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CENTRM Validation

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Prepared by

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ACKNOWLEDGMENTS

This validation study of CENTRM/PMC (**C**ontinuous **EN**ergy **TR**ansport **M**odule/**P**roduce **M**ultigroup **C**ross sections), as well as much of the earlier code development and the continuing software maintenance, has been sponsored jointly by the Department of Energy (DOE) Office of Nuclear Safety Policy and Standards (DOE/EH-53) and the DOE Office of Nuclear Material and Spent Fuel (DOE/EM-21). Currently, this work area is also supported by the DOE National Nuclear Security Administration, Office of Facilities Management and Environment, Safety, and Health Support (DOE/NA-117). The work is being performed as part of the DOE Nuclear Criticality Safety Program. A special acknowledgement is extended to Jan Anderson for her patient assistance in preparing this report.

ABSTRACT

This report documents the validation of CENTRM/PMC (**C**ontinuous **EN**ergy **TR**ansport **M**odule/**P**roduce **M**ultigroup **C**ross sections) as the resolved resonance processor to KENO-VI and XSDRN using the 238-group ENDF/B-V cross-section library against critical experiments. A wide range of experiments were selected which include high-enriched, intermediate-enriched, and low-enriched uranium systems; mixed-oxide and plutonium systems; ^{233}U systems, and a set of Organization for Economic Co-operation and Development (OECD) calculational benchmarks. The types of systems include solutions in a tank, fuel pins in water, fuel pins in a fuel solution, solutions with absorber rods, stacked discs, and solution spheres with different reflectors. Although this selection of critical experiments primarily examines thermal systems, one set each of fast- and intermediate-energy critical experiments were also included. In all cases the 238-group ENDF/B-V cross-section library was used. Cross-section data for each problem were processed by BONAMI in the unresolved resonance region and CENTRM/PMC in the resolved resonance region. For each problem, in addition to the system k_{eff} and sigma, the energy of the average lethargy of fission (EALF) is reported. These data show that CENTRM/PMC, using BONAMI to process the unresolved resonance data and KENO-VI or XSDRN to solve the problem, can be used with confidence for the design and criticality safety analysis of a wide range of systems.

1. INTRODUCTION

The objective of this study is to validate the CENTRM/PMC (**C**ontinuous **EN**ergy **TR**ansport **M**odule/**P**roduce **M**ultigroup **C**ross sections) resonance processing codes against critical experiments. CENTRM and PMC are part of the SCALE computer code system.[1] This report validates the CSAS26 sequence of CSAS6, which runs BONAMI, WORKER, CENTRM, PMC, WORKER, and KENO-VI in series.[2,3,4,5,6,7] All five modules are documented in the SCALE manual. The 238-group ENDF/B-V library is used for all calculations.[8,9]

ANSI Standards ANSI/ANS-8.1[10] and ANSI/ANS-8.17[11] require that calculational methods used for criticality safety be validated and that 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.

Several validation reports have been produced using various functional modules in the SCALE code system. All the SCALE cross-section libraries have been evaluated over a wide range of materials, system configurations, and energy ranges. The 238-group ENDF/B-V library, used in these evaluations, was previously evaluated along with other SCALE libraries and was found to produce excellent results.[8,12] KENO-VI was also previously compared against KENO V.a, both using the NITAWL resonance processor, for a smaller set of problems and was found to produce excellent results.[12,13,14,15,16]

The objective of this report is to document the validation for the use of the CENTRM/PMC resonance processing codes over a wide range of applications using SCALE 5. This validation consists of 164 critical configurations from 17 experiments, plus a set of 30 Organisation for Economic Co-operation and Development/Nuclear Energy Agency (OECD/NEA) calculational benchmarks. All but one of the experiments and the calculational benchmarks are listed in the *International Criticality Safety Benchmark Evaluation Project* (ICSBEP) handbook.[17] The one experiment not listed in the ICSBEP handbook is a set of mixed-oxide (MOX) experiments with gadolinium poison that was performed at Pacific Northwest Laboratory (PNL). The calculational benchmarks consist of a set of MOX pellets in a uranyl nitrate solution at various uranium enrichments and concentrations. The experiments are divided into seven chapters based on the type of fuel. The seven chapters consist of the following: high-enriched uranium fuel, intermediate-enriched uranium fuel, low-enriched uranium fuel, mixed plutonium/uranium fuel, plutonium metal fuel, ^{233}U fuel, and OECD calculational benchmarks. The calculational benchmarks use XSDRNPM instead of KENO-VI to calculate the system criticality.[18] Each experiment is briefly described in a separate section in its appropriate chapter. At the end of each chapter, a separate section analyzes all the experiments in the chapter and examines any trends in the data. Table 1 contains a listing of all the experiments in this validation report, the sections pertaining to each experiment, the number of critical configurations in each experiment, and a brief description of each experiment.

The evaluations in this validation report are divided into seven chapters dictated by fissile material composition. Each chapter contains from one to four evaluations, most from the ICSBEP handbook.[17] Each chapter is divided into sections, with one benchmark evaluation per section and a final section that contains the results of all the evaluations in the chapter. The ICSBEP evaluations are briefly compared with the results contained in the handbook. All the results were compared with the benchmark k_{eff} and uncertainty in the ICSBEP handbook except those in Section 9.1, which were compared with MCNP results.[19] The results listed in this validation report compare well with the results listed in the ICSBEP handbook or the MCNP results.

Table 1. List of evaluations used in this validation report

Sect.	ICSBEP Designation [a]	No. of cases	Description
3.1	HEU-COMP-THERM-010	21	U(62.4)O_2 and BeO fuel pins surrounded by water, borated water, or uranyl nitrate
3.2	HEU-SOL-THERM-025	18	Uranyl nitrate solution (89.0 wt % ^{235}U) with gadolinium nitrate in a 40-cm-diameter tank
3.3	HEU-SOL-THERM-035	9	Uranyl nitrate solution (89.0 wt % ^{235}U) in a 110-cm-diameter tank w/ and w/o boron carbide absorber rods
3.4	HEU-SOL-THERM-037	9	Uranyl nitrate solution (89.0 wt % ^{235}U) in a 160-cm-diameter tank w/ and w/o boron carbide absorber rods
4.1	IEU-COMP-THERM-002	6	SS clad UO_2 annular fuel rods (17 wt % ^{235}U) in H_2O w/ and w/o gadolinium and cadmium absorbers
4.2	IEU-SOL-THERM-001	4	Uranyl sulphate solution (~20.9 at % ^{235}U) with graphite reflector
5.1	LEU-COMP-THERM-031	6	UO_2 rods (5 wt % ^{235}U), water moderated, hexagonally pitched (0.8 cm), zirconium clad
5.2	LEU-COMP-THERM-032	9	UO_2 rods (5 wt % ^{235}U), water moderated, varied temps., hexagonally pitched (0.7, 1.4, 1.852 cm)
5.3	LEU-SOL-THERM-005	3	Uranyl nitrate solution (5.64 wt % ^{235}U) in a 110-cm-diameter tank w/ and w/o boron carbide absorber rods
5.4	LEU-SOL-THERM-006	5	Uranyl nitrate solution (10.0 wt % ^{235}U) in a 110-cm-diameter tank w/ and w/o boron carbide absorber rods
6.1	MIX-COMP-THERM-002 (PNL)	6	UO_2(nat.) + PuO_2 fuel, square pitched (1.778, 2.20914, 2.51447 cm), varied array size, water moderated
6.2	MIX-COMP-THERM-003 (SAXTON)	6	UO_2(nat.) + PuO_2 fuel, square pitched, varied pitch and array size, water moderated
6.3	MIX-COM-THERM-004 (TCA)	11	UO_2(nat.) + PuO_2 fuel, square pitched, varied pitch and array size, water moderated
6.4	PNL-4976[b]	1	2 wt % PuO_2 + UO_2(nat.) fuel interspersed with 4.3 wt % UO_2 fuel, hexagonally pitched, water moderated
7.1	PU-MET-FAST-045 (LCX-I)	7	Pu (w/ Ni coating) disks with Ta and Al disks stacked to form a core of varying height
8.1	U233-SOL-INTER-001	33	Be, CH_2, and Be-CH_2 reflected spherical SS tanks of ^{233}U uranyl nitrate solutions
8.2	U233-SOL-THERM-003	10	Paraffin reflected 5-, 5.4-, 6-, 6.6-, 8-, 8.5-, 9-, and 12 in.-diameter cylinder of ^{233}U uranyl nitrate solutions
9.1	OECD calculational benchmarks [c]	30	Partially dissolved UO_2 pellets in a borated solution containing uranium

[a] See ref. 17.
[b] This is not an ICSBEP designation but a PNL report number. See ref. 34.
[c] This in not an ICSBEP designation, but an OECD/NEA Working Group Benchmark 20 problem. See ref. 38.

2. DESCRIPTION OF THE CODE PACKAGE

2.1 CSAS26 SEQUENCE

The CSAS26 control sequence, which is called by the CSAS6 control module in SCALE, allows simplified data input to the functional modules (i.e., BONAMI, WORKER/CENTRM/PMC, and KENO-VI).[1,2] This sequence calculates atomic densities for both mixtures and standard solutions, which are used in all three functional modules. It also generates additional data that are required to produce the input files for BONAMI, WORKER, CENTRM, and PMC. WORKER is called prior to CENTRM and immediately following PMC. CENTRM and PMC are called once for each unit cell specified in the unit cell data. If more then one unit cell is present, WORKER is initially called and then CENTRM/PMC is called for each unit cell. When all unit cells have been processed, WORKER is once again called. This equates to two input files for WORKER, and the number of CENTRM and PMC input files equals the number of unit cells. The input files contain data that specify which of the various options for treatment of the cross sections in the resonance region will be used to process the resonance data.

2.2 RESONANCE PROCESSING

BONAMI, CENTRM, PMC, and WORKER perform resonance processing if specified as an option on the command line in the SCALE 5 sequences.[3-6] BONAMI processes the unresolved resonance data, while CENTRM/PMC processes the resolved resonance data. Currently the NITAWL code is used as the default for resolved resonance self-shielding; however, CENTRM/PMC is able to treat several effects that NITAWL cannot. Several system characteristics may cause problems with the resonance treatments. One such problem, resonance overlap, can occur 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.[1] When resonance overlap is ignored, the flux used to shield the cross sections is incorrect, and thus, the group cross section can be in error.

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. CENTRM/PMC removes these limitations and approximations that are inherent in NITAWL.

Another approximation made in NITAW is ignoring spatial effects when the same resonance nuclide appears in different regions (mixtures) of a geometry specification. CENTRM/PMC produces a pointwise flux profile for the entire unit cell, so PMC is able to properly weight the pointwise cross-section data, producing a more accurate problem-dependent master cross-section library. An example of this is in a dissolver where a fuel lump is surrounded by fissile solution containing the same resonance absorbers. Since CENTRM computes space-dependent fluxes on the entire cell, an accurate representation of the moderator flux is also obtained, rather than assuming an asymptotic flux as done in NITAWL. CENTRM also accounts for anisotropic scattering and inelastic scattering in its transport calculation and has an approximate thermal scattering source.

If temperature data are included in the library, BONAMI performs temperature broadening at the user-specified problem temperature during resonance processing. CENTRM selects the appropriate temperature data from the library ,interpolating between data for a given temperature using a $\sqrt{T}$ law. If the temperature is above or below the maximum or minimum temperature for the nuclide in the CENTRM library, the code selects the maximum or minimum temperature from the library.

2.2.1 BONAMI

The BONAMI module self-shields cross sections with Bondarenko data using the shielding-factor methodology.[3] Nuclides with Bondarenko data carry an infinite dilute cross section on the master library and tables of dilution-dependent shielding factors. BONAMI performs iterations 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 minimum amount (ε) for all nuclides, groups, and zones. In this manner, the problem-dependent self-shielded cross sections for each nuclide and group are determined while approximately accounting for interactions. When CSAS6 calls BONAMI, heterogeneous geometry effects are accounted for in the escape cross section that is passed to BONAMI.

The escape cross section, which appears in the Wigner rational approximation for the fuel excape probability, is determined from 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. The equivalence theorem of lattice physics allows all nuclides to be processed by BONAMI as infinite homogeneous media in the CSAS6 sequences.

The performance of data shielded by the Bondarenko method depends on the adequacy of the approximations used to generate and apply 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 of ^{238}U for systems with low hydrogen moderation[11] and for many nuclides when the principal moderator is an intermediate-mass nuclide. This problem does not occur in the SCALE ENDF/B-IV and ENDF/B-V libraries because Bondarenko data are used only in the unresolved resonance range.

2.2.2 WORKER

The WORKER functional module is used to read cross-section libraries formatted as AMPX master libraries or as AMPX working libraries and to produce a new library in the AMPX working library format.[6] The WORKER module is applied in all SCALE system analytical sequences that use CENTRM and PMC to perform problem-dependent cross-section processing. The AMPX working library created is compatible with the input requirements of the XSDRNPM, KENO-VI, KENO V.a, ICE, MORSE-SGC, and COUPLE modules.

2.2.3 CENTRM

CENTRM computes "continuous-energy" neutron spectra using discrete ordinance or other deterministic approximations to the Boltzmann transport equation in one-dimensional (1-D) geometry.[4] The purpose of the code is to provide highly accurate angular fluxes and flux moments for applications that require a detailed description of the fine-structure variation in the neutron energy spectrum. One of the major functions of CENTRM is to determine problem-specific fluxes for processing resonance-shielded multigroup data. This is done by performing a CENTRM calculation for a simplified system model (e.g., a 1-D unit cell either isolated or in a lattice by reflecting the surfaces), and then utilizing the spectrum as a *problem-dependent weight function* for multigroup averaging. The multigroup data processing is done by the PMC code, which reads the CENTRM continuous-energy flux spectra and cross-section data; calculates problem-dependent, group-averaged cross sections over some specified energy range; and then replaces the corresponding data in an input AMPX master library. In this manner the original AMPX master library can be corrected for resonance self-shielding and other spectral effects, over a selected energy range. The resulting application-specific multigroup cross-section library can be passed to higher dimensional calculations performed with a multigroup Monte Carlo code like KENO V.a or KENO-VI or with 1-D discrete-ordinates codes like XSDRNPM. In this approach the multigroup cross-section processing becomes an active component in the overall transport analysis, since the group averaging is tailored specifically to the system being analyzed.

CENTRM solves the Boltzmann transport equation for infinite homogeneous media or for 1-D slab, spherical, or cylindrical systems, over an energy range that typically varies from ~0 to 20 MeV. A distinguishing feature of the calculation is that a combination of multigroup and pointwise solution techniques allow a continuous spectrum to be computed over the full energy range of interest for criticality safety and reactor physics analysis. The continuous spectrum consists of values for the flux per unit lethargy defined over a discrete energy mesh, for which a linear variation of the flux between energy points is assumed. Several transport approximations are available for both the multigroup and pointwise calculations. Depending on the specified transport approximation, the flux spectrum may vary as a function of space and direction, as well as energy. Spherical harmonic moments of the angular flux, which may be useful in processing matrices for higher order moments of the scattering cross section, are also determined as a function of space and energy mesh.

CENTRM solves the fixed-source (inhomogeneous) form of the transport equation, with a user-specified fixed source term. The input source may correspond to multigroup spectra in the form of volumetric or surface sources, as in XSDRNPM, or it may be a fission source, which has a fission-spectrum energy distribution (computed internally) appropriate for each fissionable mixture. Note that eigenvalue calculations are *not* presently performed in CENTRM—these must be performed by downstream modules that utilize multigroup data processed with the CENTRM spectra. For example, to obtain the infinite multiplication factor for a simple 1-D unit cell, an eigenvalue calculation with the 1-D transport code XSDRNPM must be run after the CENTRM calculation using the multigroup data produced by PMC. For more complex three-dimensional (3-D) systems, the multigroup Monte Carlo code KENO V.a or KENO-VI may be run following CENTRM. SCALE criticality sequences have been developed which automate several calculational series.

2.2.4 PMC

PMC calculates "multigroup" cross sections using point fluxes calculated in CENTRM and point cross-section data contained in a CENTRM pointwise continuous cross-section library.[5] The purpose of the code is to provide problem-dependent cross-section data in multigroup format. This is done by integrating point cross-section data with problem-dependent point fluxes that contain a detailed description of the fine-structure variation in the neutron energy spectrum. PMC reads the CENTRM continuous-energy flux spectra and cross-section data; calculates problem-dependent, group-averaged cross sections over some specified energy range; and then replaces the corresponding data in an input AMPX master library. In this manner the original AMPX master library can be corrected for resonance self-shielding and other spectral effects, over a selected energy range. The resulting application-specific multigroup cross-section library can be passed to higher dimensional calculations performed with a multigroup Monte Carlo code like KENO V.a or KENO-VI or with 1-D discrete-ordinates codes like XSDRNPM. In this approach the multigroup cross-section processing becomes an active component in the overall transport analysis, since the group averaging is tailored specifically to the system being analyzed.

2.3 KENO-VI

KENO-VI is a 3-D Monte Carlo, eigenvalue k_{eff} code.[7] Group cross-section data are used to randomly transport particles throughout a system containing fissile material. Particles are grouped in generations, with the fission particles for one generation providing the starting particles for the next generation. The primary purpose of KENO-VI is to calculate a system k_{eff}; however, many other physics parameters are calculated during the random walk. Other calculated quantities include neutron lifetime, generation time, energy-dependent leakages, energy- and region-dependent absorptions, fissions, fluxes, fission densities, energy of the average lethargy of fission, and system mean-free path.

KENO-VI is an extension of the KENO V.a Monte Carlo criticality program.[15] KENO-VI contains features currently in KENO V.a, while allowing more complex geometry modeling. The geometry package in KENO-VI is capable of modeling any volume that can be constructed using quadratic equations. In addition, such features as more predefined geometry volumes, geometry intersections, body rotation, hexagonal and dodecahedral 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.

Over 20 predefined geometry shapes have been incorporated into KENO-VI. Additional volumes can be constructed using the QUADRATIC geometry record, 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, a task that is 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. Dodecahedral arrays were added to facilitate the modeling of pebble-bed-type fuel arrangements. 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 retains the KENO V.a features such as flexible data input, 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.

2.4 XSDRNPM

XSDRNPM is a 1-D discrete-ordinates transport code. The function of XSDRNPM as part of a CSAS sequence is twofold: (1) perform a 1-D discrete-ordinate eigenvalue calculation in slab, cylindrical, or spherical geometry and (2) use the fluxes determined from its spectral calculation to cell-homogenize and collapse input cross sections and write these into one of several library formats.

2.5 THE 238-GROUP AND ENDF/B-V CENTRM POINTWISE CONTINUOUS NEUTRON CROSS-SECTION LIBRARIES

The 238-group ENDF/B-V library[8,9] is a general-purpose criticality analysis library and the most complete library available in SCALE. It has been extensively tested and validated over a wide range of material, systems, and energies.[14] This library is also known as the LAW (Library to Analyze Radioactive Waste) 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. It also contains data for ENDF/B-VI evaluations of ^{14}N, ^{15}N, ^{16}O, ^{154}Eu, ^{155}Eu, H in ZrH, Zr in ZrH, and Bemetal.

The library has 148 fast groups and 90 thermal groups (below 3 eV). The ^{235}U ENDF/B-V data result is slightly too reactive in the epithermal range, while the ^{238}U data result has slightly too much resonance 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.

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 of the SCALE manual. All other scattering processes use P_0 fits.

Each nuclide in the 238- or 44-group ENDF/B-V master multigroup library has a corresponding nuclide in the CENTRM pointwise continuous library. The pointwise continuous library is a general-purpose criticality analysis library and the most complete library available in SCALE. The library contains data for all nuclides (more than 300) available in ENDF/B-V processed by the AMPX system.[20] It also contains data for ENDF/B-VI evaluations of ^{14}N, ^{15}N, ^{16}O, ^{154}Eu, ^{155}Eu, H in ZrH, Zr in ZrH, and Bemetal as discussed in Sect. M4.2.5 of the SCALE manual.[1]

The pointwise continuous library is actually a directory structure with a separate file for each nuclide type, version, and revision. The file structure is set up so that each library type (i.e., ENDF, JENDL, JEF, etc.) has a separate directory. Within each library directory are subdirectories for each library version. (For example, ENDF contains an ENDF/B-V and an ENDF/B-VI subdirectory.) The files that contain the point data are contained in the library version subdirectories. A file exists for each revision number of each nuclide, so it is possible to have a nuclide present multiple times in the subdirectory. Currently, a complete set of ENDF/B-V cross-section data files and a few ENDF/B-VI cross-section data files are contained in the pointwise continuous library.

Each nuclide in the pointwise continuous library was generated with the latest version of AMPX to a tolerance of 0.1%. All nuclide files contain data for MT 1 (Total Cross Sections), MT 2 (Elastic Scattering Cross-Sections), and MT 102 (Collision Cross Sections). Fissile nuclides also contain MT 18 (Fission Cross Sections). Other MTs, such as discrete inelastic scattering cross sections, are contained if they are present in the library data. All data are 1-D cross-section data, no angular data are present. CENTRM assumes s_wave scatter when using these data.

Each nuclide file contains cross-section data at multiple temperatures. Except for a few special nuclides, cross-section data are present at 0, 300, 600, 1200, and 2400 K. Nuclides such as hydrogen in water and graphite have additional temperature data. See Table M.2.11 of the SCALE manual for a complete list of nuclides and corresponding temperatures. A complete listing of the nuclides and their revisions are contained in Table M4.A.10 of the SCALE manual.

3. HIGH-ENRICHED URANIUM EVALUATION

3.1 HEU-COMP-THERM-010

EBOR FUEL PINS IN WATER, BORATED WATER, OR URANYL NITRATE

3.1.1 DESCRIPTION

The text, tables, and figures in this section were taken in whole or in part from the ICSBEP handbook, identification number HEU-COMP-THERM-010. Section 1 in the evaluation provides an excellent, concise overall description of the experimental critical assembly configurations.[21]

This section describes a set of 21 critical experiments involving lattices of Experimental Beryllium Oxide Reactor (EBOR) fuel pins. The fuel pins consisted of compressed ceramic pellets contained in Hastelloy X-280 tubes. The pellets were a homogeneous mixture of $U(62.4)O_2$ and BeO.

The experimental configurations are divided into two sets. The first set (Cases 1 through 15) consisted of EBOR fuel pins arranged in various lattice configurations moderated and reflected by water. The second set consisted of one configuration in water (Case 16), three in borated water (Cases 17–19), one in uranyl nitrate solution (Case 20), and one in borated uranyl nitrate solution (Case 21). Each case had at least a 6-in. water reflector at the bottom and at least a 12-in. water reflector (30.48 cm) on the sides.

