 2p5.1 2p2.5 2p0.6150
cuboid  4 1 44.3 -5.1 2p38.75  2p0.615
unit  17
com='plexiglas sheet bottom south reflector with tris'
cuboid  0 1 2p5.1 2p2.5 2p0.6150
cuboid  5 1 44.3 -5.1 2p38.75 2p0.6150
unit  18
com='lower portion south bottom reflector with tris'
cuboid  0 1 2p5.1 2p2.5 2p8.855
cuboid  5 1 44.3 -5.1 2p38.75 2p8.855
unit  19
com='south bottom reflector with regular and tris'
array 4 3*0.0
unit  20
com='east and west reflectors for north reflector with tris'
cuboid  5 1 2p15.8 2p12.65 2p54.2825
unit  21
com='array for east and west reflectors for north reflector'
array 5 3*0.0
unit  22
com='east and west reflectors for south reflector with tris'
cuboid  5 1 2p24.700 2p12.65 2p54.2825
unit  23
com='array for east and west reflectors for south reflector'
array 6 3*0.0
unit  24
com='north top reflector with tris'
cuboid  5 1 2p28.35 2p64.05 2p12.15
unit  25
com='array for north top reflector'
array 7 3*0.0
unit  26
com='south top reflector with tris'
cuboid  0 1 2p5.1 2p2.5 2p12.15
cuboid  5 1 69.4 -5.1 2p64.05 2p12.15
unit  27
com='array for south top reflector'
array 8 3*0.0
unit  28
com='north end reflector 9.8cm portion without tris'
cuboid  4 1 2p4.9000 2p64.0500 2p54.2825
unit  29
com='north end relfector 5.2 cm portion with tris'
cuboid  5 1 2p2.6 2p64.0500 2p54.2825
unit  30
com='north end relfector 10.1 cm portion without tris'
cuboid  4 1 2p5.05 2p64.05 2p54.2825
unit  31
com='array for north end reflector'
array 9 3*0.0
unit  32
com='south end reflector'
cuboid  5 1 2p12.55 2p64.05 2p54.2825
```

```
unit  33
com='array for south end reflector'
array 10 3*0.0
unit  38
com='north core with bottom reflector'
array 13 3* 0.0
unit  39
com='north core with east and west reflector'
array 14 3*0.0
unit  40
com='north core with end reflector'
array 15 3*0.0
unit  42
com='north core with top reflector'
array 16 3*0.0
unit  48
com='south core with bottom reflectors'
array 20 3*0.0
unit  49
com='south core with east west reflectors'
array 21 3*0.0
unit  50
com='south core end reflector'
array 22 3*0.0
unit  52
com='south core with top reflector'
array 23 3*0.0
unit  54
com='air gap'
cuboid  0 1 0.732 0.0 64.475 -63.625 69.13 -63.735
global
unit  55
com='total'
array 25 3*0.0
unit  56
com='combination of two regular fuel boxes'
array 28 3*0.0
unit  57
com='combination of regular fuel box and special fuel box'
array 29 3*0.0
unit  58
com='combination of two regular weight distribution plates'
array 30 3*0.0
unit  59
com='combination of regular and special weight distribution plates'
array 31 3*0.0
unit  60
com='north core solution driver'
cuboid  8 1 2p7.5 2p14.9 1.863 -7.5
cuboid  0 1 2p7.5 2p14.9 2p7.5
cuboid  9 1 2p7.65 2p15.05 2p7.65
cuboid  0 1 2p7.665 2p15.33 2p7.665
unit  61
com='south core solution driver'
cuboid  8 1 2p7.5 2p14.9 1.794 -7.5
cuboid  0 1 2p7.5 2p14.9 2p7.5
cuboid  9 1 2p7.65 2p15.05 2p7.65
cuboid  0 1 2p7.665 2p15.33 2p7.665
end geometry
read array
ara=1  nux=2 nuy=4 nuz=9
com='north split table core'
fill   2r7  2r56  4r7
```

```
        2r35 2r58  4r35
        2r7  2r56  4r7
        2r35 2r58  4r35
        2r7  56 60 4r7
        2r35 2r58  4r35
        2r7  2r56  4r7
        2r35 2r58  4r35
        2r7  2r56  4r7
end fill
ara=2  nux=3 nuy=4 nuz=9
com='south split table core'
fill    3r7  3r56     6r7
        3r35 3r58     6r35
        3r7  3r56     6r7
        3r35 3r58     6r35
        3r7  61 56 56 6r7
        3r35 3r58     6r35
        3r7  57 56 56 6r7
        3r35 59 58 58 6r35
        3r7  57 56 56 6r7
end fill
ara=3  nux=1 nuy=1 nuz=3
com='north bottom reflector'
fill  14 11 13  end fill
ara=4  nux=1 nuy=1 nuz=7
com='south bottom reflector'
fill  18 16 17 16 16 17 17  end fill
ara=5  nux=1 nuy=1 nuz=1
com='east and west walls of north reflector'
fill  20 end fill
ara=6  nux=1 nuy=1 nuz=1
com='east and west walls of south reflector'
fill  22  end fill
ara=7  nux=1 nuy=1 nuz=1
com='array for north top reflector'
fill  24  end fill
ara=8  nux=1 nuy=1 nuz=1
com='array for south top reflector'
fill  26 end fill
ara=9  nux=3 nuy=1 nuz=1
com='array for north end reflector'
fill  28 29 30  end fill
ara=10  nux=1 nuy=1 nuz=1
com='array for south end reflector'
fill  32  end fill
ara=13  nux=1 nuy=1 nuz=2
com='combination of north core with bottom reflector'
fill  15 9  end fill
ara=14  nux=1 nuy=3 nuz=1
com='north core with side reflectors'
fill  21 38 21  end fill
ara=15  nux=2 nuy=1 nuz=1
com='north core with end reflector'
fill  31 39  end fill
ara=16  nux=1 nuy=1 nuz=2
com='north core with top reflector'
fill  40 25  end fill
ara=20  nux=1 nuy=1 nuz=2
com='south core with bottom reflector'
fill  19 10  end fill
ara=21 nux=1 nuy=3 nuz=1
com='south core with east west reflectors'
fill  23 48 23  end fill
```

```
ara=22 nux=2 nuy=1 nuz=1
com='south core with end reflector'
fill  49 33  end fill
ara=23  nux=1 nuy=1 nuz=2
com='combination of core with top reflector'
fill  50 27  end fill
ara=25  nux=3 nuy=1 nuz=1
com='total'
fill  42 54 52  end fill
ara=26  nux=3 nuy=1 nuz=1
com='assembly of fuel box front and rear'
fill  2 1 3  end fill
ara=27  nux=1 nuy=1 nuz=3
com='assembly of fuel box top and bottom'
fill  5 4 5  end fill
ara=28  nux=1 nuy=2 nuz=1
com='combination of two fuel boxes'
fill  7 7  end fill
ara=29  nux=1 nuy=2 nuz=1
com='combination of special and regular fuel boxes'
fill  7 6  end fill
ara=30  nux=1 nuy=2 nuz=1
com='combination of two weight distribution plates'
fill  35 35  end fill
ara=31  nux=1 nuy=2 nuz=1
com='combination of special and regular weight distribution plates'
fill  35 34  end fill
end array
read plot ttl='yz slice of south core first row'
xul=64.319 yul=40.000 zul=72.000
xlr=64.319 ylr=72.000 zlr=56.000
vax=1  wdn=-1 nax=130  nch='012345678'end
ttl='xz slice of sphere cuboid'
xul=56.0 yul=63.625 zul=71.735
xlr=72.0 ylr=63.625 zlr=55.735
uax=1  wdn=-1 nax=130  nch='012345678'
end plot
' read start  nst=1 xsm=41.37 xsp=72.894 ysm=40.63 ysp=71.29
'   zsm=56.071 zsp=71.4   end start
read start  nst=1  end start
end data
end


=csas25
rocky flats criticals nureg/cr-2500 experiment number ? (27 group model)
' fuel cube 15.28 cm, u(4.46)3o8 @ h/u=2.03, hi enriched sphere driven
238groupndf5  infhommedium
u3o8  1 5.4078e-1 293.0 92234 0.03 92235 4.46 92236 0.08 92238 95.43 end
h2o   1 2.6356e-1 end
arbm-baggie  1.0 3 0 0 0 1001 14.01 6012 84.79 8016 1.20 1 1.9134e-2
   end
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 2 9.5390e-1
   end
arbm-tape(vinyl)  1.0 7 0 0 0 1001 5.92 6012 47.93 8016 10.82 17000
   25.73 20000 6.9 22000 1.6 82000 1.1 2 1.1115e-2 end
arbm-tape(mylar)  1.0 3 0 0 0 1001 6.83 6012 66.15 8016 27.02 2
   1.7491e-2 end
arbm-moderator  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 3 end
arbm-plex(reg)  1.0 3 0 0 0 1001 7.84 6012 59.93 8016 32.23 4
   1.1773 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 4
   3.7534e-3 end
```

```
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 4
   1.1648e-3 end
arbm-plex(tris)  1.0 8 0 0 1 1001 7.16 6012 52.93 7014 0.16 8016 29.82
   15031 1.02 17000 1.81 35079 4.260 35081 2.840 5 1.2757 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 5
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 5
   1.1648e-3 end
arbm-filler  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 6 0.7 end
' this material is actually moderator adjusted for the volume
' fraction of the void filled between core and reflector.
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 7 2.715  end
uranium  8 0.9483 293.0 92234 1.0 92235 93.19 92236 0.4 92238  5.41 end
arbm-pj  0.816 2 0 0 0 1001 85.1 6012 14.9 8 0.0089  end
ss304  9 1.0 end
end comp
rocky flats criticals nureg/cr-2500 experiment number ? (27 group model)
' fuel cube 15.28 cm, u(4.46)3o8 @ h/u=2.03, hi enriched sphere driven
read parm  npg=2000 nub=yes fdn=yes plt=no  end parm
read geom
unit  1
com='fuel box with void and part of al box'
cuboid  0 1 9.80  0.0 3.75   0.0   14.98 0.0
cuboid  2 1 9.95  0.0 3.90  -0.15  14.98 0.0
cuboid  1 1 14.98 0.0 9.365 -5.615 14.98 0.0
unit  2
com='front of fuel box'
cuboid  2 1 0.15 0.0  5.615 0.0 14.98 0.0
cuboid  0 1 0.15 0.0  9.365 0.0 14.98 0.0
cuboid  2 1 0.15 0.0 14.98  0.0 14.98 0.0
unit  3
com='rear of fuel box'
cuboid  2 1 0.15 0.0 14.98  0.0 14.98 0.0
unit  4
com='array to assemble part of box'
array 26 3*0
unit  5
com='top and bottom of box'
cuboid  0 1  9.80 0.0 3.750  0.0   0.15 0.0
cuboid  2 1 15.28 0.0 9.365 -5.615 0.15 0.0
global
unit  6
com='array to assemble top and bottom'
array 27 3*0
cuboid  2 1 15.28   0.0   15.13  -0.15  15.28   0.0
cuboid  0 1 15.305 -0.025 15.155 -0.175 15.305 -0.025
unit  7
com='fuel box 15.28 cm on a side with .15 cm walls .05cm stacking void'
cuboid  1 1 6p7.49
cuboid  2 1 6p7.64
cuboid  0 1 6p7.6650
unit  8
com='box for driver'
cylinder  9 1 0.3175 2p2.318
sphere    0 1 2.34
sphere    8 1 5.67
hole   36 0.0 0.0  2.3401
hole  100 0.0 0.0 -2.3401
cuboid  0 1 8.71 -6.62 2p7.665 7.365 -7.965
hole   37 0.0 0.0 -7.965
unit  34
com='aluminum weight distribution plate for special box'
cuboid  0 1  9.80 0.0 3.750  0.0   0.16 0.0
```

```
cuboid  7 1 15.33 0.0 9.54 -5.79 0.16 0.0
unit  35
com='aluminum weight distribution plate for boxes'
cuboid  7 1  4p7.665 0.16 0.0
unit  36
com='driver support'
cylinder  9 1 0.3175 3.32 0.0
unit  100
com='driver support'
cylinder  9 1 0.3175 0.0 -3.32
unit  37
com='driver mount'
cylinder  9 1 1.56 2.2 0.0
unit  9
com='north split table core'
array 1 3*0.0
cuboid  0 1 30.66 -0.94 77.5 0.0 83.475 0.0
unit  10
com='south split table core'
array 2 3*0.0
cuboid  0 1 49.4 0.0 77.5 0.0 83.475 0.0
unit  11
com='plexiglass reflector sheet without tris, north bottom reflector'
cuboid  4 1 2p15.8000 2p38.7500 2p0.6150
unit  12
com='plexiglass reflector sheet with tris, north bottom reflector'
cuboid  5 1 2p15.8000 2p38.7500 2p0.6150
unit  13
com='upper portion north bottom reflector with tris'
cuboid  5 1 2p15.8 2p38.75 2p8.24
unit  14
com='lower portion north bottom reflector with tris'
cuboid  5 1 2p15.8 2p38.75 2p3.69
unit  15
com='north bottom reflector includes regular and tris'
array 3 3*0.0
unit  16
com='plexiglas sheet bottom south reflector without tris'
cuboid  0 1 2p5.1 2p2.5 2p0.6150
cuboid  4 1 44.3 -5.1 2p38.75  2p0.615
unit  17
com='plexiglas sheet bottom south reflector with tris'
cuboid  0 1 2p5.1 2p2.5 2p0.6150
cuboid  5 1 44.3 -5.1 2p38.75 2p0.6150
unit  18
com='lower portion south bottom reflector with tris'
cuboid  0 1 2p5.1 2p2.5 2p8.855
cuboid  5 1 44.3 -5.1 2p38.75 2p8.855
unit  19
com='south bottom reflector with regular and tris'
array 4 3*0.0
unit  20
com='east and west reflectors for north reflector with tris'
cuboid  5 1 2p15.8 2p12.65 2p54.2825
unit  21
com='array for east and west reflectors for north reflector'
array 5 3*0.0
unit  22
com='east and west reflectors for south reflector with tris'
cuboid  5 1 2p24.700 2p12.65 2p54.2825
unit  23
com='array for east and west reflectors for south reflector'
array 6 3*0.0
```

```
unit  24
com='north top reflector with tris'
cuboid  5 1 2p28.35 2p64.05 2p12.15
unit  25
com='array for north top reflector'
array 7 3*0.0
unit  26
com='south top reflector with tris'
cuboid  0 1 2p5.1 2p2.5 2p12.15
cuboid  5 1 69.4 -5.1 2p64.05 2p12.15
unit  27
com='array for south top reflector'
array 8 3*0.0
unit  28
com='north end reflector 9.8cm portion without tris'
cuboid  4 1 2p4.9000 2p64.0500 2p54.2825
unit  29
com='north end relfector 5.2 cm portion with tris'
cuboid  5 1 2p2.6 2p64.0500 2p54.2825
unit  30
com='north end relfector 10.1 cm portion without tris'
cuboid  4 1 2p5.05 2p64.05 2p54.2825
unit  31
com='array for north end reflector'
array 9 3*0.0
unit  32
com='south end reflector'
cuboid  5 1 2p12.55 2p64.05 2p54.2825
unit  33
com='array for south end reflector'
array 10 3*0.0
unit  38
com='north core with bottom reflector'
array 13 3* 0.0
unit  39
com='north core with east and west reflector'
array 14 3*0.0
unit  40
com='north core with end reflector'
array 15 3*0.0
unit  42
com='north core with top reflector'
array 16 3*0.0
unit  48
com='south core with bottom reflectors'
array 20 3*0.0
unit  49
com='south core with east west reflectors'
array 21 3*0.0
unit  50
com='south core end reflector'
array 22 3*0.0
unit  52
com='south core with top reflector'
array 23 3*0.0
unit  54
com='air gap'
cuboid  0 1 1.49 0.0 64.475 -63.625 69.13 -63.735
global
unit  55
com='total'
array 25 3*0.0
end geometry
```

```
read array
ara=1  nux=2 nuy=5 nuz=9
com='north split table core'
fill  10r7
      10r35
      10r7
      10r35
      10r7
      10r35
      10r7
      10r35
      10r7   end fill
ara=2  nux=3 nuy=5 nuz=9
com='south split table core'
fill  6r7 6 8r7
      6r35 34 8r35
      6r7 6 8r7
      6r35 34 8r35
      6r7 8 8r7
      6r35 34 8r35
      6r7 6 8r7
      6r35 34 8r35
      6r7 6 8r7  end fill
ara=3  nux=1 nuy=1 nuz=3
com='north bottom reflector'
fill  14 11 13  end fill
ara=4  nux=1 nuy=1 nuz=7
com='south bottom reflector'
fill  18 16 17 16 16 17 17  end fill
ara=5  nux=1 nuy=1 nuz=1
com='east and west walls of north reflector'
fill  20 end fill
ara=6  nux=1 nuy=1 nuz=1
com='east and west walls of south reflector'
fill  22  end fill
ara=7  nux=1 nuy=1 nuz=1
com='array for north top reflector'
fill  24  end fill
ara=8  nux=1 nuy=1 nuz=1
com='array for south top reflector'
fill  26 end fill
ara=9  nux=3 nuy=1 nuz=1
com='array for north end reflector'
fill  28 29 30  end fill
ara=10  nux=1 nuy=1 nuz=1
com='array for south end reflector'
fill  32  end fill
ara=13  nux=1 nuy=1 nuz=2
com='combination of north core with bottom reflector'
fill  15 9  end fill
ara=14  nux=1 nuy=3 nuz=1
com='north core with side reflectors'
fill  21 38 21  end fill
ara=15  nux=2 nuy=1 nuz=1
com='north core with end reflector'
fill  31 39  end fill
ara=16  nux=1 nuy=1 nuz=2
com='north core with top reflector'
fill  40 25  end fill
ara=20  nux=1 nuy=1 nuz=2
com='south core with bottom reflector'
fill  19 10  end fill
ara=21 nux=1 nuy=3 nuz=1
```

```
com='south core with east west reflectors'
fill  23 48 23  end fill
ara=22 nux=2 nuy=1 nuz=1
com='south core with end reflector'
fill  49 33  end fill
ara=23  nux=1 nuy=1 nuz=2
com='combination of core with top reflector'
fill  50 27  end fill
ara=25  nux=3 nuy=1 nuz=1
com='total'
fill  42 54 52  end fill
ara=26  nux=3 nuy=1 nuz=1
com='assembly of fuel box front and rear'
fill  2 1 3  end fill
ara=27  nux=1 nuy=1 nuz=3
com='assembly of fuel box top and bottom'
fill  5 4 5  end fill
end array
read plot ttl='yz slice of south core first row'
xul=64.319 yul=55.625 zul=71.735
xlr=64.319 ylr=71.625 zlr=55.735
vax=1  wdn=-1 nax=130  nch='012345678'end
ttl='xz slice of sphere cuboid'
xul=56.0 yul=63.625 zul=71.735
xlr=72.0 ylr=63.625 zlr=55.735
uax=1  wdn=-1 nax=130  nch='012345678'
end plot
' read start  nst=6 tfx=65 tfy=63.625 tfz=63.735 lnu=300  end start
read start  nst=1 xsm=56.981 xsp=71.649 ysm=56.219 ysp=70.959
  zsm=56.401 zsp=71.069   end start
end data
end


=csas25
british handbook of criticality safety u(1.42)f4 & paraffin (case 04)
238groupndf5  infhommedium
uf4      1 0.4903 293 92235 1.4023 92238 98.5977 end
' note: the enrichment given in the refrence is not weight percent
para(h2o) 1 0.4572 end
end comp
british handbook of criticality safety u(1.42)f4 & paraffin (case 04)
read parm   npg=2000 nub=yes fdn=yes end parm
read geom
cuboid  1 1 2p46.55 2p46.50 2p61.9
end geom
end data
end


=csas25
british handbook of criticality safety u(1.42)f4 & paraffin (case 05)
238groupndf5  infhommedium
uf4      1 0.4903 293 92235 1.4023 92238 98.5977 end
' note: the enrichment given in the refrence is not weight percent
para(h2o) 1 0.4572 end
end comp
british handbook of criticality safety u(1.42)f4 & paraffin (case 05)
read parm   npg=2000 nub=yes fdn=yes end parm
read geom
cuboid  1 1 2p50.00 2p49.95 2p51.55
end geom
end data
```

```
end


=csas25
british handbook of criticality safety u(1.42)f4 & paraffin (case 06)
238groupndf5  infhommedium
uf4      1 0.4903 293 92235 1.4023 92238 98.5977 end
' note: the enrichment given in the refrence is not weight percent
para(h2o) 1 0.4572 end
end comp
british handbook of criticality safety u(1.42)f4 & paraffin (case 06)
read parm   npg=2000 nub=yes fdn=yes end parm
read geom
cuboid  1 1 2p65.35 2p65.3 2p37.1
end geom
end data
end
=csas25
british handbook of criticality safety u(1.42)f4 & paraffin (case 06)
hansen-roach  infhommedium
uf4      1 0.4903 293 92235 1.4023 92238 98.5977 end
' note: the enrichment given in the refrence is not weight percent
para(h2o) 1 0.4572 end
end comp
british handbook of criticality safety u(1.42)f4 & paraffin (case 06)
read parm  npg=2000 nub=yes fdn=yes end parm
read geom
cuboid  1 1 2p65.35 2p65.3 2p37.1
end geom
end data
end


=csas25
raffety and milhalczo u(2)f4-1 reflected (case 11)
238groupndf5  infhommedium
u-235  1 0 1.5811e-4 end
u-238  1 0 7.6467e-3 end
h      1 0 3.0864e-2 end
c      1 0 1.4839e-2 end
f      1 0 3.1219e-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)f4-1 reflected (case 11)
read parm  run=yes    npg=2000 nub=yes fdn=yes    end parm
read geom
unit  1
cuboid  1 1 4p28.110 2p56.44
replicate  2 2 5*3.048 0.0 5
unit  2
cuboid  3 1 4p28.110 2p0.0001
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
```

```
=csas25
raffety and milhalczo u(2)f4-1 reflected (case 11)
hansen-roach  infhommedium
u-235  1 0 1.5811e-4 end
u-238  1 0 7.6467e-3 end
h      1 0 3.0864e-2 end
c      1 0 1.4839e-2 end
f      1 0 3.1219e-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)f4-1 reflected (case 11)
read parm  run=yes plt=no npg=2000 nub=yes fdn=yes end parm
read geom
unit  1
cuboid  1 1 4p28.110 2p56.44
replicate  2 2 5*3.048 0.0 5
unit  2
cuboid  3 1 4p28.110 2*0.0001
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 11 showing biasing regions'
xul=-1  yul=20  zul=146
xlr=88  ylr=20  zlr=-3
uax=1  wdn=-1 nax=130  nch='0123456'
pic=wts
end plot
end data
end


=csas25
raffety and milhalczo u(2)f4-1 unreflected (case 12)
238groupndf5  infhommedium
u-235  1 0 1.5811e-4 end
u-238  1 0 7.6467e-3 end
h      1 0 3.0864e-2 end
c      1 0 1.4839e-2 end
f      1 0 3.1219e-2 end
end comp
raffety and malhalczo u(2)f4-1 unreflected (case12)
read parm   npg=2000 nub=yes fdn=yes end parm
read geom
cuboid  1 1 35.735 -35.735 35.735 -35.735 47.07 -47.07
end geom
end data
end
=csas25
raffety and milhalczo u(2)f4-1 unreflected (case 12)
hansen-roach  infhommedium
u-235  1 0 1.5811e-4 end
u-238  1 0 7.6467e-3 end
h      1 0 3.0864e-2 end
c      1 0 1.4839e-2 end
f      1 0 3.1219e-2 end
end comp
raffety and malhalczo u(2)f4-1 unreflected (case12)
```

```
read parm  npg=2000 nub=yes fdn=yes end parm
read geom
cuboid  1 1 35.735 -35.735 35.735 -35.735 47.07 -47.07
end geom
end data
end


=csas25
raffety and milhalczo u(2)f4-2 unreflected (case 14)
238groupndf5  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 parm   npg=2000 nub=yes fdn=yes end parm
read geom
cuboid  1 1 28.11 -28.11 28.11 -28.11 61.235 -61.235
end geom
end data
end
=csas25
raffety and milhalczo u(2)f4-2 unreflected (case 14)
hansen-roach  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 parm  npg=2000 nub=yes fdn=yes end parm
read geom
cuboid  1 1 28.11 -28.11 28.11 -28.11 61.235 -61.235
end geom
end data
end


=csas25
raffety and malhalczo u(2)f4-3 reflected (case 15)
238groupndf5  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 parm  run=yes    npg=2000 nub=yes fdn=yes end parm
read geom
unit  1
cuboid  1 1 4p26.835 2p27.145
replicate  2 2 5*3.048 0.0 5
unit  2
cuboid  3 1 4p26.835 2p0.0001
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


=csas25
raffety and milhalczo u(2)f4-4 reflected (case 16)
238groupndf5  infhommedium
u-235  1 0 0.9924e-4 end
u-238  1 0 4.7998e-3 end
h      1 0 4.9212e-2 end
c      1 0 2.3660e-2 end
f      1 0 1.9596e-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)f4-4 reflected (case 16)
read parm  run=yes  npg=2000 nub=yes fdn=yes end parm
read geom
unit  1
cuboid  1 1 4p23.000 2p48.285
replicate  2 2 5*3.048 0.0 5
unit  2
cuboid  3 1 4p23.000 2p0.0001
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


=csas25
raffety and milhalczo u(2)f4-6 reflected (case 19)
238groupndf5  infhommedium
u-235  1 0 0.6232e-4 end
u-238  1 0 3.0100e-3 end
h      1 0 6.0557e-2 end
c      1 0 2.9114e-2 end
f      1 0 1.2309e-2 end
poly(h2o) 2 1.0 end
plexiglass  3 0.918 end
al          3 0.062 end
end comp
raffety and malhalczo u(2)f4-6 reflected (case 19)
read parm  run=yes   npg=2000 nub=yes fdn=yes end parm
read geom
unit  1
cuboid  1 1 2p38.255 2p38.220 2p41.210
replicate  2 2 5*3.048 0.0 5
unit  2
cuboid  3 1 2p38.255 2p38.220 2p0.0001
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
=csas25
raffety and milhalczo u(2)f4-6 reflected (case 19)
hansen-roach  infhommedium
u-235  1 0 0.6232e-4 end
u-238  1 0 3.0100e-3 end
h      1 0 6.0557e-2 end
c      1 0 2.9114e-2 end
f      1 0 1.2309e-2 end
poly(h2o)   2 1.0 end
plexiglass  3 0.918 end
al          3 0.062 end
end comp
raffety and malhalczo u(2)f4-6 reflected (case 19)
read parm  run=yes plt=no npg=2000 nub=yes fdn=yes end parm
read geom
unit  1
cuboid  1 1 2p38.255 2p38.220 2p41.210
replicate  2 2 5*3.048 0.0 5
unit  2
cuboid  3 1 2p38.255 2p38.220 2*0.0
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 19 showing biasing regions'
xul=-1  yul=20  zul=115
xlr=108  ylr=20  zlr=-3
uax=1  wdn=-1 nax=130  nch='0123456'
pic=wts
end plot
end data
end


=csas25
raffety and milhalczo u(2)f4-6 unreflected (case 20)
238groupndf5  infhommedium
u-235  1 0 0.6232e-4 end
u-238  1 0 3.0100e-3 end
h      1 0 6.0557e-2 end
c      1 0 2.9114e-2 end
f      1 0 1.2309e-2 end
end comp
raffety and malhalczo u(2)f4-6 unreflected (case20)
read parm   npg=2000 nub=yes fdn=yes end parm
read geom
cuboid  1 1 40.725 -40.725 43.35 -43.35 44.110 -44.110
end geom
end data
end
```

```
=csas25
raffety and milhalczo u(2)f4-6 unreflected (case 20)
hansen-roach  infhommedium
u-235  1 0 0.6232e-4 end
u-238  1 0 3.0100e-3 end
h      1 0 6.0557e-2 end
c      1 0 2.9114e-2 end
f      1 0 1.2309e-2 end
end comp
raffety and malhalczo u(2)f4-6 unreflected (case20)
read parm  npg=2000 nub=yes fdn=yes end parm
read geom
cuboid  1 1 40.725 -40.725 43.35 -43.35 44.110 -44.110
end geom
end data
end


=csas25
raffety and milhalczo u(3)f4-1 reflected (case 22)
238groupndf5  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 parm  run=yes   npg=2000 nub=yes fdn=yes end parm
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  3 1 2p21.735 2p21.735 2p0.0001
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
=csas25
raffety and milhalczo u(3)f4-1 reflected (case 22)
hansen-roach  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 parm  run=yes plt=no npg=2000 nub=yes fdn=yes end parm
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  3 1 2p21.735 2p21.735 2p0.00001
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=129
xlr=79  ylr=20  zlr=-3
uax=1  wdn=-1 nax=130  nch='0123456'
pic=wts
end plot
end data
end


=csas25
raffety and milhalczo u(3)f4-1 reflected (case 24) no biasing
238groupndf5  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 24) no biasing
read parm  run=yes   npg=2000 nub=yes fdn=yes rnd=6361624605E end parm
read geom
unit  1
cuboid  1 1 2p28.125 2p28.125 2p21.705
replicate  2 2 5*3.048 0.0 5
unit  2
cuboid  3 1 2p28.125 2p28.125 2p0.0001
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
=csas25
raffety and milhalczo u(3)f4-1 reflected (case 24) no biasing
hansen-roach  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 24) no biasing
read parm  run=yes plt=no npg=2000 nub=yes fdn=yes end parm
read geom
unit  1
cuboid  1 1 2p28.125 2p28.125 2p21.705
replicate  2 2 5*3.048 0.0 5
unit  2
cuboid  3 1 2p28.125 2p28.125 2*0.0
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 24 showing biasing regions'
xul=-1  yul=20  zul=75
xlr=88  ylr=20  zlr=-3
uax=1  wdn=-1 nax=130  nch='0123456'
pic=wts
end plot
end data
end


=csas25
raffety and milhalczo u(3)f4-1 unreflected (case 26)
238groupndf5  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 parm   npg=2000 nub=yes fdn=yes end parm
read geom
cuboid  1 1 28.235 -28.235 28.235 -28.235 43.32 -43.32
end geom
end data
end
=csas25
raffety and milhalczo u(3)f4-1 unreflected (case 26)
hansen-roach  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 parm  npg=2000 nub=yes fdn=yes end parm
read geom
cuboid  1 1 28.235 -28.235 28.235 -28.235 43.32 -43.32
end geom
end data
end


=csas25
raffety and milhalczo u(3)f4-1 unreflected (case 28)
238groupndf5  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 28)
read parm   npg=2000 nub=yes fdn=yes end parm
read geom
cuboid  1 1 30.7 -30.7 30.7 -30.7 33.00 -33.00
end geom
end data
end


=csas25
raffety and milhalczo u(3)f4-2 unreflected (case 30)
238groupndf5  infhommedium
u-235  1 0 1.6709e-4 end
u-238  1 0 5.3355e-3 end
h      1 0 4.6262e-2 end
c      1 0 2.2241e-2 end
f      1 0 2.2011e-2 end
end comp
raffety and malhalczo u(3)f4-2 unreflected (case 30)
read parm  run=yes   npg=2000 nub=yes fdn=yes end parm
read geom
cuboid  1 1 2p20.450 2p20.465 2p58.400
end geom
end data
end
=csas25
raffety and milhalczo u(3)f4-2 unreflected (case 30)
hansen-roach  infhommedium
u-235  1 0 1.6709e-4 end
u-238  1 0 5.3355e-3 end
h      1 0 4.6262e-2 end
c      1 0 2.2241e-2 end
f      1 0 2.2011e-2 end
end comp
raffety and malhalczo u(3)f4-2 unreflected (case 30)
read parm  run=yes  npg=2000 nub=yes fdn=yes end parm
read geom
cuboid  1 1 2p20.450 2p20.465 2p58.400
end geom
end data
end


=csas25
critical reflected cylinder of aqueous u(4.98)o2f2 (case 33)
238groupndf5  infhommedium
solnuo2f2  1 910.36 0.0 1 298 92235 4.98 92238 95.02 end
ss304  2 1.0 end
h2o    3 1.0 end
cd     4 1.0 end
end comp
critical reflected cylinder of aqueous u(4.98)o2f2 (case 33)
read parm  run=yes   npg=2000 nub=yes fdn=yes  rnd=6361624605e end parm
read geom
unit  1
cylinder  1 1 19.545 2p27.225
cylinder  0 1 19.545 78.975 -27.225
cylinder  2 1 19.624 79.054 -27.304
```

```
cylinder  4 1 19.705 79.054 -27.304
cylinder  2 1 22.245 79.054 -27.304
cylinder  3 1 45.000 79.054 -27.304
cuboid    0 1 4p45.000 79.054 -27.304
end geom
read plot ttl='xz slice of cylinder case 33'
xul=-45 yul=0.0 zul=81
xlr=45  ylr=0.0 zlr=-29
uax=1  wdn=-1  nax=130  nch='01234'end
ttl='enlargement of lower right hand corner of cylinder'
xul=18  yul=0.0 zul=-25
xlr=23  ylr=0.0 zlr=-28
uax=1  wdn=-1  nax=130  nch='01234'
end plot
end data
end


=csas25
critical cylinder of aqueous u(4.98)o2f2 (case 36)
238groupndf5  infhommedium
solnuo2f2  1 910.36 0.0 1 298 92235 4.98 92238 95.02 end
ss304  2 1.0 end
end comp
critical cylinder of aqueous u(4.98)o2f2 (case 36)
read parm  run=yes   npg=2000 nub=yes fdn=yes end parm
read geom
unit  1
cylinder  1 1 19.5500 2p50.85
cylinder  0 1 19.5500 74.16 -50.85
cylinder  2 1 19.6287 74.16 -50.9287
cuboid    0 1 4p19.6287 74.16 -50.9287
end geom
read plot ttl='xz slice of cylinder case 36'
xul=-21  yul=0.0 zul=76
xlr=21   ylr=0.0 zlr=-52
uax=1  wdn=-1  nax=130  nch='012'end
ttl='enlargement of lower right corner of cylinder'
xul=18  yul=0.0 zul=-49
xlr=21  ylr=0.0 zlr=-52
uax=1  wdn=-1  nax=130  nch='012'
end plot
end data
end
```

Table A.4. Table 4 input data

```
=csas25
uo2f2 soln h/u-235=1112 bare sphere case 1
238groupndf5 multiregion
u-234  1 0 7.360-7 end
u-235  1 0 5.990-5 end
u-238  1 0 3.592-6 end
h      1 0 6.661-2 end
o      1 0 3.343-2 end
f      1 0 1.285-4 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 npg=2000  nub=yes fdn=yes end param
read geom
sphere  1 1 27.9
sphere  2 1 28.1
end geom
end data
end


=csas25
uo2f2 soln h/u-235=76.1 h2o refl sphere case 4
238groupndf5  multiregion
u-234  1 0 8.795-6 end
u-235  1 0 8.327-4 end
u-236  1 0 4.449-6 end
u-238  1 0 4.729-5 end
h      1 0 6.337-2 end
o      1 0 3.347-2 end
f      1 0 1.786-3 end
al     2 1 end
h2o    3 1 end
end comp
spherical end
1 11.5 oneextermod  2 11.66 noextermod  3 29.66 noextermod end zone
uo2f2 soln h/u-235=76.1 h2o refl sphere case 4
read param npg=2000  nub=yes fdn=yes end param
read geom
sphere  1 1 11.5
sphere  2 1 11.66
reflector  3 2 3 6
end geom
read bias id=500 2 7 end bias
end data
end


=csas25
uo2f2 soln h/u-235=268.8 h2o refl sphere case 7
238groupndf5  multiregion
u-235  1 0 2.438-4 300 end
u-238  1 0 1.756-5 300 end
h      1 0 6.553-2 300 end
o      1 0 3.329-2 300 end
f      1 0 5.227-4 300 end
al     2 1 300 end
```

```
h2o    3 1 300 end
end comp
spherical end
1 13.2 oneextermod  2 13.33 noextermod  3 31.33 noextermod end zone
uo2f2 soln h/u-235=268.8 h2o refl sphere case 7
read param npg=2000  nub=yes fdn=yes end param
read geom
sphere  1 1 13.2
sphere  2 1 13.33
reflector  3 2 3 6
end geom
read bias id=500 2 7 end bias
end data
end


=csas25
uo2f2 soln h/u-235=239.3 h2o refl sphere case 10
238groupndf5  multiregion
u-235  1 0 2.735-4 359 end
u-238  1 0 1.970-5 359 end
h      1 0 6.545-2 359 end
o      1 0 3.331-2 359 end
f      1 0 5.864-4 359 end
al     2 1 359 end
h2o    3 1 359 end
end comp
spherical end
1 13.2 oneextermod  2 13.33 noextermod  3 31.33 noextermod end zone
uo2f2 soln h/u-235=239.3 h2o refl sphere case 10
read param npg=2000  nub=yes fdn=yes end param
read geom
sphere  1 1 13.2
sphere  2 1 13.33
reflector  3 2 3 6
end geom
read bias id=500 2 7 end bias
end data
end


=csas25
rocky flats uo2(no3)2 soln 357.71 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 357.71 0.549 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 2
read param npg=5000  nub=yes fdn=yes end param
read geom
cylinder  1 1 14.005 30.91 0
cylinder  2 1 14.325 30.91 -.32
end geom
end data
end
```

```
=csas25
rocky flats uo2(no3)2 soln 357.71 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 357.71 .549 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 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 bare 5
read param npg=2000  nub=yes fdn=yes end param
read geom
cylinder  1 1 16.505 22.53 0
cylinder  2 1 16.825 22.53 -.32
end geom
end data
end


=csas25
rocky flats uo2(no3)2 soln 334.77 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 334.77 .521 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
rfconcrete  3 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 refl 2 conc refl
read param npg=2000  nub=yes fdn=yes end param
read geom
cylinder  1 1 14.005 28.60 0
cylinder  2 1 14.325 28.60 -.32
cuboid    0 1 64.6 -57.2 57.4 -64.8 80.8 -41.1
reflector 3 2 4r5.14 2r0 5
reflector 0 1 4r0 2r0.9  1
reflector 3 2 4r0 2r5.14 5
end geom
read bias id=301 2 6 end bias
end data
end


=csas25
rocky flats uo2(no3)2 soln 334.77 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 334.77 .521 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
rfconcrete  3 1 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 6 conc refl
read param npg=2000  nub=yes fdn=yes end param
read geom
cylinder  1 1 16.505 16.78 0
cylinder  2 1 16.825 16.78 -.32
cuboid    0 1 104.55 -17.25 16.825 -105.375 121.58 -.32
reflector 3 2 4r5.14 2r0 5
reflector 0 1 4r0 2r0.9  1
reflector 3 2 4r0 2r5.14 5
```

```
end geom
read bias id=301 2 6 end bias
end data
end


=csas25
rocky flats uo2(no3)2 soln 147.66 g u/l
238groupndf5 multiregion
solnuo2(no3)2  1 147.66 .271 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
plexiglass  3 1 end
h    4 0 5.5169-2 end
c    4 0 3.3967-2 end
o    4 0 1.4231-2 end
p    4 0 3.8500-4 end
cl   4 0 3.5610-4 end
br-79  4 0 3.184-4 end
br-81  4 0 3.116-4 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 9 plexiglass refl
read param npg=2000  nub=yes fdn=yes end param
read geom
cylinder  1 1 16.505 22.78 0
cylinder  2 1 16.825 22.78 -.32
cuboid    0 1 61.2 -61.7 60.4 -62.5 81.1 -41.8
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=500 2 8 end bias
end data
end


=csas25
rocky flats uo2(no3)2 soln 345.33 g u/l
238groupndf5  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 0 5.5169-2 end
c    4 0 3.3967-2 end
o    4 0 1.4231-2 end
p    4 0 3.8500-4 end
cl   4 0 3.5610-4 end
br-79  4 0 3.184-4 end
br-81  4 0 3.116-4 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 npg=2000  nub=yes fdn=yes end param
read geom
cylinder  1 1 16.505 17.2 0
cylinder  2 1 16.825 17.2 -.32
cuboid    0 1 105.2 -17.7 17.3 -105.6 122.58 -.32
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=500 2 8 end bias
end data
end