All cases used the same fuel. The fuel pins consisted of a homogeneous mixture of $U(62.4)O_2$ and BeO. Each fuel pin contained on average 156.27 g of ^{235}U. The benchmark-model fuel composition is 50.2 wt % uranium, 43 wt % beryllium oxide, and 6.8 wt % oxygen. The atom densities for the fuel matrix are given in Table 2. The circumferentially grooved pellets were compacted in 0.020-in.-thick Hastelloy X-280 tubes with an inner diameter (ID) of 0.33 in. Table 3 contains the dimensions of the fuel pellets

Table 2. Fuel matrix atom densities

Isotope	Atom density [atoms (barn-cm)]	Enrichment (wt. %)
U-235	3.8280×10^{-3}	62.4
U-234	2.5881×10^{-5}	0.42
U-236	1.7715×10^{-5}	0.29
U-238	2.2351×10^{-3}	36.9
Be	4.9386×10^{-2}	Natural
O	6.1599×10^{-2}	Natural

Table 3. Dimensions of EBOR fuel pins

Fuel pellet	
Diameter	0.327 in. (0.831 cm)
Height	0.427 in. (1.085 cm)
Fuel length in tube	76 in. (193 cm)
Hastelloy X-280 cladding	
Outside diameter	0.375 in. (0.952 cm)
Wall thickness	0.020 in. (0.051 cm)

The first set of critical experiments (Cases 1–15) consisted of EBOR fuel pins arranged in various lattice configurations moderated and reflected by water. The fuel pins were removed from the EBOR fuel elements for these experiments. The pins were positioned vertically and were supported by Plexiglas spacers, located at three elevations to maintain separation between adjacent fuel pins. There was at least a 6-in.-thick water reflector between the bottom of the tank and the fuel pins for all cases. Table 4 gives the critical number of pins and critical water heights for each of the lattices of EBOR fuel pins in water. Figure 1 shows the lattice configuration for each of these cases.

Table 4. Lattices of EBOR fuel pins in water

Case	Pitch (cm)	Number of pins	Critical water height above fuel (cm)
1	1.242	222	15.2
2	1.242	223	-50.3
3	1.488	138	30.8
4	1.742	102	-21.3
5	1.999	85	15.2
6	1.999	86	-60.8
7	2.276	78	15.2
8	2.276	79	-39.0
9	2.253	77	-3.9
10	2.507	75	15.2
11	2.507	76	-61.3
12	2.779	77	-43.2
13	2.995	83	-34.1
14	2.497	96	-10.4
15	1.250	75	-12.2

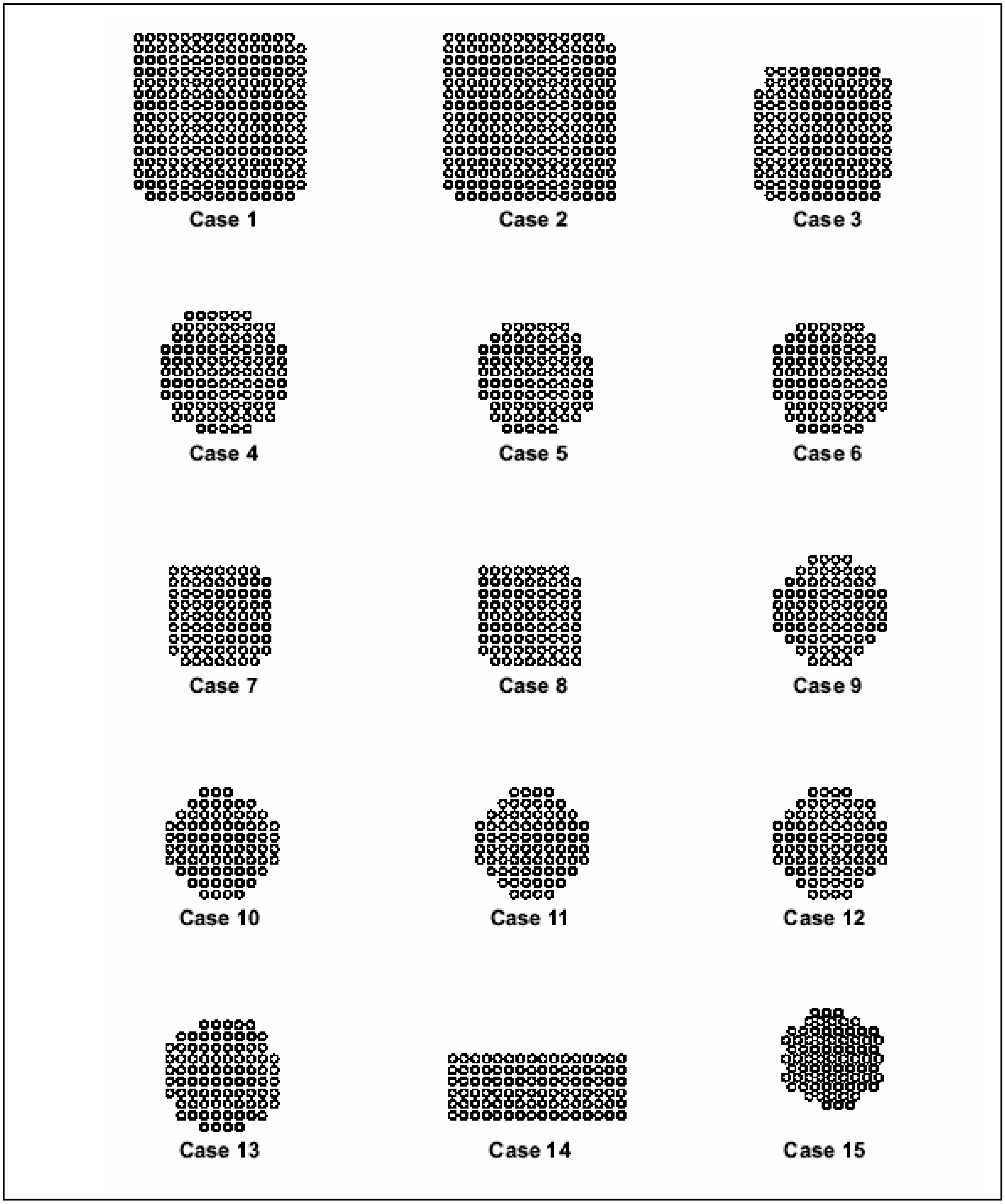


Figure 1. Lattice configurations of EBOR fuel pins in water, Cases 1–15.

The second set of critical experiments (Cases 16–21) consisted of EBOR fuel pins arranged in various lattice configurations in a solution tank with boron and/or uranyl nitrate in the reflector-moderator water. These experiments were performed to study the criticality of slab-shaped lattices in the dissolver environment. The top reflector was 7.625 in. above the top of the fuel, and the cylinder of solution was reflected by water "on the bottom and sides to its full height." The fuel pins have a center-to-center spacing of 2.48 cm. Table 5 shows moderator/reflector composition, the number of pins, and the critical water height above the top of the fuel. Figure 2 shows the arrangement of the pins in these experiments. The plexiglas spacers, grid plates, and 9-ft.-diameter stainless steel tank were omitted to simplify the model.

Table 5. Slab lattices of EBOR fuel pins in aqueous solutions

Case	Moderator/reflector composition	Critical number of pins	Critical water height above fuel (cm)
16	Water	99	15.2
17	H_3BO_3	114	-50.3
18	H_3BO_3	113	30.8
19	H_3BO_3	133	-21.3
20	$U(92.6)O_2(NO_3)_2$	83	15.2
21	$U(92.6)O_2(NO_3)_2$ + H_3BO_3	133	-60.8

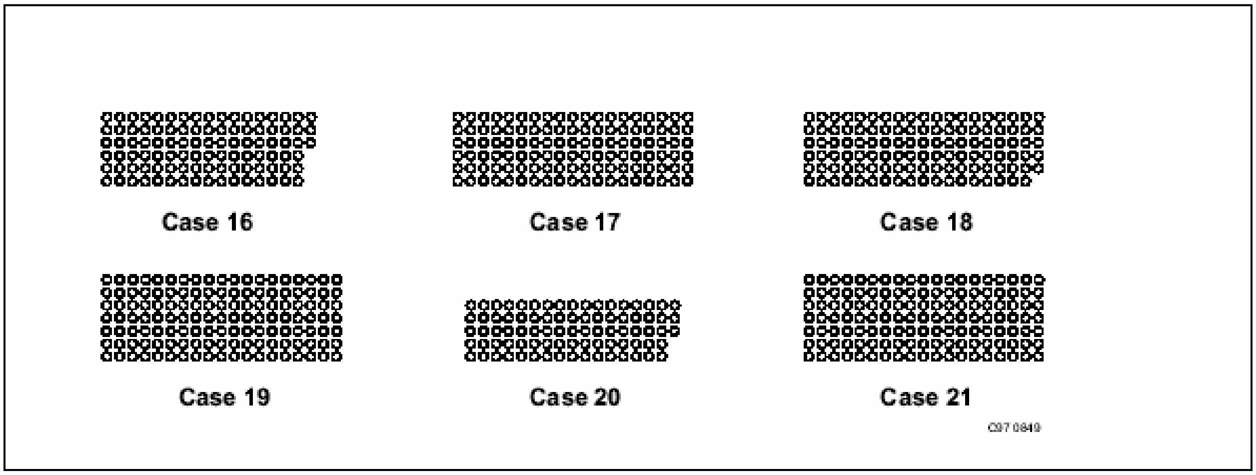


Figure 2. Lattice configurations of EBOR fuel pins in water, Cases 16–21.

3.1.2 RESULTS

All cases were set up and run as CSAS26 inputs having 550 generations and 4000 particles per generation, skipping the first 50 generations, for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 6 lists the calculated k_{eff} values and EALF along with the associated standard deviation for the computational benchmarks in this section. The suite of experiments has an average k_{eff} of 1.00321 ± 0.00076. These results agree very well with the benchmark values listed in the ICSBEP benchmark evaluation.

Table 6. Calculated k_{eff} and EALF for HEU-COMP-THERM-010

Case	k_{eff} (±σ)	EALF (±σ) (eV)	ICSBEP benchmark k_{eff} (±σ)
1	0.99983 ± 0.00063	0.7797 ± 0.0014	1.0000 ± 0.0050
2	0.99482 ± 0.00082	0.7938 ± 0.0018	1.0000 ± 0.0050
3	0.99895 ± 0.00063	0.3118 ± 0.0005	1.0000 ± 0.0050
4	0.99996 ± 0.00070	0.1869 ± 0.0003	1.0000 ± 0.0050
5	1.00265 ± 0.00060	0.1352 ± 0.0002	1.0000 ± 0.0050
6	0.99804 ± 0.00076	0.1370 ± 0.0002	1.0000 ± 0.0050
7	1.00428 ± 0.00064	0.1086 ± 0.0001	1.0000 ± 0.0050
8	1.00360 ± 0.00062	0.1093 ± 0.0001	1.0000 ± 0.0050
9	1.00223 ± 0.00067	0.1105 ± 0.0001	1.0000 ± 0.0050
10	1.00632 ± 0.00061	0.0956 ± 0.0001	1.0000 ± 0.0050
11	1.00274 ± 0.00073	0.0962 ± 0.0001	1.0000 ± 0.0050
12	1.00271 ± 0.00078	0.0858 ± 0.0001	1.0000 ± 0.0050
13	1.00009 ± 0.00061	0.0861 ± 0.0001	1.0000 ± 0.0050
14	1.00421 ± 0.00059	0.0949 ± 0.0001	1.0000 ± 0.0050
15	1.00369 ± 0.00060	0.1004 ± 0.0001	1.0000 ± 0.0050
16	1.00828 ± 0.00063	0.0953 ± 0.0001	1.0001 ± 0.0044
17	1.00797 ± 0.00057	0.0966 ± 0.0001	1.0010 ± 0.0074
18	1.00819 ± 0.00066	0.0968 ± 0.0001	1.0000 ± 0.0074
19	1.00521 ± 0.00080	0.1027 ± 0.0001	1.0000 ± 0.0074
20	1.00758 ± 0.00066	0.0766 ± 0.0001	1.0001 ± 0.0048
21	1.00623 ± 0.00060	0.0961 ± 0.0001	0.9997 ± 0.0076

3.2 HEU-SOL-THERM-025

URANIUM NITRATE SOLUTIONS WITH GADOLINIUM

3.2.1 DESCRIPTION

The text, tables, and figures in this section were taken in whole or in part from the ICSBEP handbook, identification number HEU-SOL-THERM-025. Section 1 in the evaluation provides an excellent, concise overall description of the experimental critical assembly configurations.[22]

The 18 measurements included in this evaluation are part of a series of experiments performed in 1987 at the Solution Physical Facility of the Institute of Physics and Power Engineering (IPPE), Obninsk, Russia, with highly enriched (89.0 wt % ^{235}U) uranium. Critical experiment measurements were made with uranyl nitrate solutions poisoned with gadolinium nitrate in a cylindrical tank with an inner diameter of 40 cm inserted in another cylindrical tank with an inner diameter of 59.4 cm containing uranyl nitrate solutions without gadolinium. Natural gadolinium was used in the experiments. On the bottom and side, the cores were surrounded by thick water reflectors. The experimental assembly consisted of three open-topped coaxial cylindrical tanks, shown as “stainless steel” in Figure 3, with the dimensions shown in Table 7. The inner tank was filled with an aqueous solution of uranyl nitrate [$UO_2(NO_3)_2$], with some excess of nitric acid (HNO_3). Gadolinium nitrate [$Gd(NO_3)_3$] was added in most, but not all, cases. Solution properties for each case are shown in Table 8. The isotopic distribution of the uranium, which is shown in Table 9, is the same for all cases. The critical height of the solution in the inner tank is $H_7 – H_6$. The middle tank was filled with distilled water in the first five experiments and with a solution of uranyl nitrate with some excess of nitric acid in the other experiments. The height of water or solution in this tank is $H_8 – H_4$. The outer tank was empty in Experiments 2–5 and was filled with distilled water in the other experiments. The height of water in the outer tank is designated $H_9 – H_3$. All heights were measured from H_1, which is the inner bottom of a large outer tank.

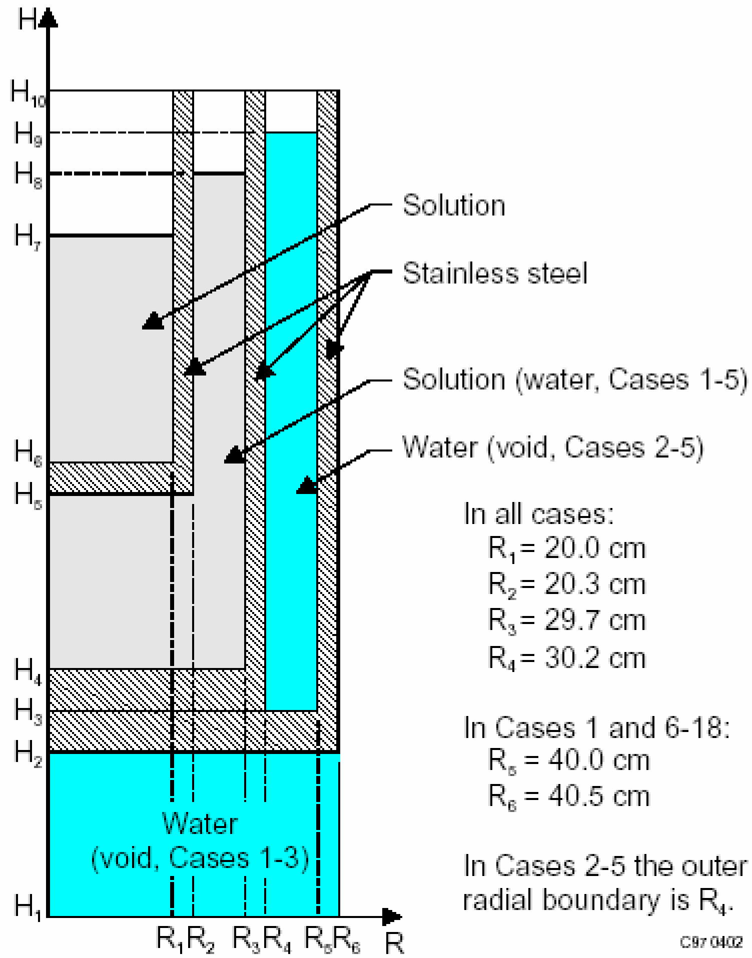


Figure 3. Cross-sectional schematic of benchmark models, IPPE experiments.
Values for all variables are listed in Table 7 for each experiment.

Table 7. Dimensional data for each evaluation related to Figure 3 (in centimeters)

Case Number	H_1	H_2	H_3	H_4	H_5	H_6	H_7	H_8	H_9	H_{10}
1	n/a	0.0	0.8	1.6	16.7	17.3	41.1	46.3	46.9	120.0
2	n/a	0.0	n/a	1.6	16.7	17.3	41.1	46.6	n/a	120.0
3	n/a	0.0	n/a	1.6	16.7	17.3	59.3	66.6	n/a	120.0
4	0.0	40.0	n/a	41.6	41.6	42.2	65.3	70.4	n/a	160.0
5	0.0	40.0	n/a	41.6	41.6	42.2	61.0	70.3	n/a	160.0
6	0.0	40.0	40.8	41.6	41.6	42.2	78.3	79.1	85.8	160.0
7	0.0	40.0	40.8	41.6	41.6	42.2	73.3	79.9	85.8	160.0
8	0.0	40.0	40.8	41.6	41.6	42.2	80.5	80.6	85.8	160.0
9	0.0	40.0	40.8	41.6	41.6	42.2	69.5	69.5	80.8	160.0
10	0.0	40.0	40.8	41.6	41.6	42.2	69.1	69.5	80.8	160.0
11	0.0	40.0	40.8	41.6	41.6	42.2	74.2	74.3	75.8	160.0
12	0.0	40.0	40.8	41.6	41.6	42.2	74.4	74.5	82.8	160.0
13	0.0	40.0	40.8	41.6	41.6	42.2	82.7	82.9	88.3	160.0
14	0.0	40.0	40.8	41.6	41.6	42.2	78.1	78.0	80.8	160.0
15	0.0	40.0	40.8	41.6	41.6	42.2	84.4	84.6	83.8	160.0
16	0.0	40.0	40.8	41.6	41.6	42.2	72.9	72.8	90.8	160.0
17	0.0	40.0	40.8	41.6	41.6	42.2	79.0	79.0	90.8	160.0
18	0.0	40.0	40.8	41.6	41.6	42.2	83.4	85.4	90.8	160.0

Table 8. Solution properties for HEU-SOL-THERMA-025

Case	Uranium concentration (g/L)	Gadolinium concentration (g/L)	Solution density (g/cm^3)	Total NO_3 concentration (mol/L)
Inner Tank				
1	51.2 ± 0.3	–	1.067 ± 0.001	0.63 ± 0.01
2	51.2 ± 0.3	–	1.067 ± 0.001	0.63 ± 0.01
3	50.5 ± 0.3	0.107 ± 0.005	1.064 ± 0.001	0.60 ± 0.01
4	53.3 ± 0.3	–	1.072 ± 0.001	0.65 ± 0.01
5	77.2 ± 0.4	–	1.104 ± 0.001	0.77 ± 0.01
6	48.7 ± 0.2	0.190 ± 0.010	1.064 ± 0.001	0.57 ± 0.01
7	67.9 ± 0.3	0.292 ± 0.014	1.092 ± 0.001	0.67 ± 0.01
8	69.8 ± 0.3	0.378 ± 0.015	1.092 ± 0.001	0.80 ± 0.01
9	95.2 ± 0.5	0.410 ± 0.016	1.129 ± 0.001	1.03 ± 0.01
10	141.6 ± 0.7	0.723 ± 0.016	1.198 ± 0.001	1.61 ± 0.02
11	142.4 ± 0.7	0.918 ± 0.019	1.198 ± 0.001	1.60 ± 0.02
12	185.2 ± 0.9	1.375 ± 0.028	1.257 ± 0.001	1.94 ± 0.02
13	189.2 ± 0.9	1.703 ± 0.034	1.257 ± 0.001	1.90 ± 0.02
14	273.3 ± 1.4	3.860 ± 0.077	1.380 ± 0.001	2.72 ± 0.03
15	267.7 ± 1.3	4.830 ± 0.097	1.377 ± 0.001	2.79 ± 0.03
16	400.0 ± 2.0	5.793 ± 0.120	1.551 ± 0.001	3.99 ± 0.04
17	393.2 ± 1.8	8.138 ± 0.163	1.552 ± 0.001	4.17 ± 0.04
18	395.2 ± 2.0	10.370 ± 0.210	1.555 ± 0.001	4.09 ± 0.04
Middle Tank				
6 – 13	50.7 ± 0.3	–	1.067 ± 0.001	0.62 ± 0.01
14 - 18	77.2 ± 0.4	–	1.104 ± 0.001	0.77 ± 0.01

Table 9. Uranium isotopic composition, HEU-SOL-THERMA-025

Isotope	Enrichment (wt %)
U-234	0.91 ± 0.06
U-235	89.04 ± 0.17
U-236	0.22 ± 0.02
U-238	9.83 ± 0.17

3.2.2 RESULTS

All critical assembly cases were set up and run as CSAS26 inputs having 500 generations and 4000 particles per generation, for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 10 lists calculated k_{eff} values and EALF along with the associated standard deviation for the computational benchmarks in this section. The suite of experiments has an average k_{eff} of 1.00785 ± 0.00055. These results agree very well with the benchmark results listed in the ICSBEP benchmark evaluation.