=csas25
rocky flats uo2(no3)2 soln 364.11 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 364.11 .584 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
rfconcrete  3 1 end
end comp
cylindrical end
1 10.5 noextermod  2 10.9 noextermod end zone
rocky flats uo2(no3)2 soln 21.12 cm d1am 4x4 array conc refl c2
read param npg=2000  nub=yes fdn=yes end param
read geom
cylinder  1 1 10.56 17.13 0
cylinder  2 1 10.96 17.13 -.32
cuboid    0 1 4p15.24 121.58 -.32
core      0 1 2r-60.96 -.32
reflector 3 2 4r5.14 2r0 5
reflector 0 1 4r0 2r1.25  1
reflector 3 2 4r0 2r5.14 5
end geom
read array nux=4 nuy=4 nuz=1 end array
read bias id=301 2 6 end bias
end data
end


=csas25
rocky flats uo2(no3)2 soln 359.55 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 359.55 .578 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
rfconcrete  3 1 end
end comp
cylindrical end
1 8 noextermod  2 8.3 noextermod end zone
rocky flats uo2(no3)2 soln 16.12 cm d1am 4x4 array conc refl c4
read param npg=2000  nub=yes fdn=yes end param
read geom
cylinder  1 1 8.06 31.82 0
cylinder  2 1 8.38 31.82 -.32
cuboid    0 1 4p15.24 121.58 -.32
core      0 1 2r-60.96 -.32
reflector 3 2 4r5.14 2r0 5
reflector 0 1 4r0 2r1.25  1
reflector 3 2 4r0 2r5.14 5
end geom
read array nux=4 nuy=4 nuz=1 end array
read bias id=301 2 6 end bias
end data
end
```

```
=csas25
rocky flats uo2(no3)2 soln 364.11 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 364.11 .584 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
rfconcrete  3 1 end
end comp
cylindrical end
1 10.5 noextermod  2 10.9 noextermod end zone
rocky flats uo2(no3)2 soln 21.12 cm d1am 2x2 array conc refl c6
read param npg=2000  nub=yes fdn=yes end param
read geom
unit 1
cylinder  1 1 10.56 31.11 0
cylinder  2 1 10.96 31.11 -.32
cuboid    0 1 4p15.24 121.58 -.32
unit 2
cuboid    0 1 4p15.24 121.58 -.32
core      0 1 2r-60.96 -.32
reflector 3 2 4r5.14 2r0 5
reflector 0 1 4r0 2r1.25  1
reflector 3 2 4r0 2r5.14 5
end geom
read array nux=4 nuy=4 nuz=1
fill 5r2 2r1 2r2 2r1 5r2 end fill
end array
read bias id=301 2 6 end bias
end data
end
```

```
=csas25
rocky flats uo2(no3)2 soln 359.55 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 359.55 .578 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
rfconcrete  3 1 end
end comp
cylindrical end
1 8 noextermod  2 8.3 noextermod end zone
rocky flats uo2(no3)2 soln 16.12 cm d1am 2x4 array conc refl c8
read param npg=2000  nub=yes fdn=yes end param
read geom
unit 1
cylinder  1 1 8.06 51.45 0
cylinder  2 1 8.38 51.45 -.32
cuboid    0 1 4p15.24 121.58 -.32
unit 2
cuboid    0 1 4p15.24 121.58 -.32
core      0 1 2r-60.96 -.32
reflector 3 2 4r5.14 2r0 5
reflector 0 1 4r0 2r1.25  1
reflector 3 2 4r0 2r5.14 5
end geom
read array nux=4 nuy=4 nuz=1
fill 2r1 2r2 3q4 end fill
end array
read bias id=301 2 6 end bias
end data
end
```

```
=csas25
rocky flats uo2(no3)2 soln 355.94 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 355.94 .494 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
plexiglass  3 1 end
h    4 0 5.5169-2 end
c    4 0 3.3967-2 end
o    4 0 1.4231-2 end
p    4 0 3.8500-4 end
cl   4 0 3.5610-4 end
br-79  4 0 3.184-4 end
br-81  4 0 3.116-4 end
end comp
cylindrical end
1 10.5 noextermod  2 10.9 noextermod end zone
rocky flats uo2(no3)2 soln 21.12 cm d1am 4x4 array plexiglass refl p2
read param npg=2000  nub=yes fdn=yes end param
read geom
cylinder  1 1 10.56 18.82 0
cylinder  2 1 10.96 18.82 -.32
cuboid    0 1 4p15.24 122.58 -.32
core      0 1 2r-60.96 -.32
reflector 0 1 4r.49  2r0 1
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 array nux=4 nuy=4 nuz=1
end array
read bias id=500 2 8 end bias
end data
end


=csas25
rocky flats uo2(no3)2 soln 355.94 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 355.94 .494 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
plexiglass  3 1 end
h    4 0 5.5169-2 end
c    4 0 3.3967-2 end
o    4 0 1.4231-2 end
p    4 0 3.8500-4 end
cl   4 0 3.5610-4 end
br-79  4 0 3.184-4 end
br-81  4 0 3.116-4 end
end comp
cylindrical end
1 8 noextermod  2 8.3 noextermod end zone
rocky flats uo2(no3)2 soln 16.12 cm d1am 4x4 array plexiglass refl p4
read param npg=2000  nub=yes fdn=yes end param
read geom
cylinder  1 1 8.06 35.56 0
cylinder  2 1 8.38 35.56 -.32
cuboid    0 1 4p15.24 122.58 -.32
core      0 1 2r-60.96 -.32
reflector 0 1 4r.49  2r0 1
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 array nux=4 nuy=4 nuz=1
end array
read bias id=500 2 8 end bias
end data
end


=csas25
rocky flats uo2(no3)2 soln 355.94 g u/l
238groupndf5 multiregion
solnuo2(no3)2  1 355.94 .494 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
plexiglass  3 1 end
h    4 0 5.5169-2 end
c    4 0 3.3967-2 end
o    4 0 1.4231-2 end
p    4 0 3.8500-4 end
cl   4 0 3.5610-4 end
br-79  4 0 3.184-4 end
br-81  4 0 3.116-4 end
end comp
cylindrical end
1 10.5 noextermod  2 10.9 noextermod end zone
rocky flats uo2(no3)2 soln 21.12 cm d1am 2x2 array plexiglass refl p6
read param npg=2000  nub=yes fdn=yes end param
read geom
unit 1
cylinder  1 1 10.56 33.20 0
cylinder  2 1 10.96 33.20 -.32
cuboid    0 1 4p15.24 122.58 -.32
unit 2
cuboid    0 1 4p15.24 122.58 -.32
core      0 1 2r-60.96 -.32
reflector 0 1 4r.49  2r0 1
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 array nux=4 nuy=4 nuz=1
fill 5r2 2r1 2r2 2r1 5r2 end fill
end array
read bias id=500 2 8 end bias
end data
end
```

Table A.5. Table 5 input data

```
=csas25
keno-5 validation case a-1
238groupndf5  multiregion
uranium  1 .9837 293 92235 93.8 92238 6.2 end
end comp
spherical  end
1 8.73136 noextermod end zone
keno-5 validation case a-1
read param     npg=2000 fdn=yes nub=yes end param
read geom
sphere    1 1 8.73136
end geom
end data
end


=csas25
keno-5 validation case a-3
238groupndf5  multiregion
solnuo2f2  1 19.992 0 1 293 92235 93.2 92238 6.8 end
al         2 end
end comp
spherical  end
1 34.6 oneextermod  2 34.92 noextermod end zone
keno-5 validation case a-3
read param   npg=2000 fdn=yes nub=yes end param
read geom
sphere    1 1 34.6
sphere    2 1 34.92
cube      0 1 35.0 -35.0
end geom
end data
end


=csas25
keno-5 validation case a-5
238groupndf5  multiregion
uranium  1  .9848 283 92235 93.5 92238 6.5 end
h2o      2 end
end comp
spherical  end
1 12.7 oneextermod  2 31. noextermod end zone
keno-5 validation case a-5
read param tme=60   npg=2000 fdn=yes nub=yes end param
read geom
hemisphere  2 1 12.7
hemisphere  1 1 15.24
cuboid     2 1 31.00 -31.00 31.00 -31.00 31.00 -16.
end geom
end data
end


=csas25
keno-5 validation case a-7
238groupndf5  multiregion
uranium  1 .9848 293 92235 94 92238 6 end
uranium  2 end
```

```
end comp
slab  end
1 7.62 noextermod  2 52.02 noextermod end zone
keno-5 validation case a-7
read param    npg=2000 fdn=yes nub=yes end param
read geom
cuboid    1 1 3.81 -3.81 4.445 -4.445 7.62 -7.62
cuboid    2 1 26.01 -26.01 26.645 -26.645 29.82 -29.82
cube       0 1 30.0 -30.0
end geom
end data
end


=csas25
keno-5 validation case a-9
238groupndf5  multiregion
arbmoil   .88 3 0 0 0 6012 86.82 1001 13.16 16000 .02 1 end
uranium   2 .9528 293 92235 93.1 92238 6.9 end
arbmpjel  .024 2 0 0 0 6012 85 1001 15 2 end
carbonsteel 3 end
end comp
spherical  end
2 8.2 oneextermod  1 40.5 noextermod end zone
keno-5 validation case a-9
read param
tme=60  npg=2000 fdn=yes nub=yes end param
read geom
hemisphere   3 1 6.012
hemisphere  2 1 10.488
sphere     1 1 40.488
cube       0 1 41.0 -41.0
end geom
end data
end


=csas25
keno-5 validation case a11
238groupndf5  multiregion
solnuo2(no3)2 1 346.73 .542 1 293 92235 93.172 92238 6.828 end
ss304  2 end
end comp
cylindrical  end
1 13.96 oneextermod  2 14.28 oneextermod  end zone
keno-5 validation case a11
read param     npg=2000 fdn=yes nub=yes end param
read geom
cylinder  1 1 13.96 14.465 -14.465
cylinder  0 1 13.96 27.135 -14.465
cylinder  2 1 14.28 27.135 -15.105
end geom
end data
end


=csas25
keno-5 validation case b-5
238groupndf5  multiregion
uranium  1 .9809 293 92235 93.2 92238 6.8 end
end comp
cylindrical  end
1 4.56 noextermod end zone
```

```
keno-5 validation case b-5
read param    npg=2000 fdn=yes nub=yes end param
read geom
box type  1
cylinder  1 1 4.558 2.16 -2.16
cylinder  0 1 5.747 2.16 -2.16
cylinder  1 1 5.747 4.851 -4.851
cuboid    0 1 5.8554 -5.8554 5.8554 -5.8554 4.9771 -4.9771
end geom
read array nux=2 nuy=2 nuz=2 end array
end data
end


=csas25
keno-5 validation case b-9
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass  2 1 end
end comp
cylindrical  end
1 9.52 oneextermod  2 10.16 noextermod  end zone
keno-5 validation case b-9
read param    npg=2000 fdn=yes nub=yes end param
read geom
box type  1
cylinder  1 1 9.52 8.7804 -8.7804
cylinder  0 1 9.52 8.9896 -8.7804
cylinder  2 1 10.16 9.6296 -9.4204
cuboid    0 1 13.4 -13.4 13.4 -13.4 12.8696 -12.6604
end geom
read array nux=3 nuy=3 nuz=3 end array
end data
end


=csas25
keno-5 validation case b-10
238groupndf5  multiregion
solnuo2(no3)2  1 63.3  0 1 293 92235 92.6 92238 7.4 end
plexiglass  2 1 end
end comp
cylindrical  end
1 9.52 oneextermod  2 10.16 noextermod  end zone
keno-5 validation case b-10
read param    npg=2000 fdn=yes nub=yes end param
read geom
box type  1
cylinder  1 1 9.52 8.7804 -8.7804
cylinder  0 1 9.52 8.9895 -8.7804
cylinder  2 1 10.16 9.6295 -9.4204
cuboid    0 1 11.282 -11.282 11.282 -11.282 10.7179 -11.7179
end geom
read array nux=3 nuy=3 nuz=3 end array
read start nst=1 end start
end data
end


=csas25
keno-5 validation case b-12
238groupndf5  multiregion
uranium  1 .9829 293 92235 93.2 92238 6.8 end
```

```
c        2 .8296 end
poly(h2o)  3 1 end
end comp
cylindrical  end
1 5.747 oneextermod  2 10.92 noextermod end zone
keno-5 validation case b-12
read param tme=60   npg=2000 fdn=yes nub=yes end param
read geom
box type  1
cylinder  1 1 5.747 3.9699 -4.1071
cylinder  0 1 5.777 4.1071 -4.1071
cuboid    2 1 10.9195 -10.9195 10.9195 -10.9195 7.8755 -7.8755
cuboid    0 1 15.047 -15.047 15.047 -15.047 12.0035 -12.0035
core      0 1 -30.094 -30.094 -24.007
cuboid    3 1 45.344 -45.344 45.344 -45.344 39.247 -39.247
cube      0 1 46.0 -46.0
end geom
read array nux=2 nuy=2 nuz=2 end array
end data
end


=csas25
keno-5 validation case b-14
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass  2 1 end
para(h2o)  3 end
end comp
cylindrical  end
1 9.52 oneextermod  2 10.16 noextermod  end zone
keno-5 validation case b-14
read param tme=60   npg=2000 fdn=yes nub=yes end param
read geom
cylinder  1 1 9.52 8.7804 -8.7804
cylinder  0 1 9.52 8.9896 -8.7804
cylinder  2 1 10.16 9.6296 -9.4204
cuboid    0 1 18.425 -18.425 18.425 -18.425 17.8946 -17.6854
core      0 1 -55.275 -55.275 -53.37
cuboid    3 1 70.515 -70.515 70.515 -70.515 68.61 -68.61
end geom
read array nux=3 nuy=3 nuz=3 end array
end data
end


=csas25
keno-5 validation case b-16
238groupndf5  multiregion
solnuo2(no3)2 1 450.8 .72 1 293 92235 93.1 92238 6.9 end
ss304         2 end
end comp
cylindrical  end
1 8.128 noextermod  2 8.4074 noextermod  end zone
keno-5 validation case b-16
read param    npg=2000 fdn=yes nub=yes end param
read geom
box type   1
xcylinder  1 1 8.128 68.3006 -68.3006
xcylinder  2 1 8.4074 68.58 -68.58
cuboid     0 1 68.58 -68.58 9.2075 -9.2075 14.999 -110.32
box type   2
ycylinder  1 1 8.128 68.3006 -68.3006
```

```
ycylinder  2 1 8.4074 68.58 -68.58
cuboid     0 1 9.2075 -9.2075 68.58 -68.58 14.999 -110.32
box type   3
xcylinder  1 1 8.128 68.3006 -68.3006
xcylinder  2 1 8.4074 68.58 -68.58
cuboid     0 1 68.58 -68.58 9.2075 -9.2075 125.09 -14.999
box type   4
ycylinder  1 1 8.128 68.3006 -68.3006
ycylinder  2 1 8.4074 68.58 -68.58
cuboid     0 1 9.2075 -9.2075 68.58 -68.58 125.09 -14.999
box type   5
cuboid     1 1 8.89 -8.89 8.89 -8.89 14.999 -110.00
cuboid     2 1 9.2075 -9.2075 9.2075 -9.2075 14.999 -110.32
box type   6
cuboid     1 1 8.89 -8.89 8.89 -8.89 125.09 -14.999
cuboid     2 1 9.2075 -9.2075 9.2075 -9.2075 125.09 -14.999
box type   7
cuboid     0 1 68.58 -68.58 68.58 -68.58 14.999 -110.32
box type   8
cuboid     0 1 68.58 -68.58 68.58 -68.58 125.09 -14.999
end geom
read array nux=3 nuy=3 nuz=2 loop
1  1 3 2 2 2 1 1 1 1  2  2 2 1 1 3 2 1 1 1  3  1 3 2 2 2 1 2 2 1
4  2 2 1 1 3 2 2 2 1  5  2 2 1 2 2 1 1 1 1  6  2 2 1 2 2 1 2 2 1
7  1 3 2 1 3 2 1 1 1  8  1 3 2 1 3 2 2 2 1
end loop end array
end data
end
member name  cas20


=csas25
keno-5 validation case b-18
238groupndf5  multiregion
solnuo2(no3)2 1 364.11 .584 1 293 92235 93.172 92238 6.828 end
arbmal        2.737 9 0 0 1 12000 1 13027 97.35 14000 .6 22000 .03
24000 .17 25055 .07 26000 .47 29000 .25 14000 .06 2 end
arbmconc     2.321 13 0 0 1 1001 .75 6012 5.55 7014 .01 8016 49.29
11023 .42 12000 1.48 13027 2.06 14000 15.7 16000 .17 19000 .75 20000 22.95
22000 .05 26000 .82 3 end
end comp
cylindrical  end
1 10.56 noextermod  2 10.96 noextermod  end zone
keno-5 validation case b-18
read param tme=60   npg=2000 fdn=yes nub=yes end param
read geom
box type  1
cylinder  1 1 10.56 8.565 -8.565
cylinder  0 1 10.56 110.535 -8.565
cylinder  2 1 10.96 110.535 -8.885
cuboid    0 1 15.25 -15.15 15.25 -15.25 115.515 -8.885
box type  2
cylinder  1 1 10.56 8.565 -8.565
cylinder  0 1 10.56 110.535 -8.565
cylinder  2 1 10.96 110.535 -8.885
cuboid    0 1 15.15 -15.25 15.25 -15.25 115.515 -8.885
box type  3
cylinder  1 1 10.56 8.565 -8.565
cylinder  0 1 10.56 110.535 -8.565
cylinder  2 1 10.96 110.535 -8.885
cuboid    0 1 15.25 -15.25 15.25 -15.25 115.515 -8.885
core      0 1 -60.9 -61.0 -62.2
reflector 0 1 2z 2r.1 2z 1
```

```
cuboid    3 1 86.6 -86.6 86.8 -86.8 87.9 -87.9
end geom
read array nux=4 nuy=4 loop
1  1 1 1 1 4 1 1 1 1   2  4 4 1 1 4 1 1 1 1   3  2 3 1 1 4 1 1 1 1
end loop end array
end data
end


=csas25
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
h2o       3 1 end
end comp
slab end
1 3.81 oneextermod  2 4.12 noextermod 3 22.12 noextermod end zone
93.2% uo2f2 3 in al slab 3x1x1 array 1 in sep h2o refl
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cuboid      1 1 2p3.81 2p60.325 19.13 0
reflector   2 1 4r.318 0 .318 1
cuboid      0 1 2p4.128 2p60.643 19.13 -.318
unit 2
cuboid      3 1 2.54 0 2p60.643 19.13 -.318
core        0 1 3r0
reflector   3 2 4r3 0 3 6
end geom
read array nux=5 nuy=1 nuz=1 fill 1 2 1 2 1 end fill end array
read bias id=500 2 7 end bias
end data
end


=csas25
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
h2o       3 1 end
end comp
slab end
1 3.81 oneextermod  2 4.12 noextermod 3 22.12 noextermod end zone
93.2% uo2f2 3 in al slab 3x1x1 array 5.5 in sep h2o refl
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cuboid      1 1 2p3.81 2p60.325 111.68 0
reflector   2 1 4r.318 0 .318 1
cuboid      0 1 2p4.128 2p60.643 111.68 -.318
unit 2
cuboid      3 1 13.97 0 2p60.643 111.68 -.318
core        0 1 3r0
reflector   3 2 4r3 0 3 6
end geom
read array nux=5 nuy=1 nuz=1 fill 1 2 1 2 1 end fill end array
read bias id=500 2 7 end bias
end data
end
```

```
=csas25
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
end comp
slab end
1 3.81 noextermod  2 4.12 noextermod end zone
93.2% uo2f2 3, 6 in al slabs 2x1x1 array 15 in sep
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cuboid      1 1 2p3.81 2p60.325 65.81 0
reflector   2 1 4r.318 0 .318 1
cuboid      0 1 2p4.128 2p65. 150. -1.
unit 2
cuboid      1 1 2p7.417 2p60.325 65.81 0
reflector   2 1 4r.318 0 .318 1
cuboid      0 1 2p7.735 2p65. 150. -1.
unit 3
cuboid      0 1 38.1 0 2p65. 150. -1.
end geom
read array nux=3 nuy=1 nuz=1 fill 2 3 1 end fill end array
end data
end


=csas25
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
end comp
slab end
1 3.81 noextermod  2 4.12 noextermod end zone
93.2% uo2f2 3, 6, 3 in al slabs 3x1x1 array 0 in sep
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cuboid      1 1 2p3.81 2p60.325 19.63 0
reflector   2 1 4r.318 0 .318 1
cuboid      0 1 2p4.128 2p65. 150. -1.
unit 2
cuboid      1 1 2p7.417 2p60.325 19.63 0
reflector   2 1 4r.318 0 .318 1
cuboid      0 1 2p7.735 2p65. 150. -1.
end geom
read array nux=3 nuy=1 nuz=1 fill 1 2 1 end fill end array
end data
end


=csas25
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
end comp
```

```
slab end
1 3.81 noextermod  2 4.12 noextermod end zone
93.2% uo2f2 3, 6, 3 in al slabs 3x1x1 array 20 in sep
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cuboid      1 1 2p3.81 2p60.325 62.56 0
reflector   2 1 4r.318 0 .318 1
cuboid      0 1 2p4.128 2p65. 150. -1.
unit 2
cuboid      1 1 2p7.417 2p60.325 62.56 0
reflector   2 1 4r.318 0 .318 1
cuboid      0 1 2p7.735 2p65. 150. -1.
unit 3
cuboid      0 1 50.8 0 2p65. 150. -1.
end geom
read array nux=5 nuy=1 nuz=1 fill 1 3 2 3 1 end fill end array
end data
end


=csas25
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
end comp
slab end
1 7.62 noextermod  2 7.94 noextermod end zone
93.2% uo2f2 6 & 3 in al slabs 2x1x1 array 12 in sep
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cuboid      1 1 2p3.81 2p60.325 58.19 0
reflector   2 1 4r.318 0 .318 1
cuboid      0 1 2p4.128 2p65. 150. -1.
unit 2
cuboid      2 1 2p.318 2p60.325 58.19 0
cuboid      1 1 2p7.938 2p60.325 58.19 0
reflector   2 1 4r.318 0 .318 1
cuboid      0 1 2p8.574 2p65. 150. -1.
unit 3
cuboid      0 1 30.48 0 2p65. 150. -1.
end geom
read array nux=3 nuy=1 nuz=1 fill 2 3 1 end fill end array
end data
end


=csas25
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
end comp
slab end
1 7.62 noextermod  2 7.94 noextermod end zone
93.2% uo2f2 6 & 3 in al slabs 2x1x1 array 30 in sep
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
```

```
cuboid      1 1 2p3.81 2p60.325 83.11 0
reflector   2 1 4r.318 0 .318 1
cuboid      0 1 2p4.128 2p65. 150. -1.
unit 2
cuboid      2 1 2p.318 2p60.325 83.11 0
cuboid      1 1 2p7.938 2p60.325 83.11 0
reflector   2 1 4r.318 0 .318 1
cuboid      0 1 2p8.574 2p65. 150. -1.
unit 3
cuboid      0 1 76.2 0 2p65. 150. -1.
end geom
read array nux=3 nuy=1 nuz=1 fill 2 3 1 end fill end array
end data
end


=csas25
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
end comp
slab end
1 7.62 noextermod  2 7.94 noextermod end zone
93.2% uo2f2 6 in al slab 2x1x1 array 6 in sep
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cuboid      1 1 2p7.417 2p60.325 32.79 0
reflector   2 1 4r.318 0 .318 1
cuboid      0 1 2p15.354 2p65. 150. -1.
unit 2
cuboud      2 1 2p.318 2p60.325 32.79 0
cuboid      1 1 2p7.938 2p60.325 32.79 0
reflector   2 1 4r.318 0 .318 1
cuboid      0 1 2p15.875 2p65. 150. -1.
end geom
read array nux=2 nuy=1 nuz=1 fill 1 2 end fill end array
end data
end


=csas25
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
end comp
slab end
1 7.62 noextermod  2 7.94 noextermod end zone
93.2% uo2f2 6 in al slab 2x1x1 array 48 in sep
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cuboid      1 1 2p7.417 2p60.325 73.23 0
reflector   2 1 4r.318 0 .318 1
cuboid      0 1 2p68.694 2p65. 150. -1.
unit 2
cuboud      2 1 2p.318 2p60.325 73.23 0
cuboid      1 1 2p7.938 2p60.325 73.23 0
reflector   2 1 4r.318 0 .318 1
```

```
cuboid      0 1 2p69.215 2p65. 150. -1.
end geom
read array nux=2 nuy=1 nuz=1 fill 1 2 end fill end array
end data
end


=csas25
uo2(no3)2 63.3 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 63.3 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
arbmwood  .640525 3 0 0 0 6012 44.435 1001 6.2639 8016 49.301 3 end
carbonsteel   4 end
reg-concrete  5 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
uo2(no3)2 63.3 g u/l 3x3x3 array unrefl. walls, floor, & tank
read param    npg=2000 fdn=yes nub=yes plt=no end param
read geom
unit 1
cylinder  1 1 9.52 17.5609 0.
cylinder  0 1 9.52 17.77   0.
cylinder  2 1 10.16 18.41  -.64
cuboid    0 1 4p11.365 19.615 -1.845
unit 2
array  1 2r-34.095 0.
cuboid 0 1 4p200. 250. -50.
unit 3
cylinder  0 1 142.8 224. -48.
cylinder  4 1 144.8 224. -50.
cuboid 0 1 218.1 -181.9 215. -185. 250. -50.
array  2 3r0.
reflector 0 1 57.4 57. 260. 559.2 400. 0. 1
reflector 2 1 5r0 .32 1
reflector 3 1 5r0 1.27 1
reflector 4 1 5r0 .64 1
reflector 0 1 5r0 365 1
reflector 5 2 6r3 10
reflector 5 12 0 3 4r0 10
end geom
read start xsm=165 xsp=234 ysm=165 ysp=234 zsm=50 zsp=115 end start
read bias id=301 2 21 end bias
read array ara=1 nux=3 nuy=3 nuz=3 fill f1 end fill
ara=2 nux=2 nuy=1 nuz=1 fill 2 3 end fill end array
read plot
xul=113.2 yul=286.8 zul=60. xlr=286.8 ylr=113.2 zlr=60.
uax=1 vdn=-1 nax=125  end
xul=437.1 yul=329.8 zul=60. xlr=726.7 ylr=40.2 zlr=60. end
end plot
end data
end


=csas25
uo2(no3)2 279 g u/l
238groupndf5 multiregion
solnuo2(no3)2  1 279 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
arbmwood  .640525 3 0 0 0 6012 44.435 1001 6.2639 8016 49.301 3 end
carbonsteel   4 end
reg-concrete  5 end
```

```
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
uo2(no3)2 279 g u/l 2x2x2 array unrefl. walls, tank, & floor
read param   plt=no  npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cylinder  1 1 9.52 17.5609 0.
cylinder  0 1 9.52 17.77   0.
cylinder  2 1 10.16 18.41  -.64
cuboid    0 1 4p10.875 19.125 -1.355
unit 2
array  1 2r-21.75 0.
cuboid 0 1 4p200. 250. -50.
unit 3
cylinder  0 1 142.8 224. -48.
cylinder  4 1 144.8 224. -50.
cuboid 0 1 218.1 -181.9 215. -185. 250. -50.
array  2 3r0.
reflector 0 1 57.4 57. 260. 559.2 400. 0. 1
reflector 2 1 5r0 .32 1
reflector 3 1 5r0 1.27 1
reflector 4 1 5r0 .64 1
reflector 0 1 5r0 365 1
reflector 5 2 6r3 10
reflector 5 12 0 3 4r0 10
end geom
read start xsm=178 xsp=222 ysm=178 ysp=222 zsm=50 zsp=91 end start
read bias id=301 2 21 end bias
read array ara=1 nux=2 nuy=2 nuz=2 fill f1 end fill
ara=2 nux=2 nuy=1 nuz=1 fill 2 3 end fill end array
read plot
xul=113.2 yul=286.8 zul=60. xlr=286.8 ylr=113.2 zlr=60.
uax=1 vdn=-1 nax=125  end
xul=437.1 yul=329.8 zul=60. xlr=726.7 ylr=40.2 zlr=60. end
end plot
end data
end


=csas25
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
arbmwood  .640525 3 0 0 0 6012 44.435 1001 6.2639 8016 49.301 3 end
carbonsteel   4 end
reg-concrete  5 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
uo2(no3)2 415 g u/l 3x3x3 array unrefl. walls, tank, & floor
read param    plt=no  npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cylinder  1 1 9.52 17.5609 0.
cylinder  0 1 9.52 17.77   0.
cylinder  2 1 10.16 18.41  -.64
cuboid    0 1 4p13.40 21.65 -3.88
unit 2
array  1 2r-40.2 0.
cuboid 0 1 4p200. 250. -50.
unit 3
```

```
cylinder  0 1 142.8 224. -48.
cylinder  4 1 144.8 224. -50.
cuboid 0 1 218.1 -181.9 215. -185. 250. -50.
array  2 3r0.
reflector 0 1 57.4 57. 260. 559.2 400. 0. 1
reflector 2 1 5r0 .32 1
reflector 3 1 5r0 1.27 1
reflector 4 1 5r0 .64 1
reflector 0 1 5r0 365 1
reflector 5 2 6r3 10
reflector 5 12 0 3 4r0 10
end geom
read start xsm=160 xsp=240 ysm=160 ysp=240 zsm=50 zsp=127 end start
read bias id=301 2 21 end bias
read array ara=1 nux=3 nuy=3 nuz=3 fill f1 end fill
ara=2 nux=2 nuy=1 nuz=1 fill 2 3 end fill end array
read plot
xul=113.2 yul=286.8 zul=60. xlr=286.8 ylr=113.2 zlr=60.
uax=1 vdn=-1 nax=125  end
xul=437.1 yul=329.8 zul=60. xlr=726.7 ylr=40.2 zlr=60. end
end plot
end data
end


=csas25
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
arbmwood  .640525 3 0 0 0 6012 44.435 1001 6.2639 8016 49.301 3 end
carbonsteel   4 end
reg-concrete  5 end
solnuo2(no3)2  6 279 0 1 293 92235 92.6 92238 7.4 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
uo2(no3)2 415 g u/l 3x3x3 array unrefl. 279 g u/l 5 cent. units walls, floor, &
read param    plt=no  npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cylinder  1 1 9.52 17.5609 0.
cylinder  0 1 9.52 17.77   0.
cylinder  2 1 10.16 18.41  -.64
cuboid    0 1 4p13.365 21.615 -3.845
unit 4
cylinder  6 1 9.52 17.5609 0.
cylinder  0 1 9.52 17.77   0.
cylinder  2 1 10.16 18.41  -.64
cuboid    0 1 4p13.365 21.615 -3.845
unit 2
array  1 2r-40.095 0.
cuboid 0 1 4p200. 250. -50.
unit 3
cylinder  0 1 142.8 224. -48.
cylinder  4 1 144.8 224. -50.
cuboid 0 1 218.1 -181.9 215. -185. 250. -50.
array  2 3r0.
reflector 0 1 57.4 57. 260. 559.2 400. 0. 1
reflector 2 1 5r0 .32 1
reflector 3 1 5r0 1.27 1
reflector 4 1 5r0 .64 1
reflector 0 1 5r0 365 1
```

```
reflector 5 2 6r3 10
reflector 5 12 0 3 4r0 10
end geom
read start xsm=138 xsp=262 ysm=138 ysp=262 zsm=50 zsp=169 end start
read bias id=301 2 21 end bias
read array ara=1 nux=3 nuy=3 nuz=3 fill 10r1 4 1 3r4 1 4 10r1 end fill
ara=2 nux=2 nuy=1 nuz=1 fill 2 3 end fill end array
read plot
xul=113.2 yul=286.8 zul=60. xlr=286.8 ylr=113.2 zlr=60.
uax=1 vdn=-1 nax=125  end
xul=437.1 yul=329.8 zul=60. xlr=726.7 ylr=40.2 zlr=60. end
end plot
end data
end


=csas25
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
uo2(no3)2 415 g u/l 3x3x3 array 15.24 cm par. bot., 2.54 cm plex.
read param    npg=2000 fdn=yes nub=yes end param
read geom
cylinder  1 1 9.52 17.5609 0.
cylinder  0 1 9.52 17.77   0.
cylinder  2 1 10.16 18.41  -.64
cuboid    0 1 4p16.13 24.38 -6.61
core  0 1 3r0.
reflector  2 2 5r2.54 0 1
reflector  3 2 5r0 3 4
reflector  3 6 5r0 3.24 1
end geom
read bias id=400 2 6 end bias
read array nux=3 nuy=3 nuz=3 end array
end data
end


=csas25
uo2(no3)2 415 g u/l
238groupndf5 multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
uo2(no3)2 415 g u/l 3x3x3 array 15.24 cm par. bot., 7.62 cm par.
read param    npg=2000 fdn=yes nub=yes end param
read geom
cylinder  1 1 9.52 17.5609 0.
cylinder  0 1 9.52 17.77   0.
cylinder  2 1 10.16 18.41  -.64
cuboid    0 1 4p18.085 26.335 -8.565
core  0 1 3r0.
reflector  3 2 5r3  0 2
reflector  3 4 5r1.62 0 1
reflector  3 2 5r0 3 4
```

```
reflector  3 6 5r0 3.24 1
end geom
read bias id=400 2 6 end bias
read array nux=3 nuy=3 nuz=3 end array
end data
end


=csas25
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
uo2(no3)2 415 g u/l 3x3x3 array 1.27 cm paraffin refl.
read param    npg=2000 fdn=yes nub=yes end param
read geom
cylinder  1 1 9.52 17.5609 0.
cylinder  0 1 9.52 17.77   0.
cylinder  2 1 10.16 18.41  -.64
cuboid    0 1 4p14.67 22.92 -5.15
core  0 1 3r0.
reflector  3 2 6r1.27 1
end geom
read bias id=400 2 6 end bias
read array nux=3 nuy=3 nuz=3 end array
end data
end


=csas25
uo2(no3)2 415 g u/l
238groupndf5 multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
uo2(no3)2 415 g u/l 2x2x2 array 15.24 cm par. bot., 1.27 cm plex.
read param    npg=2000 fdn=yes nub=yes end param
read geom
cylinder  1 1 9.52 17.5609 0.
cylinder  0 1 9.52 17.77   0.
cylinder  2 1 10.16 18.41  -.64
cuboid    0 1 4p11.965 20.215 -2.445
core  0 1 3r0.
reflector  2 2 5r1.27 0 1
reflector  3 2 5r0 3 4
reflector  3 6 5r0 3.24 1
end geom
read bias id=400 2 6 end bias
read array nux=2 nuy=2 nuz=2 end array
end data
end
```

```
=csas25
uo2(no3)2 415 g u/l
238groupndf5 multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
uo2(no3)2 415 g u/l 2x2x2 array 15.24 cm par. bot., 2.54 cm plex.
read param    npg=2000 fdn=yes nub=yes end param
read geom
cylinder  1 1 9.52 17.5609 0.
cylinder  0 1 9.52 17.77   0.
cylinder  2 1 10.16 18.41  -.64
cuboid    0 1 4p12.865 21.115 -3.345
core  0 1 3r0.
reflector  2 2 5r2.54 0 1
reflector  3 2 5r0 3 4
reflector  3 6 5r0 3.24 1
end geom
read bias id=400 2 6 end bias
read array nux=2 nuy=2 nuz=2 end array
end data
end


=csas25
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
uo2(no3)2 415 g u/l 2x2x2 array 15.24 cm par. bot., 6.35 cm plex.
read param    npg=2000 fdn=yes nub=yes end param
read geom
cylinder  1 1 9.52 17.5609 0.
cylinder  0 1 9.52 17.77   0.
cylinder  2 1 10.16 18.41  -.64
cuboid    0 1 4p14.48 22.73 -4.96
core  0 1 3r0.
'reflector  2 2 5r3.0 0 1
'reflector  2 3 5r3.35 0 1
'reflector  3 2 5r0 3 4
'reflector  3 6 5r0 3.24 1
reflector  2 1 5r3.0 0 1
reflector  2 1 5r3.35 0 1
reflector  3 1 5r0 3 4
reflector  3 1 5r0 3.24 1
end geom
'read bias id=400 2 6 end bias
read array nux=2 nuy=2 nuz=2 end array
end data
end


=csas25
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
```

```
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
uo2(no3)2 415 g u/l 2x2x2 array 15.24 cm par. bot., 7.62 cm par.
read param    npg=2000 fdn=yes nub=yes end param
read geom
cylinder  1 1 9.52 17.5609 0.
cylinder  0 1 9.52 17.77   0.
cylinder  2 1 10.16 18.41  -.64
cuboid    0 1 4p14.515 22.765 -4.995
core  0 1 3r0.
reflector  3 2 5r3  0 2
reflector  3 4 5r1.62 0 1
reflector  3 2 5r0 3 4
reflector  3 6 5r0 3.24 1
end geom
read bias id=400 2 6 end bias
read array nux=2 nuy=2 nuz=2 end array
end data
end


=csas25
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
uo2(no3)2 415 g u/l 2x2x2 array 1.27 cm paraffin refl.
read param    npg=2000 fdn=yes nub=yes end param
read geom
cylinder  1 1 9.52 17.5609 0.
cylinder  0 1 9.52 17.77   0.
cylinder  2 1 10.16 18.41  -.64
cuboid    0 1 4p11.80 20.05 -2.28
core  0 1 3r0.
reflector  3 2 6r1.27 1
end geom
read bias id=400 2 6 end bias
read array nux=2 nuy=2 nuz=2 end array
end data
end


=csas25
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
uo2(no3)2 415 g u/l 2x2x2 array 3.81 cm paraffin refl.
read param    npg=2000 fdn=yes nub=yes end param
read geom
cylinder  1 1 9.52 17.5609 0.
cylinder  0 1 9.52 17.77   0.
```

```
cylinder  2 1 10.16 18.41  -.64
cuboid    0 1 4p13.615 21.865 -4.095
core  0 1 3r0.
reflector  3 2 6r3.81 1
end geom
read bias id=400 2 6 end bias
read array nux=2 nuy=2 nuz=2 end array
end data
end
```

Table A.6. Table 6 input data

```
=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.0        end
u-234        1  0  0.00538-4  end
u-235        1  0  0.48006-4  end
u-236        1  0  0.00138-4  end
u-238        1  0  0.02807-4  end
n            1  0  1.869-4    end
h            1  0  0.066228   end
o            1  0  0.033736   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.0        end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
sphere  1 1 34.5948
sphere 2 1 34.9148
cuboid 0 1 6p34.9148
end geom  read start nst=1 end start
end data
end
```

```
=csas25
eta experiments  exp
238groupndf5 infhommedium
u-233        1  0  0.0        end
u-234        1  0  0.00631-4  end
u-235        1  0  0.56206-4  end
u-236        1  0  0.00163-4  end
u-238        1  0  0.03281-4  end
n            1  0  2.129-4    end
h            1  0  0.066148   end
o            1  0  0.033800   end
b-10         1  0  0.01029-4  end
b-11         1  0  0.04166-4  end
th-232       1  0  0.0        end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
sphere  1 1 34.5948   sphere 2 1 34.9148   cuboid 0 1 6p34.9148
end geom  read start nst=1 end start
end data
end
```