Table 10. Calculated k_{eff} and EALF for HEU-SOL-THERM-025

Case	k_{eff} (±σ)	EALF (±σ) (eV)	ICSBEP benchmark k_{eff} (±σ)
1	1.00251 ± 0.00065	0.0405 ± 0.0000	1.0002 ± 0.0025
2	1.00274 ± 0.00073	0.0405 ± 0.0000	1.0007 ± 0.0025
3	0.99677 ± 0.00055	0.0426 ± 0.0000	1.0002 ± 0.0064
4	1.00277 ± 0.00069	0.0413 ± 0.0000	1.0003 ± 0.0027
5	1.00600 ± 0.00069	0.0487 ± 0.0000	1.0013 ± 0.0030
6	1.00909 ± 0.00054	0.0429 ± 0.0000	1.0002 ± 0.0067
7	1.01516 ± 0.00052	0.0471 ± 0.0000	1.0009 ± 0.0073
8	1.01299 ± 0.00051	0.0486 ± 0.0000	1.0000 ± 0.0067
9	1.00566 ± 0.00049	0.0552 ± 0.0000	1.0002 ± 0.0065
10	1.01134 ± 0.00055	0.0704 ± 0.0000	1.0003 ± 0.0043
11	1.01199 ± 0.00045	0.0715 ± 0.0001	1.0002 ± 0.0045
12	1.01085 ± 0.00054	0.0879 ± 0.0001	1.0002 ± 0.0045
13	1.01794 ± 0.00045	0.0889 ± 0.0001	1.0009 ± 0.0047
14	1.00966 ± 0.00050	0.1184 ± 0.0002	1.0008 ± 0.0053
15	1.00250 ± 0.00057	0.1127 ± 0.0002	1.0002 ± 0.0058
16	1.01517 ± 0.00047	0.1844 ± 0.0004	1.0000 ± 0.0049
17	1.00611 ± 0.00051	0.1711 ± 0.0004	1.0000 ± 0.0055
18	1.00219 ± 0.00052	0.1607 ± 0.0004	1.0000 ± 0.0061

3.3 HEU-SOL-THERM-035

BORON CARBIDE ABSORBER RODS IN URANIUM (89% ^{235}U) NIRATE SOLUTIONS

3.3.1 DESCRIPTION

The text, tables, and figures in this section were taken in whole or in part from the ICSBEP handbook, identification number HEU-SOL-THERM-035. Section 1 in the evaluation provides an excellent, concise overall description of the experimental critical assembly configurations.[23]

The nine experiments included in this evaluation were performed with uranium enriched to 89 wt % ^{235}U. Uranyl nitrate solution with a uranium concentration of 37.51, 74.87, or 152.3 g/L was pumped into the core or inner tank, a 250.0-cm-tall stainless steel cylindrical tank with an inner diameter of 110 cm, a wall thickness of 0.6 cm, and a bottom thickness of 1.5 cm. Three experiments were performed without absorber rods. In six experiments different numbers of boron carbide absorber rods were inserted in the core tank. The absorber rods were arranged in a hexagonal lattice with different pitches. There was a thick side and bottom water reflector in these experiments.

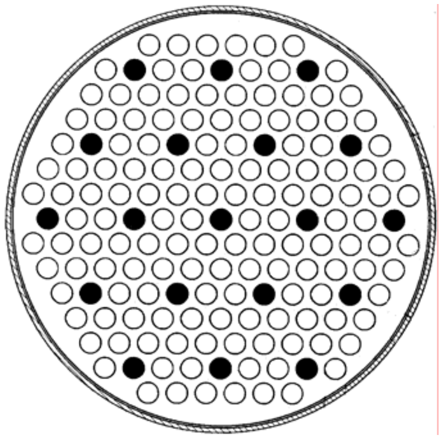
The tank was filled with a solution of uranyl nitrate to the height (measured from the inner surface of the tank bottom) shown in Table 11. The reflector tank—with an inner diameter of 198.4 cm, a wall thickness of 0.8 cm, a bottom thickness of 1.0 cm, and a height of 287.0 cm—is filled with water to the height (measured from the inner surface of the core tank bottom) shown in Table 11. The distance between the inner surface of the reflector tank bottom and the outer surface of the core tank bottom is 36.0 cm. There is only solution in the core tank (no absorber rods) in Cases 1, 5, and 7. The boron absorber rods are inserted in the core tank in Cases 2–4, 6, 8, and 9. The number of the boron absorber rods in the tank is shown in Table 11, and the arrangements of the absorber rods in the tank are shown in Figure 4.

The boron absorber rods are 248.5-cm-long stainless steel tubes with an outer diameter of 5.5 cm, a wall thickness of 0.5 cm, and a bottom thickness of 0.7 cm, filled with natural boron carbide. The absorber rods extend to the bottom of the core tank. The top surface of the absorber rods is coplanar with the top surfaces of the core and reflector tanks.

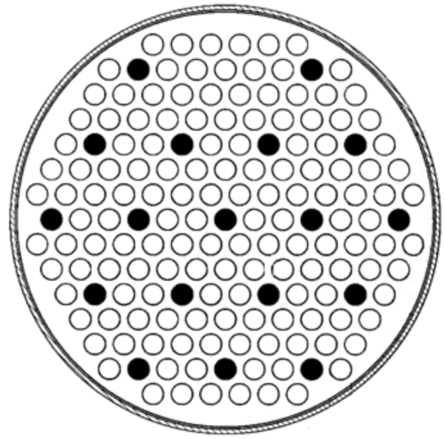
The lower stainless steel lattice plate is also included in the benchmark models of all cases except Case 7. This plate is lying on the bottom of the core tank. It has a diameter 109.6 cm and is 1.7 cm thick. Two different lattice plates are used. There are 85 holes in the first, arranged in a hexagonal lattice with a pitch of 10.6 cm. There are 163 holes in the second, arranged in a hexagonal lattice with a pitch of 7.6 cm. The lattice plate used in each particular case is indicated in Table 11 by the number of holes.

Table 11. Critical configuration/dimensions for HEU-SOL-THERM-035 evaluation

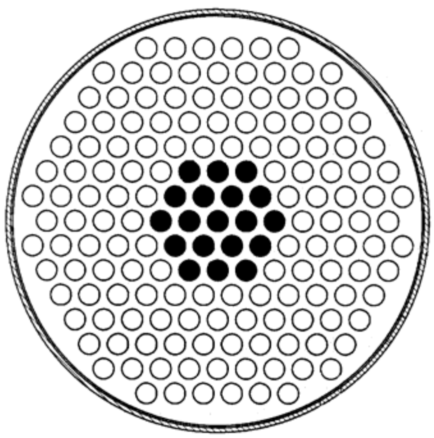
Case No.	Uranium concentration (g/L)	Number of absorber rods	Number of holes in the lattice plate	Solution height (cm)	Water reflector height (cm)
1	37.51	0	163	20.3439	40.0
2	"	19	163	24.7831	40.0
3	"	18	163	24.4979	40.0
4	"	19	163	23.1260	40.0
5	74.87	0	163	15.0826	40.0
6	"	19	85	17.5148	40.0
7	152.3	0	n/a	11.8906	95.0
8	"	19	85	14.4216	95.0
9	"	61	163	15.6113	95.0



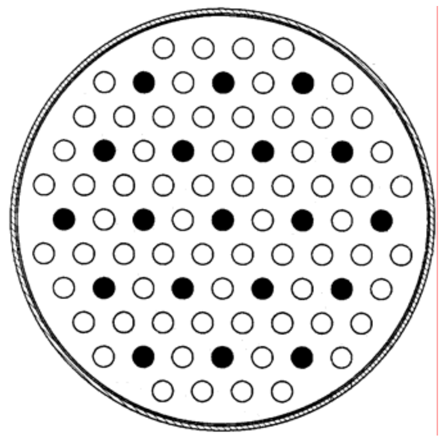
Case 2



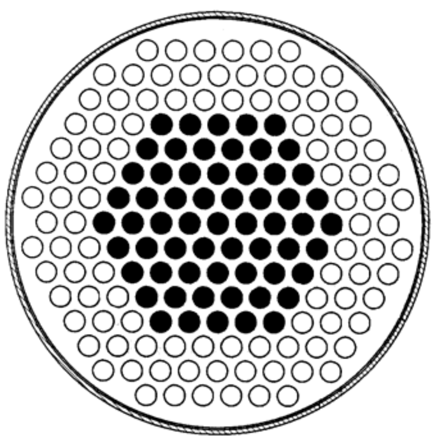
Case 3



Case 4



Cases 6 and 8



Case 9

Figure 4. Absorber pin positions for each critical assembly, HEU-SOL-THERM-035.

Three separate solutions were used in the experiment. For each solution a critical assembly was first created using no absorber rods. Then critical assemblies were established for each solution with different numbers and configurations of absorber rods. Calculated atom densities for the 37.51, 74.87, and 152.2 g U/L uranyl nitrate solutions are given in Table 12. The weight percent values of the uranium in the uranyl nitrate are given in Table 13, and the calculated atom densities for the B_4C absorber rods are given in Table 14.

Table 12. Calculated atom densities for uranyl nitrate solutions, HEU-SOL-THERM-035

Element	37.51 g U/L solution [atom/(barn-cm)]	74.87 gU/l solution [atom/(barn-cm)]	152.3 gU/l solution [atom/(barn-cm)]
U-234	8.6865×10^{-7}	1.7338×10^{-6}	3.5269×10^{-6}
U-235	8.5610×10^{-5}	1.7088×10^{-4}	3.4760×10^{-4}
U-236	2.0096×10^{-7}	4.0112×10^{-7}	8.1596×10^{-7}
U-238	9.3088×10^{-6}	1.8580×10^{-5}	3.7796×10^{-5}
N	3.1174×10^{-4}	$6x1064 \times 10^{-4}$	1.1324×10^{-3}
O	3.3885×10^{-2}	3.4454×10^{-2}	3.5408×10^{-2}
H	6.5631×10^{-2}	6.4695×10^{-2}	6.2794×10^{-2}

Table 13. Uranium isotopic composition, HEU-SOL-THERM-035

Isotope	Enrichment (wt %)
U-234	0.90 ± 0.06
U-235	89.08 ± 0.17
U-236	0.21 ± 0.02
U-238	9.81 ± 0.17

Table 14. Calculated atom densities for B_4C rods, HEU-SOL-THERM-035

Element	Atom density, [atom/(barn-cm)]
B-10	1.0844×10^{-2}
B-11	4.3648×10^{-2}
C	1.3623×10^{-2}

3.3.2 RESULTS

All cases were set up and run as CSAS26 inputs having 550 generations and 4000 particles per generation, skipping the first 50 generations, for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 15 lists calculated k_{eff} values and EALF along with the associated standard deviation for the computational benchmarks in this section. The suite of experiments has an average k_{eff} of 1.00360 ± 0.00066. These results agree very well with the benchmark results listed in the ICSBEP benchmark evaluation.

Table 15. Calculated k_{eff} and EALF for HEU-SOL-THERM-035

Case	k_{eff} (±σ)	EALF (±σ) (eV)	ICSBEP benchmark k_{eff} (±σ)
1	1.00032 ± 0.00058	0.03690 ± 0.00001	1.0000 ± 0.0031
2	1.00148 ± 0.00067	0.03724 ± 0.00001	1.0000 ± 0.0032
3	1.00276 ± 0.00058	0.03720 ± 0.00001	1.0000 ± 0.0030
4	1.00473 ± 0.00057	0.03693 ± 0.00001	1.0000 ± 0.0030
5	1.00193 ± 0.00071	0.04880 ± 0.00002	1.0000 ± 0.0033
6	1.00236 ± 0.00065	0.04945 ± 0.00002	1.0000 ± 0.0029
7	1.01112 ± 0.00079	0.07918 ± 0.00005	1.0000 ± 0.0035
8	0.99904 ± 0.00074	0.08319 ± 0.00005	1.0000 ± 0.0038
9	1.00869 ± 0.00073	0.08194 ± 0.00005	1.0000 ± 0.0041

3.4 HEU-SOL-THERM-037

HEXAGONALY PITCHED LATTICES OF BORON CARBIDE ABSORBER RODS IN URANIUM (89% ^{235}U) NITRATE SOLUTION

3.4.1 DESCRIPTION

The text, tables, and figures in this section were taken in whole or in part from the ICSBEP handbook, identification number HEU-SOL-THERM-037. Section 1 in the evaluation provides an excellent, concise overall description of the experimental critical assembly configurations.[24]

The nine experiments included in this evaluation were performed with uranium enriched to 89 wt % ^{235}U. Uranyl nitrate solution with a uranium concentration of 41.9, 61.4, or 83.0 g/L was pumped into the core or inner tank, a 200.0-cm-tall stainless steel cylindrical tank with an inner diameter of 160 cm and a 0.65 cm bottom and wall thickness. Three experiments were performed without absorber rods. In six experiments different numbers of boron carbide absorber rods were inserted in the core tank. The absorber rods were arranged in a hexagonal lattice with a pitch of 6.0 cm. There was a thin side and bottom water reflector in these experiments.

A concentric stainless steel jacket with a 170.6-cm OD; 155.95-cm height, and wall, top, and bottom thickness of 0.65 cm was welded to the core tank. The distance between the bottom (outer surface) of the core tank and the bottom (inner surface) of the jacket was 4.0 cm. The distance between the outer wall surface of the core tank and the inner wall surface of the jacket was also 4.0 cm. There was also a 198.4-cm ID, 300-cm-tall reflector tank, having 0.8-cm-thick walls and a 1.0-cm-thick bottom. The core tank with jacket was coaxially suspended in the reflector tank 95.85 cm above the bottom of its inner surface.

In all cases the jacket was filled to the top with distilled water and the reflector tank was empty. The core tank was partially filled with the aqueous solution of uranyl nitrate $UO_2(NO_3)_2$, with some excess nitric acid (HNO_3) to the level shown in Table 16. The empty reflector tank is not included in the model.

Table 16. Critical configuration/dimensions, HEU-SOL-THERM-037

Case number	Uranium concentration, (g/L)	Number of absorber rods	Solution height (cm)
1	41.9	0	17.8055
2	"	313	31.3895
3	61.4	0	14.8710
4	"	313	22.5203
5	"	379	15.0826
6	83.0	0	17.5148
7	"	313	11.8906
8	"	379	14.4216
9	"	451	15.6113

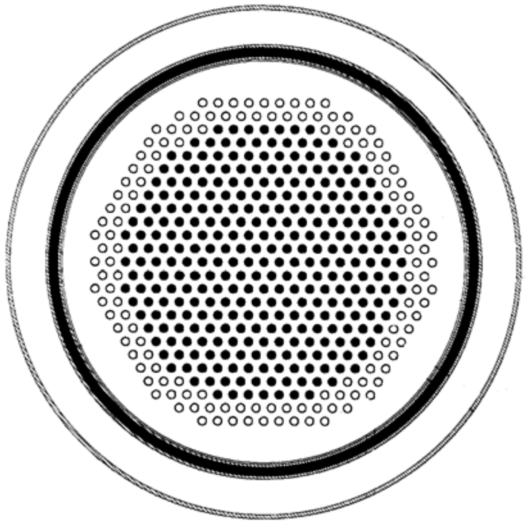
There is only solution in the core tank (no absorber rods) in Cases 1, 3, and 6. The boron absorber rods are inserted in the core tank in Cases 2, 4, 5, and 7–9. The 199.35-cm-long boron absorber rods are stainless steel tubes with outer diameters of 3.2 cm, wall thicknesses of 0.25 cm, and bottom thicknesses of 0.4 cm, filled with natural boron carbide.

The absorber rods extend to the bottom of the core tank. The configuration of the boron carbide absorber rods for each experimental setup is shown in Figure 5.

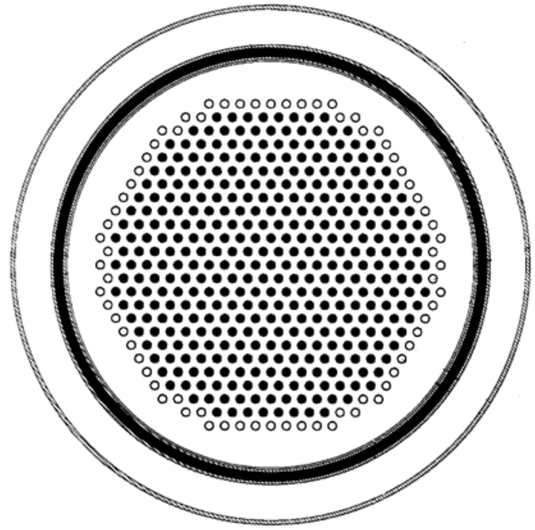
The lower stainless steel lattice plate is also included in the benchmark models of cases with absorber rods. The distance between the inner surface of the core tank bottom and lower surface of the plate is 15.0 cm. It has a diameter of 159.4 cm and is 0.5 cm thick. There are 451 holes in the plate, arranged in a hexagonal lattice with a pitch of 6.0 cm. The holes have a 3.25-cm diameter. There is no lattice plate in Cases 1, 3, and 6.

Each of the three steel channels has an outer diameter of 4.8 cm and a wall thickness of 0.2 cm. The bottom of each channel has the form of a hemisphere, 2.4 cm in outer radius and 0.2 cm in wall thickness. All the channels are submerged in the fissile solution to the same depth. There is a 3.0-cm gap between the inner surface of the vessel and the lower surface of the central channel along the axis. The space inside the channels is simulated by void.

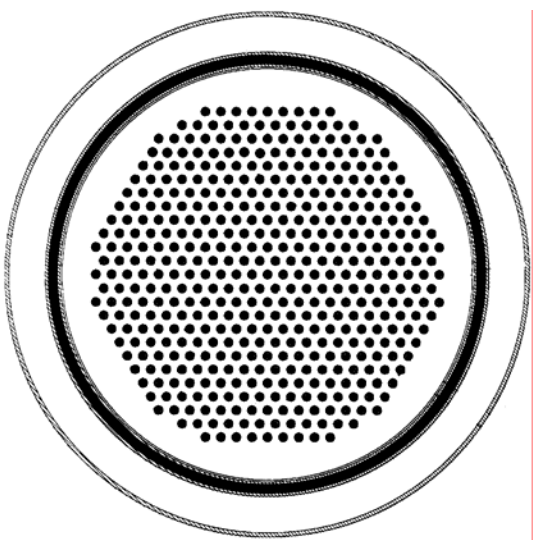
There are three separate solutions used in the experiment. For each solution a critical assembly was first created using no absorber rods. Then critical assemblies were established for each solution with different numbers and configurations of absorber rods. Calculated atom densities for the 41.9 , 61.4 , and 83.0 g U/L uranyl nitrate solutions are given in Table 17. The weight percent values of the uranium in the uranyl nitrate are given in Table 18, and the calculated atom densities for the B_4C absorber rods are given in Table 19.



Cases 2, 4, and 7



Cases 5 and 8



Case 9

Figure 5. Absorber pin positions for each critical assembly, HEU-SOL-THERM-037.

Table 17 Calculated atom densities for uranyl nitrate solutions, HEU-SOL-THERM-037

Element	41.9 g U/L solution [atom/(barn-cm)]	61.4 g U/L solution [atom/(barn-cm)]	83.0 g U/L solution [atom/(barn-cm)]
^{234}U	9.7031×10^{-7}	1.4219×10^{-6}	1.9221×10^{-6}
^{235}U	9.5630×10^{-5}	1.4014×10^{-4}	1.8943×10^{-4}
^{236}U	2.2448×10^{-7}	3.2896×10^{-7}	4.4468×10^{-7}
^{238}U	1.0398×10^{-5}	5.6990×10^{-5}	2.0598×10^{-5}
N	3.7096×10^{-4}	6x1064 × 10^{-4}	7.3772×10^{-4}
O	3.3980×10^{-2}	3.4347×10^{-2}	3.4660×10^{-2}
H	6.5455×10^{-3}	6.4892×10^{-3}	6.4345×10^{-2}

Table 18. Uranium isotopic composition, HEU-SOL-THERM-037

Isotope	Enrichment (wt %)
U-234	0.90 ± 0.06
U-235	89.08 ± 0.17
U-236	0.21 ± 0.02
U-238	9.81 ± 0.17

Table 19. Calculated atom densities for B_4C rods, HEU-SOL-THERM-037

Element	Atom density [atom/(barn-cm)]
B-10	1.0844×10^{-2}
B-11	4.3648×10^{-2}
C	1.3623×10^{-2}

3.4.2 RESULTS

All cases were set up and run as CSAS26 inputs having 550 generations and 4000 particles per generation, skipping the first 50 generations, for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 20 lists calculated k_{eff} values and EALF along with the associated standard deviation for the computational benchmarks in this section. The suite of experiments has an average k_{eff} of 1.00965 ± 0.00069. These results all calculate high relative to the benchmark results listed in the ICSBEP evaluation. However, they compare favorably with other results listed in the evaluation.

Table 20. Calculated k_{eff} and EALF for HEU-SOL-THERM-037

Case	k_{eff} (±σ)	EALF (±σ) (eV)	ICSBEP benchmark k_{eff} (±σ)
1	1.01077 ± 0.00065	0.03782 ± 0.00001	0.9980 ± 0.0034
2	1.00656 ± 0.00058	0.03876 ± 0.00001	0.9990 ± 0.0035
3	1.00897 ± 0.00062	0.04362 ± 0.00001	0.9970 ± 0.0042
4	1.01136 ± 0.00070	0.04490 ± 0.00002	0.9980 ± 0.0035
5	1.00637 ± 0.00067	0.04529 ± 0.00002	0.9980 ± 0.0042
6	1.01402 ± 0.00061	0.05056 ± 0.00002	0.9960 ± 0.0051
7	1.01313 ± 0.00072	0.05223 ± 0.00003	0.9980 ± 0.0034
8	1.00954 ± 0.00098	0.05289 ± 0.00003	0.9980 ± 0.0040
9	1.00613 ± 0.00074	0.05385 ± 0.00003	0.9980 ± 0.0047

3.5 HEU RESULTS SUMMARY

Figure 6 shows the performance of high-enriched uranium fuel at thermal energies. There are two types of problems in this section. HEU-COMP-THERM-010 consists of rectangular arrays of fuel pins consisting of 62.4 wt % enriched UO_2 and BeO surrounded by water or borated water. This configuration gives excellent results, having an average k_{eff} of 1.00070. The other three evaluations involve uranyl nitrate solutions. The worst results came from HE-SO-THERM-025, which consisted of 89.04 wt % enriched uranium in uranyl nitrate with dissolved gadolinium. These produced an average k_{eff} of 1.00943 but had individual results as much as 2% high. The other two evaluations consist of a similar uranyl nitrate solution without gadolinium, but with boron carbide absorber rods in various rectangular pitched arrays. These produced consistent results that are approximately 1% high.

These results show that high-enriched pins in a lattice with a water reflector calculate close to the experimental value of k_{eff} but uranyl nitrate solutions with an absorber calculate as much as 2% high with an average of about 1% high.