```
=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.0         end
u-234        1  0  0.00716-4  end
u-235        1  0  0.63944-4  end
u-236        1  0  0.00184-4  end
u-238        1  0  0.03734-4  end
n            1  0  2.392-4    end
h            1  0  0.066070   end
o            1  0  0.033865   end
b-10         1  0  0.02057-4  end
b-11         1  0  0.08332-4  end
th-232       1  0  0.0         end
al           2  1              end
ss316        3  1              end
carbonsteel  4  1              end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
sphere  1 1 34.5948   sphere 2 1 34.9148   cuboid 0 1 6p34.9148
end geom  read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.0         end
u-234        1  0  0.00762-4  end
u-235        1  0  0.67959-4  end
u-236        1  0  0.00197-4  end
u-238        1  0  0.03967-4  end
n            1  0  2.548-4    end
h            1  0  0.066028   end
o            1  0  0.034028   end
b-10         1  0  0.02532-4  end
b-11         1  0  0.10255-4  end
th-232       1  0  0.0         end
al           2  1              end
ss316        3  1              end
carbonsteel  4  1              end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
sphere  1 1 34.5948   sphere 2 1 34.9148   cuboid 0 1 6p34.9148
end geom  read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.43284-4  end
u-234        1  0  0.00716-4  end
u-235        1  0  0.00018-4  end
u-236        1  0  0.0         end
u-238        1  0  0.00281-4  end
n            1  0  1.178-4    end
```

```
h             1  0  0.066360   end
o             1  0  0.033608   end
b-10          1  0  0.0        end
b-11          1  0  0.0        end
th-232        1  0  0.000196-3 end
al            2  1             end
ss316         3  1             end
carbonsteel   4  1             end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
sphere  1 1 34.5948   sphere 2 1 34.9148   cuboid 0 1 6p34.9148
end geom  read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233         1  0  0.45120-4  end
u-234         1  0  0.00744-4  end
u-235         1  0  0.00018-4  end
u-236         1  0  0.0        end
u-238         1  0  0.00291-4  end
n             1  0  1.224-4    end
h             1  0  0.066345   end
o             1  0  0.033621   end
b-10          1  0  0.00263-4  end
b-11          1  0  0.01066-4  end
th-232        1  0  0.000205-3 end
al            2  1             end
ss316         3  1             end
carbonsteel   4  1             end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
sphere  1 1 34.5948   sphere 2 1 34.9148   cuboid 0 1 6p34.9148
end geom  read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233         1  0  0.46798-4  end
u-234         1  0  0.00772-4  end
u-235         1  0  0.00018-4  end
u-236         1  0  0.0        end
u-238         1  0  0.00301-4  end
n             1  0  1.274-4    end
h             1  0  0.066329   end
o             1  0  0.033634   end
b-10          1  0  0.00512-4  end
b-11          1  0  0.02075-4  end
th-232        1  0  0.000213-3 end
al            2  1             end
ss316         3  1             end
carbonsteel   4  1             end
end comp
```

```
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
sphere  1 1 34.5948   sphere 2 1 34.9148   cuboid 0 1 6p34.9148
end geom  read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.48455-4  end
u-234        1  0  0.00801-4  end
u-235        1  0  0.00021-4  end
u-236        1  0  0.0        end
u-238        1  0  0.00311-4  end
n            1  0  1.319-4    end
h            1  0  0.066315   end
o            1  0  0.033646   end
b-10         1  0  0.00758-4  end
b-11         1  0  0.03069-4  end
th-232       1  0  0.000221-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
sphere  1 1 34.5948   sphere 2 1 34.9148   cuboid 0 1 6p34.9148
end geom  read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5 infhommedium
u-233        1  0  0.5066-4   end
u-234        1  0  0.00827-4  end
u-235        1  0  0.00021-4  end
u-236        1  0  0.0        end
u-238        1  0  0.00327-4  end
n            1  0  1.363-4    end
h            1  0  0.0663     end
o            1  0  0.033659   end
b-10         1  0  0.01005-4  end
b-11         1  0  0.04070-4  end
th-232       1  0  0.000227-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
sphere  1 1 34.5948   sphere 2 1 34.9148   cuboid 0 1 6p34.9148
end geom  read start nst=1 end start
end data
end
```

```
=csas25
eta experiments  exp
238groupndf5 infhommedium
u-233        1  0  0.0         end
u-234        1  0  0.00409-4  end
u-235        1  0  0.36185-4  end
u-236        1  0  0.00220-4  end
u-238        1  0  0.01985-4  end
n            1  0  1.116-4    end
h            1  0  0.066394   end
o            1  0  0.033592   end
b-10         1  0  0.0         end
b-11         1  0  0.0         end
th-232       1  0  0.0         end
al           2  1              end
ss316        3  1              end
carbonsteel  4  1              end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
sphere  1 1 61.0108  sphere 2 1 61.7808  cuboid 0 1 6p61.7808
end geom  read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.33460-4  end
u-234        1  0  0.00525-4  end
u-235        1  0  0.00010-4  end
u-236        1  0  0.0         end
u-238        1  0  0.00256-4  end
n            1  0  0.753-4    end
h            1  0  0.066467   end
o            1  0  0.033525   end
b-10         1  0  0.0         end
b-11         1  0  0.0         end
th-232       1  0  0.000148-3 end
al           2  1              end
ss316        3  1              end
carbonsteel  4  1              end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
sphere  1 1 61.0108  sphere 2 1 61.7808  cuboid 0 1 6p61.7808
end geom  read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.00000-4  end
u-234        1  0  0.00469-4  end
u-235        1  0  0.41364-4  end
u-236        1  0  0.00243-4  end
u-238        1  0  0.02271-4  end
n            1  0  1.27200-4  end
```

```
h            1  0  0.066345   end
o            1  0  0.033624   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000000-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom  cylinder  1 1  77.3684     45.1358   0.0
cylinder  0 1  77.3684    264.0    0.0
cylinder  3 1  77.4984    264.13  -0.13
cuboid    0 1  4p77.4984  264.13  -0.13
end geom
read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.00000-4  end
u-234        1  0  0.00451-4  end
u-235        1  0  0.40595-4  end
u-236        1  0  0.00222-4  end
u-238        1  0  0.02339-4  end
n            1  0  1.40900-4  end
h            1  0  0.066343   end
o            1  0  0.033655   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000000-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom  cylinder  1 1  77.3684     47.4472   0.0
cylinder  0 1  77.3684    264.0    0.0
cylinder  3 1  77.4984    264.13  -0.13
cuboid    0 1  4p77.4984  264.13  -0.13
end geom
read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.00000-4  end
u-234        1  0  0.00409-4  end
u-235        1  0  0.36452-4  end
u-236        1  0  0.00209-4  end
u-238        1  0  0.02048-4  end
n            1  0  1.18500-4  end
h            1  0  0.066383   end
o            1  0  0.033605   end
b-10         1  0  0.0        end
```

```
b-11         1  0  0.0         end
th-232       1  0  0.000000-3 end
al           2  1              end
ss316        3  1              end
carbonsteel  4  1              end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom  cylinder  1 1  77.3684     72.7456   0.0
cylinder  0 1  77.3684    264.0    0.0
cylinder  3 1  77.4984    264.13  -0.13
cuboid    0 1  4p77.4984  264.13  -0.13
end geom
read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.00000-4  end
u-234        1  0  0.00397-4  end
u-235        1  0  0.34845-4  end
u-236        1  0  0.00194-4  end
u-238        1  0  0.01962-4  end
n            1  0  1.20800-4  end
h            1  0  0.066389   end
o            1  0  0.033609   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000000-3 end
al           2  1              end
ss316        3  1              end
carbonsteel  4  1              end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom  cylinder  1 1  77.3684     105.2068   0.0
cylinder  0 1  77.3684    264.0    0.0
cylinder  3 1  77.4984    264.13  -0.13
cuboid    0 1  4p77.4984  264.13  -0.13
end geom
read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.00000-4  end
u-234        1  0  0.00384-4  end
u-235        1  0  0.33519-4  end
u-236        1  0  0.00186-4  end
u-238        1  0  0.01924-4  end
n            1  0  1.24400-4  end
h            1  0  0.066391   end
o            1  0  0.033615   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000000-3 end
al           2  1              end
```

```
ss316        3  1              end
carbonsteel  4  1              end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom  cylinder  1 1  77.3684     203.2762   0.0
cylinder  0 1  77.3684    264.0    0.0
cylinder  3 1  77.4984    264.13  -0.13
cuboid    0 1  4p77.4984  264.13  -0.13
end geom
read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.36517-4  end
u-234        1  0  0.00556-4  end
u-235        1  0  0.00000-4  end
u-236        1  0  0.00000-4  end
u-238        1  0  0.00410-4  end
n            1  0  0.82600-4  end
h            1  0  0.066439   end
o            1  0  0.033539   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000037-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom  cylinder  1 1  77.3684     49.5046   0.0
cylinder  0 1  77.3684    264.0    0.0
cylinder  3 1  77.4984    264.13  -0.13
cuboid    0 1  4p77.4984  264.13  -0.13
end geom
read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.34978-4  end
u-234        1  0  0.00525-4  end
u-235        1  0  0.00000-4  end
u-236        1  0  0.00000-4  end
u-238        1  0  0.00395-4  end
n            1  0  0.84900-4  end
h            1  0  0.066444   end
o            1  0  0.033542   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000032-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
```

```
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom  cylinder  1 1  77.3684     59.2074   0.0
cylinder  0 1  77.3684    264.0    0.0
cylinder  3 1  77.4984    264.13  -0.13
cuboid    0 1  4p77.4984  264.13  -0.13
end geom
read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5 infhommedium
u-233        1  0  0.33292-4  end
u-234        1  0  0.00507-4  end
u-235        1  0  0.00000-4  end
u-236        1  0  0.00000-4  end
u-238        1  0  0.00375-4  end
n            1  0  0.80200-4  end
h            1  0  0.066459   end
o            1  0  0.033533   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000037-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom  cylinder  1 1  77.3684     77.6732   0.0
cylinder  0 1  77.3684    264.0    0.0
cylinder  3 1  77.4984    264.13  -0.13
cuboid    0 1  4p77.4984  264.13  -0.13
end geom
read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.31567-4  end
u-234        1  0  0.00481-4  end
u-235        1  0  0.00000-4  end
u-236        1  0  0.00000-4  end
u-238        1  0  0.00354-4  end
n            1  0  0.79500-4  end
h            1  0  0.066470   end
o            1  0  0.033531   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000258-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom  cylinder  1 1  77.3684     138.9126   0.0
```

```
cylinder  0 1  77.3684    264.0    0.0
cylinder  3 1  77.4984    264.13  -0.13
cuboid    0 1  4p77.4984  264.13  -0.13
end geom
read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.00000-4  end
u-234        1  0  0.00397-4  end
u-235        1  0  0.33940-4  end
u-236        1  0  0.00240-4  end
u-238        1  0  0.01975-4  end
n            1  0  1.40700-4  end
h            1  0  0.066367   end
o            1  0  0.033645   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000000-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom  cylinder  1 1 136.7790     90.8812   0.0
cylinder  0 1  136.7790   274.0    0.0
cylinder  4 1  138.6840   275.905 -1.905
cuboid    0 1 4p138.6840  275.905 -1.905
end geom
read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.00000-4  end
u-234        1  0  0.00381-4  end
u-235        1  0  0.33124-4  end
u-236        1  0  0.00232-4  end
u-238        1  0  0.01942-4  end
n            1  0  1.36700-4  end
h            1  0  0.066374   end
o            1  0  0.033634   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000000-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom  cylinder  1 1 136.7790     122.4280   0.0
cylinder  0 1  136.7790   274.0    0.0
cylinder  4 1  138.6840   275.905 -1.905
cuboid    0 1 4p138.6840  275.905 -1.905
```

```
end geom
read start nst=1 end start
end data
end


=csas25
eta experiments  exp
238groupndf5  infhommedium
u-233        1  0  0.00000-4  end
u-234        1  0  0.00368-4  end
u-235        1  0  0.32347-4  end
u-236        1  0  0.00220-4  end
u-238        1  0  0.01894-4  end
n            1  0  1.33800-4  end
h            1  0  0.066385   end
o            1  0  0.033631   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000000-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
eta experiments
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom  cylinder  1 1 136.7790     241.1222   0.0
cylinder  0 1  136.7790   274.0    0.0
cylinder  4 1  138.6840   275.905 -1.905
cuboid    0 1 4p138.6840  275.905 -1.905
end geom
read start nst=1 end start
end data
end
```

# APPENDIX B

# KENO-VI INPUT DATA USED FOR VALIDATION CASES LISTED IN TABLES 1–6 (238 group)

# APPENDIX B

# KENO-VI INPUT DATA USED FOR VALIDATION CASES LISTED IN TABLES 1–6 (238 GROUP)

Input data for the validation appears in the same order as listed in Tables 1–6 of Section 1 of this report.

Table B.1. Table 1 input data

```
=csas26    parm=size=5000000
libby exp. 4.89% rods 30 cm long, .762 cm diam, 1.3 cm pitch
238groupndf5 latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
h2o        2 1 end
plexiglass  3 1 end
end comp
squarepitch  1.3 .762 1 2 end
read param npg=2000  nub=yes fdn=yes end param
read geom
unit 1
cylinder  10  .381 5.08 0
cuboid    20  4p.65 5.08 0
media  1 1 10
media  2 1  20 -10
boundary  20
unit 2
cylinder  10  .381 1.27 0
cuboid    20  4p.65 1.27 0
media  1 1 10
media  3 1  20 -10
boundary  20
unit 3
cylinder  10  .381 17.935 0
cuboid    20  4p.65 17.935 0
media  1 1 10
media  2 1  20 -10
boundary  20
unit 4
cylinder  10  .381 .635 0
cuboid    20  4p.65 .635 0
media  1 1 10
media  3 1  20 -10
boundary  20
unit 5
cuboid    10  4p.65 5.08 0
media  2 1 10
boundary 10
unit 6
cylinder  10  .381 1.27 0
cuboid    20  4p.65 1.27 0
media  2 1 10
media  3 1  20 -10
boundary  20
unit 7
cuboid    10  4p.65 17.935 0
media  2 1 10
boundary  10
unit 8
cylinder  10  .381 .635 0
cuboid    20  4p.65 .635 0
media  2 1 10
media  3 1  20 -10
boundary  20
global unit  10
cuboid   10 26.0  0.0  27.3  0.0  30.0  0.0
cuboid   20  26.0  0.0  27.3  0.0  30.0  -3.81
cuboid   30  41.0  -15.0  42.3  -15.0  39.2  -15.0
array  1  10  place 1 1 1  .65  .65  0.0
```

```
media   3 1 20 -10
media  2  1 30 -20 -10
boundary  30
end geom
read array nux=20 nuy=21 nuz=5 fill
19r5 401r1  19r6 401r2  19r7 401r3 19r8 401r4 19r5 401r1
end fill end array
end data
end


=csas26     parm=size=5000000
libby exp. 4.89 rods 30 cm long, .762 cm diam, 2.05 cm pitch
238groupndf5  latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
h2o        2 1 end
plexiglass  3 1 end
end comp
squarepitch  2.05 .762 1 2 end
read param npg=2000  nub=yes fdn=yes end param
read geom
unit 1
cylinder  10  .381 30 0
cuboid    20  4p1.025 30 0
media  1 1 10
media  2 1 20 -10
boundary  20
unit 2
cuboid    10 4p1.025 30 0
media  2 1 10
boundary  10
global
unit  3
cuboid  10  28.7  0.0   30.75  0.0    30.0  0.0
cuboid  20  31.7 -3.0   33.75  -3.0   33.0  -3.0
cuboid  30  34.7 -6.0   36.75  -6.0   36.0  -6.0
cuboid  40  37.7 -9.0   39.75  -9.0   39.0  -9.0
cuboid  50  40.7 -12.0  42.75  -12.0  39.3  -12.0
cuboid  60  43.7 -15.0  45.75  -15.0  39.3  -15.0
array   1 10 place 1 1 1  1.025  1.025  0.0
media  2 2 20 -10
media  2 3 30 -20 -10
media  2 4 40 -30 -20 -10
media  2 5 50 -40 -30 -20 -10
media  2 6 60 -50 -40 -30 -20 -10
boundary  60
end geom
read array nux=14 nuy=15 nuz=1 fill
7r1 7r2 f1
end fill end array
read bias id=500 2 6 end bias
end data
end


=csas26   parm=size=5000000
libby exp. 4.89% rods 30 cm long, .762 cm diam, 1.3 cm pitch
238groupndf5  latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
h2o        2 1 end
plexiglass  3 1 end
pb   4 1 end
end comp
```

```
squarepitch  1.3 .762 1 2 end
read param npg=2000  nub=yes plt=no fdn=yes end param
read geom
unit 1
cylinder  10 .381 30 0
cuboid    20 4p.65 30 0
media  1 1 10
media  2 1 20 -10
boundary  20
unit 2
cuboid    10  4p.65 30 0
media  2 1 10
boundary  10
unit 3
cuboid  10  26.0  0.0  26.0  0.0  30.0  0.0
cuboid  20  33.32  -7.32  26.0  -7.32  30.0  0.0
array 1  10  place  1 1 1  .65  .65    0.0
media  2 1 20 -10
boundary  20
unit 4
cuboid  10  2p20.32 2p10.16 25.4 0
cuboid  20  20.32  -20.32   10.16  -10.16  26.825  0.0
cuboid  30  20.32  -20.32   10.16  -10.16  26.825  -3.175
media  4  1 10
media  2  1 20 -10
media  3  1 30 -20 -10
boundary  30
global
unit  5
cuboid  10  40.64    0.0  53.64   0.0   30.0  0.0
cuboid  20  48.32  -7.68  53.64  -7.68  35.1  0.0
cuboid  30  48.32  -7.68  53.64  -7.68  35.1  -13.97
array 2 10 place 1 1 1    7.32  7.32  0.0
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
read array ara=1 nux=20 nuy=20 nuz=1 fill
18r1 2r2 f1
end fill
ara=2 nux=1 nuy=2 nuz=1 fill 3 4
end fill end array
read plot ttl='14a x-y' pic=mix
xul=-7.8 yul=53.8 zul=15  xlr=48.8 ylr=-7.8 zlr=15
uax=1 vdn=-1 nax=125 end
ttl='14a x-y' pic=wts end
ttl='14a y-z' pic=mix
xul=20 yul=-7.8 zul=35.5  xlr=20 ylr=53.8 zlr=-14.1
vax=1 wdn=-1 uax=0 vdn=0 nax=125 end
ttl='14a y-z' pic=wts end
end plot
end data
end


=csas26
libby exp. 4.89% rods 30 cm long, .762 cm diam, 1.3 cm pitch
238groupndf5  latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
h2o        2 1 end
plexiglass  3 1 end
pb   4 1 end
end comp
```

```
squarepitch  1.3 .762 1 2 end
read param npg=2000  nub=yes plt=no fdn=yes end param
read geom
unit 1
cylinder  10  .381 30 0
cuboid    20  4p.65 30 0
media  1 1 10
media  2 1 20 -10
boundary 20
unit 2
cuboid    10 4p.65 30 0
media  2 1 10
boundary 10
unit 3
cuboid  10  29.9  0.0  26.0  0.0  30.0  0.0
cuboid  20  30.52  -0.62  26.62  -4.52  30.0  0.0
array 1  10  place  1 1 1  .65  .65  0.0
media  2 1 20 -10
boundary  20
unit 4
cuboid   10 2p10.16 2p15.57 25.4 0
cuboid   20 2p10.16 2p15.57 26.825 0
cuboid   30 2p10.16 2p15.57 26.825 -3.175
media  4 1 10
media  2 2 20 -10
media  3 2 30 -20 -10
boundary 30
unit 5
cuboid  10  71.78  0.0  31.14  0.0  30.0  0.0
array 2  10  place  1 1 1 10.16  15.57  3.175
boundary 10
unit 6
cuboid  10 2p35.89 2p10.16 25.4 0
cuboid  20 2p35.89 2p10.16 26.825 0
cuboid  30 2p35.89 2p10.16 26.825 -3.175
media  4 1 10
media  2 2 20 -10
media  3 2 30 -20 -10
boundary 30
global unit  7
cuboid  10  71.78  0.0  71.78  0.0  30.0  0.0
cuboid  20  71.78  0.0  71.78  0.0  33.0  0.0
cuboid  30  71.78  0.0  71.78  0.0  36.0  0.0
cuboid  40  71.78  0.0  71.78  0.0  37.95 0.0
cuboid  50  71.78  0.0  71.78  0.0  37.95 -3.0
cuboid  60  71.78  0.0  71.78  0.0  37.95 -6.0
cuboid  70  71.78  0.0  71.78  0.0  37.95 -9.0
cuboid  80  71.78  0.0  71.78  0.0  37.95 -12.0
cuboid  90  71.78  0.0  71.78  0.0  37.95 -13.97
array 3  10 place 1 1 1  35.89  10.16  3.175
media  2 2 20 -10
media  2 3 30 -20 -10
media  2 4 40 -30 -20 -10
media  3 5 50 -40 -30 -20 -10
media  3 6 60 -50 -40 -30 -20 -10
media  3 7 70 -60 -50 -40 -30 -20 -10
media  3 8 80 -70 -60 -50 -40 -30 -20 -10
media  3 9 90 -80 -70 -60 -50 -40 -30 -20 -10
boundary 90
end geom
read array ara=1 nux=23 nuy=20 nuz=1 fill
3r2 2r1 2 5q3 2r1  q23  23r2  q69  2 1 2 2r1 2 5q3 2r1
2r1 2 6q3 2r1  23r2  2r1 2 6q3 2r1  q23  23r2  2q69
```

```
2r1 2 6q3 2r1  q23
end fill
ara=2 nux=3 nuy=1 nuz=1 fill 4 3 4 end fill
ara=3 nux=1 nuy=3 nuz=1 fill 6 5 6
end fill end array
read bias id=500 2 9 end bias
read plot ttl=' x-y' pic=mix
xul=0 yul=72 zul=15  xlr=72 ylr=0 zlr=15
uax=1 vdn=-1 nax=125 end
ttl=' x-y' pic=wts end
ttl=' y-z' pic=mix
xul=33 yul=0 zul=40  xlr=33 ylr=72 zlr=-14.1
vax=1 wdn=-1 uax=0 vdn=0 nax=125 end
ttl=' y-z' pic=wts end
end plot
end data
end


=csas26    parm=size=5000000
libby exp. 4.89% rods 30 cm long, .762 cm diam, 1.3 cm pitch
238groupndf5  latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
h2o        2 1 end
plexiglass  3 1 end
pb   4 1 end
b-10  5 0 4.617-3 end
b-11  5 0 1.872-2 end
c     5 0 5.750-3 end
al    5 0 4.765-2 end
end comp
squarepitch  1.3 .762 1 2 end
read param npg=2000  nub=yes plt=no fdn=yes end param
read geom
unit 1
cylinder  10 .381 30 0
cuboid    20 4p.65 30 0
media  1 1 10
media  2 1 20 -10
boundary  20
unit 2
cuboid    10 4p.65 30 0
media  2 1 10
boundary  10
unit 3
cuboid  10  29.9  0.0  22.1  0.0  30.0  0.0
cuboid  20  30.52  -.62  22.1  -.62  30.0  0.0
array 1 10  place  1 1 1   .65  .65  0.0
media   2 1 20 -10
boundary  20
unit 7
cuboid  10  29.9  0.0  6.5  0.0  30.0  0.0
cuboid  20  30.52  -.62  7.12  0.0  30.0  0.0
array  4  10  place 1 1 1    .65  .65  0.0
media  2 1 20 -10
boundary  20
unit 8
cuboid  10 2p15.57 2p.3175 25.4 0
cuboid  20 2p15.57  2p.65  26.825  -3.175
media 5 1 10
media  2 1 20 -10
boundary  20
unit 4
```

```
cuboid  10  2p10.16 2p15.57 25.4 0
cuboid  20  2p10.16  2p15.57  26.825  0.0
cuboid  30  2p10.16  2p15.57  26.825  -3.175
media  4 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 9
cuboid  10 31.14  0.0  31.14  0.0  30.0  0.0
array 5  10  place  1 1 1  .62  .62  0.0
boundary  10
unit 5
cuboid  10  71.78  0.0  31.14  0.0  30.0 0.0
array 2  10 place  1 1 1   10.16  15.57  3.175
boundary  10
unit 6
cuboid  10 2p35.89 2p10.16 25.4 0
cuboid  20  2p35.89  2p10.16  26.825  0.0
cuboid  30  2p35.89  2p10.16  26.825  -3.175
media  4 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
global
unit  10
cuboid  10  71.78  0.0  71.78  0.0  30.0  0.0
cuboid  20  71.78  0.0  71.78  0.0  34.8  0.0
cuboid  30  71.78  0.0  71.78  0.0  34.8  -13.97
array  3  10  place 1 1 1  35.89  10.16 3.175
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
read array ara=1 nux=23 nuy=17 nuz=1 fill
2r2 19r1 2r2  2 21r1 2  f1
end fill
ara=4 nux=23 nuy=5 nuz=1 fill
69r1 2 21r1 2  2r2 19r1 2r2
end fill
ara=5 nux=1 nuy=3 nuz=1 fill 3 8 7 end fill
ara=2 nux=3 nuy=1 nuz=1 fill 4 9 4 end fill
ara=3 nux=1 nuy=3 nuz=1 fill 6 5 6
end fill end array
read plot ttl=’ x-y’ pic=mix
xul=0 yul=72 zul=15  xlr=72 ylr=0 zlr=15
uax=1 vdn=-1 nax=125 end
ttl=’ x-y’ pic=wts end
ttl=’ y-z’ pic=mix
xul=33 yul=0 zul=40  xlr=33 ylr=72 zlr=-14.1
ttl=’ y-z’ pic=wts end
end plot
end data
end


=csas26   parm=size=5000000
libby exp. 4.89% rods 30 cm long, .762 cm diam, 1.3 cm pitch
238groupndf5  latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
h2o        2 1 end
plexiglass  3 1 end
pb   4 1 end
cd  5 1 end
```

```
end comp
squarepitch  1.3 .762 1 2 end
read param npg=2000  nub=yes plt=no fdn=yes end param
read geom
unit 1
cylinder  10 .381 30 0
cuboid    20 4p.65 30 0
media 1 1 10
media  2 1 20 -10
boundary 20
unit 2
cuboid   10    4p.65 30 0
media  2 1 10
boundary 10
unit 3
cuboid  10  29.9  0.0  22.1  0.0  30.0  0.0
cuboid  20  30.52  -.62  22.1  -.62   30.0  0.0
array  1  10  place  1 1 1  .65  .65  0.0
media  2 1 20 -10
boundary 20
unit 7
cuboid  10  29.9  0.0  6.5  0.0  30.0  0.0
cuboid  20  30.52  -.62  7.12  0.0  30.0  0.0
array  4  10  place   1 1 1  .65  .65  0.0
media  2 1 20 -10
boundary  20
unit 8
cuboid  10 2p15.57 2p.04445 25.4 0
cuboid  20 15.57  -15.57  .65  -.65  26.825  -3.175
media 5 1 10
media  2 1 20 -10
boundary  20
unit 4
cuboid   10  2p10.16 2p15.57 25.4 0
cuboid   20 2p10.16 2p15.57 26.825 0.0
cuboid   30  2p10.16  2p15.57  26.825  -3.175
media  4 1 10
media  2 2 20 -10
media  3 2 30 -20 -10
boundary 30
unit 9
cuboid  10   31.14  0.0  31.14  0.0  30.0  0.0
array  5 10 place 1 1 1  .62  .62  0.0
boundary  10
unit 5
cuboid  10 71.78  0.0  31.14  0.0  30.0  0.0
array  2 10 place 1 1 1   10.16  15.57  3.175
boundary  10
unit 6
cuboid  10 2p35.89 2p10.16 25.4 0
cuboid  20  35.89  -35.89  10.16  -10.16  26.825  0.0
cuboid  30  35.89  -35.89  10.16  -10.16  26.825  -3.175
media  4 1 10
media  2 2 20 -10
media  3 2 30 -20 -10
boundary  30
global
unit 10
cuboid  10  71.78  0.0  71.78  0.0  30.0  0.0
cuboid  20  71.78  0.0  71.78  0.0  30.5  0.0
cuboid  30  71.78  0.0  71.78  0.0  30.5  -3.0
cuboid  40  71.78  0.0  71.78  0.0  30.5  -6.0
cuboid  50  71.78  0.0  71.78  0.0  30.5  -9.0
```

```
cuboid  60  71.78  0.0  71.78  0.0  30.5  -12.0
cuboid  70  71.78  0.0  71.78  0.0  30.5  -13.97
array  3  10  place  1 1 1 35.89  10.16  3.175
media  2 2 20 -10
media  3 2 30 -20 -10
media  3 3 40 -30 -20 -10
media  3 4 50 -40 -30 -20 -10
media  3 5 60 -50 -40 -30 -20 -10
media  3 6 70 -60 -50 -40 -30 -20 -10
boundary 70
end geom
read array ara=1 nux=23 nuy=17 nuz=1 fill
11r1 12r2   f1
end fill
ara=4 nux=23 nuy=5 nuz=1 fill
f1
end fill
ara=5 nux=1 nuy=3 nuz=1 fill 3 8 7 end fill
ara=2 nux=3 nuy=1 nuz=1 fill 4 9 4 end fill
ara=3 nux=1 nuy=3 nuz=1 fill 6 5 6
end fill end array
read bias id=500 2 6 end bias
read plot ttl=’ x-y’ pic=mix
xul=0 yul=72 zul=15  xlr=72 ylr=0 zlr=15
uax=1 vdn=-1 nax=125 end
ttl=’ x-y’ pic=wts end
ttl=’ y-z’ pic=mix
xul=33 yul=0 zul=40  xlr=33 ylr=72 zlr=-14.1
vax=1 wdn=-1 uax=0 vdn=0 nax=125 end
ttl=’ y-z’ pic=wts end
end plot
end data
end
l


=csas26    parm=size=5000000
libby exp. 4.89% rods 30 cm long, .762 cm diam, 3.25 cm pitch in uo2f2 soln
238groupndf5  latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
solnuo2f2  2 301.16 0 1 293 92235 4.89 92238 95.11 end
plexiglass  3 1 end
al  4 1 end
solnuo2f2  5 301.16 0 1 293 92235 4.89 92238 95.11 end
end comp
squarepitch  3.25 .762 1 2 end
read param npg=2000  far=yes  nub=yes fdn=yes end param
read geom
unit 1
cylinder  10 .381 5.08 0
cuboid    20 4p1.625 5.08 0
media  1 1 10
media  5 1 20 -10
boundary  20
unit 2
cylinder  10  .381 1.27 0
cuboid    20  4p1.625 1.27 0
media  1 1 10
media  3 1 20 -10
boundary  20
unit 3
cylinder  10 .381 17.935 0
cuboid    20  4p1.625 17.935 0
```

```
media  1 1 10
media  5 1 20 -10
boundary  20
unit 4
cylinder  10 .381 .635 0
cuboid    20  4p1.625 .635 0
media  1 1 10
media  3 1 20 -10
boundary  20
unit 5
cuboid   10 4p1.625 5.08 0
media  2 1 10
boundary 10
unit 6
cylinder  10  .381 1.27 0
cuboid    20  4p1.625 1.27 0
media  2 1 10
media  3 1 20 -10
boundary  20
unit 7
cuboid    10  4p1.625 17.935 0
media  2 1 10
boundary  10
unit 8
cylinder  10  .381 .635 0
cuboid    20  4p1.625 .635 0
media  2 1 10
media  3 1 20 -10
boundary  20
global
unit  9
cuboid  10  2p14.625  2p16.25  30.0  0.0
cuboid  20  2p14.625  2p16.25  30.0  -3.81
cylinder  30 47.94 38.52 -10.16
cylinder  40 48.26 38.52 -10.48
array  1 10 place 1 1 1  -13.0  -14.625  0.0
media  3 1 20 -10
media  5 1 30 -20 -10
media  4 1 40 -30
boundary  40
end geom
read array nux=9 nuy=10 nuz=5 fill
90r1 90r2 90r3 90r4 90r1
end fill end array
end data
end


=csas26     parm=size=5000000
libby exp. 4.89% rods 30 cm long, 1.31 cm diam, 3.40 cm pitch in uo2f2 soln
238groupndf5  latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
solnuo2f2  2 300.24 0 1 293 92235 4.89 92238 95.11 end
plexiglass  3 1 end
al  4 1 end
solnuo2f2  5 300.24 0 1 293 92235 4.89 92238 95.11 end
end comp
squarepitch  3.40 1.31 1 2 end
read param npg=2000  far=yes  nub=yes fdn=yes end param
read geom
unit 1
cylinder  10 .655 5.08 0
cuboid    20 4p1.70 5.08 0
```

```
media   1 1 10
media   5 1 20 -10
boundary  20
unit 2
cylinder  10 .655 1.27 0
cuboid    20 4p1.70 1.27 0
media  1 1 10
media  3 1 20 -10
boundary  20
unit 3
cylinder  10 .655 17.935 0
cuboid    20 4p1.70 17.935 0
media  1 1 10
media  5 1 20 -10
boundary  20
unit 4
cylinder  10 .655 .635 0
cuboid    20 4p1.70 .635 0
media  1 1 10
media  3 1 20 -10
boundary  20
unit 5
cuboid    10 4p1.70 5.08 0
media  2 1 10
boundary  10
unit 6
cylinder  10 .655 1.27 0
cuboid    20 4p1.70 1.27 0
media  2 1 10
media  3 1 20 -10
boundary  20
unit 7
cuboid    10 4p1.70 17.935 0
media  2 1 10
boundary  10
unit 8
cylinder  10 .655 .635 0
cuboid    20 4p1.70 .635 0
media   2 1 10
media  3 1   20 -10
boundary  20
global
unit  9
cuboid    10  2p10.2  2p11.9   30.0  0.0
cuboid    20  2p10.2  2p11.9   30.0  -3.81
cylinder  30  47.94  39.1  -10.16
cylinder  40  48.26  39.1  -10.48
array  1  10  place  1 1 1  -8.5   -10.2  0.0
media  3 1 20 -10
media  5 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
end geom
read array nux=6 nuy=7 nuz=5 fill
42r1 42r2 42r3 42r4 42r1
end fill end array
end data
end
```

```
=csas26   parm=size=5000000
libby exp. 4.89% rods 30 cm long, 1.31 cm diam, 3.940 cm pitch in uo2f2 soln
238groupndf5  latticecell
uranium    1 .9995 293 92235 4.89 92238 95.11 end
solnuo2f2  2 300.24 0 1 293 92235 4.89 92238 95.11 end
plexiglass  3 1 end
al  4 1 end
solnuo2f2  5 300.24 0 1 293 92235 4.89 92238 95.11 end
end comp
squarepitch  3.94 1.31 1 2 end
read param npg=2000  far=yes  nub=yes fdn=yes end param
read geom
unit 1
cylinder  10 .655 5.08 0
cuboid    20 4p1.97 5.08 0
media  1 1 10
media  5 1 20 -10
boundary  20
unit 2
cylinder  10 .655 1.27 0
cuboid    20 4p1.97 1.27 0
media  1 1 10
media  3 1 20 -10
boundary  20
unit 3
cylinder  10 .655 17.935 0
cuboid    20 4p1.97 17.935 0
media  1 1 10
media  5 1 20 -10
boundary  20
unit 4
cylinder  10 .655 .635 0
cuboid    20 4p1.97 .635 0
media  1 1 10
media  3 1 20 -10
boundary  20
unit 5
cuboid    10 4p1.97 5.08 0
media  2 1 10
boundary  10
unit 6
cylinder  10 .655 1.27 0
cuboid    20 4p1.97 1.27 0
media  2 1 10
media  3 1 20 -10
boundary  20
unit 7
cuboid    10 4p1.97 17.935 0
media  2 1 10
boundary  10
unit 8
cylinder  10 .655 .635 0
cuboid    20 4p1.97 .635 0
media  2 1 10
media  3 1 20 -10
boundary  20
global
unit  9
cuboid  10  2p11.82  2p13.79  30.0  0.0
cuboid  20  2p11.82  2p13.79  30.0  -3.81
cylinder  30   47.94  39.25  -10.16
cylinder  40   48.26  39.25  -10.48
array 1 10 place 1 1 1   -9.85  -11.82  0.0
```

```
media  3 1 20 -10
media  5 1  30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
end geom
read array nux=6 nuy=7 nuz=5 fill
42r1 42r2 42r3 42r4 42r1
end fill end array
end data
end


=csas26    parm=zsize=5000000
4.89% green blocks   unreflected h/u-235=395.0 40.6 g u-235/l
238groupndf5  multiregion
u-234  1 0 4.3000-7 end
u-235  1 0 1.0402-4 end
u-238  1 0 1.9972-3 end
h      1 0 4.1088-2 end
c      1 0 2.1291-2 end
o      1 0 7.8456-3 end
al     2 1 end
end comp
spherical  end
1 28 noextermod  end zone
read param npg=2000  nub=yes fdn=yes end param
read geom
global  unit 1
cuboid  10 50.8 0 60.96 0 60.452 0
media  1 1 10
boundary   10
end geom
end data
end


=csas26    parm=size=5000000
4.89% green blocks h/u-235=503.5 33.3 g u-235/l
238groupndf5  multiregion
u-234  1 0 3.5000-7 end
u-235  1 0 8.5320-5 end
u-238  1 0 1.6381-3 end
h      1 0 4.2959-2 end
c      1 0 2.2261-2 end
o      1 0 6.9399-3 end
al     2 1 end
end comp
spherical  end
1 36 noextermod  end zone
read param npg=2000  nub=yes fdn=yes end param
read geom
global
unit 1
cuboid  10 60.96 0 60.96 0 52.832 0
media  1   1 10
boundary  10
end geom
end data
end
```

```
=csas26   parm=size=5000000
4.89% green blocks h/u-235=199.3 64.9 g u-235/l
238groupndf5  multiregion
u-234  1 0 6.8000-7 end
u-235  1 0 1.6628-4 end
u-238  1 0 3.1926-3 end
h      1 0 3.3140-2 end
c      1 0 1.7173-2 end
o      1 0 1.0766-2 end
al     2 1 end
h2o    3 1 end
para(h2o)  4 1 end
end comp
spherical  end
1 22 oneextermod 3 40 noextermod  end zone
read param npg=2000  nub=yes fdn=yes    rnd=6b4f695d171d   plt=yes  end param
read geom
unit 1
cuboid  10 6p10.16
media 1 1 10
boundary  10
unit 2
cuboid  10 4p10.16  2p8.763
media  1 1 10
boundary  10
global
unit  3
cuboid  10  40.64   0.0    40.64  0.0    58.166  0.0
cuboid  20  40.64   0.0    40.64  0.0    73.406  0.0
cuboid  30  58.64  -18.0  58.64  -18.0  73.406  -18.0
array  1 10   place  1 1 1  10.16  10.16  10.16
media  4 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
read array nux=2 nuy=2 nuz=3 fill 8r1 4r2 end fill end array
read plot scr=yes
ttl='xz slice'
xul=-18.0 yul=20  zul=73.4
xlr=58.64  ylr=20  zlr=-18.0
uax=1  wdn=-1  nax=640 nch='0123'
end plot
end data
end


=csas26   parm=size=5000000
4.89 green blocks h/u-235=396.7 40.6 g u-235/l
238groupndf5  multiregion
u-234  1 0 4.3000-7 end
u-235  1 0 1.0402-4 end
u-238  1 0 1.9972-3 end
h      1 0 4.1265-2 end
c      1 0 2.1383-2 end
o      1 0 7.8552-3 end
al     2 1 end
h2o    3 1 end
para(h2o)  4 1 end
end comp
spherical  end
1 20 oneextermod 3 38 noextermod  end zone
read param npg=2000  nub=yes fdn=yes end param
read geom
```

```
global   unit  1
cuboid  10   40.64 0 40.64 0 57.658 0
cuboid   20  40.64  0.0  40.64  0.0  72.898  0.0
cuboid  30  58.64  -18.0  58.64  -18.0  72.898  -18.0
media  1  1 10
media  4  8  20 -10
media  3  2  30 -20 -10
boundary  30
end geom
read bias id=500 2 7 id=400 8 12 end bias
end data
end


=csas26   parm=size=5000000
4.89% green blocks h/u-235=146.8 81.1 g u-235/l
238groupndf5  multiregion
u-234  1 0 8.5000-7 end
u-235  1 0 2.0779-4 end
u-238  1 0 3.9896-3 end
h      1 0 3.0504-2 end
c      1 0 1.5807-2 end
o      1 0 1.2859-2 end
al     2 1 end
h2o    3 1 end
para(h2o)  4 1 end
end comp
spherical  end
1 22 oneextermod 3 40 noextermod  end zone
read param npg=2000  nub=yes fdn=yes end param
read geom
global
unit 1
cuboid  10 50.8 0 50.8 0 42.164 0
cuboid  20  50.8  0.0  50.8  0.0  57.404 0.0
cuboid  30  68.8  -18.0  68.8  -18.0  57.404  -18.0
media  1 1 10
media  4 8 20 -10
media  3 2 30 -20 -10
boundary  30
end geom
end data
end


=csas26   parm=size=5000000
4.89% green blocks h/u-235=504.1 33.3 g u-235/l
238groupndf5  multiregion
u-234  1 0 3.5000-7 end
u-235  1 0 8.5320-5 end
u-238  1 0 1.6381-3 end
h      1 0 4.3010-2 end
c      1 0 2.2287-2 end
o      1 0 6.9427-3 end
al     2 1 end
h2o    3 1 end
para(h2o)  4 1 end
end comp
spherical  end
1 29 oneextermod 3 47 noextermod  end zone
read param npg=2000  nub=yes fdn=yes end param
read geom
global
```

```
unit 1
cuboid  10 50.8 0 50.8 0 41.148 0
cuboid  20  50.8  0.0  50.8  0.0  56.388  0.0
cuboid  30  68.8  -18.0  68.8  -18.0  56.388  -18.0
media  1 1 10
media  4 1 20 -10
media  3  1  30 -20 -10
boundary  30
end geom
end data
end


=csas26    parm=size=5000000
4.89% uo2f2 h/u-235=524
238groupndf5  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
read param npg=2000  nub=yes fdn=yes end param
read geom
global    unit 1
cylinder  10 25.4 38.66 0
cylinder  20 25.559 38.66 -.159
media   1  1   10
media   2   1   20  -10
boundary  20
end geom
end data
end


=csas26   parm=size=5000000
4.89% uo2f2 h/u-235=1002
238groupndf5  multiregion
solnuo2f2  1 491.6 0 1 293 92234 .02 92235 4.89
92238 95.09 end
al        2 1 end
end comp
spherical end
1 34.6 noextermod  2 34.76 noextermod end zone
read param npg=2000  nub=yes fdn=yes end param
read geom
global unit  1
sphere      10  34.6
plane  20  zpl=1.0  con=-30
sphere      30  34.759
media  1  1  10 -20
media  0  1  20 10
media  2  1  30  -10
boundary  30
end geom
end data
end


=csas26     parm=size=5000000
4.89% uo2f2 h/u-235=524
238groupndf5  multiregion
solnuo2f2  1 869.9 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 19 oneextermod 2 19.2 noextermod 3 37.2 noextermod end zone
read param npg=2000  nub=yes fdn=yes end param
read geom
global  unit 1
cylinder  10  19.05 50.37 0
cylinder  20  19.209 50.529 -.159
cylinder  30   37.209  68.529  -18.159
media  1 1 10
media  2 1  20 -10
media  3 2 30 -20
boundary  30
end geom
read bias id=500 2 7 end bias
end data
end


=csas26     parm=size=500000
4.89% uo2f2 h/u-235=735
238groupndf5  multiregion
solnuo2f2  1 650.1 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 19 oneextermod 2 19.2 noextermod 3 37.2 noextermod end zone
read param npg=2000  nub=yes fdn=yes end param
read geom
global  unit 1
cylinder  10  19.05  153.01  0.0
cylinder  20  19.209  153.169  -.159
cylinder  30  37.209  171.17  -18.159
media 1 1 10
media  2 1 20 -10
media  3 1 30 -20
boundary  30
end geom
end data
end


=csas26     parm=size=5000000
4.89% uo2f2 h/u-235=994
238groupndf5  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
read param npg=2000  nub=yes fdn=yes end param
read geom
global unit  1
cylinder  10  25.4 85.72 0
cylinder  20  25.559 85.879 -.159
cylinder  30    43.559  103.88  -18.159
```

```
media  1  1 10
media  2  1 20 -10
media  3  1 30 -20
boundary  30
end geom
end data
end
```

Table B.2. Table 2 input data

```
=csas26   parm=size=500000
case ebj.1 u(3.85) 15 @ 7.2"/0"/0"/77.8cm, square
238groupndf5 infhommedium
' u(3.85) metal
u-235        1 0.  1.8643e-3 end
u-238        1 0.  4.5971e-2 end
' full density water moderator/reflector
h2o          2 1.0           end
' fir timber model
c            3 0.  1.06802e-2 end
h            3 0.  2.21713e-2 end
o            3 0.  1.10850e-2 end
' steel for grating, tank walls and floor
carbonsteel  4 1.0           end
' stainless steel lining for tank
ss304        5 1.0           end
end comp
read parm
npg=2000  plt=yes fdn=yes nub=yes tme=90 tba=2
end parm
read geom
unit 1
com=* fir timber 7.25" x 72" x 7.25" *
cuboid 10  182.88 0. 18.415 0. 18.415 0.
media  3 1 10
boundary  10
unit 2
com=* water gap 3.5" x 72" x 7.25" between timbers *
cuboid 10 182.88 0. 8.89 0. 18.415 0.
media  2 1 10
boundary  10
unit 3
com=* array of timbers 72" x 72" x 7.25" *
cuboid  10  182.88  0.0  182.245  0.0  18.415  0.0
cuboid  20  182.88  0.0  182.5625  -.3175  18.415  0.0
array 1 10  place 1 1 1  0.0  0.0  0.0
media  2 1 20 -10
boundary 20
unit 4
com=* section of steel grating *
cuboid  10  2.778125 .238125 .396875 -.396875 3.175 2.38125
cuboid  20  2.778125 .238125 4.524375 -4.524375 3.175 0.
cuboid  30  3.01625 0. 4.524375 -4.524375 3.175 0.
media  4 1 10
media  2 1 20 -10
media  4 2 30 -20 -10
boundary  30
unit 5
com=* array of steel grating *
cuboid  10  180.975  0.0  180.975  0.0  3.175  0.0
cuboid  20  181.9275  -.9525  181.9275  -.9525  3.175  0.0
array 2 10  place  1 1 1  0.0   4.524375  0.0
media  2 1  20 -10
boundary 20
unit 6
com=* u(3.85) annulus with insert *
cylinder  10 3.175 76.2 0.
cylinder  20 3.302 76.2 0.
cylinder  30 9.144 76.2 0.
cuboid    40 4p9.144 76.2 0.
```

```
media  1 1 10
media  2 1 20 -10
media  1 1 30 -20 -10
media  2 1 40 -30 -20 -10
boundary 40
unit 7
com=* water cuboid to complete annuli array *
cuboid  10  4p9.144 76.2 0.
media  2 1 10
boundary  10
unit 8
com=* array of 15 annuli with u(3.85) inserts *
cuboid  10   73.152  0.0  73.152  0.0  76.2  0.0
cuboid  20  128.016  -54.864  128.016  -54.864  77.8  0.0
array  3  10  place 1 1 1   9.144 9.144 0.0
media  2 1 20 -10
boundary 20
global unit 9
cuboid  10  91.44  -91.44  91.44  -91.44  99.39  0.0
cuboid  20  121.92  -121.92  121.92  -121.92  99.39  0.0
cuboid  30  121.92  -121.92  121.92  -121.92  99.39  -.19050
cuboid  40  121.92  -121.92  121.92  -121.92  99.39  -2.7305
array  4  10  place  1 1 1  -91.44   -91.1225  0.0
media  2 1 20 -10
media  5  1  30 -20 -10
media  4  1  40 -30 -20 -10
boundary  40
end geom
read array
ara=1 nux=1 nuy=13 nuz=1
fill 1 2 5q2 1 end fill
ara=2 nux=60 nuy=20 nuz=1
fill f4 end fill
ara=3 nux=4 nuy=4 nuz=1
loop 6  1 4 1  1 4 1  1 1 1
     7  4 4 1  1 1 1  1 1 1 end loop
gbl=4
ara=4 nux=1 nuy=1 nuz=3
fill 3 5 8 end fill
end array
read start
xsm=-36.576 xsp=36.576 ysm=-36.576 ysp=36.576 zsm=21.59 zsp=97.79
end start
read plot  scr=yes
ttl="plan view 1/6 scale of core, z=midlevel of annuli/inserts"
xul=-91.44 yul=91.44 zul=59.69
xlr=91.44 ylr=-91.44 zlr=59.69
nax=640 uax=1. vdn=-1. dlx=1.524 nch=* u.wgsc* end
'ttl="plan view 1/6 scale of core, z=midlevel of grating"
'xul=-91.44 yul=91.44 zul=20.0025
'xlr=91.44 ylr=-91.44 zlr=20.0025
'uax=1. vdn=-1. dlx=1.524 nch=* u.wgsc* end
'ttl="plan view 1/6 scale of core, z=midlevel of fir timbers"
'xul=-91.44 yul=91.44 zul=9.2075
'xlr=91.44 ylr=-91.44 zlr=9.2075
'uax=1. vdn=-1. dlx=1.524 nch=* u.wgsc* end
ttl="plan view 1/10 scale of mockup, z=midlevel of u units"
xul=-121.92 yul=121.92 zul=59.69
xlr=121.92 ylr=-121.92 zlr=59.69
nax=640 uax=1. vdn=-1. dlx=2.54 nch=* u.wgsc* end
'ttl="plan view 2x scale of single u unit, z=midlevel of unit"
'xul=0. yul=18.288 zul=59.69
'xlr=18.288 ylr=0. zlr=59.69
```

```
'uax=1. vdn=-1. dlx=0.127 nch=* u.wgsc* end
'ttl="cross section of core 1/6 scale,y=9.144"
'xul=-91.44 yul=9.144 zul=102.
'xlr=91.44 ylr=9.144 zlr=0.
'uax=1. wdn=-1. dlx=1.524 nch=* u.wgsc* end
'ttl="cross section of mockup 1/10 scale,y=9.144"
'xul=-121.92 yul=9.144 zul=105.
'xlr=121.92 ylr=9.144 zlr=-65.
'uax=1. wdn=-1. dlx=2.54 nch=* u.wgsc* end
'ttl="cross section of grating/fir timbers, full scale"
'xul=0. yul=0. zul=24.13
'xlr=25.4 ylr=0. zlr=-3.0
'uax=1. wdn=-1. dlx=.254 nch=* u.wgsc* end
'ttl="plan view of grating thru tiebars, full scale"
'xul=0. yul=25.4 zul=21.193
'xlr=25.4 ylr=0. zlr=21.193
'uax=1. vdn=-1. dlx=.254 nch=* u.wgsc* end
'ttl="plan view of grating @ grating midlevel, full scale"
'xul=0. yul=25.4 zul=20.0025
'xlr=25.4 ylr=0. zlr=20.0025
'uax=1. vdn=-1. dlx=.254 nch=* u.wgsc* end
'ttl="plan view of timbers @ timber midlevel, full scale"
'xlr=25.4 ylr=-25.4 zlr=9.2075
'uax=1. vdn=-1. dlx=.254 nch=* u.wgsc* end
end plot
end data
end


=csas26    parm=size=500000
case ebj.4 u(3.85) 16 @ 7.2"/0"/0.25"/79.3cm, triangular
238groupndf5 infhommedium
' u(3.85) metal
u-235        1 0.  1.8643e-3 end
u-238        1 0.  4.5971e-2 end
' full density water moderator/reflector
h2o          2 1.0           end
' fir timber model
c            3 0.  1.06802e-2 end
h            3 0.  2.21713e-2 end
o            3 0.  1.10850e-2 end
' steel for grating, tank walls and floor
carbonsteel  4 1.0           end
' stainless steel lining for tank
ss304        5 1.0           end
end comp
read parm
tba=3 npg=2000  nub=yes plt=yes  fdn=yes tme=90
end parm
read geom
unit 1
com=* fir timber 7.25" x 72" x 7.25" *
cuboid 10 182.88 0. 18.415 0. 18.415 0.
media  3 1 10
boundary 10
unit 2
com=* water gap 3.5" x 72" x 7.25" between timbers *
cuboid 10 182.88 0. 8.89 0. 18.415 0.
media  2 1 10
boundary 10
unit 3
com=* array of timbers 72" x 72" x 7.25" *
cuboid 10  182.88  0.0  182.245  0.0 18.415  0.0
```

```
cuboid 20   182.88  0.0  182.5625  -.3175  18.415  0.0
array  1  10  place  1 1 1   0.0 0.0 0.0
media  2 1 20 -10
boundary 20
unit 4
com=* section of steel grating *
cuboid 10 2.778125 .238125 .396875 -.396875 3.175 2.38125
cuboid 20 2.778125 .238125 4.524375 -4.524375 3.175 0.
cuboid 30 3.01625 0. 4.524375 -4.524375 3.175 0.
media  4 1 10
media  2 1 20 -10
media  4 1 30 -20 -10
boundary 30
unit 5
com=* array of steel grating *
cuboid  10  180.975  0.0  180.975  0.0  3.175  0.0
cuboid  20  181.9275 -.9525  181.9275  -.9525  3.175  0.0
array 2  10  place  1 1 1   0.0 4.524375  0.0
media  2 1  20 -10
boundary 20
unit 6
com=* u(3.85) annulus with insert *
cylinder 10 3.175 76.2 0.
cylinder 20 3.302 76.2 0.
cylinder 30 9.144 76.2 0.
media  1 1 10
media  2 1 20 -10
media  1 1 30 -20 -10
boundary 30
unit 7
com=* array of 16 annuli with u(3.85) inserts *
cylinder 10  9.144  76.2  0.0
hole 6 10
cylinder 20  9.144  76.2  0.0    origin x=-18.923
hole 6 20
 origin x=-18.923
cylinder 30  9.144  76.2  0.0  origin x=-9.4615  y=16.3878
hole 6 30
origin x=-9.4615  y=16.3878
cylinder 40  9.144  76.2  0.0   origin x=9.4615  y=16.3878
hole 6 40
 origin x=9.4615  y=16.3878
cylinder 50  9.144  76.2  0.0  origin x=18.923
hole 6 50
 origin x=18.923
cylinder 60  9.144  76.2  0.0  origin x=9.4615 y=-16.3878
hole 6 60
 origin x=9.4615 y=-16.3878
cylinder 70   9.144  76.2  0.0  origin x=-9.4615 y=-16.3878
hole 6 70
 origin x=-9.4615 y=-16.3878
cylinder 80  9.144  76.2  0.0   origin x=-28.3845  y=16.3878
hole 6 80
 origin x=-28.3845  y=16.3878
cylinder 90  9.144  76.2  0.0  origin x=-18.923   y=32.7756
hole 6 90
 origin x=-18.923   y=32.7756
cylinder 100 9.144  76.2  0.0  origin      y=32.7756
hole 6  100
 origin      y=32.7756
cylinder 110  9.144  76.2  0.0   origin x=28.3845  y=16.3878
hole 6  110
 origin x=28.3845  y=16.3878
```

```
cylinder 120 9.144  76.2  0.0  origin x=37.846
hole 6  120
 origin x=37.846
cylinder 130  9.144  76.2  0.0   origin x=28.3845 y=-16.3878
hole 6  130
 origin x=28.3845 y=-16.3878
cylinder 140  9.144  76.2  0.0 origin  x=0.0    y=-32.7756
hole 6  140
 origin  x=0.0    y=-32.7756
cylinder  150  9.144 76.2  0.0   origin x=-18.923  y=-32.7756
hole 6 150
 origin x=-18.923  y=-32.7756
cylinder 160  9.144  76.2  0.0  origin x=-28.3845 y=-16.3878
hole 6 160
 origin x=-28.3845 y=-16.3878
cuboid  170  91.44  -91.44   91.44   -91.44    79.3  0.0
media  2 1 170 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120
-130 -140 -150 -160
boundary  170
global
unit  8
cuboid  10  91.44  -91.44  91.44  -91.44  100.89  0.0
cuboid  20  121.92  -121.92  121.92  -121.92  100.89  0.0
cuboid  30  121.92  -121.92  121.92  -121.92  100.89  -.19050
cuboid  40  121.92  -121.92  121.92  -121.92  100.89  -2.7305
array  3 10 place 1 1 1 -91.44  -91.1225  0.0
media  2 1 20 -10
media  5 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
end geom
read array
ara=1 nux=1 nuy=13 nuz=1
fill 1 2 5q2 1 end fill
ara=2 nux=60 nuy=20 nuz=1
fill f4 end fill
gbl=3
ara=3 nux=1 nuy=1 nuz=3
fill 3 5 7 end fill
end array
read start
nst=1
xsm=-37.5285 xsp=46.99
ysm=-41.9196 ysp=41.9196
zsm= 21.59   zsp=97.79
end start
read plot scr=yes
'ttl="plan view 1/6 scale of core, z=midlevel of annuli/inserts"
'xul=-91.44 yul=91.44 zul=59.69
'xlr=91.44 ylr=-91.44 zlr=59.69
'uax=1. vdn=-1. dlx=1.524 nch=* u.wgsc* end
'ttl="plan view 1/6 scale of core, z=midlevel of grating"
'xul=-91.44 yul=91.44 zul=20.0025
'xlr=91.44 ylr=-91.44 zlr=20.0025
'uax=1. vdn=-1. dlx=1.524 nch=* u.wgsc* end
'ttl="plan view 1/6 scale of core, z=midlevel of fir timbers"
'xul=-91.44 yul=91.44 zul=9.2075
'xlr=91.44 ylr=-91.44 zlr=9.2075
'uax=1. vdn=-1. dlx=1.524 nch=* u.wgsc* end
ttl="plan view 1/10 scale of mockup, z=midlevel of u units"
xul=-121.92 yul=121.92 zul=59.69
xlr=121.92 ylr=-121.92 zlr=59.69
nax=640 uax=1. vdn=-1. dlx=2.54 nch=* u.wgsc* end
```

```
'ttl="plan view full scale of single u unit, z=midlevel of unit"
'xul=-16.75 yul=16.75 zul=59.69
'xlr=16.75 ylr=-16.75 zlr=59.69
'uax=1. vdn=-1. dlx=0.254 nch=* u.wgsc* end
'ttl="cross section of core 1/6 scale,y=0.0"
'xul=-91.44 yul=0.0 zul=102.
'xlr=91.44 ylr=0.0 zlr=0.
'uax=1. wdn=-1. dlx=1.524 nch=* u.wgsc* end
'ttl="cross section of mockup 1/10 scale,y=0.0"
'xul=-121.92 yul=0.0 zul=105.
'xlr=121.92 ylr=0.0 zlr=-65.
'uax=1. wdn=-1. dlx=2.54 nch=* u.wgsc* end
'ttl="cross section of grating/fir timbers, full scale"
'xul=0. yul=0. zul=24.13
'xlr=25.4 ylr=0. zlr=-3.0
'uax=1. wdn=-1. dlx=.254 nch=* u.wgsc* end
'ttl="plan view of grating thru tiebars, full scale"
'xul=0. yul=25.4 zul=21.193
'xlr=25.4 ylr=0. zlr=21.193
'uax=1. vdn=-1. dlx=.254 nch=* u.wgsc* end
'ttl="plan view of grating @ grating midlevel, full scale"
'xul=0. yul=25.4 zul=20.0025
'xlr=25.4 ylr=0. zlr=20.0025
'uax=1. vdn=-1. dlx=.254 nch=* u.wgsc* end
'ttl="plan view of timbers @ timber midlevel, full scale"
'xul=0. yul=25.4 zul=9.2075
'xlr=25.4 ylr=-25.4 zlr=9.2075
'uax=1. vdn=-1. dlx=.254 nch=* u.wgsc* end
end plot
end data
end


=csas26     parm=size=500000
case ebj.8 u(3.85) 6 @ 7.2"/2.6"/0.75"/91.4cm, square
238groupndf5 infhommedium
' u(3.85) metal
u-235        1 0.  1.8643e-3 end
u-238        1 0.  4.5971e-2 end
' full density water moderator/reflector
h2o          2 1.0           end
' fir timber model
c            3 0.  1.06802e-2 end
h            3 0.  2.21713e-2 end
o            3 0.  1.10850e-2 end
' steel for grating, tank walls and floor
carbonsteel  4 1.0           end
' stainless steel lining for tank
ss304        5 1.0           end
end comp
read parm
npg=2000  nub=yes plt=no fdn=yes tme=90 tba=2
end parm
read geom
unit 1
com=* fir timber 7.25" x 72" x 7.25" *
cuboid 10 182.88 0. 18.415 0. 18.415 0.
media  3 1 10
boundary  10
unit 2
com=* water gap 3.5" x 72" x 7.25" between timbers *
cuboid 10 182.88 0. 8.89 0. 18.415 0.
media  2 1 10
```

```
boundary  10
unit 3
com=* array of timbers 72" x 72" x 7.25" *
cuboid  10  182.88  0.0  182.245  0.0  18.415  0.0
cuboid  20  213.362 -30.48  213.04  -30.8  18.415  0.0
array    1  10  place  1 1 1   0.0 0.0 0.0
media  2 1 20 -10
boundary  20
unit 4
com=* section of steel grating *
cuboid  10 2.778125 .238125 .396875 -.396875 3.175 2.38125
cuboid  20 2.778125 .238125 4.524375 -4.524375 3.175 0.
cuboid  30 3.01625 0. 4.524375 -4.524375 3.175 0.
media  4 1 10
media  2 1 20 -10
media  4 1 30 -20 -10
boundary  30
unit 5
com=* array of steel grating *
cuboid  10  180.975  0.0  180.975  0.0  3.175  0.0
cuboid  20  212.41  -31.432  212.41  -31.43  3.175  0.0
array 2 10  place  1 1 1   0.0 4.524375  0.0
media  2 1 20 -10
boundary  20
unit 6
com=* u(3.85) annulus, h=76.2, submerged, on corner *
cylinder 10 3.302 76.2 0.
cylinder 20 9.144000 76.2 0.
cuboid  30 4p10.0965 91.4 0.
media 2 1 10
media  1 1 20 -10
media  2 1 30 -20 -10
boundary 30
unit 7
com=* u(3.85) annulus, h=76.2, submerged, on side *
cylinder 10 3.302 76.2 0.
cylinder 20 9.144000 76.2 0.
cuboid  30 4p10.0965 91.4 0.
media 2 1 10
media  1 1 20 -10
media  2 1 30 -20 -10
boundary 30
unit 8
com=* array of 6 annuli, h=76.2, submerged *
cuboid  10  60.579  0.0  40.386  0.0  91.4  0.0
cuboid  20  152.211  -91.631  142.11  -101.73  91.44  0.0
array 3 10 place 1 1 1  10.0965  10.0965  0.0
media  2 1 20 -10
boundary  20
global unit  9
cuboid  10  121.921  -121.921  121.92  -121.92  112.99  0.0
cuboid  20  121.921  -121.921  121.92  -121.92  112.99  -0.19050
cuboid  30  121.921  -121.921  121.92  -121.92  112.99  -2.7305
array  4 10 place  1 1 1   -91.441  -91.12  0.0
media   5 1 20 -10
media  4 1 30 -20 -10
boundary  30
end geom
read array
ara=1 nux=1 nuy=13 nuz=1
fill 1 2 5q2 1 end fill
ara=2 nux=60 nuy=20 nuz=1
fill f4 end fill
```

```
ara=3 nux=3 nuy=2 nuz=1
fill 6 7 6 6 7 6 end fill
gbl=4
ara=4 nux=1 nuy=1 nuz=3
fill 3 5 8 end fill
end array
read start
nst=1
xsm=-30.2895 xsp=30.2895
ysm=-20.193 ysp=20.193
zsm=21.59 zsp=97.79
end start
read plot
ttl="plan view 1/6 scale of core, z=midlevel of annuli/inserts"
xul=-91.44 yul=91.44 zul=59.69
xlr=91.44 ylr=-91.44 zlr=59.69
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of grating"
xul=-91.44 yul=91.44 zul=20.0025
xlr=91.44 ylr=-91.44 zlr=20.0025
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of fir timbers"
xul=-91.44 yul=91.44 zul=9.2075
xlr=91.44 ylr=-91.44 zlr=9.2075
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/10 scale of mockup, z=midlevel of u units"
xul=-135. yul=135. zul=59.69
xlr=135. ylr=-135. zlr=59.69
uax=1. vdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="plan view 2x scale of single u unit, z=midlevel of unit"
xul=0.0 yul=20.193 zul=59.69
xlr=20.193 ylr=0.0 zlr=59.69
uax=1. vdn=-1. dlx=0.127 nch=* u.wgs* end
ttl="cross section of core 1/6 scale,y=10.0965"
xul=-91.44 yul=10.0965 zul=125.
xlr=91.44 ylr=10.0965 zlr=-10.
uax=1. wdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="cross section of mockup 1/10 scale,y=10.0965"
xul=-135. yul=10.0965 zul=125.
xlr=135. ylr=10.0965 zlr=-10.
uax=1. wdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="cross section of grating/fir timbers, full scale"
xul=0. yul=0. zul=24.13
xlr=25.4 ylr=0. zlr=-3.0
uax=1. wdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating thru tiebars, full scale"
xul=0. yul=25.4 zul=21.193
xlr=25.4 ylr=0. zlr=21.193
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating @ grating midlevel, full scale"
xul=0. yul=25.4 zul=20.0025
xlr=25.4 ylr=0. zlr=20.0025
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of timbers @ timber midlevel, full scale"
xul=0. yul=25.4 zul=9.2075
xlr=25.4 ylr=-25.4 zlr=9.2075
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="cross section of central unit, full scale,y=10.0965"
xul=-10.0965 yul=10.0965 zul=125.
xlr=10.0965 ylr=10.0965 zlr=-10.
uax=1. wdn=-1. dlx=.254 nch=* u.wgs* end
end plot
end data
```

```
end


=csas26   parm=size=500000
case ebj.10 u(3.85) 20 @ 7.2"/2.6"/1.87"/79.0cm, square
238groupndf5 infhommedium
' u(3.85) metal
u-235        1 0.  1.8643e-3 end
u-238        1 0.  4.5971e-2 end
' full density water moderator/reflector
h2o          2 1.0           end
' fir timber model
c            3 0.  1.06802e-2 end
h            3 0.  2.21713e-2 end
o            3 0.  1.10850e-2 end
' steel for grating, tank walls and floor
carbonsteel  4 1.0           end
' stainless steel lining for tank
ss304        5 1.0           end
end comp
read parm
npg=2000  nub=yes plt=no fdn=yes tme=90 tba=2
end parm
read geom
unit 1
com=* fir timber 7.25" x 72" x 7.25" *
cuboid 10 182.88 0. 18.415 0. 18.415 0.
media  3 1 10
boundary 10
unit 2
com=* water gap 3.5" x 72" x 7.25" between timbers *
cuboid 10 182.88 0. 8.89 0. 18.415 0.
media  2 1 10
boundary 10
unit 3
com=* array of timbers 72" x 72" x 7.25" *
cuboid  10  182.88  0.0  182.245  0.0  18.415  0.0
cuboid  20  213.36  -30.48  213.0425  -30.7975  18.415  0.0
array  1  10 place  1 1 1  3*0.0
media  2 1  20 -10
boundary  20
unit 4
com=* section of steel grating *
cuboid 10 2.778125 .238125 .396875 -.396875 3.175 2.38125
cuboid 20 2.778125 .238125 4.524375 -4.524375 3.175 0.
cuboid 30 3.01625 0. 4.524375 -4.524375 3.175 0.
media  4 1 10
media  2 1 20 -10
media  4 1 30 -20 -10
boundary  30
unit 5
com=* array of steel grating *
cuboid  10  180.975  0.0  180.975  0.0  3.175  0.0
cuboid  20  212.4075  -31.4325  212.4075  -31.4325  3.175   0.0
array  2  10 place  1 1 1  0.0  4.524375  0.0
media  2 1 20 -10
boundary  20
unit 6
com=* u(3.85) annulus, h=76.2, submerged *
cylinder 10 3.302 76.2 0.
cylinder 20 9.144 76.2 0.
cuboid 30 4p11.5189 79.0 0.
media  2 1 10
```

```
media  1 1 20 -10
media  2 1 30 -20 -10
boundary 30
unit 26
com=* water cuboid to complete array *
cuboid 10 4p11.5189 79.0 0.
media  2 1 10
boundary  10
unit 27
com=* array of 20 annuli, h=76.2, submerged *
cuboid  10  115.189  0.0  115.189  0.0   79.0  0.0
cuboid  20   179.5145  -64.3255  179.5145  -64.3255  79.0  0.0
array  3  10  place 1 1 1 11.5189  11.5189  0.0
media   2 1 20 -10
boundary  20
global unit  28
cuboid  10  213.36  -30.48  213.0425  -30.7975  97.79  0.0
cuboid  20  213.36  -30.48  213.0425  -30.7975  97.79  -.1905
cuboid  30  213.36  -30.48  213.0425  -30.7975  97.79  -2.7305
array  4  10 place 1 1 1 0.0 0.0 0.0
media  5 1 20 -10
media  4 2 30 -20 -10
boundary  30
end geom
read array
ara=1 nux=1 nuy=13 nuz=1
fill 1 2 5q2 1 end fill
ara=2 nux=60 nuy=20 nuz=1
fill f4 end fill
ara=3 nux=5 nuy=5 nuz=1
fill 26 26 6 6 26 15r6
26 3r6 26 end fill
gbl=4
ara=4 nux=1 nuy=1 nuz=3
fill 3 5 27 end fill
end array
'read start
'nst=1
'xsm=-57.5945 xsp=57.5945
'ysm=-57.5945 ysp=57.5945
'zsm=21.59 zsp=97.79
'end start
read plot
ttl="plan view 1/6 scale of core, z=midlevel of annuli/inserts"
xul=-91.44 yul=91.44 zul=59.69
xlr=91.44 ylr=-91.44 zlr=59.69
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of grating"
xul=-91.44 yul=91.44 zul=20.0025
xlr=91.44 ylr=-91.44 zlr=20.0025
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of fir timbers"
xul=-91.44 yul=91.44 zul=9.2075
xlr=91.44 ylr=-91.44 zlr=9.2075
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/10 scale of mockup, z=midlevel of u units"
xul=-135. yul=135. zul=59.69
xlr=135. ylr=-135. zlr=59.69
uax=1. vdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="plan view 2x scale of single u unit, z=midlevel of unit"
xul=-11.5189 yul=11.5189 zul=59.69
xlr=11.5189 ylr=-11.5189 zlr=59.69
uax=1. vdn=-1. dlx=0.127 nch=* u.wgs* end
```

```
ttl="cross section of core 1/6 scale,y=0.0"
xul=-91.44 yul=0.0 zul=110.
xlr=91.44 ylr=0.0 zlr=-10.
uax=1. wdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="cross section of mockup 1/10 scale,y=0.0"
xul=-135. yul=0.0 zul=125.
xlr=135. ylr=0.0 zlr=-10.
uax=1. wdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="cross section of grating/fir timbers, full scale"
xul=0. yul=0. zul=24.13
xlr=25.4 ylr=0. zlr=-3.0
uax=1. wdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating thru tiebars, full scale"
xul=0. yul=25.4 zul=21.193
xlr=25.4 ylr=0. zlr=21.193
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating @ grating midlevel, full scale"
xul=0. yul=25.4 zul=20.0025
xlr=25.4 ylr=0. zlr=20.0025
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of timbers @ timber midlevel, full scale"
xul=0. yul=25.4 zul=9.2075
xlr=25.4 ylr=-25.4 zlr=9.2075
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="cross section of central unit, full scale,y=0.0"
xul=-11.5189 yul=0.0 zul=110.
xlr=11.5189 ylr=0.0 zlr=-10.
uax=1. wdn=-1. dlx=.254 nch=* u.wgs* end
end plot
end data
end


=csas26    parm=size=500000
case ebj.11 u(3.85) 8 @ 7.2"/2.6"/0.0"/72.5cm, square
238groupndf5 infhommedium
' u(3.85) metal
u-235        1 0.  1.8643e-3 end
u-238        1 0.  4.5971e-2   end
' full density water moderator/reflector
h2o          2 1.0            end
' fir timber model
c            3 0.  1.06802e-2  end
h            3 0.  2.21713e-2   end
o            3 0.  1.10850e-2   end
' steel for grating, tank walls and floor
carbonsteel  4 1.0             end
' stainless steel lining for tank
ss304        5 1.0             end
end comp
read parm
npg=2000  nub=yes plt=yes fdn=yes tme=90 tba=2
end parm
read geom
unit 1
com=* fir timber 7.25" x 72" x 7.25" *
cuboid  10 182.88 0. 18.415 0. 18.415 0.
media  3 1 10
boundary  10
unit  2
com=* water gap 3.5" x 72" x 7.25" between timbers *
cuboid 10 182.88 0. 8.89 0. 18.415 0.
media  2 1 10
```

```
boundary 10
unit  3
com=* array of timbers 72" x 72" x 7.25" *
cuboid  10  182.88  0.0  182.245  0.0  18.415  0.0
cuboid  20  213.36 -30.48    213.0425  -30.7975  18.415  0.0
array 1 10 place 1 1 1  3*0.0
media  2 1 20 -10
boundary  20
unit 4
com=* section of steel grating *
cuboid  10 2.778125 .238125 .396875 -.396875 3.175 2.38125
cuboid  20 2.778125 .238125 4.524375 -4.524375 3.175 0.
cuboid  30 3.01625 0. 4.524375 -4.524375 3.175 0.
media  4 1 10
media  2 1 20 -10
media  4 1 30 -20 -10
boundary  30
unit  5
com=* array of steel grating *
cuboid  10  180.975 0.0  180.975 0.0  3.175  0.0
cuboid  20  212.4075  -31.4325   212.4075  -31.4325  3.175 0.0
array 2  10 place 1 1 1    0.0  4.524375 0.0
media  2 1 20 -10
boundary  20
unit 6
com=* u(3.85) annulus, h=72.5, submerged, on corner *
cylinder 10 3.302 72.5 0.
cylinder 20 9.144000 72.5 0.
cuboid  30 4p9.144 72.5 0.
media  2 1 10
media  1 1 20 -10
media  2 1 30 -20 -10
boundary  30
unit 7
com=* u(3.85) annulus, h=72.5, submerged, on side *
cylinder 10 3.302 72.5 0.
cylinder 20 9.144000 72.5 0.
cuboid 30 4p9.144 72.5 0.
media  2 1 10
media  1 1 20 -10
media  2 1 30 -20 -10
boundary  30
unit 8
com=* u(3.85) annulus, h=3.7, dry, on corner *
cylinder 10 3.302 3.7 0.
cylinder 20 9.144000 3.7 0.
cuboid 30 4p9.144 3.7 0.
media  0 1 10
media  1 1 20 -10
media  0 1 30 -20 -10
boundary  30
unit 9
com=* u(3.85) annulus, h=3.7, dry, on side *
cylinder 10 3.302 3.7 0.
cylinder 20 9.144000 3.7 0.
cuboid 30 4p9.144 3.7 0.
media  0 1 10
media  1 1 20 -10
media  0 1 30 -20 -10
boundary  30
unit 10
com=* array of 8 annuli, h=72.5, submerged *
cuboid  10  73.152  0.0  36.576  0.0  72.5  0.0
```

```
cuboid  20  158.496  -85.344  140.208  -103.632  72.5  0.0
array  3 10 place 1 1 1  9.144  9.144  0.0
media  2 1 20 -10
boundary  20
unit  11
com=* array of 8 annuli, h=3.7, dry *
cuboid  10  73.152  0.0  36.576  0.0  3.7  0.0
cuboid  20 158.496  -85.344 140.208  -103.632  3.7  0.0
array  4  10  place 1 1 1  9.144  9.144  0.0
media  0 1 20 -10
boundary  20
global unit  12
cuboid  10  213.36  -30.48  213.0425  -30.7975   97.79  0.0
cuboid  20  213.36  -30.48  213.0425  -30.7975   97.79  -.1905
cuboid  30  213.36  -30.48  213.0425  -30.7975   97.79  -2.7305
array  5 10  place 1 1 1  0.0  0.0  0.0
media  5 1 20 -10
media  4 2 30 -20 -10
boundary  30
end geom
read array
ara=1 nux=1 nuy=13 nuz=1
fill 1 2 5q2 1   end fill
ara=2 nux=60 nuy=20 nuz=1
fill f4   end fill
ara=3 nux=4 nuy=2 nuz=1
fill 6 7 7 6 6 7 7 6   end fill
ara=4 nux=4 nuy=2 nuz=1
fill 8 9 9 8 8 9 9 8  end fill
gbl=5
ara=5 nux=1 nuy=1 nuz=4
fill 3 5 10 11  end fill
end array
read plot  scr=yes
ttl="plan view 1/6 scale of core, z=midlevel of annuli/inserts"
xul=0.0 yul=125 zul=30.0
xlr=182 ylr=62 zlr=30.0
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* nax=640  end
end plot
end data
end


=csas26   parm=size=500000
case ebj.13 u(3.85) 15 @ 2.5"/0.0"/0.75"/64.8cm, square
238groupndf5 infhommedium
' u(3.85) metal
u-235        1 0.  1.8643e-3 end
u-238        1 0.  4.5971e-2 end
' full density water moderator/reflector
h2o          2 1.0           end
' fir timber model
c            3 0.  1.06802e-2 end
h            3 0.  2.21713e-2 end
o            3 0.  1.10850e-2 end
' steel for grating, tank walls and floor
carbonsteel  4 1.0           end
' stainless steel lining for tank
ss304        5 1.0           end
end comp
read parm
npg=2000  nub=yes plt=no fdn=yes tme=90 tba=2
end parm
```

```
read geom
unit 1
com=* fir timber 7.25" x 72" x 7.25" *
cuboid 10 182.88 0. 18.415 0. 18.415 0.
media  3 1 10
boundary  10
unit 2
com=* water gap 3.5" x 72" x 7.25" between timbers *
cuboid 10 182.88 0. 8.89 0. 18.415 0.
media  2 1 10
boundary  10
unit 3
com=* array of timbers 72" x 72" x 7.25" *
cuboid  10  182.88  0.0  182.245  0.0  18.415  0.0
cuboid  20  213.36  -30.48  213.0425 -30.7975  18.415  0.0
array  1 10  place  1 1 1  3*0.0
media  2 1 20 -10
boundary 20
unit 4
com=* section of steel grating *
cuboid 10 2.778125 .238125 .396875 -.396875 3.175 2.38125
cuboid 20 2.778125 .238125 4.524375 -4.524375 3.175 0.
cuboid 30  3.01625 0. 4.524375 -4.524375 3.175 0.
media  4 1 10
media  2 1 20 -10
media  4 1 30 -20 -10
boundary 30
unit 5
com=* array of steel grating *
cuboid  10  180.975  0.0  180.975  0.0  3.175  0.0
cuboid  20  212.41  -31.43  212.4075  -31.4325  3.175  0.0
array  2 10  place 1 1 1  0.0  4.524375  0.0
media  2 1 20 -10
boundary  20
unit 6
com=* u(3.85) rod, h=64.8, submerged *
cylinder 10 3.175000 64.8 0.
cuboid 20 4p4.1275 64.8 0.
media  1 1 10
media  2 1 20 -10
boundary  20
unit 7
com=* water cuboid to complete array 3 *
cuboid 10 4p4.1275 64.8 0.
media  2 1 10
boundary  10
unit 8
com=* u(3.85) rod, h=11.4, dry *
cylinder 10 3.175000 11.4 0.
cuboid 20 4p4.1275 11.4 0.
media  1 1 10
media  0 1 20 -10
boundary  20
unit 9
com=* void cuboid to complete array 4 *
cuboid 10 4p4.1275 11.4 0.
media  0 1 10
boundary  10
unit 10
com=* u(3.85) rod array, h=64.8, submerged *
cuboid  10  33.02  0.0  33.02  0.0  64.8  0.0
cuboid  20  138.43  -105.41  138.43  -105.41  64.8  0.0
array  3 10  place 1 1 1  4.1275  4.1275 0.0
```