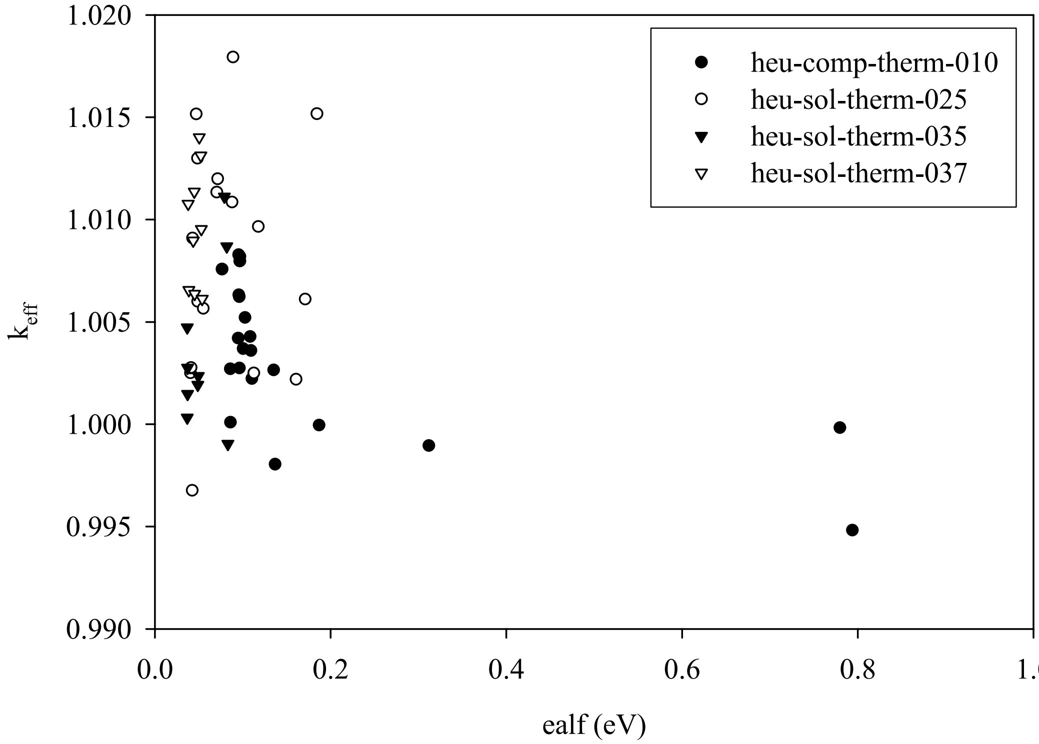


Figure 6. Summary of k_{eff} values vs EALF for high-enriched uranium.

4. INTERMEDIATE-ENRICHED URANIUM EVALUATION

4.1 IEU-COMP-THERM-002

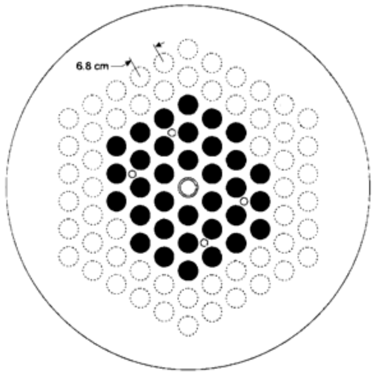
WATER-MODERATED $U(17)O_2$ ANNULAR FUEL RODS WITHOUT ABSORBER AND WITH GADOLINIUM OR CADMIUM ABSORBERS IN 6.8-cm PITCH HEXAGONAL LATTICES AT DIFFERENT TEMPERATURES

4.1.1 DESCRIPTION

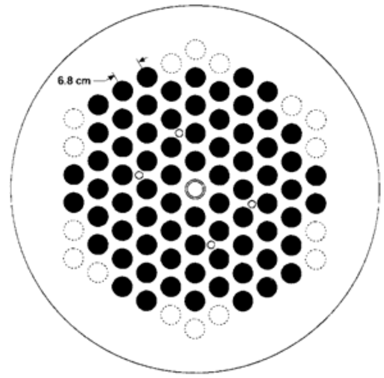
The text, tables, and figures in this section were taken in whole or in part from the ICSBEP handbook, identification number IEU-COMP-THERM-002. Section 1 in the evaluation provides an excellent, concise overall description of the experimental critical assembly configurations.[25]

The six experiments included in this evaluation were performed with stainless steel clad UO_2 fuel rods (17 wt % ^{235}U) in a water-filled tank. The fuel rods were arranged in hexagonal lattices having a pitch of 6.8 cm. Each lattice comprised one of three forms of the fuel rod: without absorber element, with gadolinium absorber element, or with cadmium absorber element in the center of each fuel rod. The lattices were fully reflected on all sides with water. The critical mass was defined for cold (~20ºC) and hot (~ 200ºC) assemblies. The six assemblies were zero-power experiments. Water for the hot assemblies was heated by an external electric heater.

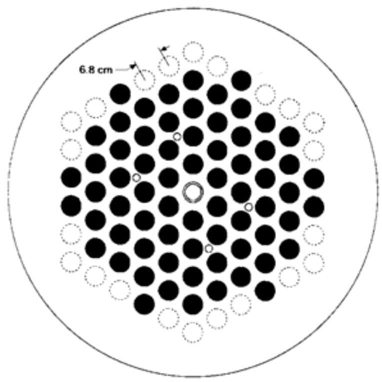
The experiments were performed in a 1.5-m-OD, 2.2-m-inside-height stainless steel tank, with a 15-cm-thick bottom and walls, and a 22-cm top. An 88.0-cm-OD, 125.0-cm-tall stainless steel annulus with a 2.0-cm-thick wall was placed inside the tank. The experiments were set up inside the annulus. The arrangement of the fuel rods in each experimental assembly is shown in Figure 7. Table 21 contains the critical parameters for each experiment.



Cases 1 and 2
(No Absorber Rods)



Cases 3 and 4
(Gd Absorber Rods)



Cases 5 and 6
(Cd Absorber Rods)

Figure 7. Fuel rod configuration for each experimental critical assembly, IEU-COMP-THERM-002.

Table 21. Critical parameters of assemblies, IEU-COMP-THERM-002

Case	Number of fuel rods	Temperature (°C)	Water density (g/cm^3)	Absorber material
1	34	22.7 ± 0.3	0.9976	—
2	34	218.4 ± 0.3	0.8439	—
3	74	16.4 ± 0.3	0.9988	Gadolinium
4	74	151.0 ± 0.3	0.9179	Gadolinium
5	68	14.5 ± 0.3	0.9991	Cadmium
6	68	150.6 ± 0.3	0.9183	Cadmium

The fuel rods consisted of two annular parts plus a possible inner rod containing absorber material. The inner annular part had two concentric stainless steel tubes of 60.6-cm length with outer diameters of 2.92 and 2.4 cm and wall thickness of 0.03 cm. The annular space between these tubes was filled with uranium dioxide The outer annular part had two concentric stainless steel tubes of 60.0-cm length with outer diameters of 4.16 and 3.66 cm and a wall thickness of 0.03 cm. The top of each annular region was closed by a 0.3-cm-thick stainless steel plug. A stainless steel spiral of 0.3-cm diameter with a spiral pitch of 40.0 cm was welded to the outer surface of the 2.92-cm-diameter tube to maintain spacing between the two fuel regions. Both fuel parts were placed in a 4.58-cm-OD, 64.9-cm-tall stainless steel tube. Atom densities of isotopes in the fuel rod materials are listed in Table 22.

Table 22. Atom densities, IEU-COMP-THERM-002

Material	Element	Atom density, [atom/(barn-cm)]
$U(17)O_2$ fuel	^{234}U	1.6683×10^{-5}
	^{235}U	1.8827×10^{-3}
	^{238}U	9.0594×10^{-3}
	O	2.2396×10^{-2}
Gadolinium absorber	Gd	2.1593×10^{-3}
	Al	1.4775×10^{-2}
	O	2.5401×10^{-2}
Cadmium absorber	Cd	2.3463×10^{-3}
	Al	1.4775×10^{-2}
	O	2.5408×10^{-2}
Stainless steel	Fe	5.9986×10^{-2}
	Cr	1.5724×10^{-2}
	Ni	8.5030×10^{-3}
	Mn	1.0431×10^{-3}
	Si	8.5018×10^{-4}
	Ti	4.7476×10^{-4}
	C	4.1748×10^{-4}
Aluminium	Al	6.0262×10^{-2}

In some experiments an absorber rod consisting of a 1.1-cm-OD stainless steel tube with a 0.3-cm wall thickness was placed in the central tube of each fuel rod. The tube was filled with Al and either Gd_2O_3 or CdO. The centers of the fuel rods are modeled as follows: the centers of the fuel rods in Cases 1 and 2 conain water, in the centers of the fuel rods in Cases 3 and 4 are the gadolinium absorber elements, in the centers of the fuel rods in Cases 5 and 6 are the cadmium absorber elements, and all the other spaces inside the fuel rods are filled with water.

In the benchmark models, there are 91 holes with a diameter of 4.7 cm in the support plate, 91 holes with a diameter of 1.5 cm in the bottom lattice plate, and 90 holes with a diameter of 4.7 cm and a central hole with a diameter of 5.06 cm in the upper lattice plate. The radius of the support plate and the lattice plates is 41 cm in the models. The pitch of fuel rods is 6.8 cm. Included in the models are four empty stainless steel tubes, the safety/control rod guide tubes, each with an outer diameter of 3.0 cm and a wall thickness of 0.3 cm. The space inside the tubes is modeled as void. During all experiments the experimental tank was completely filled with water, resulting in a bottom reflector equivalent to 25 cm, a minimum side reflector of 25 cm, and a top reflector of 35 cm.

The fuel rod lattices were investigated at both room temperature (cold) and raised temperatures (hot). Critical conditions were achieved with the same loading at the two different temperatures for each of the three assemblies.

4.1.2 Results

All cases were set up and run as CSAS26 inputs having 500 generations and 4000 particles per generation for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 23 lists calculated k_{eff} values and EALF along with the associated standard deviation for the computational benchmarks in this section. The suite of experiments has an average k_{eff} of 0.99569 ± 0.00063. These results agree reasonably well with the benchmark results listed in the ICSBEP benchmark evaluation, however, they are on average about 0.5% low.

Table 23. Calculated k_{eff} and EALF for IEU-COMP-THERM-002

Case	k_{eff} (±σ)	EALF (±σ) (eV)	ICSBEP benchmark k_{eff} (±σ)
1	0.99942 ± 0.00058	0.0889 ± 0.0001	1.0004 ± 0.0039
2	0.99808 ± 0.00062	0.1333 ± 0.0002	1.0005 ± 0.0040
3	1.00006 ± 0.00059	0.0987 ± 0.0000	1.0007 ± 0.0044
4	0.99417 ± 0.00072	0.1105 ± 0.0001	1.0004 ± 0.0044
5	0.98947 ± 0.00059	0.1041 ± 0.0001	1.0002 ± 0.0043
6	0.99294 ± 0.00069	0.1294 ± 0.0001	1.0000 ± 0.0044

4.2 IEU-SOL-THERM-001

GRAPHITE-REFLECTED URANYL SULPHATE (20.9%) ^{235}U SOLUTIONS

4.2.1 Description

The text, tables, and figures in this section were taken in whole or in part from the ICSBEP handbook, identification number IEU-COMP-THERM-001. Section 1 in the evaluation provides an excellent, concise overall description of the experimental critical assembly configurations.[26]

Four critical assembly configurations with different concentrations of uranium in an aqueous solution of uranyl sulphate (~20.9% at ^{235}U) are examined in this set of experiments. In its outward shape the benchmark model is a rectangular parallelepiped with a height of 116.4 cm and a cross section of 160 × 138 cm. Figure 8 is a general schematic of the longitudinal section of the assembly. Figure 9 is a schematic of the assembly showing all transverse dimensions needed and arrangement of the channels at the section. The space below and above the graphite reflector and next to its side surfaces is modeled as void.

The aqueous solution of uranyl sulphate is contained in the steel vessel, which has an inner diameter of 30.5 cm. Two different vessels are used for this set of critical experiments. A 0.5-cm-thick vessel is used for Cases 1, 2, and 4. A 0.3-cm-thick vessel is used for Case 3. The longitudinal section of the core and vessel model is shown in Figure 10, which gives dimensions needed for the assembly. The vessel also contains a coiled cooling pipe that contains water. Table 24 lists the values of the uranyl sulphate solution heights for each critical assembly as well as the uranium concentration and solution volume. The uranyl sulphate solution characteristics for each solution are shown in Table 25, and the uranium isotropics in the solution are listed in Table 26.

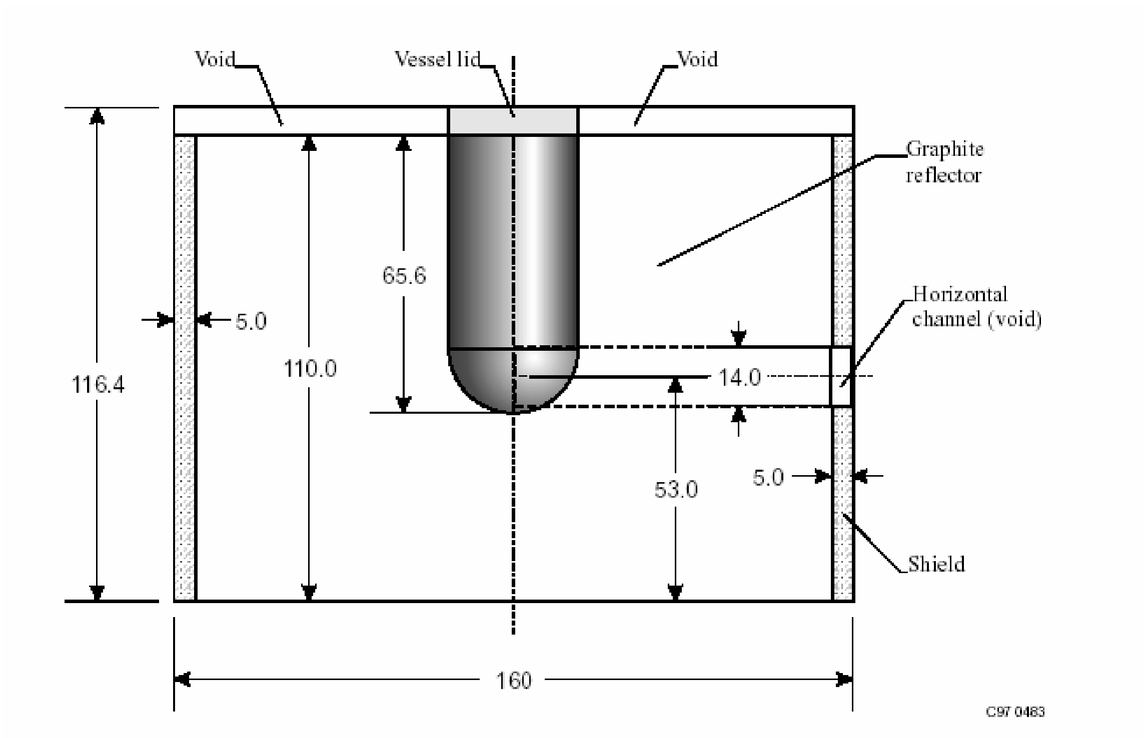


Figure 8. Schematic of the longitudinal section of the assembly for IEU-COMP-THERM-001.

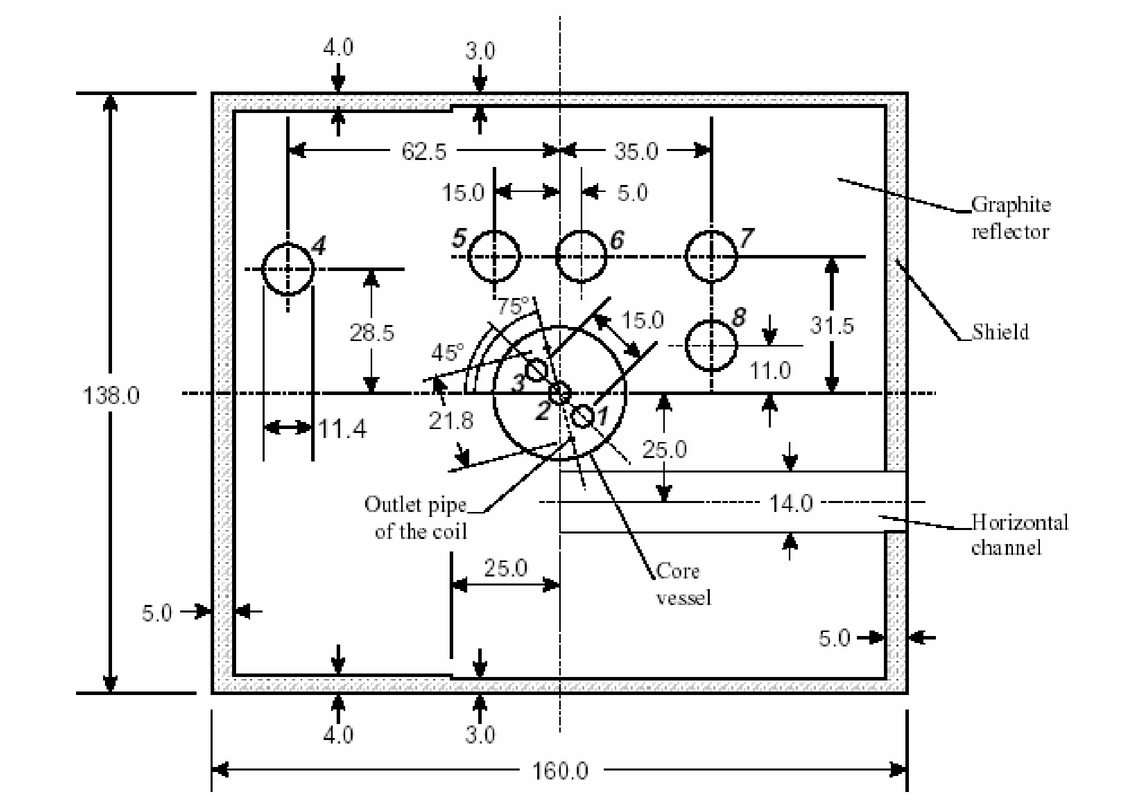


Figure 9. Schematic of the IEU-COMP-THERM-001 assembly cross section.

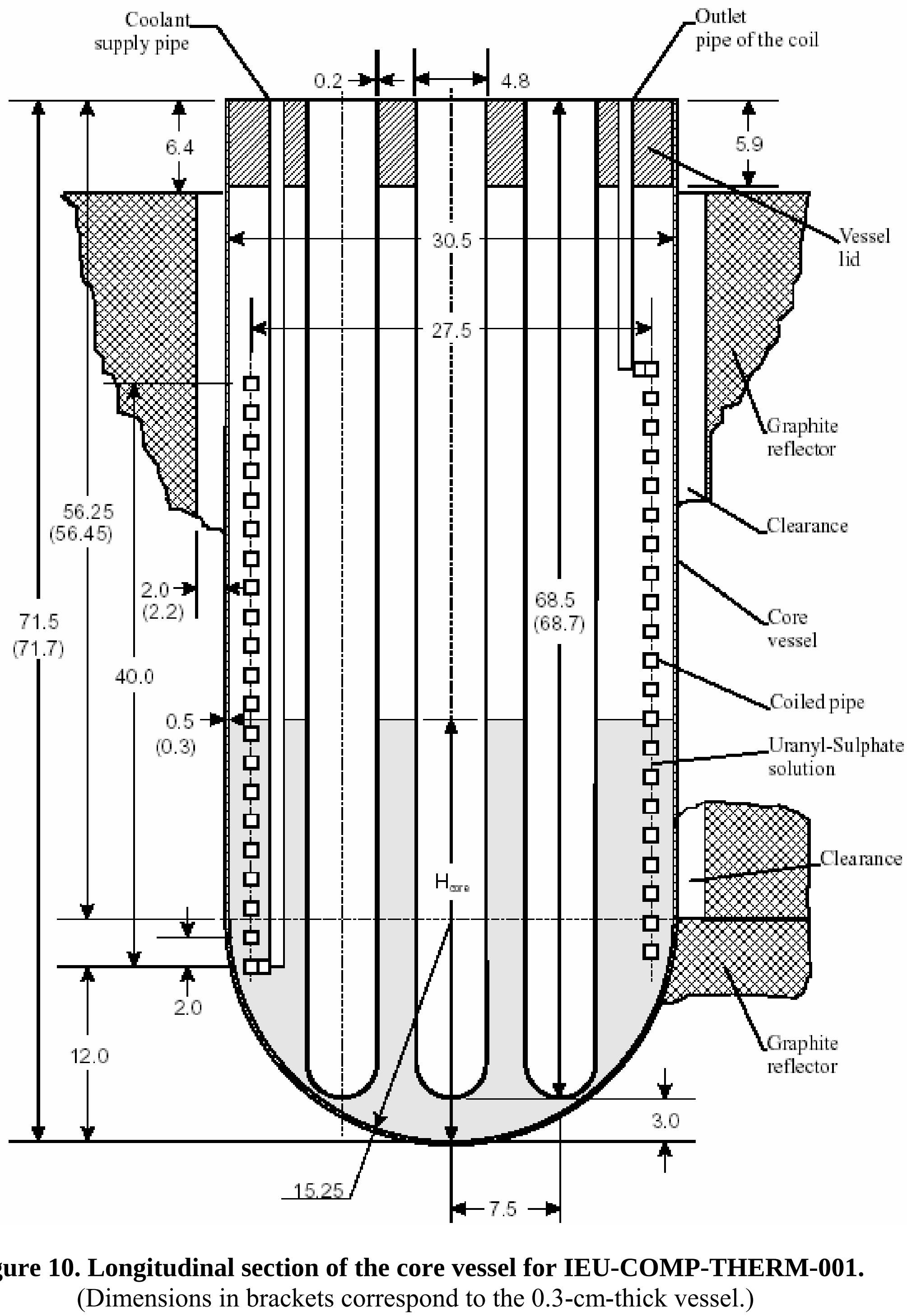


Figure 10. Longitudinal section of the core vessel for IEU-COMP-THERM-001.
(Dimensions in brackets correspond to the 0.3-cm-thick vessel.)