```
media  2 1 20 -10
boundary  20
unit 11
com=* array of 15 rods, h=11.4, dry *
cuboid  10  33.02  0.0  33.02 0.0  11.4  0.0
cuboid  20  138.43  -105.41  138.43  -105.41  11.4  0.0
array 4 10  place  1 1 1  4.1275  4.1275  0.0
media  0 1 20 -10
boundary  20
global unit  12
cuboid  10  213.36  -30.48  213.0425  -30.7975  97.79  0.0
cuboid  20  213.36  -30.48  213.0425  -30.7975  97.79  -.19050
cuboid  30  213.36  -30.48  213.0425  -30.7975  97.79  -2.7305
array  5 10  place  1 1 1 3*0.0
media  5 1 20 -10
media  4 1 30 -20 -10
boundary  30
end geom
read array
ara=1 nux=1 nuy=13 nuz=1
fill 1 2 5q2 1 end fill
ara=2 nux=60 nuy=20 nuz=1
fill f4 end fill
ara=3 nux=4 nuy=4 nuz=1
fill 3r6 7 12r6 end fill
ara=4 nux=4 nuy=4 nuz=1
fill 3r8 9 12r8 end fill
gbl=5
ara=5 nux=1 nuy=1 nuz=4
fill 3 5 10 11 end fill
end array
read plot
ttl="plan view 1/6 scale of core, z=midlevel of annuli/inserts"
xul=-91.44 yul=91.44 zul=59.69
xlr=91.44 ylr=-91.44 zlr=59.69
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view full scale of array, z=midlevel of units"
xul=-16.51 yul=16.51 zul=59.69
xlr=16.51 ylr=-16.51 zlr=59.69
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of grating"
xul=-91.44 yul=91.44 zul=20.0025
xlr=91.44 ylr=-91.44 zlr=20.0025
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of fir timbers"
xul=-91.44 yul=91.44 zul=9.2075
xlr=91.44 ylr=-91.44 zlr=9.2075
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/10 scale of mockup, z=midlevel of u units"
xul=-135. yul=135. zul=59.69
xlr=135. ylr=-135. zlr=59.69
uax=1. vdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="plan view 2x scale of single u unit, z=midlevel of unit"
xul=0.0 yul=8.255 zul=59.69
xlr=8.255 ylr=0.0 zlr=59.69
uax=1. vdn=-1. dlx=0.127 nch=* u.wgs* end
ttl="cross section of core 1/6 scale,y=4.1275"
xul=-91.44 yul=4.1275 zul=110.
xlr=91.44 ylr=4.1275 zlr=-10.
uax=1. wdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="cross section of mockup 1/10 scale,y=4.1275"
xul=-135. yul=4.1275 zul=125.
xlr=135. ylr=4.1275 zlr=-10.
```

```
uax=1. wdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="cross section of grating/fir timbers, full scale"
xul=0. yul=0. zul=24.13
xlr=25.4 ylr=0. zlr=-3.0
uax=1. wdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating thru tiebars, full scale"
xul=0. yul=25.4 zul=21.193
xlr=25.4 ylr=0. zlr=21.193
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating @ grating midlevel, full scale"
xul=0. yul=25.4 zul=20.0025
xlr=25.4 ylr=0. zlr=20.0025
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of timbers @ timber midlevel, full scale"
xul=0. yul=25.4 zul=9.2075
xlr=25.4 ylr=-25.4 zlr=9.2075
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="cross section of central unit, 2x scale,y=4.1275"
xul=0.0 yul=4.1275 zul=110.
xlr=8.255 ylr=4.1275 zlr=-10.
uax=1. wdn=-1. dlx=.127 nch=* u.wgs* end
end plot
end data
end


=csas26    parm=size=500000
case ebj.14 u(3.85) 23 @ 2.5"/0.0"/1.50"/68.9cm, square
238groupndf5 infhommedium
' u(3.85) metal
u-235        1 0.  1.8643e-3 end
u-238        1 0.  4.5971e-2 end
' full density water moderator/reflector
h2o          2 1.0           end
' fir timber model
c            3 0.  1.06802e-2 end
h            3 0.  2.21713e-2 end
o            3 0.  1.10850e-2 end
' steel for grating, tank walls and floor
carbonsteel  4 1.0           end
' stainless steel lining for tank
ss304        5 1.0           end
end comp
read parm
npg=2000  nub=yes plt=no fdn=yes tme=90 tba=2
end parm
read geom
unit 1
com=* fir timber 7.25" x 72" x 7.25" *
cuboid 10 182.88 0. 18.415 0. 18.415 0.
media  3 1 10
boundary 10
unit 2
com=* water gap 3.5" x 72" x 7.25" between timbers *
cuboid 10 182.88 0. 8.89 0. 18.415 0.
media  2 1 10
boundary 10
unit 3
com=* array of timbers 72" x 72" x 7.25" *
cuboid  10  182.88  0.0  182.245  0.0  18.415  0.0
cuboid  20  213.36  -30.48  213.0425  -30.7975  18.415  0.0
array  1  10  place 1 1 1  3*0.0
media  2 1 20 -10
```

```
boundary  20
unit 4
com=* section of steel grating *
cuboid  10 2.778125 .238125 .396875 -.396875 3.175 2.38125
cuboid 20 2.778125 .238125 4.524375 -4.524375 3.175 0.
cuboid 30 3.01625 0. 4.524375 -4.524375 3.175 0.
media  4 2 10
media  2 1 20 -10
media  4 1 30 -20 -10
boundary  30
unit 5
com=* array of steel grating *
cuboid  10  180.975  0.0  180.975  0.0  3.175  0.0
cuboid  20  212.41  -31.43  212.4075  -31.4325  3.175  0.0
array  2 10  place 1 1 1  0.0  4.524375  0.0
media  2 1 20 -10
boundary  20
unit 6
com=* u(3.85) rod, h=68.9, submerged *
cylinder 10 3.175000 68.9 0.
cuboid 20 4p5.08 68.9 0.
media 1 1 10
media  2 1 20 -10
boundary  20
unit 7
com=* water cuboid to complete array 3 *
cuboid 10 4p5.08 68.9 0.
media  2 1 10
boundary  10
unit 8
com=* u(3.85) rod, h=7.3, dry *
cylinder 10 3.175000 7.3 0.
cuboid 20 4p5.08 7.3 0.
media  1 1 10
media  0 1 20 -10
boundary  20
unit 9
com=* void cuboid to complete array 4 *
cuboid 10 4p5.08 7.3 0.
media  0 1 10
boundary  10
unit 10
com=* u(3.85) rod array, h=68.9, submerged *
cuboid 10 50.8  0.0  50.8  0.0  68.9  0.0
cuboid  20  147.32  -96.52  147.32  -96.52  68.9  0.0
array  3  10  place 1 1 1  5.08  5.08  0.0
media  2 1 20 -10
boundary  20
unit 11
com=* array of 22 u(3.85) rods, h=7.3, dry *
cuboid 10  50.8  0.0  50.8  0.0  7.3  0.0
cuboid  20  147.32  -96.52  147.32  -96.52  7.3  0.0
array  4 10 place  1 1 1  5.08  5.08  0.0
media  2 1 20 -10
boundary 20
global unit  12
cuboid  10  213.36  -30.48  213.0425  -30.7975  97.79  0.0
cuboid  20  213.36 -30.48  213.0425 -30.7975  97.79  -.19050
cuboid  30  213.36 -30.48  213.0425 -30.7975  97.79  -2.7305
array  5 10  place  1 1 1 3*0.0
media  5 1 20 -10
media  4 1 30 -20 -10
boundary  30
```

```
end geom
read array
ara=1 nux=1 nuy=13 nuz=1
fill 1 2 5q2 1 end fill
ara=2 nux=60 nuy=20 nuz=1
fill f4 end fill
ara=3 nux=5 nuy=5 nuz=1
fill 3r6 2r7 20r6 end fill
ara=4 nux=5 nuy=5 nuz=1
fill 3r8 2r9 20r8 end fill
gbl=5
ara=5 nux=1 nuy=1 nuz=4
fill 3 5 10 11 end fill
end array
'read start
'nst=1
'xsm=-25.4 xsp=25.4
'ysm=-25.4 ysp=25.4
'zsm=21.59 zsp=90.49
'end start
read plot
ttl="plan view 1/6 scale of core, z=midlevel of annuli/inserts"
xul=-91.44 yul=91.44 zul=59.69
xlr=91.44 ylr=-91.44 zlr=59.69
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view of array, full scale"
xul=-25.4 yul=25.4 zul=59.69
xlr=25.4 ylr=-25.4 zlr=59.69
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of grating"
xul=-91.44 yul=91.44 zul=20.0025
xlr=91.44 ylr=-91.44 zlr=20.0025
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/6 scale of core, z=midlevel of fir timbers"
xul=-91.44 yul=91.44 zul=9.2075
xlr=91.44 ylr=-91.44 zlr=9.2075
uax=1. vdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="plan view 1/10 scale of mockup, z=midlevel of u units"
xul=-135. yul=135. zul=59.69
xlr=135. ylr=-135. zlr=59.69
uax=1. vdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="plan view 2x scale of single u unit, z=midlevel of unit"
xul=-5.08 yul=5.08 zul=59.69
xlr=5.08 ylr=-5.08 zlr=59.69
uax=1. vdn=-1. dlx=0.127 nch=* u.wgs* end
ttl="cross section of core 1/6 scale,y=0.0"
xul=-91.44 yul=0.0 zul=110.
xlr=91.44 ylr=0.0 zlr=-10.
uax=1. wdn=-1. dlx=1.524 nch=* u.wgs* end
ttl="cross section of mockup 1/10 scale,y=0.0"
xul=-135. yul=0.0 zul=125.
xlr=135. ylr=0.0 zlr=-10.
uax=1. wdn=-1. dlx=2.54 nch=* u.wgs* end
ttl="cross section of grating/fir timbers, full scale"
xul=0. yul=0. zul=24.13
xlr=25.4 ylr=0. zlr=-3.0
uax=1. wdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating thru tiebars, full scale"
xul=0. yul=25.4 zul=21.193
xlr=25.4 ylr=0. zlr=21.193
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of grating @ grating midlevel, full scale"
xul=0. yul=25.4 zul=20.0025
```

```
xlr=25.4 ylr=0. zlr=20.0025
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="plan view of timbers @ timber midlevel, full scale"
xul=0. yul=25.4 zul=9.2075
xlr=25.4 ylr=-25.4 zlr=9.2075
uax=1. vdn=-1. dlx=.254 nch=* u.wgs* end
ttl="cross section of central unit, 2x scale,y=0.0"
xul=-5.08 yul=0.0 zul=110.
xlr=5.08 ylr=0.0 zlr=-10.
uax=1. wdn=-1. dlx=.127 nch=* u.wgs* end
end plot
end data
end
```

Table B.3. Table 3 input data

```
=csas26    parm=size=500000
 rocky flats criticals nureg/cr-1071 experiment number 1 (27 group)
' 48 fuel cans 2.44 cm moderator gee.hu77.data(opt1)
238groupndf5  latticecell
u3o8  1 5.4078e-1 293.0 92234 0.03 92235 4.46 92236 0.08 92238 95.43 end
h2o   1 8.9514e-2 end
arbm-baggie  1.0 3 0 0 0 1001 14.01 6012 84.79 8016 1.20 1 1.9134e-2
   end
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 2 9.5390e-1
   end
arbm-tape(vinyl)  1.0 7 0 0 0 1001 5.92 6012 47.93 8016 10.82 17000
   25.73 20000 6.9 22000 1.6 82000 1.1 2 1.1115e-2 end
arbm-tape(mylar)  1.0 3 0 0 0 1001 6.83 6012 66.15 8016 27.02 2
   1.7491e-2 end
arbm-moderator  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 3 end
arbm-plex(reg)  1.0 3 0 0 0 1001 7.84 6012 59.93 8016 32.23 4
   1.1773 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 4
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 4
   1.1648e-3 end
arbm-plex(tris)  1.0 8 0 0 1 1001 7.16 6012 52.93 7014 0.16 8016 29.82
   15031 1.02 17000 1.81 35079 4.260 35081 2.840 5 1.2757 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 5
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 5
   1.1648e-3 end
arbm-filler  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 6 .88 end
' this material is actually moderator adjusted for the volume
' fraction of the void filled between core and reflector.
end comp
sphtriangp  19.9462 18.5857 1 3 18.9579 2 end
' 48 fuel cans 2.44 cm moderator gee.hu77.data(opt1)
read parm  run=yes npg=2000
nub=yes fdn=yes plt=yes  run=yes
end parm
read geom
unit  1
com='fuel box 15.28 cm on a side with .15 cm walls .05cm stacking void'
cuboid  10   6p7.49
cuboid  20  6p7.64
cuboid  30  6p7.6650
media 1 1 10
media 2 1 20 -10
media  0  1  30 -20
boundary  30
unit  2
com='x-face interstitial moderator'
cuboid  10 2p1.2200 4p7.665
media  3 1 10
boundary  10
unit  3
com='y-face interstitial moderator'
cuboid  10 2p7.665 2p1.2200 2p7.665
media  3 1 10
boundary  10
unit  4
com='z-face interstitial moderator'
cuboid  10 4p7.665 2p1.2200
```

```
media  3 1 10
boundary  10
unit  5
com='more x-face moderator'
cuboid  10 4p1.2200 2p7.665
media  3 1 10
boundary  10
unit  6
com='more y-face moderator'
cuboid  10 2p7.665 4p1.2200
media  3 1 10
boundary  10
unit  7
com='more z-face moderator'
cuboid  10 2p1.2200 2p7.665 2p1.2200
media   3 1 10
boundary  10
unit  8
com='last of interstitial moderator'
cuboid  10 6p1.2200
media  3 1 10
boundary 10
unit 56
com='empty fuel location'
cuboid  10  6p7.6650
media  0 1 10
boundary  10
unit 61
com='y-face moderator void'
cuboid  10  2p7.665  2p1.22  2p7.665
media  0 1 10
boundary  10
unit 9
com='north split table core'
cuboid  10  33.1  0.0  68.64  0.0  50.87  0.0
cuboid  20  33.1  0.0    72.75   -4.75   57.375  -26.1
cuboid  30   33.1 0.0  98.05  -30.05  81.675  -42.58
cuboid  40 33.1  0.0  98.05  -30.05  81.675  -43.81
cuboid  50  33.1  0.0  98.05  -30.85  81.675  -51.19
cuboid   60  42.9  0.0  98.05  -30.05  81.675  -51.19
cuboid   70  48.1  0.0  98.05  -30.05  81.675  -51.19
cuboid   80  57.7  0.0  98.05  -30.05  81.675  -51.19
cuboid  90  57.7  -1.23  98.05  -30.05  81.675  -51.19
array  1  10  place 1 1 1     7.6650  7.6650  7.6650
media  6  1  20  -10
media  5  1  30 -20 -10
media  4  1  40 -30 -20 -10
media  5  1  50 -40 -30  -20 -10
media  4  1  60 -50 -40 -30 -20 -10
media  5  1 70 -60 -50 -40 -30 -20 -10
media  4  1  80 -70 -60 -50 -40 -30 -20 -10
media   3  1  90 -80  -70  -60 -50 -40 -30 -20 -10
boundary  90
unit  10
com='south split table core'
cuboid  10  33.1  0.0  68.64   0.0  50.87  0.0
cuboid  20   33.1  -16.3  72.75  -4.75  57.375   -26.1
cuboid  30   33.1  -16.3  72.75  -4.75  57.375   -27.33
cuboid  40   33.1  -16.3  72.75  -4.75   57.375  -28.56
cuboid  50   33.1  -16.3  72.75  -4.75   57.375  -29.79
cuboid  60   33.1  -16.3  72.75  -4.75   57.375  -31.02
cuboid  70   33.1  -16.3  72.75  -4.75   57.375  -32.25
cuboid  80   33.1  -16.3  72.75  -4.75   57.375  -33.48
```

```
cuboid   90   33.1 -41.4   98.05  -30.05  81.675  -51.19
cuboid  100  34.33  -41.4  98.05  -30.05  81.675  -51.19
array  2  10  place 1 1 1     7.6650  7.6650  7.6650
media   6  1  20 -10
media   5  1  30 -20 -10
media   5  1  40 -30 -20 -10
media   4  1  50 -40 -30 -20 -10
media   4  1  60 -50  -40 -30 -20 -10
media   5  1  70 -60 -50 -40 -30 -20 -10
media   4  1  80 -70  -60 -50 -40 -30 -20 -10
media   5   1  90 -80 -70 -60 -50 -40 -30 -20 -10
media   3  1  100 -90 -80 -70 -60 -50 -40 -30 -20 -10
hole     12             origin  x=28.  y=34.  z=-38.645
hole     13              origin  x=28.  y=34.  z=69.525
boundary  100
global unit  11
cuboid  10  93.26  -41.4  98.05  -30.05  81.675  -51.19
array  3 10  place  1 1 1   0.0  0.0  0.0
boundary  10
unit  12
cuboid  10  5.1 -5.1  2.5 -2.5  12.545 -12.545
media   0 1 10
boundary 10
unit  13
cuboid  10  5.1 -5.1  2.5 -2.5  12.15 -12.15
media   0 1 10
boundary 10
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
      1 2 56 3 5 3 1 2 1 3 5 3 1q6 1 2 56  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
     56 2 1 61 5 3 2q6 56 2 1 end fill
ara=3  nux=2 nuy=1 nuz=1
fill 10 9 end fill
end array
'read plot   scr=yes
read plot
ttl='xy slice '
xul=-50.0  yul=98.0 zul=45.0
xlr=93.0 ylr=-30.0 zlr=45.0
uax=1  vdn=-1 nax=640  nch='0123456' end
ttl='xz slice '
xul=-50.0  yul=0.0 zul=81.0
xlr=93.0 ylr=0.0 zlr=-51.0
uax=1  wdn=-1 nax=640  nch='0123456' end
end plot
end data
end


=csas26
rocky flats criticals nureg/cr-1071 experiment number 15 (27 group)
238groupndf5  latticecell
u3o8  1 5.4078e-1 293.0 92234 0.03 92235 4.46 92236 0.08 92238 95.43 end
```

```
h2o   1 8.9514e-2 end
arbm-baggie  1.0 3 0 0 0 1001 14.01 6012 84.79 8016 1.20 1 1.9134e-2
   end
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 2 9.5390e-1
   end
arbm-tape(vinyl)  1.0 7 0 0 0 1001 5.92 6012 47.93 8016 10.82 17000
   25.73 20000 6.9 22000 1.6 82000 1.1 2 1.1115e-2 end
arbm-tape(mylar)  1.0 3 0 0 0 1001 6.83 6012 66.15 8016 27.02 2
   1.7491e-2 end
arbm-moderator  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 3 end
h2o   4.0  1.0-15 end
rfconcrete   5  1.0 end
end comp
sphtriangp  19.0000 18.5857 1 3 18.9579 2 end
read parm  run=yes npg=2000 plt=yes
fdn=yes nub=yes
end parm
read geom
unit  1
com='fuel box 15.28 cm on a side with .15 cm walls .05cm stacking void'
cuboid  10  6p7.49
cuboid  20  6p7.64
cuboid  30  6p7.6650
media  1  1 10
media  2  1 20 -10
media  0  1 30 -20
boundary  30
unit  2
com='x-face interstitial moderator'
cuboid   10  2p0.4645 4p7.665
media  3 1 10
boundary  10
unit  3
com='y-face interstitial moderator'
cuboid   10 2p7.665 2p0.4645 2p7.665
media  3 1 10
boundary  10
unit  4
com='z-face interstitial moderator'
cuboid  10 4p7.665 2p0.4645
media  3 1 10
boundary  10
unit  5
com='more x-face moderator'
cuboid  10 4p0.4645 2p7.665
media  3 1 10
boundary  10
unit  6
com='more y-face moderator'
cuboid  10 2p7.665 4p0.4645
media  3 1 10
boundary  10
unit  7
com='more z-face moderator'
cuboid  10 2p0.4645 2p7.665 2p0.4645
media  3 1 10
boundary  10
unit  8
com='last of interstitial moderator'
cuboid  10 6p0.4645
media  3 1 10
boundary  10
global unit  9
```

```
com='north split table core'
cuboid  10   31.589  0.0   64.107  0.0  80.366  0.0
cuboid  20  31.589  0.0   76.207  0.0  80.366  -25.5
cuboid  30  31.589   -.711  77.5    0.0  83.2    -25.5
cuboid  40  31.589   -26.211  103.0  -25.5 108.7   -25.5
array  1  10  place  1 1 1      7.6650  7.6650  7.6650
media  5  1 20 -10
media  0  1 30 -20 -10
media  5  1 40 -30 -20 -10
boundary  40
unit  10
com='south split table core'
cuboid  10    47.848  0.0  64.107  0.0  80.366  0.0
cuboid   20 47.848 0.0  76.207 0.0  80.366 -25.5
cuboid   30 47.848 0.0  77.5   0.0  83.2   -25.5
cuboid   40 47.848 0.0 103.0 -25.5 108.7   -25.5
cuboid   50 48.848 0.0 103.0 -25.5 108.7   -25.5
cuboid   60 74.348 0.0 103.0 -25.5 108.7   -25.5
array   2  10    place  1 1 1       7.6650  7.6650  7.6650
media  5  1  20 -10
media  0  1  30 -20 -10
media  5  1  40 -30 -20 -10
media  0  1  50  -40 -30 -20 -10
media  5  1  60  -50 -40 -30 -20 -10
hole  11      origin  x=42.748  y=32.0535   z=-12.751
hole  11      origin  x=42.748  y=32.0535   z=95.95
boundary  60
unit  11
cuboid  10  5.1  -5.1   2.55 -2.55  12.75  -12.75
media  0 1 10
boundary 10
unit  12
com='north split table faceplate'
cuboid   10 2p0.0001 2p64.2500 2p67.1
media  3 1 10
boundary 10
unit  13
com='faceplate for south split table'
cuboid  10 2p0.4620  2p64.2500 2p67.1
media  3 1 10
boundary 10
unit  14
com='air gap'
cuboid  10 2p0.2850 2p64.2500 2p67.1
media  0 1  10
boundary 10
global unit  15
com='total'
cuboid  10  133.64  0.0  128.50  0.0  134.20  0.0
array  3  10  place 1 1 1       26.211  25.5  25.5
boundary 10
unit  56
com='empty fuel location'
cuboid  10 6p7.6650
media  0  1  10
boundary 10
unit  61
com='y-face moderator void'
cuboid  10 2p7.665 2p0.4645 2p7.665
media  0 1 10
boundary 10
end geometry
read array
```

```
ara=1  nux=3 nuy=7 nuz=9
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
      3q42
      1 2 1 3 5 3 2q6 1 2 1  end fill
ara=2  nux=5 nuy=7 nuz=9
com='south split table core'
fill  1 2 1 2 1 3 5 3 5 3 2q10 1 2 1 2 1
      4 7 4 7 4 6 8 6 8 6 2q10 4 7 4 7 4
      3q70
      1 2 1 2 1 3 5 3 5 3
      56 2 1 2 1 61 5 3 5 3
      56 2 1 2 1 3 5 3 5 3
      1 2 1 2 1              end fill
ara=3  nux=5 nuy=1 nuz=1
com='total'
fill  9 12 14 13 10  end fill
end array
read plot   scr=yes
ttl='xy slice of rfp1 showing material regions'
xul=0.0  yul=128.0 zul=12.5
xlr=134 ylr=0.0 zlr=12.5
uax=1  vdn=-1 nax=640  nch='0123456'end
ttl='xy slice of rfp1 showing material regions'
xul=0.0  yul=128.0 zul=121.45
xlr=134 ylr=0.0 zlr=121.45
uax=1  vdn=-1 nax=640  nch='0123456'end
'ttl='yz slice of north core second row'
'xul=28  yul=-2   zul=136
'xlr=28  ylr=136 zlr=-2
'vax=1  wdn=-1 nax=640  nch='0123456'end
'ttl='yz slice of south core second row'
'xul=80 yul=-2   zul=136
'xlr=80 ylr=136  zlr=-2
'vax=1  wdn=-1 nax=640  nch='0123456'
'ttl='xz slice of rfp1 showing material regions'
'xul=-2  yul=32. zul=136
'xlr=137 ylr=32.0 zlr=-2
'uax=1  wdn=-1 nax=640  nch='0123456'end
end plot
read start  nst=1
xsm=15 xsp=122 ysm=15 ysp=122 zsm=30 zsp=122  end start
end data
end


=csas26
rocky flats criticals nureg/cr-0674 experiment number ? (27 group model)
' fuel cube 15.28 cm, u(4.46)3o8 @ h/u=0.77, hi enriched sphere driven
238groupndf5  infhommedium
u3o8  1 5.4078e-1 293.0 92234 0.03 92235 4.46 92236 0.08 92238 95.43 end
h2o   1 8.9514e-2 end
arbm-baggie  1.0 3 0 0 0 1001 14.01 6012 84.79 8016 1.20 1 1.9134e-2
   end
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 2 9.5390e-1
   end
arbm-tape(vinyl)  1.0 7 0 0 0 1001 5.92 6012 47.93 8016 10.82 17000
   25.73 20000 6.9 22000 1.6 82000 1.1 2 1.1115e-2 end
arbm-tape(mylar)  1.0 3 0 0 0 1001 6.83 6012 66.15 8016 27.02 2
   1.7491e-2 end
arbm-moderator  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 3 end
arbm-plex(reg)  1.0 3 0 0 0 1001 7.84 6012 59.93 8016 32.23 4
```

```
   1.1773 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 4
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 4
   1.1648e-3 end
arbm-plex(tris)  1.0 8 0 0 1 1001 7.16 6012 52.93 7014 0.16 8016 29.82
   15031 1.02 17000 1.81 35079 4.260 35081 2.840 5 1.2757 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 5
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 5
   1.1648e-3 end
arbm-filler  1.185 3 0 0 0 1001 7.83 6012 59.69  8016 32.48 6 0.7 end
' this material is actually moderator adjusted for the volume
' fraction of the void filled between core and reflector.
arbm-al1100  1.0 3 0 0 1 13027 99.3  26000 0.5 29000 0.2 7 2.715  end
uranium  8 0.9516 293.0 92234 1.0 92235 93.19 92236 0.4 92238  5.41 end
arbm-pj  0.816 2 0 0 0 1001 85.1 6012 14.9 8 0.0041  end
ss304  9 1.0 end
end comp
read parm  npg=2000 nub=yes fdn=yes plt=yes    run=yes  end parm
read geom
unit  1
'com='slotted fuel box'
cuboid  10  9.95   0.0    3.75    0.0     14.98  0.0
cuboid  20  10.1   0.0    3.9    -.15     14.98  0.0
cuboid  30  15.13  .15    9.365  -5.615   14.98  0.0
cuboid  40  15.28  0.0    9.515  -5.765   15.13  -.15
cuboid  50  15.305  -.025  9.54  -5.79    15.155  -.175
media  0 1 10
media  2 1  20 -10
media  1  1  30 -20 -10
media  2  1  40 -30 -20 -10
media  0 1  50 -40 -30 -20 -10
boundary  50
unit  2
'com='fuel box 15.28 cm on a side with .15 cm walls .05cm stacking void'
cuboid  10  6p7.49
cuboid  20  6p7.64
cuboid  30  6p7.6650
media  1 1 10
media  2 1 20 -10
media  0 1  30 -20 -10
boundary  30
unit  3
'com='aluminum weight distribution plate for boxes'
cuboid 10  4p7.665 0.16 0.0
media  7 1 10
boundary  10
unit 4
'com='aluminum weight distribution plate for special box'
cuboid  10  9.80  0.0  3.75  0.0 .16  0.0
cuboid  20  15.33  0.0  9.54  -5.79  .16  0.0
media  0 1 10
media  7 1 20 -10
boundary  20
unit  5
cylinder    10  .3175  2p7.32
sphere    20  7.334
cylinder  30  1.56  .33099 0.0          origin  z= -7.6649
cuboid    40  8.512 -6.818   2p7.665   2p7.665
media  9 1 10 20
media  8 1 20 -10
media  9 1 30 -20 -10
```

```
media  0 1 40 -10 -20 -30
boundary  40
unit  9
com='north split table core'
cuboid   10  30.66  0.0  76.65  0.0  77.29  0.0
cuboid   20  30.66 -0.94 77.5 0.0 83.475 0.0
cuboid   30  30.66 -0.94 77.5 0.0 83.475 -16.48
cuboid   40  30.66 -0.94 77.5 0.0 83.475 -17.71
cuboid   50  30.66 -0.94 77.5 0.0 83.475 -25.09
cuboid  60  30.66 -12.544  77.5 0.0  83.475 -25.09
cuboid  70  30.66 -17.744  77.5 0.0  83.475 -25.09
cuboid  80  30.66 -27.544  77.5 0.0  83.475 -25.09
cuboid  90  30.66 -27.544  102.8 -25.3 107.775 -25.09
array  1  10  place 1 1 1    7.665  7.665   7.665
media  0 1 20 -10
media  5 1 30 -20 -10
media  4 1 40 -30 -20 -10
media  5 1 50 -40 -30 -20 -10
media  4  1 60 -50 -40 -30 -20 -10
media  5 1 70 -60 -50 -40 -30 -20 -10
media  4  1 80 -70 -60 -50 -40 -30 -20 -10
media  5  1 90 -80 -70 -60 -50 -40 -30 -20 -10
boundary  90
unit 10
com='south split table core'
cuboid  10 45.99  0.0  76.65  0.0  77.29   0.0
cuboid  20  49.4  0.0  77.5  0.0  83.475   0.0
cuboid  30  49.4  0.0  77.5  0.0  83.475   -1.23
cuboid  40  49.4  0.0  77.5  0.0  83.475   -2.46
cuboid  50  49.4  0.0  77.5  0.0  83.475   -3.69
cuboid  60  49.4  0.0  77.5  0.0  83.475   -4.92
cuboid  70  49.4  0.0  77.5  0.0  83.475   -6.15
cuboid  80  49.4  0.0  77.5  0.0  83.475   -7.38
cuboid  90  74.5  0.0  102.8  -25.3  107.775  -25.09
array  2 10 place 1 1 1 7.665  7.665  7.665
media  0 1 20 -10
media  5 1 30 -20 -10
media  5 1 40 -30 -20 -10
media  4 1 50 -40 -30 -20 -10
media  4 1 60 -50 -40 -30 -20 -10
media  5 1 70 -60 -50 -40 -30 -20 -10
media  4 1 80 -70 -60 -50 -40 -30 -20 -10
media  5 1 90 -80 -70 -60 -50 -40 -30 -20 -10
hole 13     origin x=0.0  y=36.425  z=-25.09
hole 14    origin x=0.0  y=36.425  z=83.475
boundary 90
unit 11
com='air gap'
sphere  10  7.334
cuboid  20 -6.818  -7.619  64.475  -63.625  69.13  -63.735
media  8 1 10
media  0 1 20 -10
boundary 20
global unit 12
com='total'
cuboid  10  133.505  0.0  128.1  0.0  132.865  0.0
array  3 10    place 1 1 1       27.544    25.3   25.09
boundary 10
unit  13
'com='bottom hole'
cuboid  10  9.95   0.0    3.75    0.0     25.09  0.0
media  0 1 10
boundary 10
```

```
unit  14
'com='top hole'
cuboid  10  9.95   0.0    3.75    0.0     24.3  0.0
media  0 1 10
boundary 10
end geometry
read array
ara=1  nux=2 nuy=5 nuz=9
com='north split table core'
fill  10r2
      10r3
      10r2
      10r3
      10r2
      10r3
      10r2
      10r3
      10r2   end fill
ara=2  nux=3 nuy=5 nuz=9
com='south split table core'
fill  6r2 1 8r2
      6r3 4 8r3
      6r2 1 8r2
      6r3 4 8r3
      6r2 5 8r2
      6r3 4 8r3
      6r2 1 8r2
      6r3 4 8r3
      6r2 1 8r2  end fill
ara=3 nux=3 nuy=1  nuz=1
com='total'
fill 9 11 10  end fill
end array
read plot   scr=yes
ttl='xy slice '
xul=0.0  yul=128.1  zul=125.0
xlr=133.505 ylr=0.0  zlr=125.0
uax=1  vdn=-1 nax=640  nch='012345678'end
ttl='xz slice of sphere cuboid'
xul=0.0 yul=64.05 zul=132.865
xlr=133.505 ylr=64.05 zlr=0.0
uax=1  wdn=-1 nax=390  nch='012345678'
end plot
' read start  nst=6 tfx=65 tfy=63.625 tfz=63.735 lnu=300  end start
read start  nst=1 xsm=56.981 xsp=71.649 ysm=56.219 ysp=70.959
  zsm=56.401 zsp=71.069   end start
end data
end


=csas26
rocky flats criticals nureg/cr-0674 experiment number ? (27 group model)
' fuel cube 15.28 cm, u(4.46)3o8 @ h/u=0.77, low conc. solution driven
238groupndf5  infhommedium
u3o8  1 5.4078e-1 293.0 92234 0.03 92235 4.46 92236 0.08 92238 95.43 end
h2o   1 8.9514e-2 end
arbm-baggie  1.0 3 0 0 0 1001 14.01 6012 84.79 8016 1.20 1 1.9134e-2
   end
arbm-al1100  1.0 3  0  0 1 13027 99.3 26000 0.5 29000 0.2 2 9.5390e-1
   end
arbm-tape(vinyl)  1.0 7 0 0 0 1001 5.92 6012 47.93 8016 10.82 17000
   25.73 20000 6.9 22000 1.6 82000 1.1 2 1.1115e-2 end
arbm-tape(mylar)  1.0 3 0 0 0 1001 6.83 6012 66.15 8016 27.02 2
```

```
   1.7491e-2 end
arbm-moderator  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 3 end
arbm-plex(reg)  1.0 3 0 0 0 1001 7.84 6012 59.93 8016 32.23 4
   1.1773 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 4
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 4
   1.1648e-3 end
arbm-plex(tris)  1.0 8 0 0 1 1001 7.16 6012 52.93 7014 0.16 8016 29.82
   15031 1.02 17000 1.81 35079 4.260 35081 2.840 5 1.2757 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 5
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 5
   1.1648e-3 end
arbm-filler  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 6 0.7 end
' this material is actually moderator adjusted for the volume
' fraction of the void filled between core and reflector.
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 7 2.715  end
solnuo2(no3)2  8 86.42 0.149 1.0 293.0 92234 1.022 92235 93.172
   92236 0.434 92238 5.372  end
ss304  9 1.0 end
end comp
' fuel cube 15.28 cm, u(4.46)3o8 @ h/u=0.77, low conc. solution driven
read parm  npg=2000 nub=yes fdn=yes plt=no  end parm
read geom
unit  1
com='fuel box with void and part of al box'
cuboid  10 9.80  0.0 3.75   0.0   14.98 0.0
cuboid  20 9.95  0.0 3.90  -0.15  14.98 0.0
cuboid  30 14.98 0.0 9.365 -5.615 14.98 0.0
media  0 1 10
media  2 1 20 -10
media  1 1 30 -20
boundary  30
unit  2
com='front of fuel box'
cuboid  10 0.15 0.0  5.615 0.0 14.98 0.0
cuboid  20 1 0.15 0.0  9.365 0.0 14.98 0.0
cuboid  30 1 0.15 0.0 14.98  0.0 14.98 0.0
media  2 1 10
media  0 1 20 -10
media  2 1 30 -20
boundary  30
unit  3
com='rear of fuel box'
cuboid  10 0.15 0.0 14.98  0.0 14.98 0.0
media  2 1 10
boundary 10
unit  4
com='array to assemble part of box'
array 26 3*0
unit  5
com='top and bottom of box'
cuboid  0 1  9.80 0.0 3.750  0.0   0.15 0.0
cuboid  2 1 15.28 0.0 9.365 -5.615 0.15 0.0
global
unit  6
com='array to assemble top and bottom'
array 27 3*0
cuboid  2 1 15.28   0.0   15.13  -0.15  15.28   0.0
cuboid  0 1 15.305 -0.025 15.155 -0.175 15.305 -0.025
unit  7
com='fuel box 15.28 cm on a side with .15 cm walls .05cm stacking void'
```

```
cuboid  1 1 6p7.49
cuboid  2 1 6p7.64
cuboid  0 1 6p7.6650
unit  34
com='aluminum weight distribution plate for special box'
cuboid  0 1  9.80 0.0 3.750  0.0   0.16 0.0
cuboid  7 1 15.33 0.0 9.54 -5.79 0.16 0.0
unit  35
com='aluminum weight distribution plate for boxes'
cuboid  7 1  4p7.665 0.16 0.0
unit  9
com='north split table core'
array 1 3*0.0
cuboid  0 1 30.66 -0.94 77.5 0.0 83.475 0.0
unit  10
com='south split table core'
array 2 3*0.0
cuboid  0 1 49.4 0.0 77.5 0.0 83.475 0.0
unit  11
com='plexiglass reflector sheet without tris, north bottom reflector'
cuboid  4 1 2p15.8000 2p38.7500 2p0.6150
unit  12
com='plexiglass reflector sheet with tris, north bottom reflector'
cuboid  5 1 2p15.8000 2p38.7500 2p0.6150
unit  13
com='upper portion north bottom reflector with tris'
cuboid  5 1 2p15.8 2p38.75 2p8.24
unit  14
com='lower portion north bottom reflector with tris'
cuboid  5 1 2p15.8 2p38.75 2p3.69
unit  15
com='north bottom reflector includes regular and tris'
array 3 3*0.0
unit  16
com='plexiglas sheet bottom south reflector without tris'
cuboid  0 1 2p5.1 2p2.5 2p0.6150
cuboid  4 1 44.3 -5.1 2p38.75  2p0.615
unit  17
com='plexiglas sheet bottom south reflector with tris'
cuboid  0 1 2p5.1 2p2.5 2p0.6150
cuboid  5 1 44.3 -5.1 2p38.75 2p0.6150
unit  18
com='lower portion south bottom reflector with tris'
cuboid  0 1 2p5.1 2p2.5 2p8.855
cuboid  5 1 44.3 -5.1 2p38.75 2p8.855
unit  19
com='south bottom reflector with regular and tris'
array 4 3*0.0
unit  20
com='east and west reflectors for north reflector with tris'
cuboid  5 1 2p15.8 2p12.65 2p54.2825
unit  21
com='array for east and west reflectors for north reflector'
array 5 3*0.0
unit  22
com='east and west reflectors for south reflector with tris'
cuboid  5 1 2p24.700 2p12.65 2p54.2825
unit  23
com='array for east and west reflectors for south reflector'
array 6 3*0.0
unit  24
com='north top reflector with tris'
cuboid  5 1 2p28.35 2p64.05 2p12.15
```

```
unit  25
com='array for north top reflector'
array 7 3*0.0
unit  26
com='south top reflector with tris'
cuboid  0 1 2p5.1 2p2.5 2p12.15
cuboid  5 1 69.4 -5.1 2p64.05 2p12.15
unit  27
com='array for south top reflector'
array 8 3*0.0
unit  28
com='north end reflector 9.8cm portion without tris'
cuboid  4 1 2p4.9000 2p64.0500 2p54.2825
unit  29
com='north end relfector 5.2 cm portion with tris'
cuboid  5 1 2p2.6 2p64.0500 2p54.2825
unit  30
com='north end relfector 10.1 cm portion without tris'
cuboid  4 1 2p5.05 2p64.05 2p54.2825
unit  31
com='array for north end reflector'
array 9 3*0.0
unit  32
com='south end reflector'
cuboid  5 1 2p12.55 2p64.05 2p54.2825
unit  33
com='array for south end reflector'
array 10 3*0.0
unit  38
com='north core with bottom reflector'
array 13 3* 0.0
unit  39
com='north core with east and west reflector'
array 14 3*0.0
unit  40
com='north core with end reflector'
array 15 3*0.0
unit  42
com='north core with top reflector'
array 16 3*0.0
unit  48
com='south core with bottom reflectors'
array 20 3*0.0
unit  49
com='south core with east west reflectors'
array 21 3*0.0
unit  50
com='south core end reflector'
array 22 3*0.0
unit  52
com='south core with top reflector'
array 23 3*0.0
unit  54
com='air gap'
cuboid  0 1 0.912 0.0 64.475 -63.625 69.13 -63.735
global
unit  55
com='total'
array 25 3*0.0
unit  56
com='combination of two regular fuel boxes'
array 28 3*0.0
```