Table 24. Critical parameters of experimental setups for IEU-COMP-THERM-001

Case	Solution height (cm)	Uranium concentration (gU/L)	Vessel Thickness (cm)	Critical volume (L)
1	49.240	263.3 ± 0.5	0.5 ± 0.01	28.50 ± 0.03
2	33.498	382.2 ± 0.8	0.5 ± 0.01	18.40 ± 0.03
3	32.251	382.2 ± 0.8	0.3 ± 0.01	17.60 ± 0.03
4	29.056	505.0 ±1.0	0.5 ± 0.01	15.55 ± 0.03

Table 25. Uranyl sulphate solution properties, IEU-COMP-THERM-001

Case	Uranium concentration (g U/L)	Solution density (g/cm^3)	Excess H_2SO_4 (mol/L)
1	263.3	1.3373	0.050
2	382.2	1.4945	0.050
3	382.2	1.4945	0.050
4	505.0	1.6527	0.050

Table 26. Uranium isotopic composition, IEU-COMP-THERM-001

Isotope	Enrichment (wt %)
U-234	0.15 ± 0.003
U-235	20.90 ± 0.050
U-236	0.211 ± 0.003
U-238	78.713 ± 0.050

4.2.2 RESULTS

All critical assembly cases were set up and run as CSAS26 inputs having 500 generations and 4000 particles per generation for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 27 lists calculated k_{eff} values and EALF along with the associated standard deviation for the computational benchmarks in this section. The suite of experiments has an average k_{eff} of 0.98334 ± 0.00065. These results calculate 1 to 2% low compared with the benchmark results listed in the ICSBEP benchmark evaluation.

Table 27. Calculated k_{eff} and EALF for IEU-SOL-THERM-001

Case	k_{eff} (±σ)	EALF (±σ) (eV)	ICSBEP benchmark k_{eff} (±σ)
1	0.99083 ± 0.00064	0.04870 ± 0.00002	1.0000 ± 0.0052
2	0.98201 ± 0.00064	0.06119 ± 0.00003	1.0000 ± 0.0052
3	0.98187 ± 0.00071	0.06054 ± 0.00003	1.0000 ± 0.0052
4	0.97865 ± 0.00063	0.07724 ± 0.00004	1.0000 ± 0.0052

4.3 IEU RESULTS SUMMARY

Figure 11 shows the performance of intermediate-enriched uranium fuel at thermal energies. Two types of problems were described in this section. IEU-COMP-THERM-002 consists of triangular arrays of fuel pins consisting of 17 wt % enriched UO_2 surrounded by water. This configuration gives results that calculate as much as 1% low with an average k_{eff} of 0.99569. The other evaluation, IEU-SOL-THERM-001, involves uranyl sulphate solutions. These cases calculate between 1 and 2% low, with an average k_{eff} of 0.98334.

These results show that intermediate-enriched pins in a lattice with a water reflector calculate on average about 0.5% low and uranyl sulphate solutions calculate about 1.5% low.

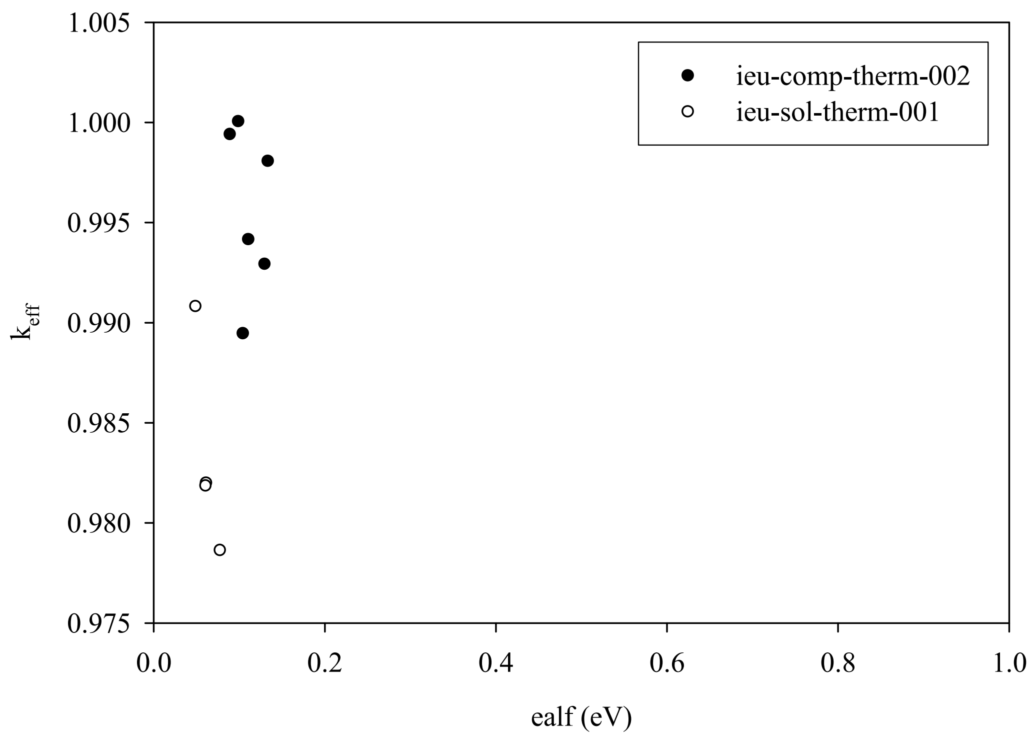


Figure 11. Summary of k_{eff} values vs EALF for intermediate-enriched uranium.

5. LOW-ENRICHED URANIUM EVALUATION

5.1 LEU-COMP-THERM-031

WATER-MODERATED HEXAGONALLY PITCHED PARTIALLY FLOODED LATTICES OF $U(5\%)O_2$ ZIRCONIUM-CLAD FUEL RODS, 0.8 cm PITCH

5.1.1 DESCRIPTION

The text, tables, and figures in this section were taken in whole or in part from the ICSBEP handbook, identification number LEU-COMP-THERM-031. Section 1 in the evaluation provides an excellent, concise overall description of the experimental critical assembly configurations.[27]

Six configurations of critical assemblies with water-moderated hexagonally pitched lattices with low-enriched (approximately 5% ^{235}U) cylindrical fuel rods are examined in this set of experiments. These critical lattices consist of partially flooded water-moderated uniform hexagonally pitched lattices of zirconium clad cylindrical fuel rods having a pitch of 8 mm. The experiments were performed in a large stainless steel tank having a 25-mm-thick wall. Each lattice is a roughly cylindrical arrangement of fuel rods with a water moderator and reflector. The fuel lattice sat in the tank so that there was at least 1100 mm of water below the fuel and 500 mm of water surrounding the fuel. The critical configurations and the fuel rod lattice, as modeled, are shown in Figure 12. Figure 13 contains a schematic of how the fuel rods sit between the top and bottom plate. For each critical configuration the water level was raised until the core went critical. In all cases the critical water level was in the fuel region. The critical water height was measured from the bottom plane of the fuel. Critical numbers of fuel rods and critical height of water for the six cases are given in Table 28.

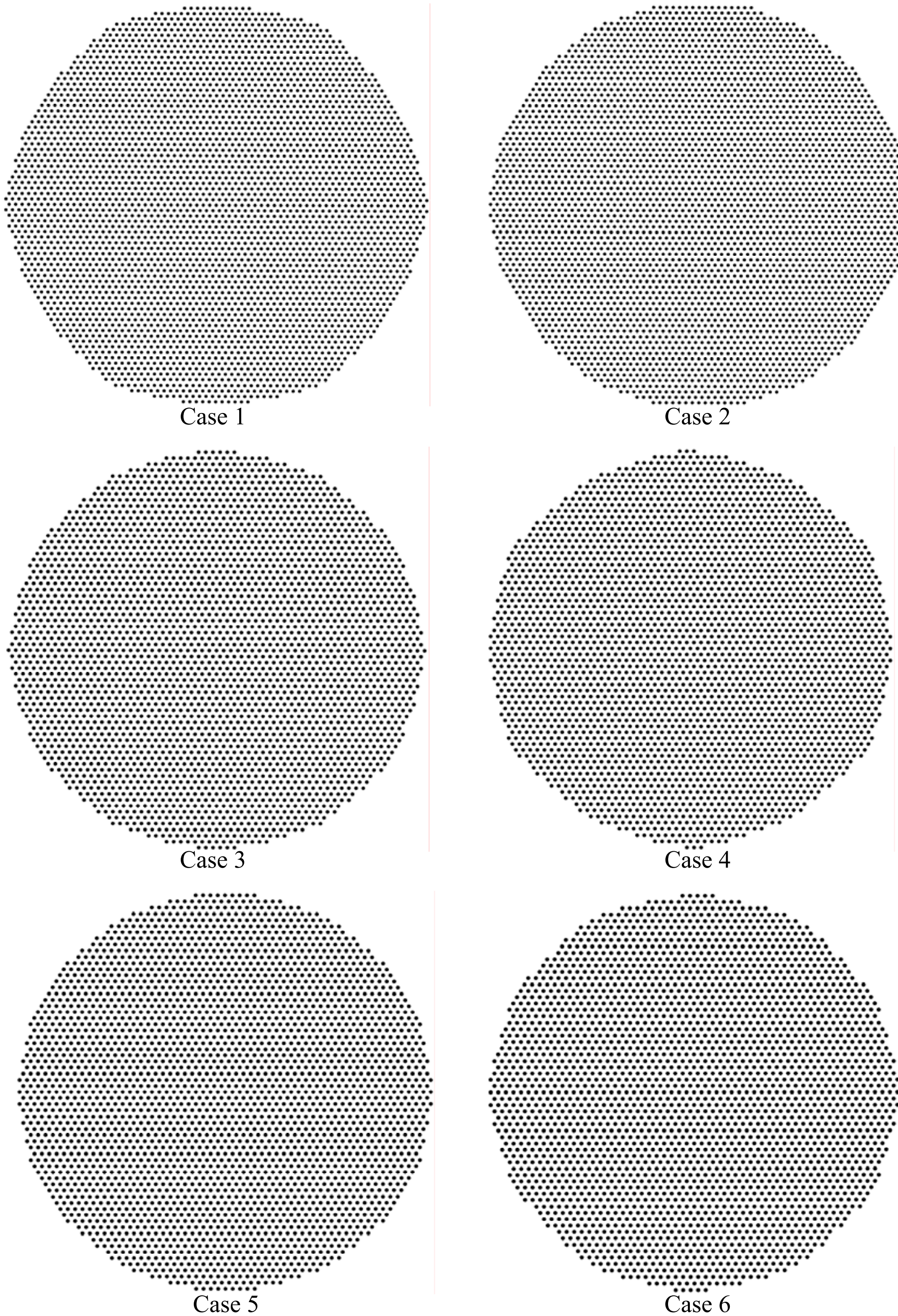


Figure 12. Fuel rod configuration for each experimental critical assembly, LEU-COMP-THERM-031.

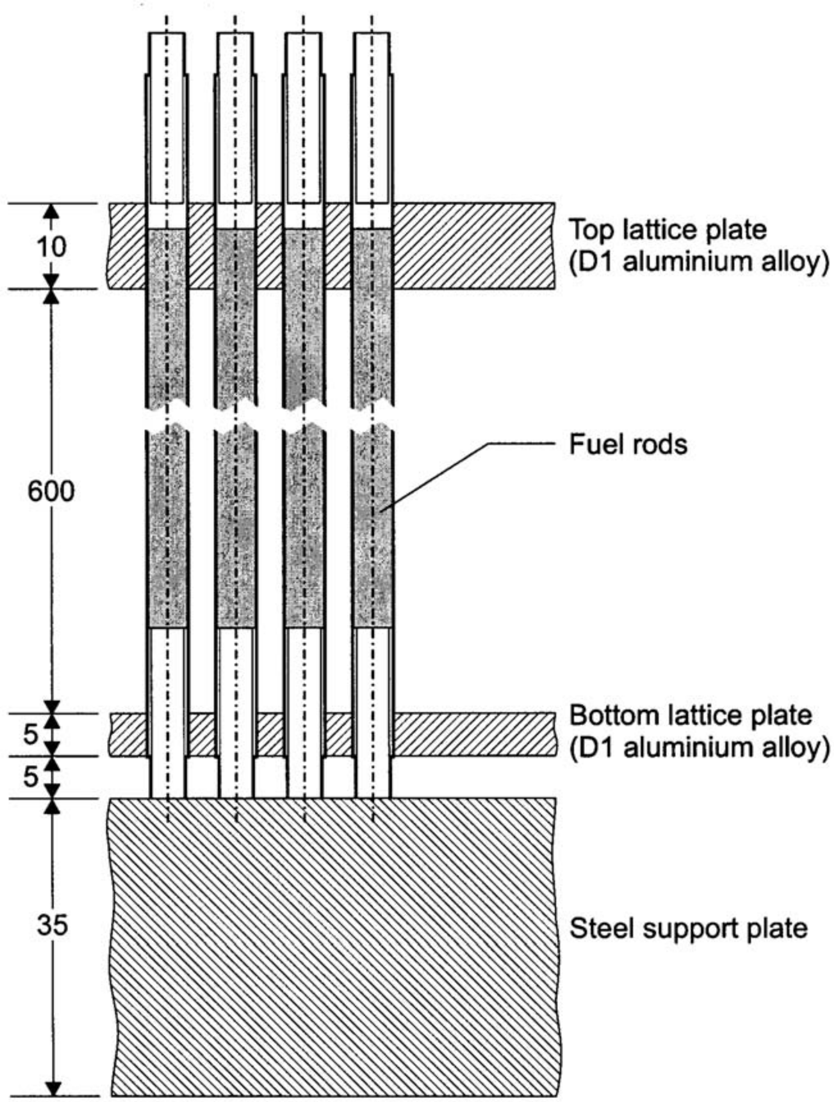


Figure 13. Schematic of fuel rod placement in the core, LEU-COMP-THERM-031.

Table 28. Number of fuel rods and water height for critical configuration, LEU-COMP-THERM-031

Case	Critical water height (mm)	Critical number of fuel rods
1	337.6	3717
2	344.9	3710
3	407.0	3011
4	408.9	2903
5	414.3	2877
6	452.3	2649

The cylindrical fuel rods used in the experiments consisted of a 0.75-mm-thick zirconium alloy 110 clad containing UO_2 pellets. The average fuel height of a rod was 596.6 mm. The pellets fit tightly so that no radial gap was present between the rod wall and pellets. The rods had a top and bottom 20-mm-high cylindrical zirconium alloy 110 plug and a ~3.4 mm air gap, resulting in an overall rod length of 640 mm. The UO_2 in the rod had a density of 9.2416 g/cm^3 and contained uranium having an average enrichment of 5.059 at. %. The average material characteristics for the fuel, cladding, lattice plates, and water are listed in Table 29.

Table 29. Summary of experimental model materials for LEU-COMP-THERM-031

Material description	Density (g/cm^3)	Element	Atom density [atoms/(barn-cm)]	wt %
Water (H_2O)	0.9982	H	6.6736×10^{-2}	
(moderator and reflector)		0	3.3368×10^{-2}	
Aluminum alloy D1	2.7	Al	5.6526×10^{-2}	93.8
(lattice plates)		Fe	2.0380×10^{-4}	0.7
		Cu	1.1003×10^{-3}	4.3
		Mg	4.0139×10^{-4}	0.6
		Mn	1.7758×10^{-4}	0.6
Zirconium alloy 110	6.48	Zr	4.2157×10^{-2}	98.5516
(clad and end caps)		V	1.8155×10^{-6}	0.00237
		Cu	1.4493×10^{-6}	0.00236
		Nb	5.7544×10^{-4}	1.37
		Mo	4.0675×10^{-6}	0.01
		Ta	5.6719×10^{-7}	0.00263
		Ni	8.8432×10^{-6}	0.0133
		Hf	1.0165×10^{-5}	0.0465
UO_2 fuel	9.2416	U-234	6.3924×10^{-6}	
		U-235	1.0432×10^{-3}	
		U-236	6.3924×10^{-6}	
		U-238	1.9565×10^{-2}	
		0	4.1241×10^{-2}	

5.1.2 Results

All cases were set up and run as CSAS26 inputs having 500 generations and 4000 particles per generation for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 30 lists calculated k_{eff} values and EALF along with the associated standard deviation for the benchmarks in this section. The suite of experiments has an average k_{eff} of 0.98918 ± 0.00067. These results calculate on average about 1% low when compared with the benchmark results listed in the ICSBEP benchmark evaluation.

Table 30. Calculated k_{eff} and EALF for LEU-COMP-THERM-031

Case	k_{eff} (±σ)	EALF (±σ) (eV)	ICSBEP benchmark k_{eff} (±σ)
1	0.98618 ± 0.00072	0.3562 ± 0.0009	1.0000 ± 0.0045
2	0.99218 ± 0.00062	0.3516 ± 0.0008	1.0000 ± 0.0045
3	0.99249 ± 0.00079	0.3195 ± 0.0007	1.0000 ± 0.0045
4	0.98701 ± 0.00061	0.3186 ± 0.0007	1.0000 ± 0.0045
5	0.98835 ± 0.00063	0.3170 ± 0.0007	1.0000 ± 0.0045
6	0.98888 ± 0.00066	0.3040 ± 0.0006	1.0000 ± 0.0045

5.2 LEU-COMP-THERM-032

UNIFORM WATER-MODERATED LATTICES OF RODS WITH $U(10\%)O_2$ FUEL IN RANGE FROM 20°C TO 274°C

5.2.1 Description

The text, tables, and figures in this section were taken in whole or in part from the ICSBEP handbook, identification number LEU-COMP-THERM-032. Section 1 in the evaluation provides an excellent, concise overall description of the experimental critical assembly configurations.[28]

This evaluation describes nine critical experiments of uniform, fully flooded hexagonal lattices with pitch values of 0.7, 1.4, and 1.852 cm at three different temperatures (ranging from 20 to 274°C) for each lattice. The room-temperature experiments were performed in an open-top stainless steel tank having a 1590-mm ID and a 2550-mm inside height. Experiments at higher temperatures were performed in a stainless steel pressure vessel at 14.7 MPa. The pressure vessel had 1400-mm ID, an inside height of 3000 mm, and a wall thickness of 150 mm. The room-temperature experiments had at least 200 mm of water above the fuel, 1000 mm beneath the fuel, and a radial reflector of at least 500 mm. The hot experiments had a top and bottom water reflector of at least 1000 mm and a radial reflector of at least 400 mm. Table 31 lists the fuel rod pitch, water temperature, and number of fuel rods for each experiment. Figure 14 and Figure 15 show a cross section of the fuel rod array configuration for each experiment.

Table 31. Critical array descriptions, LEU-COMP-THERM-032

Array	Pitch (cm)	Temperature (°C)	Critical number of fuel rods
1	0.7	20	2002
2	"	166	2323
3	"	263	3058
4	1.4	20	421
5	"	206	481
6	"	274	565
7	1.852	20	523
8	"	193	523
9	"	263	559

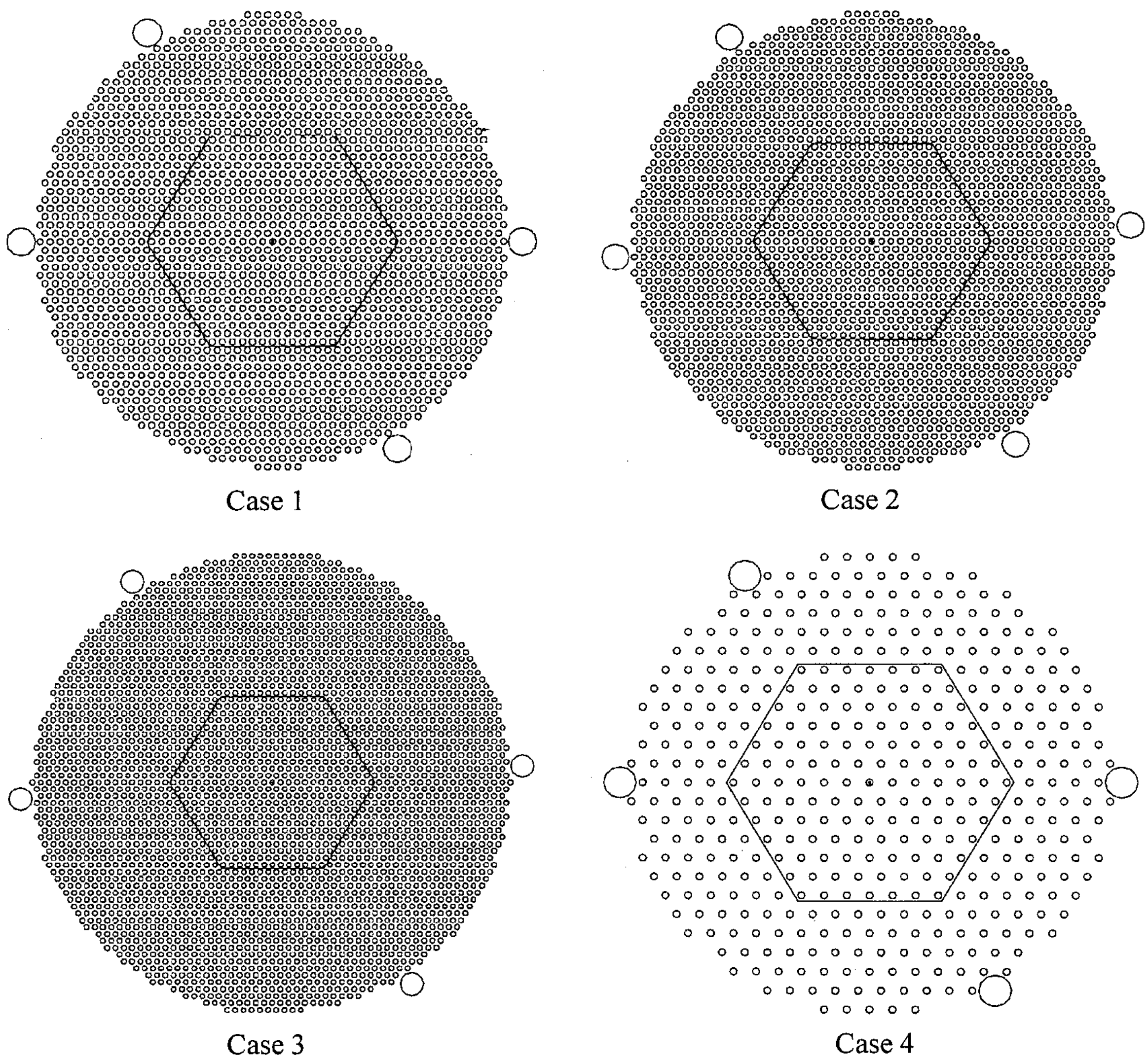


Figure 14. Fuel rod configuration for Case 1–4 critical assemblies, LEU-COMP-THERM-032.