```
unit  57
com='combination of regular fuel box and special fuel box'
array 29 3*0.0
unit  58
com='combination of two regular weight distribution plates'
array 30 3*0.0
unit  59
com='combination of regular and special weight distribution plates'
array 31 3*0.0
unit  60
com='north core solution driver'
cuboid  8 1 2p7.5 2p14.9 5.374 -7.5
cuboid  0 1 2p7.5 2p14.9 2p7.5
cuboid  9 1 2p7.65 2p15.05 2p7.65
cuboid  0 1 2p7.665 2p15.33 2p7.665
unit  61
com='north core solution driver'
cuboid  8 1 2p7.5 2p14.9 5.328 -7.5
cuboid  0 1 2p7.5 2p14.9 2p7.5
cuboid  9 1 2p7.65 2p15.05 2p7.65
cuboid  0 1 2p7.665 2p15.33 2p7.665
end geometry
read array
ara=1  nux=2 nuy=4 nuz=9
com='north split table core'
fill   2r7  2r56  4r7
       2r35 2r58  4r35
       2r7  2r56  4r7
       2r35 2r58  4r35
       2r7  56 60 4r7
       2r35 2r58  4r35
       2r7  2r56  4r7
       2r35 2r58  4r35
       2r7  2r56  4r7
end fill
ara=2  nux=3 nuy=4 nuz=9
com='south split table core'
fill   3r7  3r56     6r7
       3r35 3r58     6r35
       3r7  3r56     6r7
       3r35 3r58     6r35
       3r7  61 56 56 6r7
       3r35 3r58     6r35
       3r7  57 56 56 6r7
       3r35 59 58 58 6r35
       3r7  57 56 56 6r7
end fill
ara=3  nux=1 nuy=1 nuz=3
com='north bottom reflector'
fill  14 11 13  end fill
ara=4  nux=1 nuy=1 nuz=7
com='south bottom reflector'
fill  18 16 17 16 16 17 17  end fill
ara=5  nux=1 nuy=1 nuz=1
com='east and west walls of north reflector'
fill  20 end fill
ara=6  nux=1 nuy=1 nuz=1
com='east and west walls of south reflector'
fill  22  end fill
ara=7  nux=1 nuy=1 nuz=1
com='array for north top reflector'
fill  24  end fill
ara=8  nux=1 nuy=1 nuz=1
```

```
com='array for south top reflector'
fill  26 end fill
ara=9  nux=3 nuy=1 nuz=1
com='array for north end reflector'
fill  28 29 30  end fill
ara=10  nux=1 nuy=1 nuz=1
com='array for south end reflector'
fill  32  end fill
ara=13  nux=1 nuy=1 nuz=2
com='combination of north core with bottom reflector'
fill  15 9  end fill
ara=14  nux=1 nuy=3 nuz=1
com='north core with side reflectors'
fill  21 38 21  end fill
ara=15  nux=2 nuy=1 nuz=1
com='north core with end reflector'
fill  31 39  end fill
ara=16  nux=1 nuy=1 nuz=2
com='north core with top reflector'
fill  40 25  end fill
ara=20  nux=1 nuy=1 nuz=2
com='south core with bottom reflector'
fill  19 10  end fill
ara=21 nux=1 nuy=3 nuz=1
com='south core with east west reflectors'
fill  23 48 23  end fill
ara=22 nux=2 nuy=1 nuz=1
com='south core with end reflector'
fill  49 33  end fill
ara=23  nux=1 nuy=1 nuz=2
com='combination of core with top reflector'
fill  50 27  end fill
ara=25  nux=3 nuy=1 nuz=1
com='total'
fill  42 54 52  end fill
ara=26  nux=3 nuy=1 nuz=1
com='assembly of fuel box front and rear'
fill  2 1 3  end fill
ara=27  nux=1 nuy=1 nuz=3
com='assembly of fuel box top and bottom'
fill  5 4 5  end fill
ara=28  nux=1 nuy=2 nuz=1
com='combination of two fuel boxes'
fill  7 7  end fill
ara=29  nux=1 nuy=2 nuz=1
com='combination of special and regular fuel boxes'
fill  7 6  end fill
ara=30  nux=1 nuy=2 nuz=1
com='combination of two weight distribution plates'
fill  35 35  end fill
ara=31  nux=1 nuy=2 nuz=1
com='combination of special and regular weight distribution plates'
fill  35 34  end fill
end array
read plot ttl='yz slice of south core first row'
xul=64.319 yul=40.000 zul=72.000
xlr=64.319 ylr=72.000 zlr=56.000
vax=1  wdn=-1 nax=130  nch='012345678'end
ttl='xz slice of sphere cuboid'
xul=56.0 yul=63.625 zul=71.735
xlr=72.0 ylr=63.625 zlr=55.735
uax=1  wdn=-1 nax=130  nch='012345678'
end plot
```

```
read start  nst=1 xsm=41.37 xsp=72.894 ysm=40.63 ysp=71.29
  zsm=56.071 zsp=71.4   end start
end data
end


=csas26
rocky flats criticals nureg/cr-1653 experiment a (27 group)
' 48 fuel cans 2.44 cm moderator gee.hu125.data(opt)
238groupndf5  latticecell
u3o8  1 5.4078e-1 293.0 92234 0.03 92235 4.46 92236 0.08 92238 95.43 end
h2o   1 1.5627e-1 end
arbm-baggie  1.0 3 0 0 0 1001 14.01 6012 84.79 8016 1.20 1 1.9134e-2
   end
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 2 9.5390e-1
   end
arbm-tape(vinyl)  1.0 7 0 0 0 1001 5.92 6012 47.93 8016 10.82 17000
   25.73 20000 6.9 22000 1.6 82000 1.1 2 1.1115e-2 end
arbm-tape(mylar)  1.0 3 0 0 0 1001 6.83 6012 66.15 8016 27.02 2
   1.7491e-2 end
arbm-moderator  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 3 end
arbm-plex(reg)  1.0 3 0 0 0 1001 7.84 6012 59.93 8016 32.23 4
   1.1773 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 4
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 4
   1.1648e-3 end
arbm-plex(tris)  1.0 8 0 0 1 1001 7.16 6012 52.93 7014 0.16 8016 29.82
   15031 1.02 17000 1.81 35079 4.260 35081 2.840 5 1.2757 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 5
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 5
   1.1648e-3 end
arbm-filler  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 6 .888 end
' this material is actually moderator adjusted for the volume
' fraction of the void filled between core and reflector.
end comp
sphtriangp  19.9462 18.5857 1 3 18.9579 2 end
' 48 fuel cans 2.44 cm moderator gee.hu77.data(opt1)
read parm  run=yes npg=2000
nub=yes fdn=yes plt=yes  run=yes
end parm
read geom
unit  1
com='fuel box 15.28 cm on a side with .15 cm walls .05cm stacking void'
cuboid  10   6p7.49
cuboid  20  6p7.64
cuboid  30  6p7.6650
media 1 1 10
media 2 1 20 -10
media  0  1  30 -20
boundary  30
unit  2
com='x-face interstitial moderator'
cuboid  10 2p1.2200 4p7.665
media  3 1 10
boundary  10
unit  3
com='y-face interstitial moderator'
cuboid  10 2p7.665 2p1.2200 2p7.665
media  3 1 10
boundary  10
```

```
unit  4
com='z-face interstitial moderator'
cuboid  10 4p7.665 2p1.2200
media  3 1 10
boundary  10
unit  5
com='more x-face moderator'
cuboid  10 4p1.2200 2p7.665
media  3 1 10
boundary  10
unit  6
com='more y-face moderator'
cuboid  10 2p7.665 4p1.2200
media  3 1 10
boundary  10
unit  7
com='more z-face moderator'
cuboid  10 2p1.2200 2p7.665 2p1.2200
media   3 1 10
boundary  10
unit  8
com='last of interstitial moderator'
cuboid  10 6p1.2200
media  3 1 10
boundary 10
unit 56
com='empty fuel location'
cuboid  10  6p7.6650
media  0 1 10
boundary  10
unit 61
com='y-face moderator void'
cuboid  10  2p7.665  2p1.22  2p7.665
media  0 1 10
boundary  10
unit 62
com='x-face moderator void'
cuboid  10    2p1.22  4p7.665
media  0 1 10
boundary  10
unit 9
com='north split table core'
cuboid  10  33.1  0.0  68.64  0.0  50.87  0.0
cuboid  20  33.1  0.0    72.75   -4.75   50.87 0.0
cuboid  25  33.1  0.0    72.75   -4.75   57.375  -26.1
cuboid  30   33.1 0.0  98.05  -30.05  81.675  -42.58
cuboid  40 33.1  0.0  98.05  -30.05  81.675  -43.81
cuboid  50  33.1  0.0  98.05  -30.85  81.675  -51.19
cuboid   60  42.9  0.0  98.05  -30.05  81.675  -51.19
cuboid   70  48.1  0.0  98.05  -30.05  81.675  -51.19
cuboid   80  57.7  0.0  98.05  -30.05  81.675  -51.19
cuboid  90  57.7  -1.23  98.05  -30.05  81.675  -51.19
array  1  10  place 1 1 1     7.6650  7.6650  7.6650
media  5  1  20  -10
media  6  1  25 -20 -10
media  5  1  30 -20 -10 -25
media  4  1  40 -30 -20 -10 -25
media  5  1  50 -40 -30  -20 -10 -25
media  4  1  60 -50 -40 -30 -20 -10 -25
media  5  1 70 -60 -50 -40 -30 -20 -10 -25
media  4  1  80 -70 -60 -50 -40 -30 -20 -10 -25
media   3  1  90 -80  -70  -60 -50 -40 -30 -20 -10 -25
boundary  90
```

```
unit  10
com='south split table core'
cuboid  10   33.1  0.0    68.64   0.0     50.87  0.0
cuboid  20   33.1  0.0    72.75  -4.75    50.87  0.0
cuboid  25   33.1  -16.3  72.75  -4.75   57.375  -26.1
cuboid  30   33.1  -16.3  72.75  -4.75   57.375   -27.33
cuboid  40   33.1  -16.3  72.75  -4.75   57.375  -28.56
cuboid  50   33.1  -16.3  72.75  -4.75   57.375  -29.79
cuboid  60   33.1  -16.3  72.75  -4.75   57.375  -31.02
cuboid  70   33.1  -16.3  72.75  -4.75   57.375  -32.25
cuboid  80   33.1  -16.3  72.75  -4.75   57.375  -33.48
cuboid   90   33.1 -41.4   98.05  -30.05  81.675  -51.19
cuboid  100  34.33  -41.4  98.05  -30.05  81.675  -51.19
array  2  10  place 1 1 1     7.6650  7.6650  7.6650
media   5  1  20 -10
media   6  1  25 -20 -10
media   5  1  30 -20 -10  -25
media   5  1  40 -30 -20 -10  -25
media   4  1  50 -40 -30 -20 -10  -25
media   4  1  60 -50  -40 -30 -20 -10  -25
media   5  1  70 -60 -50 -40 -30 -20 -10  -25
media   4  1  80 -70  -60 -50 -40 -30 -20 -10  -25
media   5   1  90 -80 -70 -60 -50 -40 -30 -20 -10  -25
media   3  1  100 -90 -80 -70 -60 -50 -40 -30 -20 -10  -25
hole     12             origin  x=28.  y=34.  z=-38.645
hole     13              origin  x=28.  y=34.  z=69.525
boundary  100
global unit  11
cuboid  10  93.26  -41.4  98.05  -30.05  81.675  -51.19
array  3 10  place  1 1 1   0.0  0.0  0.0
boundary  10
unit  12
cuboid  10  5.1 -5.1  2.5 -2.5  12.545 -12.545
media   0 1 10
boundary 10
unit  13
cuboid  10  5.1 -5.1  2.5 -2.5  12.15 -12.15
media   0 1 10
boundary 10
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
      1 2 56 3 5 61 1 2 56 3 5 61 1q6 56 62 56  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
      56 2 1 61 5 3 2q6 56 62 56  end fill
ara=3  nux=2 nuy=1 nuz=1
fill 10 9 end fill
end array
read plot   scr=yes
 ttl='xy slice '
xul=-50.0  yul=98.0 zul=50.0
xlr=93.0 ylr=-30.0 zlr=50.0
uax=1  vdn=-1 nax=640  nch='0123456' end
 ttl='xz slice '
xul=-50.0  yul=0.0 zul=81.0
```

```
xlr=93.0 ylr=0.0 zlr=-51.0
uax=1  wdn=-1 nax=640  nch='0123456' end
end plot
end data
end


=csas26
rocky flats criticals nureg/cr-1653 experiment c (27 group)
' 80 fuel cans 0.929 cm moderator gee.hu125.data(und2)
238groupndf5  latticecell
u3o8  1 5.4078e-1 293.0 92234 0.03 92235 4.46 92236 0.08 92238 95.43 end
h2o   1 1.5627e-1 end
arbm-baggie  1.0 3 0 0 0 1001 14.01 6012 84.79 8016 1.20 1 1.9134e-2
   end
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 2 9.5390e-1
   end
arbm-tape(vinyl)  1.0 7 0 0 0 1001 5.92 6012 47.93 8016 10.82 17000
   25.73 20000 6.9 22000 1.6 82000 1.1 2 1.1115e-2 end
arbm-tape(mylar)  1.0 3 0 0 0 1001 6.83 6012 66.15 8016 27.02 2
   1.7491e-2 end
arbm-moderator  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 3 end
arbm-plex(reg)  1.0 3 0 0 0 1001 7.84 6012 59.93 8016 32.23 4
   1.1773 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 4
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 4
   1.1648e-3 end
arbm-plex(tris)  1.0 8 0 0 1 1001 7.16 6012 52.93 7014 0.16 8016 29.82
   15031 1.02 17000 1.81 35079 4.260 35081 2.840 5 1.2757 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 5
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 5
   1.1648e-3 end
arbm-filler  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 6 .854 end
' this material is actually moderator adjusted for the volume
' fraction of the void filled between core and reflector.
end comp
sphtriangp  19.00 18.5857 1 3 18.9579 2 end
' 80 fuel cans 0.929 cm moderator gee.hu125.data(und2)
read parm  run=yes npg=2000 fdn=yes nub=yes plt=yes  end parm
read geom
unit  1
com='fuel box 15.28 cm on a side with .15 cm walls .05cm stacking void'
cuboid  10  6p7.49
cuboid  20  6p7.64
cuboid  30  6p7.6650
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary 30
unit  2
com='x-face interstitial moderator'
cuboid   10  2p0.4645 4p7.665
media  3 1 10
boundary 10
unit  3
com='y-face interstitial moderator'
cuboid  10 2p7.665 2p0.4645 2p7.665
media  3 1 10
boundary 10
```

```
unit  4
com='z-face interstitial moderator'
cuboid  10 4p7.665 2p0.4645
media  3 1 10
boundary 10
unit  5
com='more x-face moderator'
cuboid  10 4p0.4645 2p7.665
media  3 1 10
boundary 10
unit  6
com='more y-face moderator'
cuboid  10 2p7.665 4p0.4645
media  3 1 10
boundary 10
unit  7
com='more z-face moderator'
cuboid  10 2p0.4645 2p7.665 2p0.4645
media  3 1 10
boundary 10
unit  8
com='last of interstitial moderator'
cuboid  10 6p0.4645
media  3 1 10
boundary 10
unit  9
com='north split table core'
cuboid  10  31.589  0.0   64.107  0.0  64.107  0.0
cuboid  20  31.589  0.0   77.057  0.0  67.057  -16.259
cuboid  30  31.589  0.0   102.357 -25.3  67.057  -32.739
cuboid  40  31.589  0.0   102.357  -25.3  67.057  -33.969
cuboid  50  31.589  0.0   102.357  -25.3  67.057  -41.349
cuboid  60  41.389  0.0   102.357  -25.3  67.057  -41.349
cuboid  70  46.589  0.0   102.357  -25.3  67.057  -41.349
cuboid  80  56.689  0.0   102.357  -25.3  67.057  -41.349
cuboid  90  56.689  0.0  102.357   -25.3  91.357  -41.349
cuboid  100  56.689  -1.23   102.357  -25.3  91.357  -41.349
array  1  10  place  1 1  1  7.665  7.665  7.665
media  6 1 20 -10
media  5 1 30 -20 -10
media  4  1  40 -30 -20 -10
media  5  1  50 -40 -30 -20 -10
media  4  1 60 -50 -40 -30 -20 -10
media  5 1 70 -60 -50 -40 -30 -20 -10
media  4 1 80 -70 -60 -50 -40 -30 -20 -10
media  5  1 90 -80 -70 -60 -50 -40 -30 -20 -10
media  3  1  100 -90 -80 -70 -60 -50 -40 -30 -20 -10
boundary  100
unit  10
com='south split table core'
cuboid  10  47.848  0.0  64.107  0.0  64.107  0.0
cuboid  20  47.848  0.0  77.057  0.0  67.057  0.0
cuboid  30  47.8480  -1.552   77.5    0.0  67.057  0.0
cuboid  40  47.8480  -1.552   77.5    0.0  67.057  -16.259
cuboid  50  47.8480  -1.552   102.357  -25.3  67.057  -16.259
cuboid  60  47.848   -1.552  102.357  -25.3  67.057 -18.719
cuboid  70  47.848   -1.552  102.357  -25.3  67.057 -21.179
cuboid  80  47.848   -1.552  102.357  -25.3  67.057 -22.409
cuboid  90  47.848   -1.552  102.357  -25.3  67.057 -23.639
cuboid  100  47.848  -26.652  102.357  -25.3  91.357 -41.349
cuboid  110  49.078  -26.652  102.357  -25.3  91.357  -41.349
array 2 10 place  1 1 1   7.665   7.665   7.665
media  6 1 20 -10
```

```
media  0 1 30 -20 -10
media  6 1 40  -30 -20 -10
media  5 1 50 -40 -30 -20 -10
media  5 1 60 -50 -40 -30 -20 -10
media  4 1 70 -60 -50 -40 -30 -20 -10
media  5  1 80 -70  -60 -50 -40 -30 -20 -10
media  4  1 90 -80 -70 -60 -50 -40 -30 -20 -10
media  5  1 100 -90 -80 -70 -60 -50 -40 -30 -20 -10
media  3  1  110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
hole  11     origin  x=42.748  y=32.0535   z=79.207
hole  12     origin  x=42.748  y=32.0535   z=-28.804
boundary 110
unit 11
cuboid  10  5.1  -5.1  2.5  -2.5  12.15 -12.15
media  0 1 10
boundary 10
unit 12
cuboid  10  5.1  -5.1  2.5  -2.5  12.545 -12.545
media  0 1 10
boundary 10
unit  54
com='air gap'
cuboid  10  2p0.7805    102.357  -25.3  91.357 -41.349
media  0 1 10
boundary 10
global
unit  55
com='total'
cuboid 10  108.558 -26.652  102.357  -25.3  91.357  -41.349
array 3 10      place 1 1 1          0.0 0.0 0.0
boundary 10
end geometry
read array
ara=1  nux=3 nuy=7 nuz=7
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
      2q42
      1 2 1 3 5 3 2q6 1 2 1  end fill
ara=2  nux=5 nuy=7 nuz=7
com='south split table core'
fill  1 2 1 2 1 3 5 3 5 3 2q10 1 2 1 2 1
      4 7 4 7 4 6 8 6 8 6 2q10 4 7 4 7 4
      2q70
      1 2 1 2 1 3 5 3 5 3 2q10 1 2 1 2 1  end fill
ara=3  nux=3 nuy=1 nuz=1
com='total'
fill  10 54 9      end fill
end array
read plot  scr=yes
ttl='xy slice'
xul=-30.0 yul=105.0  zul=-28.8
xlr=110.0 ylr=-30.0  zul=-28.8
uax=1  vdn=-1  nax=640  nch='0123456' end
ttl='xz slice of rfp3 showing material regions'
xul=-27  yul=64.05 zul=92.0
xlr=110 ylr=64.05 zlr=-46.0
uax=1  wdn=-1 nax=640  nch='0123456'end
ttl='yz slice of north core second row'
xul=28  yul=-30   zul=92.0
xlr=28  ylr=136 zlr=-46.0
vax=1  wdn=-1 nax=640  nch='0123456'end
ttl='yz slice of south core second row'
```

```
xul=80 yul=-30   zul=92.0
xlr=80 ylr=136  zlr=-46.0
vax=1  wdn=-1 nax=640  nch='0123456'
end plot
end data
end


=csas26
rocky flats criticals nureg/cr-1653 experiment number ? (27 group model)
' fuel cube 15.28 cm, u(4.46)3o8 @ h/u=1.25, hi conc. solution driven
238groupndf5  infhommedium
u3o8  1 5.4078e-1 293.0 92234 0.03 92235 4.46 92236 0.08 92238 95.43 end
h2o   1 1.5627e-1 end
arbm-baggie  1.0 3 0 0 0 1001 14.01 6012 84.79 8016 1.20 1 1.9134e-2
   end
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 2 9.5390e-120
   end
arbm-tape(vinyl)  1.0 7 0 0 0 1001 5.92 6012 47.93 8016 10.82 17000
   25.73 20000 6.9 22000 1.6 82000 1.1 2 1.1115e-2 end
arbm-tape(mylar)  1.0 3 0 0 0 1001 6.83 6012 66.15 8016 27.02 2
   1.7491e-2 end
arbm-moderator  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 3 end
arbm-plex(reg)  1.0 3 0 0 0 1001 7.84 6012 59.93 8016 32.23 4
   1.1773 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 4
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 4
   1.1648e-3 end
arbm-plex(tris)  1.0 8 0 0 1 1001 7.16 6012 52.93 7014 0.16 8016 29.82
   15031 1.02 17000 1.81 35079 4.260 35081 2.840 5 1.2757 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 5
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 5
   1.1648e-3 end
arbm-filler  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 6 0.7 end
' this material is actually moderator adjusted for the volume
' fraction of the void filled between core and reflector.
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 7 2.715  end
solnuo2(no3)2  8 351.18 0.549 1.0 293.0 92234 1.022 92235 93.172
   92236 0.434 92238 5.372  end
ss304  9 1.0 end
end comp
read parm  npg=2000 nub=yes fdn=yes plt=yes    run=yes  end parm
read geom
unit  1
'com='slotted fuel box'
cuboid  10  9.95   0.0    3.75    0.0     14.98  0.0
cuboid  20  10.1   0.0    3.9    -.15     14.98  0.0
cuboid  30  15.13  .15    9.365  -5.615   14.98  0.0
cuboid  40  15.28  0.0    9.515  -5.765   15.13  -.15
cuboid  50  15.305  -.025  9.54  -5.79    15.155  -.175
media  0 1 10
media  2 1  20 -10
media  1  1  30 -20 -10
media  2  1  40 -30 -20 -10
media  0 1  50 -40 -30 -20 -10
boundary  50
unit  2
'com='fuel box 15.28 cm on a side with .15 cm walls .05cm stacking void'
cuboid  10  6p7.49
cuboid  20  6p7.64
cuboid  30  6p7.6650
```

```
media  1 1 10
media  2 1 20 -10
media  0 1  30 -20 -10
boundary  30
unit  3
'com='aluminum weight distribution plate for boxes'
cuboid 10  4p7.665 0.16 0.0
media  7 1 10
boundary  10
unit 4
'com='aluminum weight distribution plate for special box'
cuboid  10  9.80  0.0  3.75  0.0 .16  0.0
cuboid  20  15.33  0.0  9.54  -5.79  .16  0.0
media  0 1 10
media  7 1 20 -10
boundary  20
unit  5
com='solution driver'
cuboid  10  2p7.5  2p14.9  1.863 -7.5
cuboid  20  2p7.5  2p14.9  2p7.5
cuboid  30  2p7.65  2p15.05  2p7.65
cuboid  40  2p7.665  2p15.33  2p7.665
media  8 1 10
media  0 1 20 -10
media  9 1 30 -20 -10
media  0 1 40 -30 -20 -10
boundary  40
unit  9
com='north split table core'
cuboid   10  30.66  0.0  76.65  0.0  77.29  0.0
cuboid   20  30.66 -0.94 77.5 0.0 83.475 0.0
cuboid   30  30.66 -0.94 77.5 0.0 83.475 -16.48
cuboid   40  30.66 -0.94 77.5 0.0 83.475 -17.71
cuboid   50  30.66 -0.94 77.5 0.0 83.475 -25.09
cuboid  60  30.66 -12.544  77.5 0.0  83.475 -25.09
cuboid  70  30.66 -17.744  77.5 0.0  83.475 -25.09
cuboid  80  30.66 -27.544  77.5 0.0  83.475 -25.09
cuboid  90  30.66 -27.544  102.8 -25.3 107.775 -25.09
array  1  10  place 1 1 1    7.665  7.665   7.665
media  0 1 20 -10
media  5 1 30 -20 -10
media  4 1 40 -30 -20 -10
media  5 1 50 -40 -30 -20 -10
media  4  1 60 -50 -40 -30 -20 -10
media  5 1 70 -60 -50 -40 -30 -20 -10
media  4  1 80 -70 -60 -50 -40 -30 -20 -10
media  5  1 90 -80 -70 -60 -50 -40 -30 -20 -10
hole  5    origin  x=22.995  y=46.31  z=38.645
boundary  90
unit 10
com='south split table core'
cuboid  10 45.99  0.0  76.65  0.0  77.29   0.0
cuboid  20  49.4  0.0  77.5  0.0  83.475   0.0
cuboid  30  49.4  0.0  77.5  0.0  83.475   -1.23
cuboid  40  49.4  0.0  77.5  0.0  83.475   -2.46
cuboid  50  49.4  0.0  77.5  0.0  83.475   -3.69
cuboid  60  49.4  0.0  77.5  0.0  83.475   -4.92
cuboid  70  49.4  0.0  77.5  0.0  83.475   -6.15
cuboid  80  49.4  0.0  77.5  0.0  83.475   -7.38
cuboid  90  74.5  0.0  102.8  -25.3  107.775  -25.09
array  2 10  place 1 1 1 7.665  7.665  7.665
media  0 1 20 -10   -
media  5 1 30 -20 -10  -
```

```
media  5 1 40 -30 -20 -10  -
media  4 1 50 -40 -30 -20 -10  -
media  4 1 60 -50 -40 -30 -20 -10
media  5 1 70 -60 -50 -40 -30 -20 -10
media  4 1 80 -70 -60 -50 -40 -30 -20 -10
media  5 1 90 -80 -70 -60 -50 -40 -30 -20 -10
hole 13     origin x=0.0  y=36.425  z=-25.09
hole 14    origin x=0.0  y=36.425  z=83.475
hole  5    origin  x=7.665  y=46.31  z=38.645
boundary 90
unit 11
com='air gap'
cuboid  10 -6.818  -7.619  64.475  -63.625  69.13  -63.735
media  0 1 10
boundary 10
global unit 12
com='total'
cuboid  10  133.505  0.0  128.1  0.0  132.865  0.0
array  3 10    place 1 1 1       27.544    25.3   25.09
boundary 10
unit  13
'com='bottom hole'
cuboid  10  9.95   0.0    3.75    0.0     25.09  0.0
media  0 1 10
boundary 10
unit  14
'com='top hole'
cuboid  10  9.95   0.0    3.75    0.0     24.3  0.0
media  0 1 10
boundary 10
end geometry
read array
ara=1  nux=2 nuy=5 nuz=9
com='north split table core'
fill  10r2
      10r3
      10r2
      10r3
      10r2
      10r3
      10r2
      10r3
      10r2   end fill
ara=2  nux=3 nuy=5 nuz=9
com='south split table core'
fill  6r2 2 8r2
      6r3 3 8r3
      6r2 2 8r2
      6r3 3 8r3
      6r2 2 8r2
      6r3 3 8r3
      6r2 1 8r2
      6r3 4 8r3
      6r2 1 8r2  end fill
ara=3 nux=3 nuy=1  nuz=1
com='total'
fill 9 11 10  end fill
end array
read plot   scr=yes
ttl='xy slice '
xul=0.0  yul=128.1  zul=63.0
xlr=133.505 ylr=0.0  zlr=63.0
uax=1  vdn=-1 nax=640  nch='012345678'end
```

```
ttl='xz slice of sphere cuboid'
xul=0.0 yul=64.05 zul=132.865
xlr=133.505 ylr=64.05 zlr=0.0
uax=1  wdn=-1 nax=640  nch='012345678'
end plot
' read start  nst=6 tfx=65 tfy=63.625 tfz=63.735 lnu=300  end start
 read start  nst=1 xsm=56.981 xsp=71.649 ysm=56.219 ysp=70.959
  zsm=56.401 zsp=71.069   end start
end data
end


=csas26
rocky flats criticals nureg/cr-2500 experiment number ? (27 group model)
' fuel cube 15.28 cm, u(4.46)3o8 @ h/u=2.03, hi enriched sphere driven
238groupndf5  infhommedium
u3o8  1 5.4078e-1 293.0 92234 0.03 92235 4.46 92236 0.08 92238 95.43 end
h2o   1 2.6356e-1 end
arbm-baggie  1.0 3 0 0 0 1001 14.01 6012 84.79 8016 1.20 1 1.9134e-2
   end
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 2 9.5390e-1
   end
arbm-tape(vinyl)  1.0 7 0 0 0 1001 5.92 6012 47.93 8016 10.82 17000
   25.73 20000 6.9 22000 1.6 82000 1.1 2 1.1115e-2 end
arbm-tape(mylar)  1.0 3 0 0 0 1001 6.83 6012 66.15 8016 27.02 2
   1.7491e-2 end
arbm-moderator  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 3 end
arbm-plex(reg)  1.0 3 0 0 0 1001 7.84 6012 59.93 8016 32.23 4
   1.1773 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 4
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 4
   1.1648e-3 end
arbm-plex(tris)  1.0 8 0 0 1 1001 7.16 6012 52.93 7014 0.16 8016 29.82
   15031 1.02 17000 1.81 35079 4.260 35081 2.840 5 1.2757 end
arbm-plex(paper)  1.0 3 0 0 0 1001 6.48 6012 42.17 8016 51.35 5
   3.7534e-3 end
arbm-plex(glue)  1.0 3 0 0 0 1001 11.67 6012 87.13 8016 1.20 5
   1.1648e-3 end
arbm-filler  1.185 3 0 0 0 1001 7.83 6012 59.69 8016 32.48 6 0.7 end
' this material is actually moderator adjusted for the volume
' fraction of the void filled between core and reflector.
arbm-al1100  1.0 3 0 0 1 13027 99.3 26000 0.5 29000 0.2 7 2.715  end
uranium  8 0.9483 293.0 92234 1.0 92235 93.19 92236 0.4 92238  5.41 end
arbm-pj  0.816 2 0 0 0 1001 85.1 6012 14.9 8 0.0089  end
ss304  9 1.0 end
end comp
read parm  npg=2000 nub=yes fdn=yes plt=yes    run=yes  end parm
read geom
unit  1
'com='slotted fuel box'
cuboid  10  9.95   0.0    3.75    0.0     14.98  0.0
cuboid  20  10.1   0.0    3.9    -.15     14.98  0.0
cuboid  30  15.13  .15    9.365  -5.615   14.98  0.0
cuboid  40  15.28  0.0    9.515  -5.765   15.13  -.15
cuboid  50  15.305  -.025  9.54  -5.79    15.155  -.175
media  0 1 10
media  2 1  20 -10
media  1  1  30 -20 -10
media  2  1  40 -30 -20 -10
media  0 1  50 -40 -30 -20 -10
boundary  50
```

```
unit  2
'com='fuel box 15.28 cm on a side with .15 cm walls .05cm stacking void'
cuboid  10  6p7.49
cuboid  20  6p7.64
cuboid  30  6p7.6650
media  1 1 10
media  2 1 20 -10
media  0 1  30 -20 -10
boundary  30
unit  3
'com='aluminum weight distribution plate for boxes'
cuboid 10  4p7.665 0.16 0.0
media  7 1 10
boundary  10
unit 4
'com='aluminum weight distribution plate for special box'
cuboid  10  9.80  0.0  3.75  0.0 .16  0.0
cuboid  20  15.33  0.0  9.54  -5.79  .16  0.0
media  0 1 10
media  7 1 20 -10
boundary  20
unit  5
cylinder    10  .3175  2p5.675
sphere   15  2.34
sphere    20  5.67
cylinder  30  1.56  2.2 0.0          origin  z= -7.6649
cuboid    40  8.512 -6.818   2p7.665   2p7.665
media  9 1 10
media  0 1 15 -10
media  8 1 20 -15 -10
media  9 1 30 -20 -10 -15
media  0 1 40 -10  -20 -30
boundary  40
unit  9
com='north split table core'
cuboid   10  30.66  0.0  76.65  0.0  77.29  0.0
cuboid   20  30.66 -0.94 77.5 0.0 83.475 0.0
cuboid   30  30.66 -0.94 77.5 0.0 83.475 -16.48
cuboid   40  30.66 -0.94 77.5 0.0 83.475 -17.71
cuboid   50  30.66 -0.94 77.5 0.0 83.475 -25.09
cuboid  60  30.66 -12.544  77.5 0.0  83.475 -25.09
cuboid  70  30.66 -17.744  77.5 0.0  83.475 -25.09
cuboid  80  30.66 -27.544  77.5 0.0  83.475 -25.09
cuboid  90  30.66 -27.544  102.8 -25.3 107.775 -25.09
array  1  10  place 1 1 1    7.665  7.665   7.665
media  0 1 20 -10
media  5 1 30 -20 -10
media  4 1 40 -30 -20 -10
media  5 1 50 -40 -30 -20 -10
media  4  1 60 -50 -40 -30 -20 -10
media  5 1 70 -60 -50 -40 -30 -20 -10
media  4  1 80 -70 -60 -50 -40 -30 -20 -10
media  5  1 90 -80 -70 -60 -50 -40 -30 -20 -10
boundary  90
unit 10
com='south split table core'
cuboid  10 45.99  0.0  76.65  0.0  77.29   0.0
cuboid  20  49.4  0.0  77.5  0.0  83.475   0.0
cuboid  30  49.4  0.0  77.5  0.0  83.475   -1.23
cuboid  40  49.4  0.0  77.5  0.0  83.475   -2.46
cuboid  50  49.4  0.0  77.5  0.0  83.475   -3.69
cuboid  60  49.4  0.0  77.5  0.0  83.475   -4.92
cuboid  70  49.4  0.0  77.5  0.0  83.475   -6.15
```

```
cuboid  80  49.4  0.0  77.5  0.0  83.475   -7.38
cuboid  90  74.5  0.0  102.8  -25.3  107.775  -25.09
array  2 10 place 1 1 1 7.665  7.665  7.665
media  0 1 20 -10
media  5 1 30 -20 -10
media  5 1 40 -30 -20 -10
media  4 1 50 -40 -30 -20 -10
media  4 1 60 -50 -40 -30 -20 -10
media  5 1 70 -60 -50 -40 -30 -20 -10
media  4 1 80 -70 -60 -50 -40 -30 -20 -10
media  5 1 90 -80 -70 -60 -50 -40 -30 -20 -10
hole 13     origin x=0.0  y=36.425  z=-25.09
hole 14    origin x=0.0  y=36.425  z=83.475
boundary 90
unit 11
com='air gap'
cuboid  10 -6.818  -7.619  64.475  -63.625  69.13  -63.735
media  0 1 10
boundary 10
global unit 12
com='total'
cuboid  10  133.505  0.0  128.1  0.0  132.865  0.0
array  3 10    place 1 1 1       27.544    25.3   25.09
boundary 10
unit  13
'com='bottom hole'
cuboid  10  9.95   0.0    3.75    0.0     25.09  0.0
media  0 1 10
boundary 10
unit  14
'com='top hole'
cuboid  10  9.95   0.0    3.75    0.0     24.3  0.0
media  0 1 10
boundary 10
end geometry
read array
ara=1  nux=2 nuy=5 nuz=9
com='north split table core'
fill  10r2
      10r3
      10r2
      10r3
      10r2
      10r3
      10r2
      10r3
      10r2   end fill
ara=2  nux=3 nuy=5 nuz=9
com='south split table core'
fill  6r2 1 8r2
      6r3 4 8r3
      6r2 1 8r2
      6r3 4 8r3
      6r2 5 8r2
      6r3 4 8r3
      6r2 1 8r2
      6r3 4 8r3
      6r2 1 8r2  end fill
ara=3 nux=3 nuy=1  nuz=1
com='total'
fill 9 11 10  end fill
end array
```

```
read plot   scr=yes
ttl='xy slice '
xul=0.0  yul=128.1  zul=125.0
xlr=133.505 ylr=0.0  zlr=125.0
uax=1  vdn=-1 nax=640  nch='012345678'end
ttl='xz slice of sphere cuboid'
xul=0.0 yul=64.05 zul=132.865
xlr=133.505 ylr=64.05 zlr=0.0
uax=1  wdn=-1 nax=640  nch='012345678'
end plot
' read start  nst=6 tfx=65 tfy=63.625 tfz=63.735 lnu=300  end start
 read start  nst=1 xsm=56.981 xsp=71.649 ysm=56.219 ysp=70.959
  zsm=56.401 zsp=71.069   end start
end data
end


=csas26
british handbook of criticality safety u(1.42)f4 & paraffin (case 04)
238groupndf5  infhommedium
uf4      1 0.4903 293 92235 1.4023 92238 98.5977 end
' note: the enrichment given in the refrence is not weight percent
para(h2o) 1 0.4572 end
end comp
read parm   npg=2000 nub=yes fdn=yes end parm
read geom
global unit 1
cuboid  10 2p46.55 2p46.50 2p61.9
media  1 1 10
boundary 10
end geom
end data
end


=csas26
british handbook of criticality safety u(1.42)f4 & paraffin (case 05)
238groupndf5  infhommedium
uf4      1 0.4903 293 92235 1.4023 92238 98.5977 end
' note: the enrichment given in the refrence is not weight percent
para(h2o) 1 0.4572 end
end comp
read parm   npg=2000 nub=yes fdn=yes end parm
read geom
global
unit 1
cuboid  10 2p50.00 2p49.95 2p51.55
media  1 1 10
boundary 10
end geom
end data
end


=csas26
british handbook of criticality safety u(1.42)f4 & paraffin (case 06)
238groupndf5  infhommedium
uf4      1 0.4903 293 92235 1.4023 92238 98.5977 end
' note: the enrichment given in the refrence is not weight percent
para(h2o) 1 0.4572 end
end comp
read parm   npg=5000 nub=yes fdn=yes end parm
read geom
```

```
global
unit  1
cuboid  10 2p65.35 2p65.3 2p37.1
media  1 1 10
boundary  10
end geom
end data
end


=csas26
raffety and milhalczo u(2)f4-1 reflected (case 11)
238groupndf5  infhommedium
u-235  1 0 1.5811e-4 end
u-238  1 0 7.6467e-3 end
h      1 0 3.0864e-2 end
c      1 0 1.4839e-2 end
f      1 0 3.1219e-2 end
para(h2o)  2 1.0 end
plexiglass  3 0.918 end
al          3 0.062 end
end comp
read parm  run=yes    npg=2000 nub=yes fdn=yes   end parm
read geom
unit  1
cuboid  10 4p28.110 2p56.44
cuboid   20  4p43.35   71.68  -56.44
media  1 1 10
media  2 2 20 -10
boundary 20
unit  2
cuboid  10  4p28.110 2p0.0001
cuboid  20   4p43.35   0.0001  -15.24
media  3  1  10
media  3  2  20 -10
boundary 20
global unit  3
cuboid  10  4p43.35  128.1201  -15.24
array   1 10  place 1 1 1    0.0 0.0 0.0
boundary  10
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 11 showing biasing regions'
xul=-40  yul=20  zul=130
xlr=40  ylr=20  zlr=-15
uax=1  wdn=-1 nax=130  nch='0123456'
end plot
end data
end