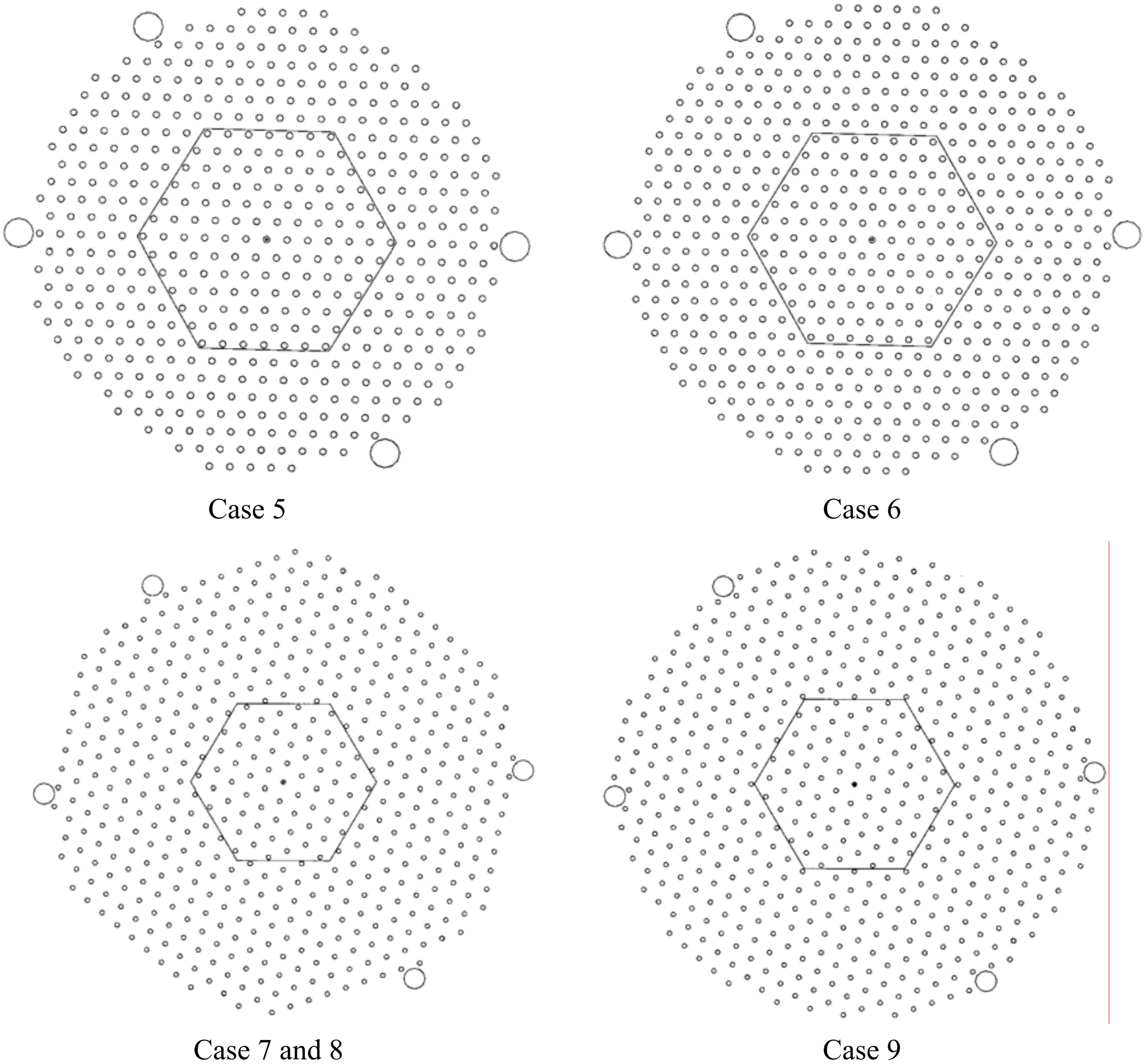


Figure 15. Fuel rod configuration for Cases 5–9 critical assemblies, LEU-COMP-THERM-032.

The fuel rods consist of UO_2 pellets (at an enrichment of 9.83 wt % ^{235}U) clad in stainless steel in a hexagonal array with a water moderator and reflector. The UO_2 pellets (having a 4.16 mm diameter) are encased in a 5.1-mm OD stainless steel rod creating an overall fuel length of 856 mm. Each rod contained an average of 113.48 g of UO_2, which results in 99.6752 g of uranium. The UO_2 in the rods had an average density of 9.7537 g/cm^3. The average density of the stainless steel was 7.90 g/cm^3. Table 32 shows the atom densities for the fuel, cladding, and water, and Table 33 lists the weight percent of the uranium used in the fuel.

Table 32. Atomic densities of materials used in LEU-COMP-THERM-032

Material	Isotope	Atom density [atoms/(barn-cm)]
UO_2 Fuel	^{234}U	1.7636×10^{-5}
	^{235}U	2.1577×10^{-3}
	^{236}U	1.5300×10^{-5}
	^{238}U	1.9510×10^{-2}
	O	4.4661×10^{-2}
Stainless Steel	Fe	5.8894×10^{-2}
Clad and	Cr	1.6469×10^{-2}
End Caps	Ni	8.1061×10^{-3}
0X 18H9T	Si	1.3551×10^{-3}
	Mn	1.2990×10^{-3}
	C	2.3766×10^{-4}
	Ti	4.4713×10^{-4}
Water (20°C)	H	6.6736×10^{-2}
	0	3.3368×10^{-2}
Water (166°C)	H	6.0827×10^{-2}
	O	3.0414×10^{-2}
Water (193°C)	H	5.8977×10^{-2}
	O	2.9488×10^{-2}
Water (206°C)	H	5.8004×10^{-2}
	O	2.9002×10^{-2}
Water (263°C)	H	5.2913×10^{-2}
	O	2.6456×10^{-2}
Water (274°C)	H	5.1717×10^{-2}
	O	2.5859×10^{-2}

Table 33. Uranium isotopic composition, LEU-COMP-THERM-032

Isotope	Enrichment (wt %)
U-234	0.08 ± 0.04
U-235	9.83 ± 0.10
U-236	0.07 ± 0.04
U-238	90.02 ± 0.10

5.2.2 RESULTS

All cases were set up and run as CSAS26 inputs having 500 generations and 4000 particles per generation for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 34 lists calculated k_{eff} values and EALF along with the associated standard deviation for the benchmarks in this section. The suite of experiments has an average k_{eff} of

0.99992 ± 0.00058. These results agree on average very well with the benchmark results listed in the ICSBEP benchmark evaluation; however, the individual cases range from over 1% low to 1% high.

Table 34. Calculated k_{eff} and EALF for LEU-COMP-THERM-032

Case	k_{eff} (±σ)	EALF (±σ) (eV)	ICSBEP benchmark k_{eff} (±σ)
1	0.99749 ± 0.00056	0.70929 ± 0.00144	1.0000 ± 0.0045
2	0.98935 ± 0.00070	0.87356 ± 0.00190	1.0000 ± 0.0041
3	0.98670 ± 0.00053	1.23269 ± 0.00277	1.0000 ± 0.0042
4	1.00956 ± 0.00055	0.06919 ± 0.00007	1.0000 ± 0.0037
5	0.99878 ± 0.00056	0.07466 ± 0.00009	1.0000 ± 0.0032
6	0.99850 ± 0.00067	0.08020 ± 0.00010	1.0000 ± 0.0033
7	1.01053 ± 0.00054	0.05424 ± 0.00006	1.0000 ± 0.0045
8	1.00405 ± 0.00064	0.05629 ± 0.00006	1.0000 ± 0.0038
9	1.00440 ± 0.00054	0.05842 ± 0.00006	1.0000 ± 0.0037

5.3 LEU-SOL-THERM-005

BORON CARBIDE ABSORBER RODS IN URANIUM (5.64% ^{235}U) NITRATE SOLUTION

5.3.1 DESCRIPTION

The text, tables, and figures in this section were taken in whole or in part from the ICSBEP handbook, identification number LEU-SOL-THERM-005. Section 1 in the evaluation provides an excellent, concise overall description of the experimental critical assembly configurations.[29]

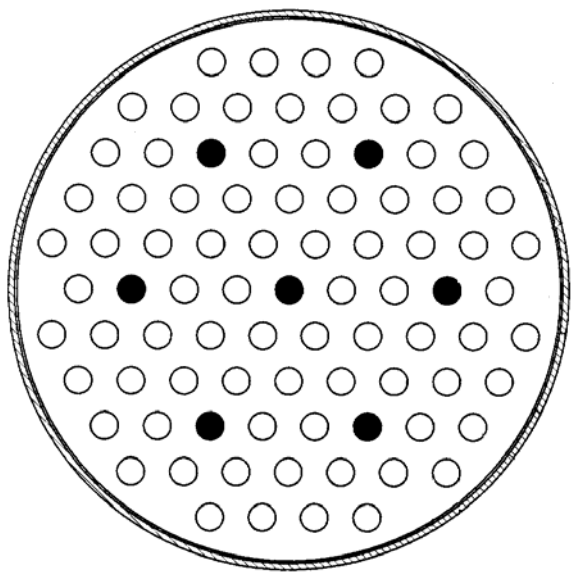
The three experiments included in this evaluation were performed with uranium enriched to 5.64 wt % ^{235}U. Uranyl nitrate solution with a uranium concentration of 400.2 g/L was pumped into the core or inner tank, a stainless steel cylindrical tank with an inner diameter of 110 cm. One experiment was performed without absorber rods, another one with a central rod, and another one with a cluster of seven absorber rods arranged at the corners and center of a hexagon with a pitch of 31.8 cm, inserted in the center of the core tank. There was a thick side and bottom water reflector in these experiments.

The model contains two open-top coaxial stainless steel cylindrical tanks. The core tank had a 110.0-cm ID, 0.6-cm wall thickness, a 1.5-cm bottom thickness, and a 250.0-cm overall height. It was filled with a solution of uranyl nitrate to the height (measured from the inner surface of the tank bottom) shown in Table 35. The reflector tank had a 198.4-cm ID, 0.8-cm wall thickness, 1.0-cm bottom thickness, and 287.0-cm overall height. It was filled with water to the height of 108.0 cm (measured from the inner surface of the core tank bottom). The distance between the inner surface of the reflector tank bottom and the outer surface of the core tank bottom is 36.0 cm.

Table 35. Geometrical sizes of benchmark models, LEU-SOL-THERM-005

Case	Number of absorber rods	Solution height (cm)
1	0	58.9839
2	1	65.2501
3	7	106.6233

There are three experimental configurations. Case 1 contains no absorber rods. Case 2 contains one absorber rod in the center of the core tank. Case 3 contains a cluster of seven boron absorber rods in a hexagonal lattice (one rod at each corner of the hexagon and one rod at the center) inserted in the center of the core tank. The pitch of the lattice is 31.8 cm. Figure 16 contains a schematic of the Case 3 lower lattice plate with the absorber rods installed.



Case 3

Figure 16. Absorber rod configuration for the Case 3 critical assemblies, LEU-SOL-THERM-005.

The boron absorber rods are stainless steel tubes with a 5.5-cm OD, 0.5-cm wall thickness, 0.7-cm bottom thickness, and 248.5-cm length, filled with natural boron carbide having a density of 1.25 g/cm^3. The absorber rods extend to the bottom of the core tank. The top surface of the absorber rods is coplanar with the top surfaces of the core and reflector tanks. The lower stainless steel lattice plate is also included in the three benchmark models. This plate is lying on the bottom of the core tank. It has a diameter of 109.6 cm and is 1.7 cm thick. There are 85 holes in the plate arranged in a hexagonal lattice with a pitch of 10.6 cm. The arrangement of the 5.5-cm diameter holes in the plate is shown in Figure 16. Atom densities of isotopes in the boron carbide are listed in Table 36.

The uranyl nitrate solution contains excess dissolved nitric acid and diluted distilled water. The uranium concentration in the solution was 400.2 g/L, the solution density was 1.590 g/cm,[3] and the concentration of nitric acid was 1.6 mol/L. Atom densities of isotopes in the solution are listed in Table 37.

Table 36. Boron carbide atom densities, LEU-SOL-THERM-005

Element	Atom density [atoms/(barn-cm)]
^{10}B	1.0844×10^{-2}
^{11}B	4.3648×10^{-2}
C	1.3623×10^{-2}

Table 37. Solution atom densities, LEU-SOL-THERM-005

Element	Atom density [atoms/(barn-cm)]
^{234}U	3.0893×10^{-7}
^{235}U	5.7830×10^{-5}
^{236}U	5.1050×10^{-7}
^{238}U	9.5450×10^{-6}
N	2.9898×10^{-4}
O	3.8624×10^{-2}
H	5.6221×10^{-2}

5.3.2 RESULTS

All cases were set up and run as CSAS26 inputs having 500 generations and 4000 particles per generation for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 38 lists calculated k_{eff} values and EALF along with the associated standard deviation for the benchmarks in this section. The suite of experiments has an average k_{eff} of 0.99844 ± 0.00045. These results agree very well with the benchmark results listed in the ICSBEP benchmark evaluation.

Table 38. Calculated k_{eff} and EALF for LEU-SOL-THERM-005

Case	k_{eff} (±σ)	EALF (±σ) (eV)	ICSBEP benchmark k_{eff} (±σ)
1	0.99888 ± 0.00051	0.04016 ± 0.00001	1.0000 ± 0.0042
2	0.99845 ± 0.00039	0.04018 ± 0.00001	1.0000 ± 0.0051
3	0.99801 ± 0.00045	0.04028 ± 0.00001	1.0000 ± 0.0064

5.4 LEU-SOL-THERM-006

BORON CARBIDE ABSORBER RODS IN URANIUM (10% ^{235}U) NITRATE SOLUTION

5.4.1 DESCRIPTION

The text, tables, and figures in this section were taken in whole or in part from the ICSBEP handbook, identification number LEU-SOL-THERM-006. Section 1 in the evaluation provides an excellent, concise overall description of the experimental critical assembly configurations.[30]

The five experiments included in this evaluation were performed with uranium enriched to 10 wt % ^{235}U. Uranyl nitrate solution with a uranium concentration of 420.5 g/L was pumped into the core or inner tank, a stainless steel cylindrical tank with an inner diameter of 110 cm. One experiment was performed without absorber rods. In each of the four experiments a different number of boron carbide absorber rods was inserted in the core tank. The absorber rods were arranged in a hexagonal lattice with different pitches. There was a thick side and bottom water reflector in these experiments.

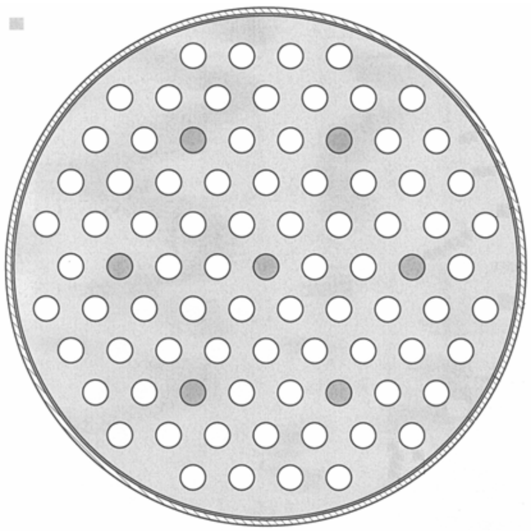
The set of experiments contains two open-top coaxial stainless steel cylindrical tanks. The core tank has a 110.0-cm ID, a 0.6-cm-wall thickness, a 1.5-cm bottom thickness, and a 250.0-cm overall height. The core tank is filled with a solution of uranyl nitrate to the heights shown in Table 39. This height is measured from the inner surface of the tank bottom. The reflector tank has a 198.4-cm ID, a 0.8-cm wall thickness, a 1.0-cm bottom thickness, and a 287.0-cm overall height. The reflector tank is filled with water to a height of 108.0 cm (measured from the inner surface of the core tank bottom). The distance between the inner surface of the reflector tank bottom and the outer surface of the core tank bottom is 36.0 cm.

There is only solution in the core tank (no absorber rods) in Case 1. The boron absorber rods are inserted in the core tank in Cases 2–5. The arrangement of the absorber rods in the tank is shown in Figure 17, and the number of the boron rods in the tank is shown in Table 39.

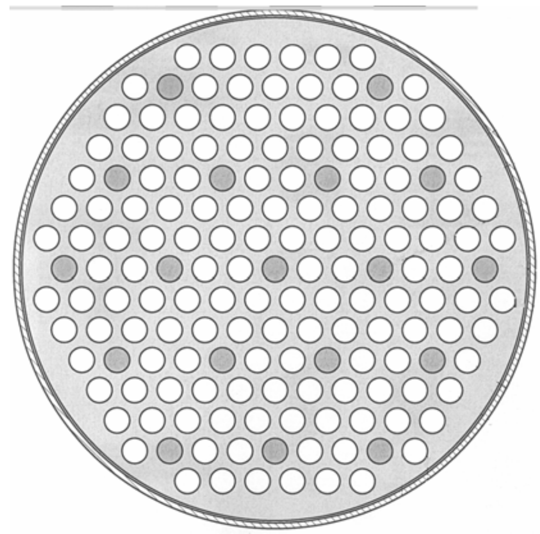
The boron absorber rods are stainless steel tubes with a 5.5-cm OD, a 0.5-cm wall thickness, a 0.7-cm bottom thickness, and a 248.5-cm length. The stainless steel tube is filled with natural boron carbide at a density of 1.25 g/cm^3. The boron carbide atom densities are listed in Table 40. The absorber rods extend to the bottom of the core tank. The top surface of the absorber rods is coplanar with the top surfaces of the core and reflector tanks.

Table 39. Geometrical sizes of benchmark models, LEU-SOL-THERM-006

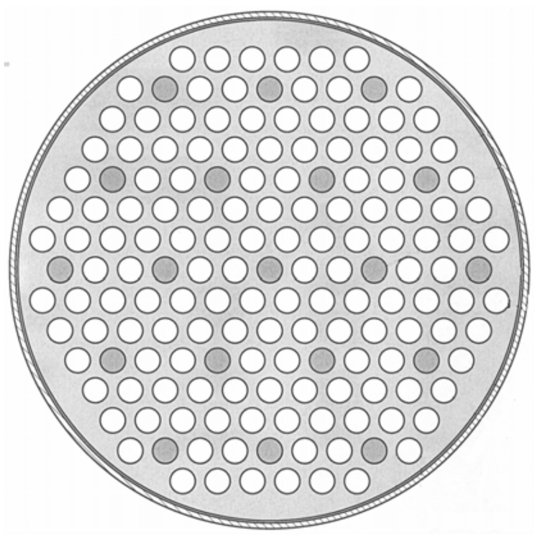
Case	Number of absorber rods	Number of holes in lattice plate	Solution height (cm)
1	0	85	23.4174
2	7	85	26.1371
3	18	163	28.7180
4	19	163	29.2573
5	31	85	36.3693



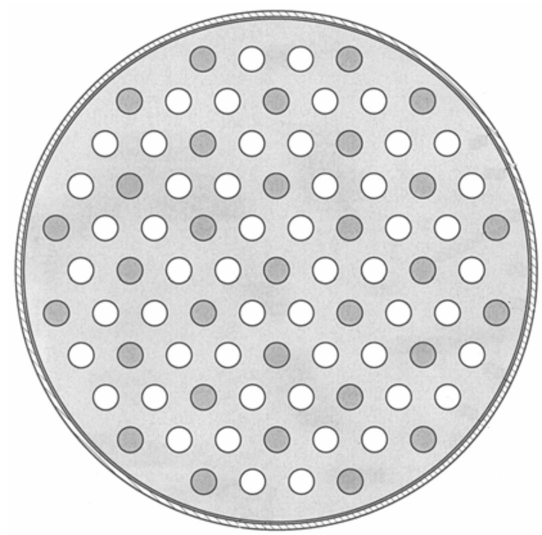
Case 2



Case 3



Case 4



Case 5

Figure 17. Absorber rod configuration for the Case 2–6 critical assemblies, LEU-SOL-THERM-006.

The lower stainless steel lattice plate is also included in the benchmark models. This plate is lying on the bottom of the core tank. It has a diameter of 109.6 cm and is 1.7 cm thick. Two kinds of lattice plates are used. The first type has 85 holes arranged in a hexagonal lattice with a pitch of 10.6 cm. The second type has 163 holes arranged in a hexagonal lattice with a pitch of 7.6 cm. The holes have a diameter of 5.55 cm. The type of lattice plate used in each particular case is shown in Table 39. The cylindrical tanks, absorber rod tubes, and base plates are made of 1X18H10T stainless steel with a density of 7.93 g/cm^3. The elements that make up the stainless steel are listed in Table 41.

The uranyl nitrate solution in all cases contained 420.5 g/L of uranium and 0.40 mol/L of nitric acid with a solution density of 1.581 g/cm^3. The uranium was enriched to 10 wt % ^{235}U. The characteristics of the solution are shown in Table 42.

Table 40. Boron carbide atom densities, LEU-SOL-THERM-006

Element	Atom density [atom/(barn-cm)]
^{10}B	1.0844×10^{-2}
^{11}B	4.3648×10^{-2}
C	1.3623×10^{-2}

Table 41. Stainless steel properties, LEU-SOL-THERM-006

Elements	wt %
Fe	69.1 ± 0.07
Cr	18.0 ± 0.05
Ni	10.0 ± 0.05
Mn	1.5 ± 0.02
Si	0.8 ± 0.01
Ti	0.6 ± 0.01

Table 42. Uranyl nitrate solution properties, LEU-SOL-THERM-006

Element	Atom density [atom/(barn-cm)]	Uranium at. %
^{234}U	9.5863×10^{-7}	0.09 ± 0.04
^{235}U	1.0854×10^{-4}	10.00 ± 0.10
^{238}U	9.5565×10^{-4}	89.91 ± 0.10
N	2.3712×10^{-3}	--
O	3.7970×10^{-2}	--
H	5.7694×10^{-2}	--

5.4.2 RESULTS

All cases were set up and run as CSAS26 inputs having 500 generations and 4000 particles per generation for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 43 lists calculated k_{eff} values and EALF along with the associated standard deviation for the benchmarks in this section. The suite of experiments has an average k_{eff} of 1.00078 ± 0.00061. These results agree well with the benchmark results listed in the ICSBEP benchmark evaluation.