=csas26
raffety and milhalczo u(2)f4-1 unreflected (case 12)
238groupndf5 infhommedium
u-235  1 0 1.5811e-4 end
u-238  1 0 7.6467e-3 end
h      1 0 3.0864e-2 end
c      1 0 1.4839e-2 end
```

```
f      1 0 3.1219e-2 end
end comp
read parm   npg=2000 nub=yes fdn=yes end parm
read geom
global unit 1
cuboid  10  35.735 -35.735 35.735 -35.735 47.07 -47.07
media  1 1 10
boundary 10
end geom
end data
end


=csas26
raffety and milhalczo u(2)f4-2 unreflected (case 14)
238groupndf5  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
read parm   npg=2000 nub=yes fdn=yes end parm
read geom
global unit 1
cuboid  10 28.11 -28.11 28.11 -28.11 61.235 -61.235
media 1 1 10
boundary  10
end geom
end data
end


=csas26
raffety and malhalczo u(2)f4-3 reflected (case 15)
238groupndf5  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
read parm  run=yes    npg=2000 nub=yes fdn=yes end parm
read geom
unit  1
cuboid  10 4p26.835 2p27.145
cuboid  20  4p42.075   42.385  -27.145
media  1 1 10
media  2 1 20 -10
boundary  20
unit  2
cuboid  10 4p42.075  0.0  -15.25
media  3 1 10
boundary 10
global
unit 3
cuboid  10  4p42.075  69.53  -15.25
array 1  10  place 1 1 1  3*0.0
boundary 10
end geom
```

```
read array
nux=1  nuy=1  nuz=2
fill  2 1 end fill
end array
end data
end


=csas26
raffety and milhalczo u(2)f4-4 reflected (case 16)
238groupndf5  infhommedium
u-235  1 0 0.9924e-4 end
u-238  1 0 4.7998e-3 end
h      1 0 4.9212e-2 end
c      1 0 2.3660e-2 end
f      1 0 1.9596e-2 end
para(h2o)  2 1.0 end
plexiglass  3 0.918 end
al          3 0.062 end
end comp
read parm  run=yes  npg=2000 nub=yes fdn=yes end parm
read geom
unit  1
cuboid  10  4p23.000 2p48.285
cuboid  20  38.24  -38.24  38.24  -38.24  63.525  -48.285
media  1 1 10
media  2 1 20 -10
boundary  20
unit  2
cuboid  10 4p38.24 0.0  -15.24
media  3 1 10
boundary  10
global unit  3
cuboid  10 4p38.24   111.81  -15.24
array  1 10 place 1 1 1 3*0.0
boundary  10
end geom
read array
nux=1  nuy=1  nuz=2
fill  2 1 end fill
end array
end data
end


=csas26
raffety and milhalczo u(2)f4-6 reflected (case 19)
238groupndf5  infhommedium
u-235  1 0 0.6232e-4 end
u-238  1 0 3.0100e-3 end
h      1 0 6.0557e-2 end
c      1 0 2.9114e-2 end
f      1 0 1.2309e-2 end
poly(h2o) 2 1.0 end
plexiglass  3 0.918 end
al          3 0.062 end
end comp
read parm  run=yes   npg=2000 nub=yes fdn=yes end parm
read geom
unit  1
cuboid  10  2p38.255 2p38.220 2p41.210
cuboid  20  2p53.495  2p53.46  56.45  -41.21
media  1 1 10
```

```
media  2 2 20 -10
boundary 20
unit  2
cuboid  10 2p38.255 2p38.220 2p0.0001
cuboid  20  2p53.495  2p53.46  .0001 -15.24
media  3 1 10
media  3 2 20 -10
boundary  20
global  unit 3
cuboid  10  2p53.495  2p53.46 97.6601  -15.24
array  1 10  place 1 1 1    0.0 0.0 0.0
boundary  10
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


=csas26
raffety and milhalczo u(2)f4-6 unreflected (case 20)
238groupndf5 infhommedium
u-235  1 0 0.6232e-4 end
u-238  1 0 3.0100e-3 end
h      1 0 6.0557e-2 end
c      1 0 2.9114e-2 end
f      1 0 1.2309e-2 end
end comp
read parm   npg=2000 nub=yes fdn=yes end parm
read geom
global unit 1
cuboid 10  40.725 -40.725 43.35 -43.35 44.110 -44.110
media  1 1 10
boundary 10
end geom
end data
end


=csas26
raffety and milhalczo u(3)f4-1 reflected (case 22)
238groupndf5  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
read parm  run=yes   npg=2000 nub=yes fdn=yes end parm
read geom
unit  1
cuboid  10 2p21.735 2p21.735 2p43.1950
cuboid  20  4p36.975  58.435  -43.195
media  1 1 10
media  2 1 20 -10
boundary  20
```

```
unit  2
cuboid  10 4p36.975  .0001  -15.24
media  3 1 10
boundary  10
global  unit  3
cuboid 10  4p36.975    101.6301 -15.24
array   1 10  place  1 1 1   3*0.0
boundary  10
end geom
read array
nux=1  nuy=1  nuz=2
fill  2 1 end fill
end array
end data
end


=csas26
raffety and milhalczo u(3)f4-1 reflected (case 24) no biasing
238groupndf5  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
read parm  run=yes   npg=2000 nub=yes fdn=yes end parm
read geom
unit  1
cuboid  10 2p28.125 2p28.125 2p21.705
cuboid  20    4p43.365 36.945  -21.705
media  1 1 10
media  2 2 20 -10
boundary 20
unit  2
cuboid  10 2p28.125 2p28.125 2p0.0001
cuboid  20   4p43.365  .0001 -15.24
media  3 1 10
media  3 2 20 -10
boundary 20
global unit 3
cuboid  10  4p43.365  58.6501 -15.24
array  1  10  place 1 1 1  0.0 0.0 0.0
boundary  10
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


=csas26
raffety and milhalczo u(3)f4-1 unreflected (case 26)
238groupndf5 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
read parm   npg=2000 nub=yes fdn=yes end parm
read geom
global  uni 1
cuboid  10 28.235 -28.235 28.235 -28.235 43.32 -43.32
media  1  1  10
boundary  10
end geom
end data
end


=csas26
raffety and milhalczo u(3)f4-1 unreflected (case 28)
238groupndf5  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
read geom
global  unit  1
cuboid  10  30.7 -30.7 30.7 -30.7 33.00 -33.00
media  1 1 10
boundary  10
end geom
end data
end


=csas26
raffety and milhalczo u(3)f4-2 unreflected (case 30)
238groupndf5 infhommedium
u-235  1 0 1.6709e-4 end
u-238  1 0 5.3355e-3 end
h      1 0 4.6262e-2 end
c      1 0 2.2241e-2 end
f      1 0 2.2011e-2 end
end comp
read parm  run=yes   npg=2000 nub=yes fdn=yes end parm
read geom
global  unit  1
cuboid  10  2p20.450 2p20.465 2p58.400
media  1 1 10
boundary 10
end geom
end data
end


=csas26
critical reflected cylinder of aqueous u(4.98)o2f2 (case 33)
238groupndf5  infhommedium
solnuo2f2  1 910.36 0.0 1 298 92235 4.98 92238 95.02 end
ss304  2 1.0 end
h2o    3 1.0 end
cd     4 1.0 end
end comp
read parm  run=yes   npg=5000 nub=yes fdn=yes    end parm
read geom
```

```
global unit  1
cylinder  10 19.545 2p27.225
cylinder  20 19.545 78.975 -27.225
cylinder  30 19.624 79.054 -27.304
cylinder  40 19.705 79.054 -27.304
cylinder  50 22.245 79.054 -27.304
cylinder  60 45.000 79.054 -27.304
media  1 1 10
media  0 1 20 -10
media  2 1  30 -20  -10
media  4 1 40 -30
media  2  1 50 -40 -30
media  3  1 60 -50 -40 -30
boundary  60
end geom
read plot ttl='xz slice of cylinder case 33'
xul=-45 yul=0.0 zul=81
xlr=45  ylr=0.0 zlr=-29
uax=1  wdn=-1  nax=130  nch='01234'end
ttl='enlargement of lower right hand corner of cylinder'
xul=18  yul=0.0 zul=-25
xlr=23  ylr=0.0 zlr=-28
uax=1  wdn=-1  nax=130  nch='01234'
end plot
end data
end
```

```
=csas26
critical cylinder of aqueous u(4.98)o2f2 (case 36)
238groupndf5 infhommedium
solnuo2f2  1 910.36 0.0 1 298 92235 4.98 92238 95.02 end
ss304  2 1.0 end
end comp
read parm  run=yes   npg=2000 nub=yes fdn=yes end parm
read geom
global unit  1
cylinder  10 19.5500 2p50.85
cylinder  20 19.5500 74.16 -50.85
cylinder  30 19.6287 74.16 -50.9287
media  1 1 10
media   0 1  20 -10
media   2  1 30 -20 -10
boundary  30
end geom
read plot ttl='xz slice of cylinder case 36'
xul=-21  yul=0.0 zul=76
xlr=21   ylr=0.0 zlr=-52
uax=1  wdn=-1  nax=130  nch='012'end
ttl='enlargement of lower right corner of cylinder'
xul=18  yul=0.0 zul=-49
xlr=21  ylr=0.0 zlr=-52
uax=1  wdn=-1  nax=130  nch='012'
end plot
end data
end
```

Table B.4. Table 4 input data

```
=csas26
uo2f2 soln h/u-235=1112 bare sphere case 1
238groupndf5  multiregion
u-234  1 0 7.360-7 end
u-235  1 0 5.990-5 end
u-238  1 0 3.592-6 end
h      1 0 6.661-2 end
o      1 0 3.343-2 end
f      1 0 1.285-4 end
al     2 1 end
end comp
spherical end
1 27.9 noextermod  2 28.10 noextermod  end zone
read param npg=3000  nub=yes fdn=yes end param
read geom
global  unit  1
sphere  10 27.9
sphere  20 28.1
media  1 1 10
media  2 1 20 -10
boundary  20
end geom
end data
end


=csas26
uo2f2 soln h/u-235=76.1 h2o refl sphere case 4
238groupndf5 multiregion
u-234  1 0 8.795-6 end
u-235  1 0 8.327-4 end
u-236  1 0 4.449-6 end
u-238  1 0 4.729-5 end
h      1 0 6.337-2 end
o      1 0 3.347-2 end
f      1 0 1.786-3 end
al     2 1 end
h2o    3 1 end
end comp
spherical end
1 11.5 oneextermod  2 11.66 noextermod  3 29.66 noextermod end zone
read param npg=3000  nub=yes fdn=yes end param
read geom
global
unit 1
sphere  10  11.5
sphere  20  11.66
sphere  30  29.66
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20
boundary  30
end geom
end data
end
```

```
=csas26
uo2f2 soln h/u-235=268.8 h2o refl sphere case 7
238groupndf5 multiregion
u-235  1 0 2.438-4 300 end
u-238  1 0 1.756-5 300 end
h      1 0 6.553-2 300 end
o      1 0 3.329-2 300 end
f      1 0 5.227-4 300 end
al     2 1 300 end
h2o    3 1 300 end
end comp
spherical end
1 13.2 oneextermod  2 13.33 noextermod  3 31.33 noextermod end zone
read param npg=3000  nub=yes fdn=yes end param
read geom
global
unit 1
sphere  10  13.2
sphere  20  13.33
sphere  30  31.33
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20
boundary  30
end geom
end data
end


=csas26
uo2f2 soln h/u-235=239.3 h2o refl sphere case 10
238groupndf5 multiregion
u-235  1 0 2.735-4 359 end
u-238  1 0 1.970-5 359 end
h      1 0 6.545-2 359 end
o      1 0 3.331-2 359 end
f      1 0 5.864-4 359 end
al     2 1 359 end
h2o    3 1 359 end
end comp
spherical end
1 13.2 oneextermod  2 13.33 noextermod  3 31.33 noextermod end zone
read param npg=3000  nub=yes fdn=yes end param
read geom
global
unit  1
sphere  10  13.2
sphere  20  13.33
sphere  30  31.33
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20
boundary  30
end geom
end data
end


=csas26
rocky flats uo2(no3)2 soln 357.71 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 357.71 0.549 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
read param npg=3000  nub=yes fdn=yes end param
read geom
global
unit 1
cylinder  10 14.005 30.91 0
cylinder  20 14.325 30.91 -.32
media  1 1 10
media  2 1 20 -10
boundary  20
end geom
end data
end


=csas26
rocky flats uo2(no3)2 soln 357.71 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 357.71 .549 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
end comp
cylindrical end
1 16.5 noextermod  2 16.8 noextermod end zone
read param npg=3000  nub=yes fdn=yes end param
read geom
global
unit  1
cylinder  10 16.505 22.53 0
cylinder  20 16.825 22.53 -.32
media  1 1 10
media  2 1 20 -10
boundary  20
end geom
end data
end


=csas26
rocky flats uo2(no3)2 soln 334.77 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 334.77 .521 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
rfconcrete  3 1 end
end comp
cylindrical end
1 14 noextermod  2 14.3 noextermod end zone
read param npg=3000  nub=yes fdn=yes end param
read geom
global
unit  1
cylinder  10 14.005 28.60 0
cylinder  20 14.325 28.60 -.32
cuboid    30  64.6 -57.2 57.4 -64.8 80.8 -41.1
cuboid    40  90.3  -82.9  83.1  -90.5  80.8  -41.1
cuboid    50  90.3  -82.9  83.1  -90.5  81.7  -42.0
cuboid  60  90.3  -82.9  83.1  -90.5  107.4  -67.7
media  1 1 10
media  2 1 20 -10
```

```
media  0 1 30 -20
media  3 1 40 -30
media  0 1 50 -40
media  3 1  60 -50
boundary 60
end geom
end data
end


=csas26
rocky flats uo2(no3)2 soln 334.77 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 334.77 .521 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
rfconcrete  3 1 end
end comp
cylindrical end
1 16.5 noextermod  2 16.8 noextermod end zone
read param npg=3000  nub=yes fdn=yes end param
read geom
global
unit  1
cylinder  10 16.505 16.78 0
cylinder  20  16.825 16.78 -.32
cuboid    30  104.55 -17.25 16.825 -105.375 121.58 -.32
cuboid    40  130.25 -42.95  42.525  -131.07  121.58  -.32
cuboid   50  130.25  -42.95  42.525  -131.07  122.48  -1.22
cuboid  60  130.25  -42.95  42.525  -131.07  148.18  -26.92
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
media  3 1 40 -30
media  0 1 50 -40
media  3 1 60 -50
boundary  60
end geom
end data
end


=csas26
rocky flats uo2(no3)2 soln 147.66 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 147.66 .271 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
plexiglass  3 1 end
h    4 0 5.5169-2 end
c    4 0 3.3967-2 end
o    4 0 1.4231-2 end
p    4 0 3.8500-4 end
cl   4 0 3.5610-4 end
br-79  4 0 3.184-4 end
br-81  4 0 3.116-4 end
end comp
cylindrical end
1 16.5 noextermod  2 16.8 noextermod end zone
read param npg=3000  nub=yes fdn=yes end param
read geom
global
```

```
unit  1
cylinder  10 16.505 22.78 0
cylinder  20  16.825 22.78 -.32
cuboid    30  61.2 -61.7 60.4 -62.5 81.1 -41.8
cuboid  40  81.997  -82.497  81.197  -83.297 81.1  -41.8
cuboid  50  81.997  -82.497  81.197  -83.297  101.30  -62.597
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
media  3  1 40 -30
media  4 1 50 -40
boundary  50
end geom
end data
end


=csas26
rocky flats uo2(no3)2 soln 345.33 g u/l
238groupndf5  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 0 5.5169-2 end
c    4 0 3.3967-2 end
o    4 0 1.4231-2 end
p    4 0 3.8500-4 end
cl   4 0 3.5610-4 end
br-79  4 0 3.184-4 end
br-81  4 0 3.116-4 end
end comp
cylindrical end
1 16.5 noextermod  2 16.8 noextermod end zone
read param npg=3000  nub=yes fdn=yes end param
read geom
global
unit  1
cylinder  10 16.505 17.2 0
cylinder  20 16.825 17.2 -.32
cuboid    30 105.2 -17.7 17.3 -105.6 122.58 -.32
cuboid  40  126.0  -38.497  38.097  -126.40  233.58  -.32
cuboid  50   126.0  -38.497  38.097  -126.40  142.78  -21.117
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
media  3 1 40 -30
media  4 1 50 -40
boundary  50
end geom
end data
end


=csas26
rocky flats uo2(no3)2 soln 364.11 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 364.11 .584 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
rfconcrete  3 1 end
end comp
cylindrical end
```

```
1 10.5 noextermod  2 10.9 noextermod end zone
read param npg=3000  nub=yes fdn=yes end param
read geom
unit  1
cylinder  10 10.56 17.13 0
cylinder  20  10.96 17.13 -.32
cuboid    30  4p15.24 121.58 -.32
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary  30
global
unit  2
cuboid  10  4p60.96  121.58  -.32
cuboid  20  4p86.66  121.58  -.32
cuboid  30  4p86.66  122.83 -1.57
cuboid  40  4p86.66  148.53  -27.27
array   1 10 place 1 1 1  -45.72  -45.72  0.0
media  3 1 20 -10
media  0 1 30 -20 -10
media  3 1 40 -30 -20 -10
boundary  40
end geom
read array nux=4 nuy=4 nuz=1 fill f1 end fill end array
end data
end


=csas26
rocky flats uo2(no3)2 soln 359.55 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 359.55 .578 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
rfconcrete  3 1 end
end comp
cylindrical end
1 8 noextermod  2 8.3 noextermod end zone
read param npg=3000  nub=yes fdn=yes end param
read geom
unit 1
cylinder  10 8.06 31.82 0
cylinder  20 8.38 31.82 -.32
cuboid    30 4p15.24 121.58 -.32
media 1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary  30
global
unit 2
cuboid  10 4p60.96  121.58  -.32
cuboid  20  4p86.66  121.58  -.32
cuboid  30 4p86.66 122.83  -1.57
cuboid  40 4p86.66  148.53  -27.27
array  1 10  place  1 1 1  -45.72  -45.72  0.0
media  3 1 20 -10
media  0 1 30 -20
media  3 1 40 -30 -20
boundary  40
end geom
read array nux=4 nuy=4 nuz=1 fill f1 end fill end array
end data
end
```

```
=csas26
rocky flats uo2(no3)2 soln 364.11 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 364.11 .584 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
rfconcrete  3 1 end
end comp
cylindrical end
1 10.5 noextermod  2 10.9 noextermod end zone
read param npg=3000  nub=yes fdn=yes end param
read geom
unit 1
cylinder  10 10.56 31.11 0
cylinder  20 10.96 31.11 -.32
cuboid    30 4p15.24 121.58 -.32
media 1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary  30
unit 2
cuboid    10 4p15.24 121.58 -.32
media  0 1 10
boundary  10
global
unit  3
cuboid   10 4p60.96  121.58  -.32
cuboid  20  4p86.66 121.58  -.32
cuboid  30  4p86.66  122.83  -1.57
cuboid  40  4p86.66  248.53  -27.27
array  1 10  place 1 1 1 -45.72  -45.72  0.0
media  3 1 20 -10
media  0 1 30 -20
media  3 1 40 -30 -20
boundary  40
end geom
read array nux=4 nuy=4 nuz=1
fill 5r2 2r1 2r2 2r1 5r2 end fill
end array
end data
end


=csas26
rocky flats uo2(no3)2 soln 359.55 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 359.55 .578 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
rfconcrete  3 1 end
end comp
cylindrical end
1 8 noextermod  2 8.3 noextermod end zone
read param npg=3000  nub=yes fdn=yes end param
read geom
unit 1
cylinder  10 8.06 51.45 0
cylinder  20 8.38 51.45 -.32
cuboid    30 4p15.24 121.58 -.32
media  1 1 10
media  2 1 20 -10
```

```
media  0 1 30 -20 -10
boundary  30
unit 2
cuboid    10 4p15.24 121.58 -.32
media  0 1 10
boundary  10
global
unit  3
cuboid   10 4p60.96  121.58  -.32
cuboid  20  4p86.66 121.58  -.32
cuboid  30  4p86.66  122.83  -1.57
cuboid  40  4p86.66  248.53  -27.27
array  1 10  place 1 1 1 -45.72  -45.72  0.0
media  3 1 20 -10
media  0 1 30 -20
media  3 1 40 -30 -20
boundary  40
end geom
read array nux=4 nuy=4 nuz=1
fill 2r1 2r2 3q4 end fill
end array
end data
end


=csas26
rocky flats uo2(no3)2 soln 355.94 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 355.94 .494 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
plexiglass  3 1 end
h    4 0 5.5169-2 end
c    4 0 3.3967-2 end
o    4 0 1.4231-2 end
p    4 0 3.8500-4 end
cl   4 0 3.5610-4 end
br-79  4 0 3.184-4 end
br-81  4 0 3.116-4 end
end comp
cylindrical end
1 10.5 noextermod  2 10.9 noextermod end zone
read param npg=3000  nub=yes fdn=yes end param
read geom
unit 1
cylinder  10 10.56 18.82 0
cylinder  20 10.96 18.82 -.32
cuboid    30 4p15.24 122.58 -.32
media  1 1 10
media  2 1 20 -10
media  0  1 30 -20
boundary  30
global
unit 2
cuboid  10  4p60.96  122.58  -.32
cuboid  20  4p61.45  122.58  -.32
cuboid  30  4p82.247  122.58  -.32
cuboid  40  4p82.247  142.78  -21.117
array  1 10  place 1 1 1  -45.72  -45.72  0.0
media  0 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20
boundary  40
```

```
end geom
read array nux=4 nuy=4 nuz=1 fill f1 end fill
end array
end data
end


=csas26
rocky flats uo2(no3)2 soln 355.94 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 355.94 .494 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
plexiglass  3 1 end
h    4 0 5.5169-2 end
c    4 0 3.3967-2 end
o    4 0 1.4231-2 end
p    4 0 3.8500-4 end
cl   4 0 3.5610-4 end
br-79  4 0 3.184-4 end
br-81  4 0 3.116-4 end
end comp
cylindrical end
1 8 noextermod  2 8.3 noextermod end zone
read param npg=3000  nub=yes fdn=yes end param
read geom
unit  1
cylinder  10 8.06 35.56 0
cylinder  20 8.38 35.56 -.32
cuboid    30 4p15.24 122.58 -.32
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary  30
global
unit  2
cuboid  10  4p60.96  122.58  -.32
cuboid  20  4p61.45  122.58  -.32
cuboid  30  4p82.247  122.58  -.32
cuboid  40  4p82.247  142.78  -21.117
array  1 10  place 1 1 1  -45.72 -45.72  0.0
media  0 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30
boundary  40
end geom
read array nux=4 nuy=4 nuz=1 fill f1 end fill
end array
end data
end


=csas26
rocky flats uo2(no3)2 soln 355.94 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 355.94 .494 1 293 92234 1.022 92235 93.172 92236 .434
92238 5.372 end
al     2 1 end
plexiglass  3 1 end
h    4 0 5.5169-2 end
c    4 0 3.3967-2 end
o    4 0 1.4231-2 end
p    4 0 3.8500-4 end
```

```
cl   4 0 3.5610-4 end
br-79  4 0 3.184-4 end
br-81  4 0 3.116-4 end
end comp
cylindrical end
1 10.5 noextermod  2 10.9 noextermod end zone
read param npg=3000  nub=yes fdn=yes end param
read geom
unit 1
cylinder  10 10.56 33.20 0
cylinder  20 10.96 33.20 -.32
cuboid    30 4p15.24 122.58 -.32
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary  30
unit 2
cuboid    10 4p15.24 122.58 -.32
media  0 1 10
boundary  10
global
unit  3
cuboid  10  4p60.96  122.58  -.32
cuboid  20  4p61.45  122.58  -.32
cuboid  30  4p82.247   122.58  -.32
cuboid  40  4p82.247  142.78  -21.117
array  1 10  place 1 1 1 -45.72 -45.72  0.0
media  0 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20
boundary  40
end geom
read array nux=4 nuy=4 nuz=1
fill 5r2 2r1 2r2 2r1 5r2 end fill
end array
end data
end
```

Table B.5. Table 5 input data

```
=csas26
keno-6 validation case a-1
238groupndf5  multiregion
uranium  1 .9837 293 92235 93.8 92238 6.2 end
end comp
spherical  end
1 8.73136 noextermod end zone
read param     npg=5000 fdn=yes nub=yes end param
read geom
global unit 1
sphere    10 8.73136
media 1 1 10
boundary  10
end geom
end data
end


=csas26
keno-6 validation case a-3
238groupndf5  multiregion
solnuo2f2  1 19.992 0 1 293 92235 93.2 92238 6.8 end
al         2 end
end comp
spherical  end
1 34.6 oneextermod  2 34.92 noextermod end zone
read param   npg=3000 fdn=yes nub=yes end param
read geom
global
unit  1
sphere    10 34.6
sphere    20 34.92
cuboid    30 6p35.0
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary  30
end geom
end data
end


=csas26
keno-6 validation case a-5
238groupndf5  multiregion
uranium  1  .9848 283 92235 93.5 92238 6.5 end
h2o      2 end
end comp
spherical  end
1 12.7 oneextermod  2 31. noextermod end zone
read param tme=60   npg=3000 fdn=yes nub=yes end param
read geom
global
unit 1
sphere  10 12.7  chord  +z=0
sphere  20 15.24 chord  +z=0
cuboid     30  31.00 -31.00 31.00 -31.00 31.00 -16.
media  2 1 10
media  1 1 20 -10
media  2 1 30 -20
```

```
boundary  30
end geom
end data
end


=csas26
keno-6 validation case a-7
238groupndf5  multiregion
uranium  1 .9848 293 92235 94 92238 6 end
uranium  2 end
end comp
slab  end
1 7.62 noextermod  2 52.02 noextermod end zone
read param    npg=3000 fdn=yes nub=yes end param
read geom
global
unit 1
cuboid    10 3.81 -3.81 4.445 -4.445 7.62 -7.62
cuboid    20 26.01 -26.01 26.645 -26.645 29.82 -29.82
cuboid    30  6p30.0
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary  30
end geom
end data
end


=csas26
keno-6 validation case a-9
238groupndf5  multiregion
arbmoil   .88 3 0 0 0 6012 86.82 1001 13.16 16000 .02 1 end
uranium   2 .9528 293 92235 93.1 92238 6.9 end
arbmpjel  .024 2 0 0 0 6012 85 1001 15 2 end
carbonsteel 3 end
end comp
spherical  end
2 8.2 oneextermod  1 40.5 noextermod end zone
read param
tme=60  npg=3000 fdn=yes nub=yes end param
read geom
global
unit 1
sphere   10 6.012  chord +z=0
sphere  20 10.488  chord +z=0
sphere     30  6p40.488
media  3 1 10
media  2 1 20 -10
media  1 1 30 -20 -10
boundary  30
end geom
end data
end


=csas26
keno-6 validation case a11
238groupndf5  multiregion
solnuo2(no3)2 1 346.73 .542 1 293 92235 93.172 92238 6.828 end
ss304  2 end
end comp
```

```
cylindrical  end
1 13.96 oneextermod  2 14.28 oneextermod  end zone
read param     npg=5000 fdn=yes nub=yes end param
read geom
global unit 1
cylinder  10 13.96 14.465 -14.465
cylinder  20 13.96 27.135 -14.465
cylinder  30 14.28 27.135 -15.105
media  1 1 10
media  0 1 20 -10
media  2 1 30 -20
boundary  30
end geom
end data
end


=csas26
keno-6 validation case b-5
238groupndf5  multiregion
uranium  1 .9809 293 92235 93.2 92238 6.8 end
end comp
cylindrical  end
1 4.56 noextermod end zone
read param    npg=3000 fdn=yes nub=yes end param
read geom
unit  1
cylinder  10 4.558 2.16 -2.16
cylinder  20 5.747 2.16 -2.16
cylinder  30 5.747 4.851 -4.851
cuboid    40 5.8554 -5.8554 5.8554 -5.8554 4.9771 -4.9771
media  1 1 10
media  0 1 20 -10
media  1 1 30 -20
media  0 1 40 -30
boundary  40
global  unit  2
cuboid  10  4p11.7108  2p9.9542
array  1 10  place 1 1 1  -5.8554  -5.8554  -4.9771
boundary  10
end geom
read array ara=1  nux=2 nuy=2 nuz=2 fill  f1 end fill  end array
end data
end


=csas26
keno-6 validation case b-9
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass  2 1 end
end comp
cylindrical  end
1 9.52 oneextermod  2 10.16 noextermod  end zone
read param    npg=3000 fdn=yes nub=yes end param
read geom
unit  1
cylinder  10 9.52 8.7804 -8.7804
cylinder  20 9.52 8.9896 -8.7804
cylinder  30 10.16 9.6296 -9.4204
cuboid    40 13.4 -13.4 13.4 -13.4 12.8696 -12.6604
media  1 1 10
media  0 1 20 -10
```

```
media  2 1 30 -20
media  0 1 40 -30
boundary  40
global unit  2
cuboid  10  4p40.2  63.9296  -12.6604
array  1 10  place 1 1 1  -26.8  -26.8  0.0
boundary 10
end geom
read array ara=1  nux=3 nuy=3 nuz=3  fill  f1  end fill end array
end data
end


=csas26
keno-6 validation case b-10
238groupndf5  multiregion
solnuo2(no3)2  1 63.3  0 1 293 92235 92.6 92238 7.4 end
plexiglass  2 1 end
end comp
cylindrical  end
1 9.52 oneextermod  2 10.16 noextermod  end zone
read param    npg=3000 fdn=yes nub=yes end param
read geom
unit   1
cylinder  10  9.52 8.7804 -8.7804
cylinder  20  9.52 8.9895 -8.7804
cylinder  30  10.16 9.6295 -9.4204
cuboid    40  11.282 -11.282 11.282 -11.282 10.7179 -11.7179
media  1 1 10
media  0 1 20 -10
media 2  1 30 -20
media  0 1 40 -30
boundary  40
global unit 2
cuboid  10  4p33.846   55.5895  -11.7179
array  1 10  place 1 1 1 -22.564  -22.564  0.0
boundary  10
end geom
read array nux=3 nuy=3 nuz=3 fill f1 end fill end array
end data
end


=csas26
keno-6 validation case b-12
238groupndf5  multiregion
uranium  1 .9829 293 92235 93.2 92238 6.8 end
c        2 .8296 end
poly(h2o)  3 1 end
end comp
cylindrical  end
1 5.747 oneextermod  2 10.92 noextermod end zone
read param tme=60   npg=3000 fdn=yes nub=yes end param
read geom
unit 1
cylinder  10 5.747 3.9699 -4.1071
cylinder  20 5.777 4.1071 -4.1071
cuboid    30 10.9195 -10.9195 10.9195 -10.9195 7.8755 -7.8755
cuboid    40 15.047 -15.047 15.047 -15.047 12.0035 -12.0035
media  1  1 10
media  0 1 20 -10
media  2 1 30 -20
media  0 1 40 -30
```

```
boundary  40
global unit 2
cuboid  10 4p30.094  22p24.007
cuboid   20 4p45.344  2p39.247
array  1 10  place  1 1 1  -15.047  -15.047  -12.0035
media  3 1 20 -10
boundary  20
end geom
read array nux=2 nuy=2 nuz=2 fill f1  end fill end array
end data
end


=csas26
keno-6 validation case b-14
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass  2 1 end
para(h2o)  3 end
end comp
cylindrical  end
1 9.52 oneextermod  2 10.16 noextermod  end zone
read param tme=60   npg=3000 fdn=yes nub=yes end param
read geom
unit  1
cylinder  10 9.52 8.7804 -8.7804
cylinder  20 9.52 8.9896 -8.7804
cylinder  30 10.16 9.6296 -9.4204
cuboid    40 18.425 -18.425 18.425 -18.425 17.8946 -17.6854
media  1 1 10
media  0 1 20 -10
media  2 1 30 -20 -10
media  0 1 40 -30
boundary  40
global  unit 2
cuboid  10  4p55.275   53.4746 -53.1568
cuboid  20  70.515 -70.515 70.515 -70.515 68.61 -68.61
array  1 10 place 1 1 1  -36.85  -36.85  -35.4717
media  3 1 20 -10
boundary  20
end geom
read array nux=3 nuy=3 nuz=3 fill f1 end fill end array
end data
end


=csas26
keno-6 validation case b-16
238groupndf5  multiregion
solnuo2(no3)2 1 450.8 .72 1 293 92235 93.1 92238 6.9 end
ss304         2 end
end comp
cylindrical  end
1 8.128 noextermod  2 8.4074 noextermod  end zone
read param    npg=3000 fdn=yes nub=yes end param
read geom
unit   1
cylinder  10 8.128 68.3006 -68.3006  rotate  a1=90 a2=90
cylinder  20 8.4074 68.58 -68.58     rotate  a1=90 a2=90
cuboid     30 68.58 -68.58 9.2075 -9.2075 14.999 -110.32
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
```

```
boundary  30
unit   2
cylinder  10 8.128 68.3006 -68.3006  rotate a2=90
cylinder  20 8.4074 68.58 -68.58     rotate  a2=90
cuboid     30 9.2075 -9.2075 68.58 -68.58 14.999 -110.32
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary  30
unit   3
cylinder  10 8.128 68.3006 -68.3006  rotate a1=90 a2=90
cylinder  20 8.4074 68.58 -68.58     rotate  a1=90 a2=90
cuboid     30 68.58 -68.58 9.2075 -9.2075 125.09 -14.999
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary  30
unit   4
cylinder  10 8.128 68.3006 -68.3006  rotate  a2=90
cylinder  20 8.4074 68.58 -68.58     rotate  a2=90
cuboid     30 9.2075 -9.2075 68.58 -68.58 125.09 -14.999
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary  30
unit   5
cuboid     10   8.89 -8.89 8.89 -8.89 14.999 -110.00
cuboid     20   9.2075 -9.2075 9.2075 -9.2075 14.999 -110.32
media  1 1 10
media  2 1 20 -10
boundary  20
unit   6
cuboid     10  8.89 -8.89 8.89 -8.89 125.09 -14.999
cuboid     20  9.2075 -9.2075 9.2075 -9.2075 125.09 -14.999
media  1 1 10
media  2 1 20 -10
boundary  20
unit   7
cuboid     10 68.58 -68.58 68.58 -68.58 14.999 -110.32
media  0 1 10
boundary  10
unit   8
cuboid     10 68.58 -68.58 68.58 -68.58 125.09 -14.999
media  0 1 10
boundary  10
global unit  9
cuboid  10  224.155  -68.58  224.155  -68.58  155.088  -110.32
array  1 10  place  1 1 1  0.0 0.0 0.0
boundary  10
end geom
read array nux=3 nuy=3 nuz=2 loop
1  1 3 2 2 2 1 1 1 1  2  2 2 1 1 3 2 1 1 1  3  1 3 2 2 2 1 2 2 1
4  2 2 1 1 3 2 2 2 1  5  2 2 1 2 2 1 1 1 1  6  2 2 1 2 2 1 2 2 1
7  1 3 2 1 3 2 1 1 1  8  1 3 2 1 3 2 2 2 1
end loop end array
end data
end


=csas26
keno-6 validation case b-18
238groupndf5  multiregion
```

```
solnuo2(no3)2 1 364.11 .584 1 293 92235 93.172 92238 6.828 end
arbmal        2.737 9 0 0 1 12000 1 13027 97.35 14000 .6 22000 .03
24000 .17 25055 .07 26000 .47 29000 .25 14000 .06 2 end
arbmconc     2.321 13 0 0 1 1001 .75 6012 5.55 7014 .01 8016 49.29
11023 .42 12000 1.48 13027 2.06 14000 15.7 16000 .17 19000 .75 20000 22.95
22000 .05 26000 .82 3 end
end comp
cylindrical  end
1 10.56 noextermod  2 10.96 noextermod  end zone
read param tme=60   npg=3000 fdn=yes nub=yes end param
read geom
unit  1
cylinder  10 10.56 8.565 -8.565
cylinder  20 10.56 110.535 -8.565
cylinder  30 10.96 110.535 -8.885
cuboid    40 15.25 -15.15 15.25 -15.25 115.515 -8.885
media  1 1 10
media  0 1 20 -10
media  2 1 30 -20 -10
media  0 1 40 -30
boundary  40
unit  2
cylinder  10 10.56 8.565 -8.565
cylinder  20 10.56 110.535 -8.565
cylinder  30 10.96 110.535 -8.885
cuboid    40 15.15 -15.25 15.25 -15.25 115.515 -8.885
media  1 1  10
media  0 1 20 -10
media  2 1 30 -20 -10
media  0 1 40 -30
boundary  40
unit  3
cylinder  10 10.56 8.565 -8.565
cylinder  20 10.56 110.535 -8.565
cylinder  30 10.96 110.535 -8.885
cuboid    40 15.25 -15.25 15.25 -15.25 115.515 -8.885
media  1 1 10
media   0 1 20 -10
media  2 1 30 -20 -10
media  0 1 40 -30
boundary  40
global unit  4
cuboid   10  2p60.90  2p61.0  115.515  -8.885
cuboid   20  2p60.90  2p61.1  115.515  -8.885
cuboid   30  2p86.6   2p86.8  141.215  -34.585
array  1 10  place 1 1 1   -45.75  -45.75  0.0
media  0 1 20 -10
media  3 1 30 -20
boundary  30
end geom
read array nux=4 nuy=4 loop
1  1 1 1 1 4 1 1 1 1   2  4 4 1 1 4 1 1 1 1   3  2 3 1 1 4 1 1 1 1
end loop end array
end data
end
```

```
=csas26
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
```

```
al        2 1 end
h2o       3 1 end
end comp
slab end
1 3.81 oneextermod  2 4.12 noextermod 3 22.12 noextermod end zone
read param    npg=3000 fdn=yes nub=yes end param
read geom
unit 1
cuboid  10  2p3.81 2p60.325 19.13 0
cuboid  20  2p4.128  2p60.643  19.13  -.318
cuboid  30  2p4.128 2p60.643 19.13 -.318
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary  30
unit 2
cuboid      10 2.54 0 2p60.643 19.13 -.318
media  3 1 10
boundary  10
global unit  3
cuboid  10  29.848  0.0  2p60.643  19.13  -.318
cuboid  20  47.848  -18.0  2p78.643  19.13  -18.318
array 1 10 place  1 1 1  4.128  0.0  0.0
media  3 1 20 -10
boundary  20
end geom
read array ara=1 nux=5 nuy=1 nuz=1 fill 1 2 1 2 1 end fill end array
end data
end


=csas26
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
h2o       3 1 end
end comp
slab end
1 3.81 oneextermod  2 4.12 noextermod 3 22.12 noextermod end zone
read param    npg=3000 fdn=yes nub=yes end param
read geom
unit 1
cuboid     10 2p3.81 2p60.325 111.68 0
cuboid  20       2p4.128  2p60.643   111.68  -.318
cuboid     30  2p4.128 2p60.643 111.68 -.318
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 2
cuboid      10 13.97 0.0 2p60.643 111.68 -.318
media  3 1 10
boundary  10
global unit  3
cuboid  10  52.708  0.0  2p60.643  111.68  -.318
cuboid  20  70.708  -18.0 2p78.643  111.68  -.318
array  1 10 place 1 1 1  4.128  0.0  0.0
media  3 1 20 -10
boundary  20
end geom
read array ara=1 nux=5 nuy=1 nuz=1 fill 1 2 1 2 1 end fill end array
```

```
end data
end


=csas26
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
end comp
slab end
1 3.81 noextermod  2 4.12 noextermod end zone
read param    npg=3000 fdn=yes nub=yes end param
read geom
unit 1
cuboid  10 2p3.81 2p60.325 65.81 0
cuboid  20  2p4.128  2p60.643  65.81  -.318
cuboid  30  2p4.128 2p65. 150. -1.
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary  30
unit 2
cuboid      10 2p7.417 2p60.325 65.81 0
cuboid      20 2p7.735 2p60.643. 65.81  -.318
cuboid      30  2p7.735  2p65.0  150.0  -1.0
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary  30
unit 3
cuboid      10 38.1 0 2p65. 150. -1.
media  0 1 10
boundary  10
global unit  4
cuboid  10  54.091  -7.735  2p65.0  150.0  -1.0
array  1 10  place  1 1 1    0.0 0.0 0.0
boundary  10
end geom
read array  ara=1 nux=3 nuy=1 nuz=1 fill 2 3 1 end fill end array
end data
end


=csas26
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
end comp
slab end
1 3.81 noextermod  2 4.12 noextermod end zone
read param    npg=3000 fdn=yes nub=yes end param
read geom
unit 1
cuboid  10  2p3.81 2p60.325 19.63 0
cuboid  20  2p4.128  2p60.643 19.63  -.318
cuboid  30  2p4.128 2p65. 150. -1.
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
```

```
boundary  30
unit 2
cuboid  10  2p7.417 2p60.325 19.63 0
cuboid  20  2p7.735  2p60.643  19.63  -.318
cuboid  30  2p7.735 2p65. 150. -1.
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary  30
global  unit  3
cuboid  10  27.854  -4.128  2p65.0  150.0  -1.0
array  1 10 place 1 1 1  0.0 0.0 0.0
boundary  10
end geom
read array  ara=1 nux=3 nuy=1 nuz=1 fill 1 2 1 end fill end array
end data
end


=csas26
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
end comp
slab end
1 3.81 noextermod  2 4.12 noextermod end zone
read param    npg=3000 fdn=yes nub=yes end param
read geom
unit 1
cuboid      10  2p3.81 2p60.325 62.56 0
cuboid      20  2p4.128  2p60.643  62.56  -.318
cuboid      30  2p4.128 2p65. 150. -1.
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary  30
unit 2
cuboid  10  2p7.417 2p60.325 62.56 0
cuboid  20  2p7.735  2p60.643  62.56  -.318
cuboid  30  2p7.735 2p65. 150. -1.
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary  30
unit 3
cuboid      10 50.8 0 2p65. 150. -1.
media  0 1 10
boundary  10
global
unit  4
cuboid  10  129.454  -4.128  2p65.0  150.0  -1.0
array  1 10  place 1 1 1  0.0 0.0 0.0
boundary  10
end geom
read array  ara=1  nux=5 nuy=1 nuz=1 fill 1 3 2 3 1 end fill end array
end data
end
```

```
=csas26
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
end comp
slab end
1 7.62 noextermod  2 7.94 noextermod end zone
read param    npg=3000 fdn=yes nub=yes end param
read geom
unit 1
cuboid  10  2p3.81 2p60.325 58.19 0
cuboid  20  2p4.128  2p60.643  58.19  -.318
cuboid  30  2p4.128 2p65. 150. -1.
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary  30
unit 2
cuboid      10 2p.318 2p60.325 58.19 0
cuboid      20 2p7.938 2p60.325 58.19 0
cuboid      30  2p8.256  2p60.643  58.19  -.318
cuboid      40 2p8.574 2p65. 150. -1.
media  2 1 10
media  1 1 20 -10
media  2 1 30 -20
media  0 1 40 -30
boundary  40
unit 3
cuboid      10 30.48 0   2p65.   150. -1.
media  0 1 10
boundary  10
global
unit  4
cuboid  10  47.31  -8.574  2p65.0  150.0  -1.0
array  1 10 place 1 1 1   0.0 0.0 0.0
boundary  10
end geom
read array  ara=1 nux=3 nuy=1 nuz=1 fill 2 3 1 end fill end array
end data
end
```

```
=csas26
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
end comp
slab end
1 7.62 noextermod  2 7.94 noextermod end zone
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cuboid      10  2p3.81   2p60.325  83.11 0
cuboid      20  2p4.128  2p60.643  83.11 -.318
cuboid      30  2p4.128  2p65.     150. -1.
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary  30
```

```
unit 2
cuboid      10  2p.318  2p60.325 83.11 0
cuboid      20  2p7.938 2p60.325 83.11 0
cuboid      30  2p8.256 2p60.643 83.11 -.318
cuboid      40  2p8.574 2p65.    150.  -1.
media  2 1 10
media  1 1 20 -10
media  2 1 30 -20
media  0 1 40 -30
boundary  40
unit 3
cuboid      10 76.2 0 2p65. 150. -1.
media  0 1 10
boundary  10
global
unit 4
cuboid  10  93.03 -8.574  2p65.  150.0  -1.0
array  1 10  place  1 1 1  0.0 0.0 0.0
boundary  10
end geom
read array nux=3 nuy=1 nuz=1 fill 2 3 1 end fill end array
end data
end


=csas26
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
end comp
slab end
1 7.62 noextermod  2 7.94 noextermod end zone
read param npg=2000  fdn=yes  nub=yes   end param
read geom
unit 1
cuboid      10  2p7.417 2p60.325  32.79  0
cuboid      20  2p7.735 2p60.643  32.79  -.318
cuboid      30  2p15.354 2p65.    150.  -1.
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary  30
unit 2
cuboid      10  2p.318   2p60.325  32.79 0
cuboid      20  2p7.938  2p60.325  32.79 0
cuboid      30  2p8.256  2p60.643  32.79 -.318
cuboid      40  2p15.875 2p65. 150. -1.
media  2 1 10
media  1 1 20 -10
media  2 1 30 -20
media  0 1 40 -30
boundary  40
global
unit  3
cuboid  10  47.104  -15.354  2p65.0  150.0 -1.0
array  1 10  place 1 1 1 0.0 0.0 0.0
boundary  10
end geom
read array nux=2 nuy=1 nuz=1 fill 1 2 end fill end array
end data
end
```

```
=csas26
93.2% uo2f2 h/u-235=337
238groupndf5  multiregion
solnuo2f2  1 81.845 0 1 293  92235 93.2
92238 6.8 end
al        2 1 end
end comp
slab end
1 7.62 noextermod  2 7.94 noextermod end zone
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cuboid      10  2p7.417 2p60.325 73.23 0
cuboid      20  2p7.735 2p60.643  73.23 -.318
cuboid      30  2p68.694 2p65. 150. -1.
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary  30
unit 2
cuboid      10  2p.318 2p60.325 73.23 0
cuboid      20  2p7.938 2p60.325 73.23 0
cuboid      30  2p8.256 2p60.643  73.34  -.318
cuboid      40  2p69.215 2p65. 150. -1.
media  2 1 10
media  1 1 20 -10
media  2 1 30 -20
media  0 1 40 -30
boundary  40
global
unit  3
cuboid  10  207.124  -68.694  65.0 -65.0  150.0 -1.0
array  1 10  place 1 1 1 0.0 0.0 0.0
boundary  10
end geom
read array nux=2 nuy=1 nuz=1 fill 1 2 end fill end array
end data
end


=csas26
uo2(no3)2 63.3 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 63.3 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
arbmwood  .640525 3 0 0 0 6012 44.435 1001 6.2639 8016 49.301 3 end
carbonsteel   4 end
reg-concrete  5 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
read param    npg=2000 fdn=yes nub=yes plt=no end param
read geom

unit 1
cylinder  10  9.52 17.5609 0.
cylinder  20  9.52 17.77   0.
cylinder  30  10.16 18.41  -.64
cuboid    40  4p11.365  19.615 -1.845
media  1 1 10
media  0 1 20 -10
```

```
media  2 1 30 -20
media  0 1 40 -30
boundary  40
unit 2
cuboid  10 56.825 -11.365  56.825 -11.365  62.535 -1.8450
cuboid  20  4p200. 250. -50.
array   1 10 place 1 1 1  0.0 0.0 0.0
media  0 1 20 -10
boundary  20
unit 3
cylinder  10  142.8 224. -48.
cylinder  20  144.8 224. -50.
cuboid    30  218.1 -181.9 215. -185. 250. -50.
media  0 1 10
media  4 1 20 -10
media  0 1 30 -20
boundary  30
unit 4
cylinder  10  9.52 17.5609 0.
cylinder  20  9.52 17.77   0.
cylinder  30  10.16 18.41  -.64
cuboid    40  4p11.365  19.615 -1.845
media  6 1 10
media  0 1 20 -10
media  2 1 30 -20
media  0 1 40 -30
boundary  40
global
unit 5
cuboid   5 600.0  -200.0  200.0  -200.0  250.0  -50.
cuboid  10 657.40 -257.0  460.0  -559.2  650.0  -50
cuboid  20 657.40 -257.0  460.0  -559.2  650.0  -50.32
cuboid  30 657.40 -257.0  460.0  -559.2  650.0  -51.59
cuboid  40 657.40 -257.0  460.0  -559.2  650.0  -52.23
cuboid  50 657.40 -257.0  460.0  -559.2  650.0  -427.23
cuboid  60  687.40 -307.00 490.00 -589.20  680.0  -457.23
array  2 5 place 1 1 1 0.0 0.0 0.0
media  0 1 10 -5
media 2 1 20 -10
media 3 1 30 -20
media 4 1 40 -30
media 0 1 50 -40
media 5 1 60 -50
boundary 60
end geom
read array
ara=1 nux=3 nuy=3 nuz=3 fill f1 end fill
ara=2 nux=2 nuy=1 nuz=1 fill 2 3 end fill
end array
end data
end


=csas26
uo2(no3)2 279 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 279 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
arbmwood  .640525 3 0 0 0 6012 44.435 1001 6.2639 8016 49.301 3 end
carbonsteel   4 end
reg-concrete  5 end
end comp
cylindrical  end
```

```
1 9.52 oneextermod   2 10.16 noextermod end zone
read param   plt=no  npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cylinder  10  9.52 17.5609 0.
cylinder  20  9.52 17.77   0.
cylinder  30  10.16 18.41  -.64
cuboid    40  4p10.875 19.125 -1.355
media  1 1 10
media  0 1 20 -10
media  2 1 30 -20
media  0 1 40 -30
boundary  40
unit 2
cuboid  10 32.625 -10.875  32.625 -10.875   39.605  -1.355
cuboid  20  4p200. 250. -50.
array   1 10 place 1 1 1  0.0 0.0 0.0
media  0 1 20 -10
boundary  20
unit 3
cylinder  10  142.8 224. -48.
cylinder  20  144.8 224. -50.
cuboid    30  218.1 -181.9 215. -185. 250. -50.
media  0 1 10
media  4 1 20 -10
media  0 1 30 -20
boundary  30
global
unit 4
cuboid   5 600.0  -200.0  200.0  -200.0  250.0  -50.
cuboid  10 657.40 -257.0  460.0  -559.2  650.0  -50
cuboid  20 657.40 -257.0  460.0  -559.2  650.0  -50.32
cuboid  30 657.40 -257.0  460.0  -559.2  650.0  -51.59
cuboid  40 657.40 -257.0  460.0  -559.2  650.0  -52.23
cuboid  50 657.40 -257.0  460.0  -559.2  650.0  -427.23
cuboid  60  687.40 -307.00 490.00 -589.20  680.0  -457.23
array  2 5 place 1 1 1 0.0 0.0 0.0
media  0 1 10 -5
media 2 1 20 -10
media 3 1 30 -20
media 4 1 40 -30
media 0 1 50 -40
media 5 1 60 -50
boundary 60
end geom
'read start xsm=178 xsp=222 ysm=178 ysp=222 zsm=50 zsp=91 end start
read array ara=1 nux=2 nuy=2 nuz=2 fill f1 end fill
ara=2 nux=2 nuy=1 nuz=1 fill 2 3 end fill end array
end data
end


=csas26
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
arbmwood  .640525 3 0 0 0 6012 44.435 1001 6.2639 8016 49.301 3 end
carbonsteel   4 end
reg-concrete  5 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
```

```
read param    plt=no  npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cylinder  10  9.52 17.5609 0.
cylinder  20  9.52 17.77   0.
cylinder  30  10.16 18.41  -.64
cuboid    40  4p13.40 21.65 -3.88
media  1 1 10
media  0 1 20 -10
media  2 1 30 -20
media  0 1 40 -30
boundary  40
unit 2
cuboid  10  67.0 -13.40  67.0 -13.40    72.71  -3.88
cuboid  20  4p200. 250. -50.
array   1 10 place 1 1 1  0.0 0.0 0.0
media  0 1 20 -10
boundary  20
unit 3
cylinder  10  142.8 224. -48.
cylinder  20  144.8 224. -50.
cuboid    30  218.1 -181.9 215. -185. 250. -50.
media  0 1 10
media  4 1 20 -10
media  0 1 30 -20
boundary  30
global
unit 4
cuboid   5 600.0  -200.0  200.0  -200.0  250.0  -50.
cuboid  10 657.40 -257.0  460.0  -559.2  650.0  -50
cuboid  20 657.40 -257.0  460.0  -559.2  650.0  -50.32
cuboid  30 657.40 -257.0  460.0  -559.2  650.0  -51.59
cuboid  40 657.40 -257.0  460.0  -559.2  650.0  -52.23
cuboid  50 657.40 -257.0  460.0  -559.2  650.0  -427.23
cuboid  60  687.40 -307.00 490.00 -589.20  680.0  -457.23
array  2 5 place 1 1 1 0.0 0.0 0.0
media  0 1 10 -5
media 2 1 20 -10
media 3 1 30 -20
media 4 1 40 -30
media 0 1 50 -40
media 5 1 60 -50
boundary 60
end geom
read array ara=1 nux=3 nuy=3 nuz=3 fill f1 end fill
ara=2 nux=2 nuy=1 nuz=1 fill 2 3 end fill end array
'read plot
'xul=113.2 yul=286.8 zul=60. xlr=286.8 ylr=113.2 zlr=60.
'uax=1 vdn=-1 nax=125  end
'xul=437.1 yul=329.8 zul=60. xlr=726.7 ylr=40.2 zlr=60. end
'end plot
end data
end


=csas26
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
arbmwood  .640525 3 0 0 0 6012 44.435 1001 6.2639 8016 49.301 3 end
carbonsteel   4 end
reg-concrete  5 end
```

```
solnuo2(no3)2  6 279 0 1 293 92235 92.6 92238 7.4 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
read param    plt=no  npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cylinder  10  9.52 17.5609 0.
cylinder  20  9.52 17.77   0.
cylinder  30  10.16 18.41  -.64
cuboid    40  4p13.365  21.615  -3.845
media  1 1 10
media  0 1 20 -10
media  2 1 30 -20
media  0 1 40 -30
boundary  40
unit 2
cuboid  10 66.825  -13.365  66.825  -13.365  72.535  -3.845
cuboid  20  4p200. 250. -50.
array   1 10 place 1 1 1  0.0 0.0 0.0
media  0 1 20 -10
boundary  20
unit 3
cylinder  10  142.8 224. -48.
cylinder  20  144.8 224. -50.
cuboid    30  218.1 -181.9 215. -185. 250. -50.
media  0 1 10
media  4 1 20 -10
media  0 1 30 -20
boundary  30
unit 4
cylinder  10  9.52 17.5609 0.
cylinder  20  9.52 17.77   0.
cylinder  30  10.16 18.41  -.64
cuboid    40  4p13.365  21.615  -3.845
media  6 1 10
media  0 1 20 -10
media  2 1 30 -20
media  0 1 40 -30
boundary  40
global
unit 5
cuboid   5 600.0  -200.0  200.0  -200.0  250.0  -50.
cuboid  10 657.40 -257.0  460.0  -559.2  650.0  -50
cuboid  20 657.40 -257.0  460.0  -559.2  650.0  -50.32
cuboid  30 657.40 -257.0  460.0  -559.2  650.0  -51.59
cuboid  40 657.40 -257.0  460.0  -559.2  650.0  -52.23
cuboid  50 657.40 -257.0  460.0  -559.2  650.0  -427.23
cuboid  60  687.40 -307.00 490.00 -589.20  680.0  -457.23
array  2 5 place 1 1 1 0.0 0.0 0.0
media  0 1 10 -5
media 2 1 20 -10
media 3 1 30 -20
media 4 1 40 -30
media 0 1 50 -40
media 5 1 60 -50
boundary 60
end geom
read array
ara=1 nux=3 nuy=3 nuz=3 fill 10r1 4 1 3r4 1 4 10r1 end fill
ara=2 nux=2 nuy=1 nuz=1 fill 2 3 end fill
end array
end data
```

```
end


=csas26
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cylinder  10 9.52 17.5609 0.
cylinder  20 9.52 17.77   0.
cylinder  30 10.16 18.41  -.64
cuboid    40 4p16.13 24.38 -6.61
media  1 1 10
media  0 1 20 -10
media  2 1 30 -20
media  0 1 40 -30
boundary 40
global
unit 2
cuboid 10  80.65  -16.13  80.65  -16.13  86.36 -6.61
cuboid 20  83.19  -18.67  83.19  -18.67  88.9  -6.61
cuboid 30  83.19  -18.67  83.19  -18.67  88.9  -21.85
array   1 10 place 1 1 1  0.0 0.0 0.0
media  2 1 20 -10
media  3 1 30 -20
boundary 30
end geom
read array
ara=1 nux=3 nuy=3 nuz=3 fill f1 end fill
end array
end data
end


=csas26
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cylinder  10 9.52 17.5609 0.
cylinder  20 9.52 17.77   0.
cylinder  30 10.16 18.41  -.64
cuboid    40 4p18.085 26.335 -8.565
media  1 1 10
media  0 1 20 -10
media  2 1 30 -20
media  0 1 40 -30
boundary 40
global
```

```
unit 2
cuboid 10  90.425  -18.085  90.425  -18.085  96.135  -8.565
cuboid 20  105.665  -25.705  105.665  -25.705  103.755  -23.805
array   1 10 place 1 1 1  0.0 0.0 0.0
media  3 1 20 -10
boundary 20
end geom
read array
ara=1 nux=3 nuy=3 nuz=3 fill f1 end fill
end array
end data
end


=csas26
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cylinder  10 9.52 17.5609 0.
cylinder  20 9.52 17.77   0.
cylinder  30 10.16 18.41  -.64
cuboid    40 4p14.67 22.92 -5.15
media  1 1 10
media  0 1 20 -10
media  2 1 30 -20
media  0 1 40 -30
boundary 40
global
unit 2
cuboid 10  73.35  -14.67  73.35  -14.67  79.06  -5.15
cuboid 20  74.62  -15.94  74.62  -15.94   80.33  -6.42
array   1 10 place 1 1 1  0.0 0.0 0.0
media  3 1 20 -10
boundary 20
end geom
read array
ara=1 nux=3 nuy=3 nuz=3 fill f1 end fill
end array
end data
end


=csas26
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
read param    npg=2000 fdn=yes nub=yes end param
read geom
```

```
unit 1
cylinder  10  9.52 17.5609 0.
cylinder  20  9.52 17.77   0.
cylinder  30  10.16 18.41  -.64
cuboid    40  4p11.965 20.215 -2.445
media 1 1 10
media 0 1 20 -10
media 2 1 30 -20
media 0 1 40 -30
boundary 40
global
unit 2
cuboid 10  35.895 -11.965  35.895  -11.965  42.875  -2.445
cuboid 20  37.165 -13.235  37.165  -13.235  44.145  -2.445
cuboid 30  37.165 -13.235  37.165  -13.235  44.145  -17.685
array   1 10 place 1 1 1  0.0 0.0 0.0
media  2 1 20 -10
media  3 1 30 -20
boundary  30
end geom
read array
ara=1 nux=2 nuy=2 nuz=2 fill f1 end array
end data
end


=csas26
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cylinder  10  9.52 17.5609 0.
cylinder  20  9.52 17.77   0.
cylinder  30  10.16 18.41  -.64
cuboid    40  4p12.865  21.115  -3.345
media 1 1 10
media 0 1 20 -10
media 2 1 30 -20
media 0 1 40 -30
boundary 40
global
unit 2
cuboid 10  38.595  -12.865  38.595  -12.865 45.575  -3.345
cuboid 20  41.135 -15.405  41.135 -15.405   48.116  -3.345
cuboid 30  41.135 -15.405  41.135 -15.405   48.116   -18.585
array   1 10 place 1 1 1  0.0 0.0 0.0
media  2 1 20 -10
media  3 1 30 -20
boundary  30
end geom
read array
ara=1 nux=2 nuy=2 nuz=2 fill f1 end array
end data
end
```

```
=csas26
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cylinder  10  9.52 17.5609 0.
cylinder  20  9.52 17.77   0.
cylinder  30  10.16 18.41  -.64
cuboid    40  4p14.48  22.73  -4.96
media 1 1 10
media 0 1 20 -10
media 2 1 30 -20
media 0 1 40 -30
boundary 40
global
unit 2
cuboid 10  43.44  -14.48  43.44  -14.48   50.42  -4.96
cuboid 20  49.79  -20.83  49.79  -20.83   56.77  -4.96
cuboid 30  49.79  -20.83  49.79  -20.83   56.77  -20.2
array   1 10 place 1 1 1  0.0 0.0 0.0
media  2 1 20 -10
media  3 1 30 -20
boundary  30
end geom
read array
ara=1 nux=2 nuy=2 nuz=2 fill f1 end array
end data
end
```

```
=csas26
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cylinder  10  9.52 17.5609 0.
cylinder  20  9.52 17.77   0.
cylinder  30  10.16 18.41  -.64
cuboid    40  4p14.515 22.765 -4.995
media 1 1 10
media 0 1 20 -10
media 2 1 30 -20
media 0 1 40 -30
boundary 40
global
unit 2
cuboid 10   43.545 -14.515 43.545 -14.515 50.525 -4.995
cuboid 20   51.165 -22.135  51.165 -22.135 58.145 -20.235
array   1 10 place 1 1 1  0.0 0.0 0.0
```

```
media  3 1 20 -10
boundary  20
end geom
read array
ara=1 nux=2 nuy=2 nuz=2 fill f1 end array
end data
end


=csas26
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cylinder  10  9.52 17.5609 0.
cylinder  20  9.52 17.77   0.
cylinder  30  10.16 18.41  -.64
cuboid    40  4p11.80 20.05 -2.28
media 1 1 10
media 0 1 20 -10
media 2 1 30 -20
media 0 1 40 -30
boundary 40
global
unit 2
cuboid 10   35.4 -11.80 35.4 -11.80   42.38 -2.28
cuboid 20   36.67 -13.07  36.67 -13.07  43.65 -3.55
array   1 10 place 1 1 1  0.0 0.0 0.0
media  3 1 20 -10
boundary  20
end geom
read array
ara=1 nux=2 nuy=2 nuz=2 fill f1 end array
end data
end


=csas26
uo2(no3)2 415 g u/l
238groupndf5  multiregion
solnuo2(no3)2  1 415 0 1 293 92235 92.6 92238 7.4 end
plexiglass     2 1 end
para(h2o)       3 1 end
end comp
cylindrical  end
1 9.52 oneextermod   2 10.16 noextermod end zone
read param    npg=2000 fdn=yes nub=yes end param
read geom
unit 1
cylinder  10  9.52 17.5609 0.
cylinder  20  9.52 17.77   0.
cylinder  30  10.16 18.41  -.64
cuboid    40  4p13.615 21.865 -4.095
media 1 1 10
media 0 1 20 -10
media 2 1 30 -20
```

```
media 0 1 40 -30
boundary 40
global
unit 2
cuboid 10   40.845 -13.615  40.845 -13.615   47.825 -4.095
cuboid 20   44.655  -17.425  44.655 -17.425  51.635  -7.905
array   1 10 place 1 1 1  0.0 0.0 0.0
media  3 1 20 -10
boundary  20
end geom
read array
ara=1 nux=2 nuy=2 nuz=2 fill f1 end array
end data
end
```

Table B.6. Table 6 input data

```
=csas26
eta experiments  exp 1
238groupndf5  infhommedium
u-233        1  0  0.0        end
u-234        1  0  0.00538-4  end
u-235        1  0  0.48006-4  end
u-236        1  0  0.00138-4  end
u-238        1  0  0.02807-4  end
n            1  0  1.869-4    end
h            1  0  0.066228   end
o            1  0  0.033736   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.0        end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
sphere  10  34.5948
sphere  20  34.9148
cuboid  30  6p34.9148
media 1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary 30
end geom
end data
end


=csas26
eta experiments  exp 2
238groupndf5    infhommedium
u-233        1  0  0.0        end
u-234        1  0  0.00631-4  end
u-235        1  0  0.56206-4  end
u-236        1  0  0.00163-4  end
u-238        1  0  0.03281-4  end
n            1  0  2.129-4    end
h            1  0  0.066148   end
o            1  0  0.033800   end
b-10         1  0  0.01029-4  end
b-11         1  0  0.04166-4  end
th-232       1  0  0.0        end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
sphere  10  34.5948
sphere  20  34.9148
cuboid  30  6p34.9148
media 1 1 10
```

```
media  2 1 20 -10
media  0 1 30 -20
boundary 30
end geom
end data
end


=csas26
eta experiments  exp 3
238groupndf5  infhommedium
u-233        1  0  0.0         end
u-234        1  0  0.00716-4  end
u-235        1  0  0.63944-4  end
u-236        1  0  0.00184-4  end
u-238        1  0  0.03734-4  end
n            1  0  2.392-4    end
h            1  0  0.066070   end
o            1  0  0.033865   end
b-10         1  0  0.02057-4  end
b-11         1  0  0.08332-4  end
th-232       1  0  0.0         end
al           2  1              end
ss316        3  1              end
carbonsteel  4  1              end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
sphere  10  34.5948
sphere  20  34.9148
cuboid  30  6p34.9148
media 1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary 30
end geom
end data
end


=csas26
eta experiments  exp 4
238groupndf5  infhommedium
u-233        1  0  0.0         end
u-234        1  0  0.00762-4  end
u-235        1  0  0.67959-4  end
u-236        1  0  0.00197-4  end
u-238        1  0  0.03967-4  end
n            1  0  2.548-4    end
h            1  0  0.066028   end
o            1  0  0.034028   end
b-10         1  0  0.02532-4  end
b-11         1  0  0.10255-4  end
th-232       1  0  0.0         end
al           2  1              end
ss316        3  1              end
carbonsteel  4  1              end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
```

```
unit 1
sphere  10  34.5948
sphere  20  34.9148
cuboid  30  6p34.9148
media 1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary 30
end geom
end data
end


=csas26
eta experiments  exp 5
238groupndf5  infhommedium
u-233        1  0  0.43284-4  end
u-234        1  0  0.00716-4  end
u-235        1  0  0.00018-4  end
u-236        1  0  0.0        end
u-238        1  0  0.00281-4  end
n            1  0  1.178-4    end
h            1  0  0.066360   end
o            1  0  0.033608   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000196-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
sphere  10  34.5948
sphere  20  34.9148
cuboid  30  6p34.9148
media 1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary 30
end geom
end data
end


=csas26
eta experiments  exp 6
238groupndf5  infhommedium
u-233        1  0  0.45120-4  end
u-234        1  0  0.00744-4  end
u-235        1  0  0.00018-4  end
u-236        1  0  0.0        end
u-238        1  0  0.00291-4  end
n            1  0  1.224-4    end
h            1  0  0.066345   end
o            1  0  0.033621   end
b-10         1  0  0.00263-4  end
b-11         1  0  0.01066-4  end
th-232       1  0  0.000205-3 end
al           2  1             end
ss316        3  1             end
```

```
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
sphere  10  34.5948
sphere  20  34.9148
cuboid  30  6p34.9148
media 1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary 30
end geom
end data
end


=csas26
eta experiments  exp 7
238groupndf5  infhommedium
u-233        1  0  0.46798-4  end
u-234        1  0  0.00772-4  end
u-235        1  0  0.00018-4  end
u-236        1  0  0.0        end
u-238        1  0  0.00301-4  end
n            1  0  1.274-4    end
h            1  0  0.066329   end
o            1  0  0.033634   end
b-10         1  0  0.00512-4  end
b-11         1  0  0.02075-4  end
th-232       1  0  0.000213-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
sphere  10  34.5948
sphere  20  34.9148
cuboid  30  6p34.9148
media 1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary 30
end geom
end data
end


=csas26
eta experiments  exp 8
238groupndf5  infhommedium
u-233        1  0  0.48455-4  end
u-234        1  0  0.00801-4  end
u-235        1  0  0.00021-4  end
u-236        1  0  0.0        end
u-238        1  0  0.00311-4  end
n            1  0  1.319-4    end
h            1  0  0.066315   end
o            1  0  0.033646   end
```

```
b-10          1  0  0.00758-4  end
b-11          1  0  0.03069-4  end
th-232        1  0  0.000221-3 end
al            2  1             end
ss316         3  1             end
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
sphere  10  34.5948
sphere  20  34.9148
cuboid  30  6p34.9148
media 1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary 30
end geom
end data
end


=csas26
eta experiments  exp 9
238groupndf5  infhommedium
u-233         1  0  0.5066-4   end
u-234         1  0  0.00827-4  end
u-235         1  0  0.00021-4  end
u-236         1  0  0.0        end
u-238         1  0  0.00327-4  end
n             1  0  1.363-4    end
h             1  0  0.0663     end
o             1  0  0.033659   end
b-10          1  0  0.01005-4  end
b-11          1  0  0.04070-4  end
th-232        1  0  0.000227-3 end
al            2  1             end
ss316         3  1             end
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
sphere  10  34.5948
sphere  20  34.9148
cuboid  30  6p34.9148
media 1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary 30
end geom
end data
end


=csas26
eta experiments  exp 10
238groupndf5 infhommedium
u-233         1  0  0.0        end
u-234         1  0  0.00409-4  end
u-235         1  0  0.36185-4  end
```

```
u-236        1  0  0.00220-4  end
u-238        1  0  0.01985-4  end
n            1  0  1.116-4    end
h            1  0  0.066394   end
o            1  0  0.033592   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.0        end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
sphere  10  61.0108
sphere  20  61.7808
cuboid  30  6p61.7808
media 1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary 30
end geom
end data
end


=csas26
eta experiments  exp 11
238groupndf5  infhommedium
u-233        1  0  0.33460-4  end
u-234        1  0  0.00525-4  end
u-235        1  0  0.00010-4  end
u-236        1  0  0.0        end
u-238        1  0  0.00256-4  end
n            1  0  0.753-4    end
h            1  0  0.066467   end
o            1  0  0.033525   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000148-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
sphere  10  61.0108
sphere  20  61.7808
cuboid  30  6p61.7808
media 1 1 10
media  2 1 20 -10
media  0 1 30 -20
boundary 30
end geom
end data
end
```

```
=csas26
eta experiments  exp 12
238groupndf5  infhommedium
u-233        1  0  0.00000-4  end
u-234        1  0  0.00469-4  end
u-235        1  0  0.41364-4  end
u-236        1  0  0.00243-4  end
u-238        1  0  0.02271-4  end
n            1  0  1.27200-4  end
h            1  0  0.066345   end
o            1  0  0.033624   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000000-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
cylinder  10   77.3684     45.1358   0.0
cylinder  20   77.3684    264.0    0.0
cylinder  30   77.4984    264.13  -0.13
cuboid    40   4p77.4984  264.13  -0.13
media  1 1 10
media  0 1 20 -10
media  3 1 30 -20
media  0 1 40 -30
boundary 40
end geom
end data
end


=csas26
eta experiments  exp 13
238groupndf5  infhommedium
u-233        1  0  0.00000-4  end
u-234        1  0  0.00451-4  end
u-235        1  0  0.40595-4  end
u-236        1  0  0.00222-4  end
u-238        1  0  0.02339-4  end
n            1  0  1.40900-4  end
h            1  0  0.066343   end
o            1  0  0.033655   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000000-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
cylinder  10   77.3684     47.4472   0.0
cylinder  20   77.3684    264.0    0.0
cylinder  30   77.4984    264.13  -0.13
cuboid    40   4p77.4984  264.13  -0.13
media  1 1 10
```

```
media  0 1 20 -10
media  3 1 30 -20
media  0 1 40 -30
boundary 40
end geom
end data
end


=csas26
eta experiments  exp 14
238groupndf5  infhommedium
u-233        1  0  0.00000-4  end
u-234        1  0  0.00409-4  end
u-235        1  0  0.36452-4  end
u-236        1  0  0.00209-4  end
u-238        1  0  0.02048-4  end
n            1  0  1.18500-4  end
h            1  0  0.066383   end
o            1  0  0.033605   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000000-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
cylinder  10   77.3684    72.7456   0.0
cylinder  20   77.3684    264.0    0.0
cylinder  30   77.4984    264.13  -0.13
cuboid    40   4p77.4984  264.13  -0.13
media  1 1 10
media  0 1 20 -10
media  3 1 30 -20
media  0 1 40 -30
boundary 40
end geom
end data
end


=csas26
eta experiments  exp 15
238groupndf5  infhommedium
u-233        1  0  0.00000-4  end
u-234        1  0  0.00397-4  end
u-235        1  0  0.34845-4  end
u-236        1  0  0.00194-4  end
u-238        1  0  0.01962-4  end
n            1  0  1.20800-4  end
h            1  0  0.066389   end
o            1  0  0.033609   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000000-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
```

```
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
cylinder  10   77.3684     105.2068   0.0
cylinder  20   77.3684    264.0    0.0
cylinder  30   77.4984    264.13  -0.13
cuboid    40   4p77.4984  264.13  -0.13
media  1 1 10
media  0 1 20 -10
media  3 1 30 -20
media  0 1 40 -30
boundary 40
end geom
end data
end


=csas26
eta experiments  exp 16
238groupndf5  infhommedium
u-233        1  0  0.00000-4  end
u-234        1  0  0.00384-4  end
u-235        1  0  0.33519-4  end
u-236        1  0  0.00186-4  end
u-238        1  0  0.01924-4  end
n            1  0  1.24400-4  end
h            1  0  0.066391   end
o            1  0  0.033615   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000000-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
cylinder  10   77.3684     203.2762   0.0
cylinder  20   77.3684    264.0    0.0
cylinder  30   77.4984    264.13  -0.13
cuboid    40   4p77.4984  264.13  -0.13
media  1 1 10
media  0 1 20 -10
media  3 1 30 -20
media  0 1 40 -30
boundary 40
end geom
end data
end


=csas26
eta experiments  exp 17
238groupndf5  infhommedium
u-233        1  0  0.36517-4  end
u-234        1  0  0.00556-4  end
u-235        1  0  0.00000-4  end
u-236        1  0  0.00000-4  end
u-238        1  0  0.00410-4  end
n            1  0  0.82600-4  end
```

```
h             1  0  0.066439   end
o             1  0  0.033539   end
b-10          1  0  0.0        end
b-11          1  0  0.0        end
th-232        1  0  0.000037-3 end
al            2  1             end
ss316         3  1             end
carbonsteel   4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
cylinder  10   77.3684     49.5046   0.0
cylinder  20   77.3684    264.0    0.0
cylinder  30   77.4984    264.13  -0.13
cuboid    40   4p77.4984  264.13  -0.13
media  1 1 10
media  0 1 20 -10
media  3 1 30 -20
media  0 1 40 -30
boundary 40
end geom
end data
end


=csas26
eta experiments  exp 18
238groupndf5  infhommedium
u-233         1  0  0.34978-4  end
u-234         1  0  0.00525-4  end
u-235         1  0  0.00000-4  end
u-236         1  0  0.00000-4  end
u-238         1  0  0.00395-4  end
n             1  0  0.84900-4  end
h             1  0  0.066444   end
o             1  0  0.033542   end
b-10          1  0  0.0        end
b-11          1  0  0.0        end
th-232        1  0  0.000032-3 end
al            2  1             end
ss316         3  1             end
carbonsteel   4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
cylinder  10   77.3684     59.2074   0.0
cylinder  20   77.3684    264.0    0.0
cylinder  30   77.4984    264.13  -0.13
cuboid    40   4p77.4984  264.13  -0.13
media  1 1 10
media  0 1 20 -10
media  3 1 30 -20
media  0 1 40 -30
boundary 40
end geom
end data
end
```

```
=csas26
eta experiments  exp 19
238groupndf5 infhommedium
u-233        1  0  0.33292-4  end
u-234        1  0  0.00507-4  end
u-235        1  0  0.00000-4  end
u-236        1  0  0.00000-4  end
u-238        1  0  0.00375-4  end
n            1  0  0.80200-4  end
h            1  0  0.066459   end
o            1  0  0.033533   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000037-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
cylinder  10   77.3684     77.6732   0.0
cylinder  20   77.3684    264.0    0.0
cylinder  30   77.4984    264.13  -0.13
cuboid    40   4p77.4984  264.13  -0.13
media  1 1 10
media  0 1 20 -10
media  3 1 30 -20
media  0 1 40 -30
boundary 40
end geom
end data
end


=csas26
eta experiments  exp 20
238groupndf5  infhommedium
u-233        1  0  0.31567-4  end
u-234        1  0  0.00481-4  end
u-235        1  0  0.00000-4  end
u-236        1  0  0.00000-4  end
u-238        1  0  0.00354-4  end
n            1  0  0.79500-4  end
h            1  0  0.066470   end
o            1  0  0.033531   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000258-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
cylinder  10   77.3684     138.9126  0.0
cylinder  20   77.3684    264.0    0.0
cylinder  30   77.4984    264.13  -0.13
cuboid    40   4p77.4984  264.13  -0.13
media  1 1 10
```

```
media  0 1 20 -10
media  3 1 30 -20
media  0 1 40 -30
boundary 40
end geom
end data
end


=csas26
eta experiments  exp 21
238groupndf5  infhommedium
u-233        1  0  0.00000-4  end
u-234        1  0  0.00397-4  end
u-235        1  0  0.33940-4  end
u-236        1  0  0.00240-4  end
u-238        1  0  0.01975-4  end
n            1  0  1.40700-4  end
h            1  0  0.066367   end
o            1  0  0.033645   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000000-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
cylinder  10 136.7790     90.8812   0.0
cylinder  20  136.7790   274.0    0.0
cylinder  30  138.6840   275.905 -1.905
cuboid    40 4p138.6840  275.905 -1.905
media  1 1 10
media  0 1 20 -10
media  3 1 30 -20
media  0 1 40 -30
boundary 40
end geom
end data
end


=csas26
eta experiments  exp 22
238groupndf5  infhommedium
u-233        1  0  0.00000-4  end
u-234        1  0  0.00381-4  end
u-235        1  0  0.33124-4  end
u-236        1  0  0.00232-4  end
u-238        1  0  0.01942-4  end
n            1  0  1.36700-4  end
h            1  0  0.066374   end
o            1  0  0.033634   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000000-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
```

```
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
cylinder  10 136.7790     122.4280   0.0
cylinder  20  136.7790   274.0    0.0
cylinder  30  138.6840   275.905 -1.905
cuboid    40 4p138.6840  275.905 -1.905
media  1 1 10
media  0 1 20 -10
media  3 1 30 -20
media  0 1 40 -30
boundary 40
end geom
end data
end


=csas26
eta experiments  exp 23
238groupndf5  infhommedium
u-233        1  0  0.00000-4  end
u-234        1  0  0.00368-4  end
u-235        1  0  0.32347-4  end
u-236        1  0  0.00220-4  end
u-238        1  0  0.01894-4  end
n            1  0  1.33800-4  end
h            1  0  0.066385   end
o            1  0  0.033631   end
b-10         1  0  0.0        end
b-11         1  0  0.0        end
th-232       1  0  0.000000-3 end
al           2  1             end
ss316        3  1             end
carbonsteel  4  1             end
end comp
read param npg=2000 fdn=yes  nub=yes  tme=59  end param
read geom
global
unit 1
cylinder  10 136.7790     241.1222   0.0
cylinder  20  136.7790   274.0    0.0
cylinder  30  138.6840   275.905 -1.905
cuboid    40 4p138.6840  275.905 -1.905
media  1 1 10
media  0 1 20 -10
media  3 1 30 -20
media  0 1 40 -30
boundary 40
end geom
end data
end
```

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