Table 43. Calculated k_{eff} and EALF for LEU-SOL-THERM-006

Case	k_{eff} (±σ)	EALF (±σ) (eV)	ICSBEP benchmark k_{eff} (±σ)
1	0.99747 ± 0.00073	0.04771 ± 0.00002	1.0000 ± 0.0037
2	1.00698 ± 0.00056	0.04785 ± 0.00002	1.0000 ± 0.0038
3	0.99883 ± 0.00055	0.04834 ± 0.00002	1.0000 ± 0.0041
4	1.00030 ± 0.00060	0.04842 ± 0.00002	1.0000 ± 0.0041
5	1.00032 ± 0.00063	0.04895 ± 0.00002	1.0000 ± 0.0047

5.5 LEU RESULTS SUMMARY

Figure 18 shows the performance of low-enriched uranium fuel at thermal energies. There are two types of problems in this section. LEU-COMP-THERM-031 and LEU-COMP-THERM-032 consist of hexagonal arrays of UO_2 fuel pins with enrichments of 5 or 10 wt % surrounded by water. The 5 wt % enriched evaluations calculate approximately 1% low, having an average k_{eff} of 0.99067. The 10 wt % enriched cases span the range from 1% low to almost 1% high, resulting in an average k_{eff} of 0.99991.

The other type of evaluations, LEU-SOL-THERM-005 and LEU-SOL-THERM-006, are uranyl nitrate solutions with and without boron carbide absorber rods in a hexagonal pattern. The solution itself or the 5.64 wt % enriched uranium solution and one absorber rod produce excellent results, within 0.2%. However, when more absorber rods are added to the 10 wt % solution, the system k_{eff} increases, ranging from 0.2% to 1.0% high.

These results show that low-enriched pins in a lattice with a water reflector produce results between 1% high and 1% low, while the uranyl nitrate solutions with absorber rods produce results between critical and about 1% high.

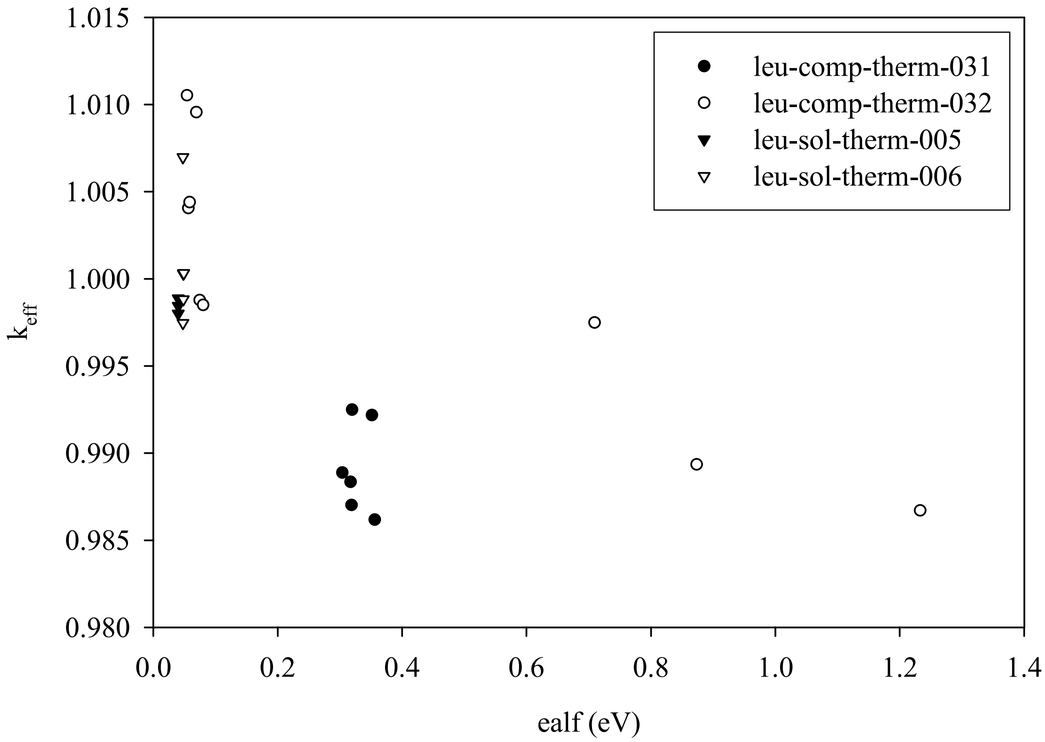


Figure 18. Summary of k_{eff} values vs EALF for low-enriched uranium.

6. MIXED URANIUM/PLUTONIUM EVALUATION

6.1 MIX-COMP-THERM-002

RECTANGULAR ARRAYS OF WATER-MODERATED UO_2-2 WT % PuO_2(8% ^{240}Pu) FUEL RODS

6.1.1 DESCRIPTION

The text, tables, and figures in this section were taken in whole or in part from the ICSBEP handbook, identification number MIX-COMP-THERM-002. Section 1 in the evaluation provides an excellent, concise overall description of the experimental critical assembly configurations.[31]

This section describes a set of six critical experiments, each consisting of a square-pitched array of mixed plutonium-uranium fuel rods submerged in water surrounded by a water reflector. The water contains boron concentrations from 0.9 to 767.2 ppm. The experiment is brought to critical by raising the water level in the tank, thus avoiding the use of control rods. The fuel rods sit on a support plate above the bottom of the tank. The tank is wide enough to assume an infinite moderator on the sides and bottom (~30 cm of water).

All fuel rods have the same physical dimensions. A schematic diagram of the fuel rods and bottom reflector is given in Figure 19. Each fuel rod has an active fuel length of 86.6775 cm, 0.5 cm of natural UO_2 at the bottom of the fuel, a 0.6985-cm cladding plug on the bottom, and a 0.8255-cm cladding plug on the top. The fuel has a radius of 0.64135 cm. The cladding has an outside radius of 0.71755 cm. A 0.3175-cm water gap is located between the top of the aluminum support plate and the bottom of the lower lattice plate. The aluminum support plate is 2.8575 cm thick. There is a 0.889-cm water gap between the bottom of the lead plate and the top of the upper lattice plate. The lead plate is 0.9525 cm thick. The top reflector varies depending on the water level for the particular problem.

The primary differences between the six benchmarks are lattice pitch, number of rods in the lattice, water level, and boron concentrations. All other benchmark characteristics are constant. There are three different lattice pitches, with each pitch used in two problems: 1.778, 2.20914, and 2.51447 cm. The fuel is arranged in a square-pitched lattice. The characteristics of each of the four lattices are given in Table 44. Table 45 lists the atom densities for all the materials in the problem except B-10 and B-11. The atom densities in Table 45 are constant for all benchmarks. Table 46 lists the atom densities of B-10 and B-11 for each benchmark. All material temperatures are assumed to be 23°C (295 K).

As shown in Table 44, the six benchmark problems differ by moderator boron concentration, number of fuel rods, lattice pitch, and upper-reflector thickness. To simplify the accumulation of power densities, advantage was taken in the symmetry of the problem whenever possible. The entire problem was explicitly modeled, but instead of having a separate unit for each pin, 1/8th symmetry was used for every problem except Case 3. Due to an irregular placement of outer rods, this problem needed to be modeled using a unit for each pin. The lattice is then filled from the 1/8th section by inserting additional pins in a mirror image. Figure 20 shows the lattice map for each problem. The remaining lattice can be extrapolated from these 1/8th sections.

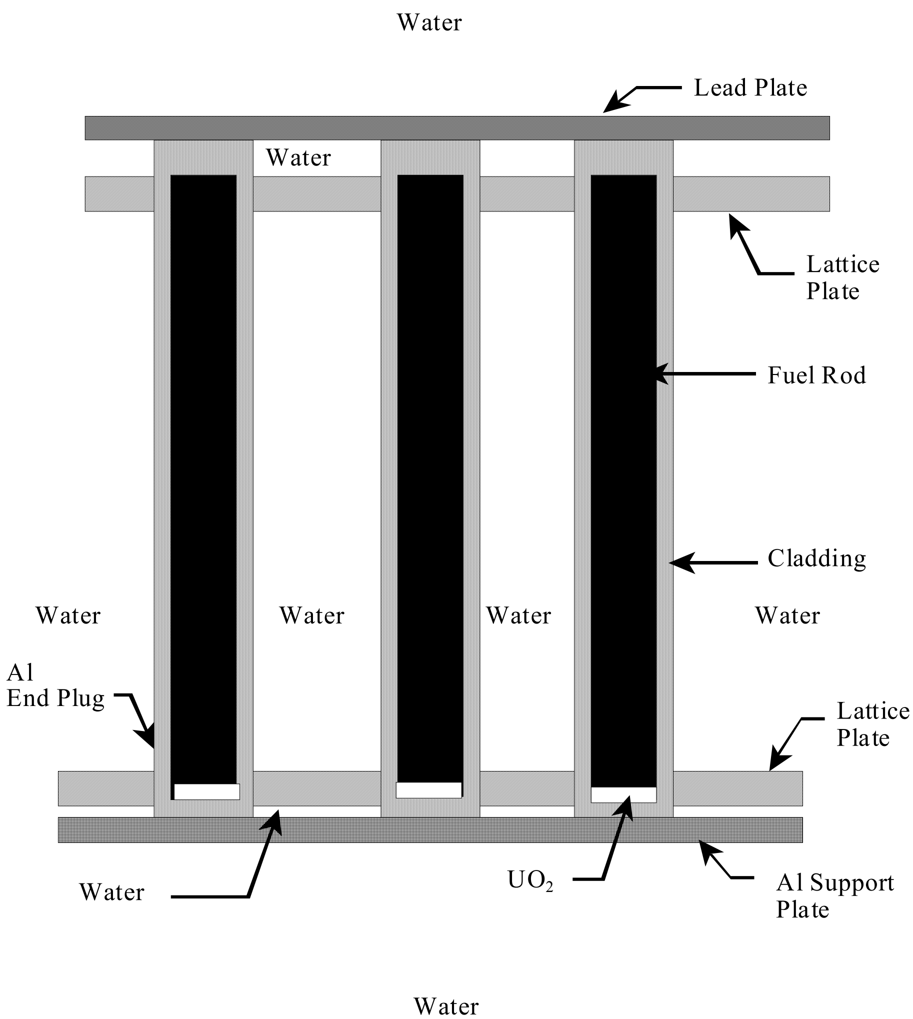


Figure 19. Cross-sectional schematic of evaluation for MIX-COMP-THERM-002.

Table 44. Lattice description for benchmarks, MIX-COMP-THERM-002

Case	Boron con. (ppm)	Critical no. rods	Lattice pitch (cm)	Water level (cm)
1	1.7	469	1.778	13.462
2	687.9	761	1.778	13.462
3	0.9	195	2.20914	3.937
4	1090.4	761	2.20914	13.462
5	1.6	160	2.51447	0.508
6	767.2	689	2.51447	13.462

Table 45. Constant benchmark atom densities, MIX-COMP-THERM-002

Material	Isotope	Atom density [atoms/(barn-cm)]	Material	Isotope	Atom density [atoms/(barn-cm)]
Fuel	U-234	1.2458×10^{-6}	Lattice plate	Si	1.3742×10^{-2}
UO_2-PuO_2	U-235	1.4886×10^{-4}	Support plate	Fe	4.5919×10^{-2}
(9.54 g/cm^3)	U-236	2.0936×10^{-9}		Cu	1.1532×10^{-4}
	U-238	2.0936×10^{-2}		Mn	9.6395×10^{-4}
	Pu-238	3.8836×10^{-8}		Mg	1.2388×10^{-4}
	Pu-239	3.9462×10^{-4}		Cr	1.7409×10^{-3}
	Pu-240	3.3206×10^{-5}		Zn	1.6617×10^{-2}
	Pu-241	1.6081×10^{-6}		Ti	4.6052×10^{-4}
	Pu-242	1.1882×10^{-7}		Al	1.5025×10^{-3}
	Am-241	1.4954×10^{-6}			
	O-16	4.3779×10^{-2}			
Natural UO_2	U-234	1.2406×10^{-6}	Cladding	Sn	4.8328×10^{-4}
(9.286 g/ cm^3)	U-235	1.4824×10^{-4}		Fe	9.5642×10^{-5}
	U-236	2.0848×10^{-9}		Cr	7.6093×10^{-5}
	U-238	2.0525×10^{-2}		Ni	3.0336×10^{-5}
	O-16	4.1943×10^{-2}		Zr	4.2621×10^{-2}
			Lead	Pb	3.2174×10^{-2}

Table 46. Moderator atom densities [atoms/(barn-cm)], MIX-COMP-THERM-002

Case	H	O	B-10	B-11
1	6.6706×10^{-2}	3.3353×10^{-2}	1.8706×10^{-8}	7.5770×10^{-8}
2	6.6605×10^{-2}	3.3400×10^{-2}	7.5838×10^{-6}	3.0718×10^{-5}
3	6.6706×10^{-2}	3.3353×10^{-2}	9.9034×10^{-9}	4.0114×10^{-8}
4	6.6672×10^{-2}	3.3427×10^{-2}	1.2034×10^{-5}	4.8746×10^{-5}
5	6.6706×10^{-2}	3.3353×10^{-2}	1.7606×10^{-8}	7.1313×10^{-8}
6	6.6682×10^{-2}	3.3405×10^{-2}	8.4597×10^{-5}	3.4266×10^{-5}

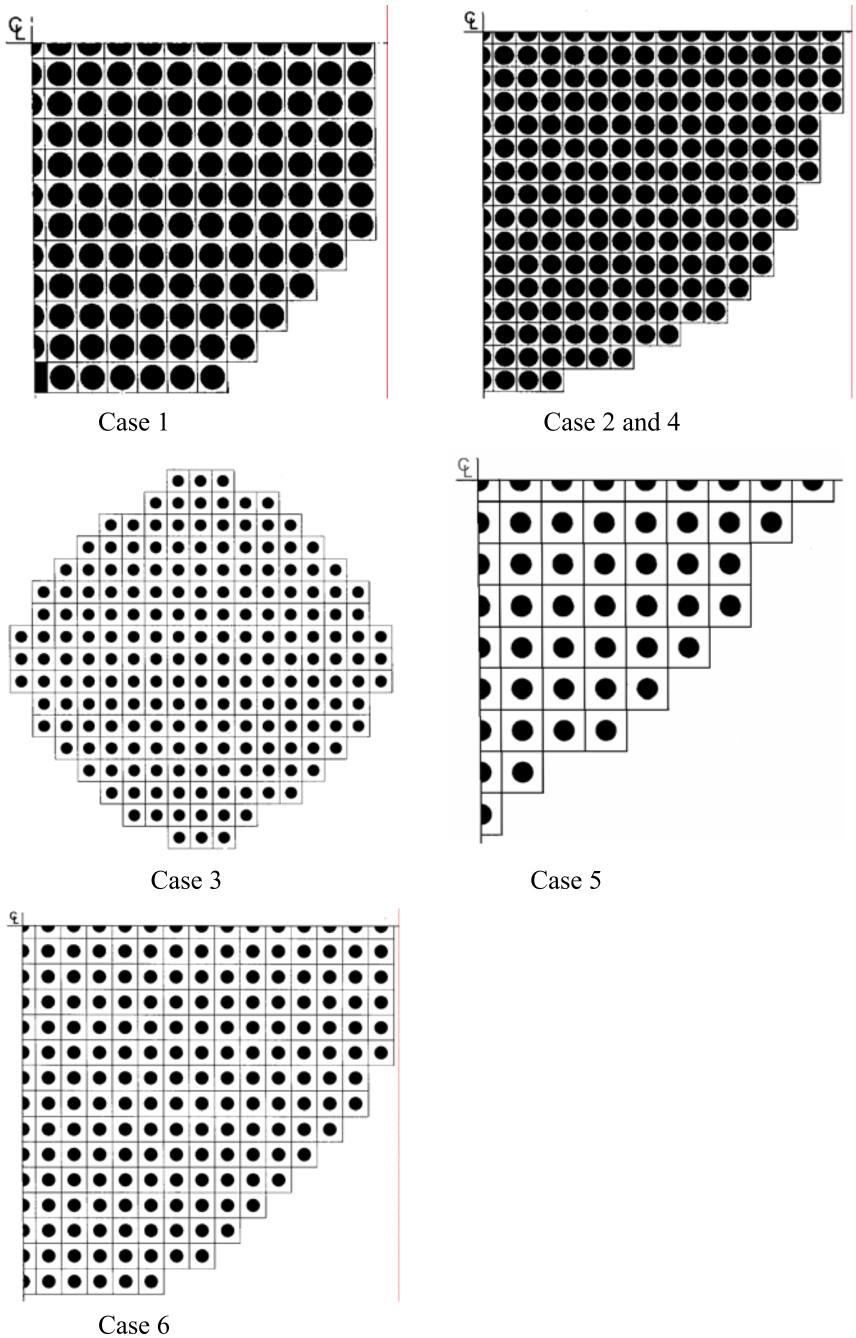


Figure 20. Fuel rod patterns for MIX-COMP-THERM-002.

6.1.2 RESULTS

All cases were set up and run as CSAS26 inputs having 500 generations and 4000 particles per generation for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 47 lists calculated k_{eff} values and EALF along with the associated standard deviation for the benchmarks in this section. The suite of experiments has an average k_{eff} of 0.99961 ± 0.00055. These results agree reasonably well on average with the benchmark results listed in the ICSBEP benchmark evaluation; however, the results range from almost 1% low to 0.2% high.

Table 47. Calculated k_{eff} and EALF for MIX-COMP-THERM-002

Case	k_{eff} (±σ)	EALF (±σ) (eV)	ICSBEP benchmark k_{eff} (±σ)
1	0.99300 ± 0.00056	0.58031 ± 0.00125	1.0024 ± 0.0060
2	0.99431 ± 0.00062	0.77223 ± 0.00169	1.0009 ± 0.0047
3	0.99792 ± 0.00056	0.19315 ± 0.00033	1.0042 ± 0.0031
4	1.00397 ± 0.00047	0.28309 ± 0.00049	1.0024 ± 0.0024
5	1.00286 ± 0.00056	0.13714 ± 0.00019	1.0038 ± 0.0025
6	1.00565 ± 0.00054	0.18256 ± 0.00028	1.0029 ± 0.0027

6.2 MIX-COMP-THERM-003

RECTANGULAR ARRAYS OF WATER-MODERATED UO_2-6.6 wt % PuO_2 FUEL RODS

6.2.1 DESCRIPTION

The text, tables, and figures in this section were taken in whole or in part from the ICSBEP handbook, identification number MIX-COMP-THERM-003. Section 1 in the evaluation provides an excellent, concise overall description of the experimental critical assembly configurations.[32]

This section describes a set of six critical experiments, each consisting of a square-pitched array of mixed plutonium-uranium fuel rods submerged in water surrounded by a water reflector. The fuel rods are identical in all cases. Criticality is controlled by varying the number of rods, rod pitch, boron in water, and water level.

The benchmark experiments are light-water-moderated critical assemblies consisting of a core array supported by upper, middle, and lower lattice plates. The lower and middle lattice plates are 0.635 cm thick. The upper lattice plate is 1.27 cm thick. The middle lattice plate was not included in the models. The experiment is brought to critical by raising the water level in the tank, thus avoiding the use of control rods. The fuel rods sit on a support plate above the bottom of the tank. The tank is wide enough to assume an infinite moderator on the sides and bottom (~30 cm of water).

All fuel rods have the same physical dimensions. A schematic diagram of the fuel rods and bottom reflector is given in Figure 21. Each fuel rod has an active fuel length of 92.964 cm, a 1.905-cm-long cladding plug on the bottom, and a 4.320-cm-long cladding plug on the top. The fuel has a diameter of 0.8570 cm. The cladding outside diameter is 0.9931 cm with a 0.0590-cm-thick wall. This leaves a 0.0090-cm gap between the fuel and cladding.

The bottom of the fuel rod and lower lattice plate rest on a 2.54-cm aluminum support plate. Between the bottom of the aluminum support plate and the top of a 5.08-cm aluminum slab is 6.35 cm of water. The space between the top of the lower lattice plate and bottom of the middle lattice plate is 46.99 cm. The space between the top of the middle lattice plate and bottom of the top lattice plate is 47.625 cm. To simplify the problem the middle lattice plate was removed and replaced with water. The water level varies with each problem but is always between the middle and upper lattice plates. The tank is large enough to assume an infinite water reflector on the sides and bottom. An infinite water reflector can be effectively modeled using 30 cm of water, which is used to model the reflector for this set of benchmarks.

The primary differences between the six benchmarks are lattice pitch; number of rods in the lattice; water level; and for Case 3, boron density in the water. The physical characteristics of each benchmark case—including moderator temperature, lattice, and water level—are given in Table 48. Figure 22 contains a schematic of the fuel rod configurations for each case. The atom densities for all the materials in the problem (except B-10, B-11 H, and O in the moderator) are listed in Table 49. The atom densities in Table 49 are constant for all benchmarks. Table 50 lists the atom densities of B-10, B-11, H, and O in the moderator for each benchmark.

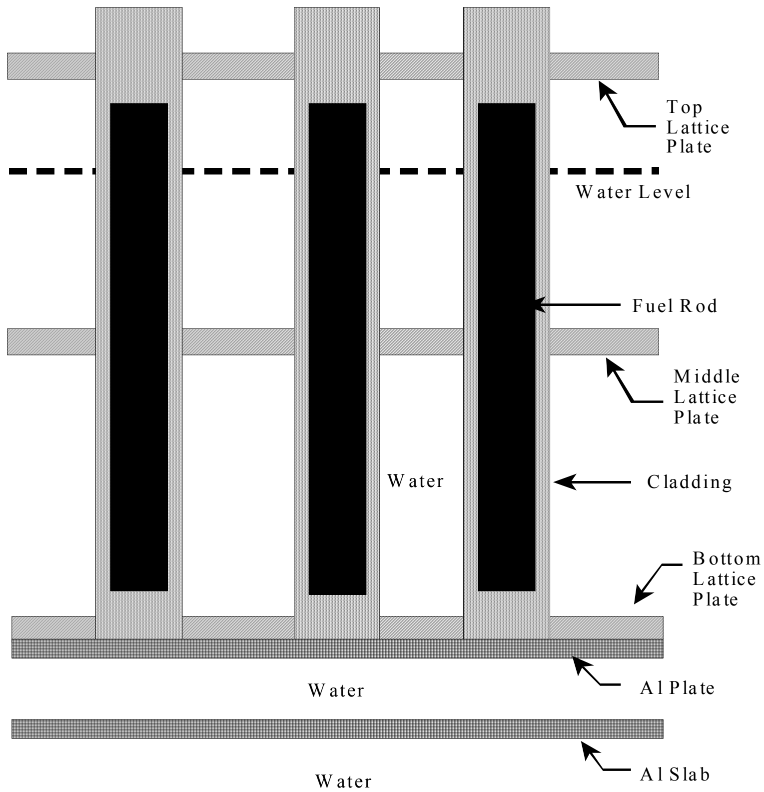


Figure 21. Cross-sectional schematic of evaluation for MIX-COMP-THERM-003

Table 48. Lattice description for benchmark cases, MIX-COMP-THERM-003

Case	Boron conc. (ppm)	Lattice	Lattice pitch (cm)	Water level (cm)	Water temp. (°C)
1	0.0	22 × 23	1.3208	82.90	25.8
2	0.0	19 × 19	1.4224	80.80	17.0
3	337	21 × 21	1.4224	88.06	18.0
4	0.0	13 × 13	1.86789	68.41	24.1
5	0.0	12 × 12	2.01158	76.76	16.1
6	0.0	11 × 11	2.6416	79.50	19.9

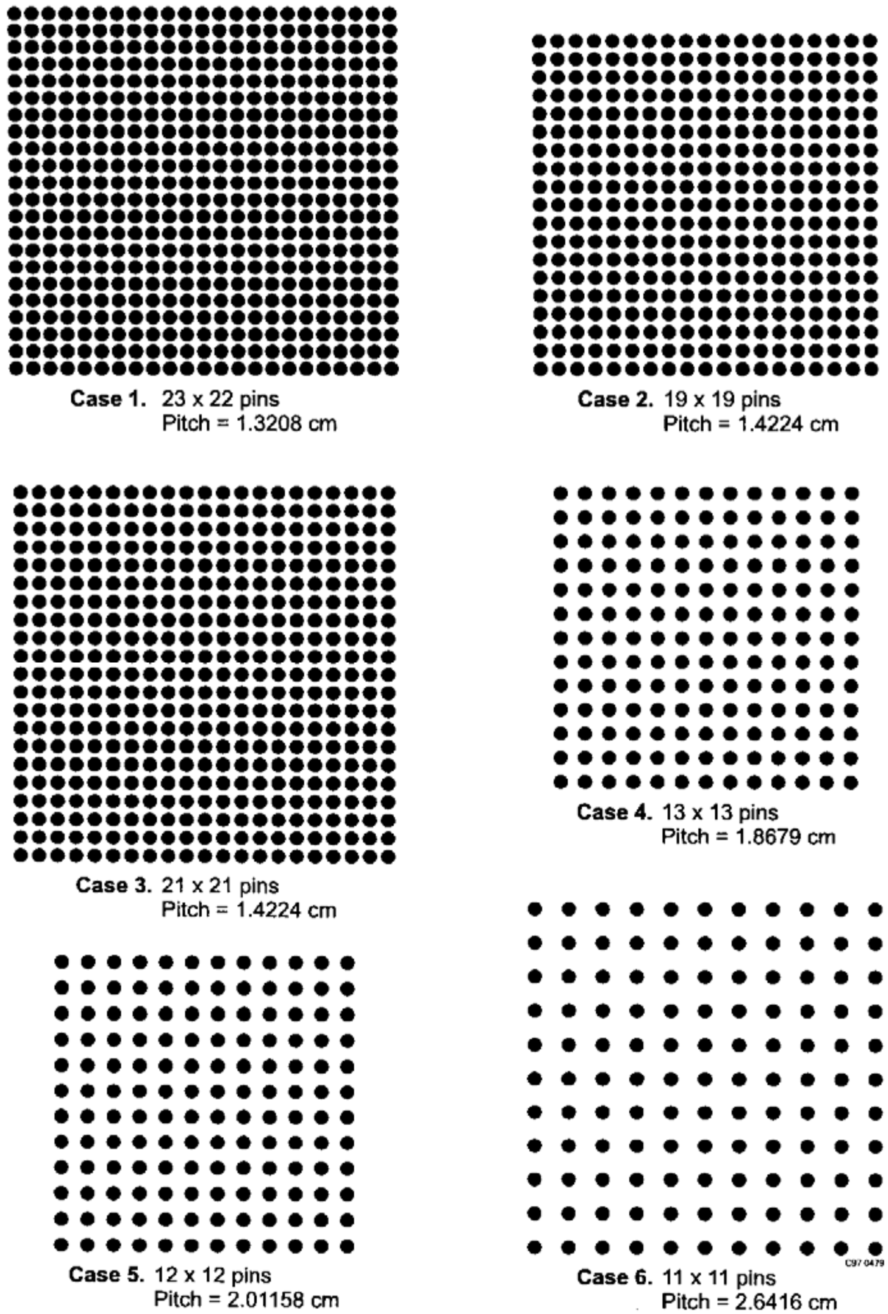


Figure 22. Fuel rod patterns for MIX-COMP-THERM-003.

Table 49. Constant benchmark atom densities, MIX-COMP-THERM-003

Material	Isotope	Atom density [atoms/(barn-cm)]	Material	Isotope	Atom density [atoms/(barn-cm)]
Fuel	U-234	4.6590×10^{-6}	Cladding	Sn	4.6590×10^{-4}
UO_2-PuO_2	U-235	1.5301×10^{-4}	and end plugs	Fe	1.4148×10^{-4}
	U-238	$2x1097 \times 10^{-2}$		Cr	7.5977×10^{-5}
	Pu-239	1.3526×10^{-3}		O	2.9630×10^{-4}
	Pu-240	1.2759×10^{-4}		Zr	4.2517×10^{-2}
	Pu-241	1.1407×10^{-5}			
	Pu-242	6.0318×10^{-7}			
	Am-241	1.7783×10^{-6}			
	O-16	4.3779×10^{-2}			
			Al lattice plate, Al support plate, Al slab (2.69 gm/cm^3)	Al	6.0039×10^{-2}

Table 50. Moderator atom densities [atoms/(barn-cm)], MIX-COMP-THERM-003

Case	H	O	B-10	B-11
1	6.6643×10^{-2}	3.3322×10^{-2}	0.0	0.0
2	6.6781×10^{-2}	3.3390×10^{-2}	0.0	0.0
3	6.6751×10^{-2}	3.3404×10^{-2}	3.7338×10^{-6}	1.5029×10^{-5}
4	6.6673×10^{-2}	3.3336×10^{-2}	0.0	0.0
5	6.6783×10^{-2}	3.3392×10^{-2}	0.0	0.0
6	6.6737×10^{-2}	3.3368×10^{-2}	0.0	0.0

6.2.2 RESULTS

All critical assembly cases were set up and run as CSAS26 inputs having 550 generations and 4000 particles per generation, skipping the first 50 generations, for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 51 lists calculated k_{eff} values and EALF along with the associated standard deviation for the computational benchmarks in this section. The suite of experiments has an average k_{eff} of 0.99895 ± 0.00062. These results agree well with the benchmark results listed in the ICSBEP benchmark evaluation.

Table 51. Calculated k_{eff} and EALF for MIX-COMP-THERM-003

Case	k_{eff} (±σ)	EALF (±σ) (eV)	ICSBEP benchmark k_{eff} (±σ)
1	0.99506 ± 0.00069	0.89512 ± 0.00213	1.0028 ± 0.0072
2	0.99615 ± 0.00063	0.54543 ± 0.00114	1.0019 ± 0.0059
3	0.99666 ± 0.00060	0.64544 ± 0.00135	1.0000 ± 0.0054
4	1.00050 ± 0.00058	0.18894 ± 0.00032	1.0022 ± 0.0031
5	1.00084 ± 0.00057	0.15629 ± 0.00027	1.0049 ± 0.0027
6	1.00453 ± 0.00066	0.10116 ± 0.00014	1.0000 ± 0.0023

6.3 MIX-COMP-THERM-004 DESCRIPTION

CRITICAL ARRAYS OF MIXED PLUTONIUM-URANIUM FUEL RODS WITH WATER-TO-FUEL VOLUME RATIOS RANGING FROM 2.4 TO 5.6

6.3.1 DESCRIPTION

The text, tables, and figures in this section were taken in whole or in part from the ICSBEP handbook, identification number MIX-COMP-THERM-004. Section 1 in the evaluation provides an excellent, concise overall description of the experimental critical assembly configurations.[33]

This section describes a set of 11 critical experiments, each consisting of a square-pitched array of mixed plutonium-uranium fuel rods partially submerged in water surrounded by a water reflector. The water-to-fuel ratios for the arrays range from 2.4 to 5.6

The Tank-Type Critical Assembly (TCA) benchmark cases are light-water-moderated critical assemblies consisting of a core array supported by upper, middle, and lower grid plates. The grid plates do not pass through the fuel region. The water level is below the top of the fuel region in all cases. The experiment is brought to critical by raising the water level in the tank, thus avoiding the use of control rods. The fuel rods sit on a support plate above the bottom of the tank. The tank is wide enough to assume an infinite moderator on the sides (~30 cm of water).

All fuel rods have the same physical dimensions. A schematic diagram of the fuel rods and bottom reflector is given in Figure 23. Each fuel rod has an active fuel length of 70.6 cm and a 16.83-cm-long bottom aluminum end plug that sits on a 1.27-cm-thick aluminum support plate. The fuel has a radius of 0.5325 cm. The cladding has an outside radius of 0.6115 cm. For the calculation, the cladding is extended 9.97 cm above the active fuel to the bottom of the middle grid plate. The middle grid plate and everything above are assumed to be insignificant and thus excluded from the model. The fuel lattice is surrounded by 30 cm of water on the four sides from the bottom of the tank to the top of the critical water level.

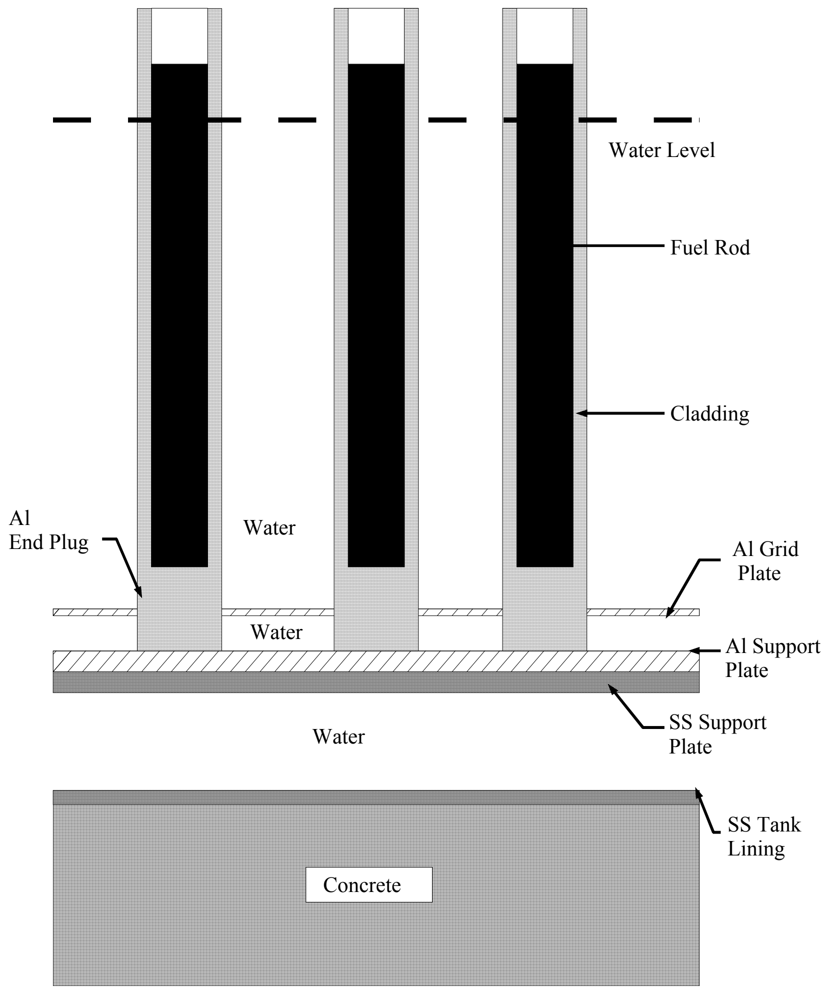


Figure 23. Cross-sectional schematic of evaluation for MIX-COMP-THERM-004.

Above the aluminum support plate is a 4.445-cm water gap and a 0.601-cm-thick lower aluminum grid plate. Below the aluminum support plate is a 2.2-cm-thick stainless steel support plate, a 13.8-cm water gap, a 0.5-cm-thick stainless steel tank liner and a 37.0 cm of concrete.

The primary differences between the 11 benchmarks are lattice pitch, number of rods in the lattice, water level, and ^{241}Pu and ^{241}Am number densities. All other benchmark characteristics are constant. The 11 benchmarks are divided into four different lattice pitches: 1.825, 1.956, 2.225, and 2.474 cm. For a given pitch, the number of pins in the lattice is given in Table 52. The fuel is arranged in a square-pitched square lattice. The characteristics of each of the four lattices are given in Table 52, and the rod patterns for the different lattice pitches are given in Figure 24. The critical fuel height variations are due to the changes in ^{241}Pu and ^{241}Am atom densities. Table 53 lists the atom densities for all the materials in the problem except ^{241}Pu and ^{241}Am. The atom densities in Table 53 are constant for all benchmarks. Table 54 lists the atom densities for ^{241}Pu and ^{241}Am for each benchmark. All material temperatures are assumed to be 20°C.

Table 52. Lattice description for benchmarks, MIX-COMP-THERM-004

Case	Water/fuel volume ratio (H/Pu ratio)	Lattice pitch (cm)	Number of rods on a side	Lattice side dimension (cm)	Critical water level (cm)
1					59.5
2	2.42	1.825	23	41.975	91.90
3	(402)				64.06
4					61.50
5	2.98	1.956	21	41.076	64.40
6	(494)				69.40
7					60.32
8	4.24	2.225	20	44.500	62.99
9	(703)				65.63
10	5.55	2.474	21	51.954	62.05
11	(921)				64.53

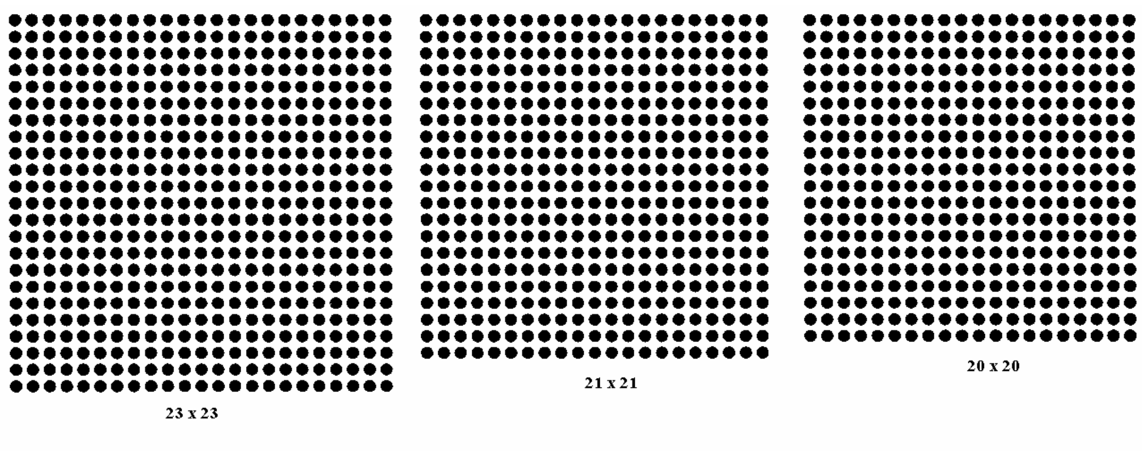


Figure 24. Fuel rod patterns for MIX-COMP-THERM-004.

Table 53. Constant benchmark atom densities, MIX-COMP-THERM-004

Material	Isotope	Atom density [atoms/(barn-cm)]	Material	Isotope	Atom density [atoms/(barn-cm)]
Fuel	U-234	7.1749×10^{-7}	Ordinary	H	1.3742×10^{-2}
UO_2-PuO_2	U-235	9.3926×10^{-5}	concrete	O	4.5919×10^{-2}
	U-238	1.2951×10^{-2}		C	1.1532×10^{-4}
	Pu-238	2.0003×10^{-6}		Na	9.6395×10^{-4}
	Pu-239	2.7491×10^{-4}		Mg	1.2388×10^{-4}
	Pu-240	8.8417×10^{-5}		Al	1.7409×10^{-3}
	Pu-241	(See Table 54)		Si	1.6617×10^{-2}
	Pu-242	8.1234×10^{-6}		K	4.6052×10^{-4}
	Am-241	(See Table 54)		Ca	1.5025×10^{-3}
	O-16	2.7837×10^{-2}		Fe	3.4492×10^{-4}
	B-10	6.0418×10^{-8}			
	B-11	2.4319×10^{-7}			
Cladding	Zr	3.7772×10^{-2}	Stainless	C	1.1928×10^{-4}
(w/ air gap)	Sn	4.3737×10^{-4}	steel	Si	1.7003×10^{-3}
	Fe	8.8570×10^{-5}	(304L)	Mn	1.7385×10^{-3}
	Cr	6.6119×10^{-5}		P	6.9381×10^{-5}
	Ni	3.5864×10^{-5}		S	4.4673×10^{-5}
				Ni	8.9506×10^{-3}
				Cr	1.7450×10^{-2}
				Fe	5.7202×10^{-2}
Water	H	6.6735×10^{-6}	Aluminum	Al	6.0224×10^{-2}
	O	3.3368×10^{-2}			

Table 54. Pu-241 and Am-241 atom densities, MIX-COMP-THERM-004

Case	Pu-241 ($\times 10^{24}$ atoms/cm^3)	Am-241 ($\times 10^{24}$ atoms/cm^3)
1	2.7923×10^{-5}	1.3351×10^{-5}
2	2.6701×10^{-5}	2.5812×10^{-5}
3	2.5447×10^{-5}	2.8361×10^{-5}
4	2.8003×10^{-5}	1.2793×10^{-5}
5	2.6670×10^{-5}	2.6129×10^{-5}
6	2.4228×10^{-5}	5.0543×10^{-5}
7	2.8133×10^{-5}	1.1498×10^{-5}
8	2.6649×10^{-5}	2.6340×10^{-5}
9	2.5373×10^{-5}	3.9098×10^{-5}
10	2.8077×10^{-5}	1.2053×10^{-5}
11	2.6617×10^{-5}	1.6656×10^{-5}

6.3.2 RESULTS

All critical assembly cases were set up and run as CSAS26 inputs having 500 generations and 4000 particles per generation for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 55 lists calculated k_{eff} values and EALF along with the associated standard deviation for the benchmarks in this section. The suite of experiments has an average k_{eff} of 1.00216 ± 0.00055. These results agree well with the benchmark results listed in the ICSBEP benchmark evaluation.

Table 55. Calculated k_{eff} and EALF for MIX-COMP-THERM-004

Case	k_{eff} (±σ)	EALF (±σ) (eV)	ICSBEP benchmark k_{eff} (±σ)
1	0.99913 ± 0.00067	0.14571 ± 0.00022	1.0000 ± 0.0046
2	0.99891 ± 0.00064	0.14477 ± 0.00021	1.0000 ± 0.0046
3	0.99936 ± 0.00059	0.14325 ± 0.00021	1.0000 ± 0.0046
4	0.99951 ± 0.00059	0.11957 ± 0.00016	1.0000 ± 0.0039
5	1.00204 ± 0.00054	0.11836 ± 0.00015	1.0000 ± 0.0039
6	1.00270 ± 0.00050	0.11651 ± 0.00016	1.0000 ± 0.0039
7	1.00331 ± 0.00058	0.09301 ± 0.00012	1.0000 ± 0.0040
8	1.00410 ± 0.00049	0.09235 ± 0.00012	1.0000 ± 0.0040
9	1.00505 ± 0.00052	0.09164 ± 0.00011	1.0000 ± 0.0040
10	1.00444 ± 0.00047	0.08002 ± 0.00010	1.0000 ± 0.0051
11	1.00523 ± 0.00049	0.07934 ± 0.00009	1.0000 ± 0.0051

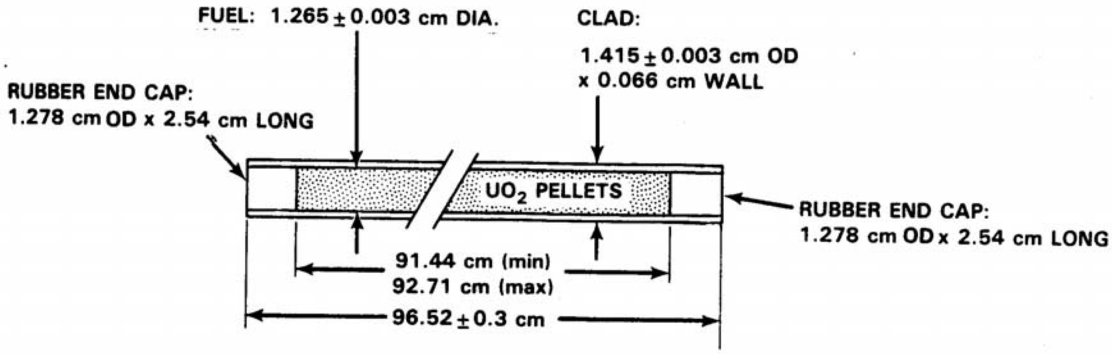
6.4 PNL-4976

CRITICALITY EXPERIMENTS WITH LOW-ENRICHED UO_2 RODS IN WATER CONTAINING DISSOLVED GADOLINIUM

6.4.1 DESCRIPTION

The text, tables, and figures in this section were taken in whole or in part from PNL-4976.[34] This series of critical experiments were performed in early 1981 at PNL in support of British Nuclear Fuels (BNFL). BNFL was interested in obtaining basic experimental data on light-water-reactor fuel rods in water and uranyl nitrate solution poisoned with a soluble compound of gadolinium. The data would be used primarily for validating calculational techniques to be used in criticality safety evaluations.

The experiments contained in PNL-4976 involved low-enriched UO_2 and PuO_2-UO_2 fuel rods in water with and without dissolved gadolinium.[34] The triangular-pitched experiment 4.3-002-196 discussed in this section utilized PuO_2 (2 wt %)-UO_2 (98 wt %) zirconium clad rods interspersed between 4.31 wt % ^{235}U-enriched UO_2 aluminum clad rods at a uniform center-to-center rod spacing of 1.598 cm. This experiment used 583 MOX and 1174 UO_2 fuel rods in water fully reflected by water. A complete description of the dimensions and materials of the UO_2 and PuO_2-UO_2 fuel rods is given in Figure 25 and 26. The loading diagram and description for experiment 4.3-002-196 are shown in Figure 27. The assembly is reflected on all sides by 30 cm of water.



CLADDING: 6061 ALUMINUM TUBING

LOADING

ENRICHMENT - 4.306 ± 0.013% ^{235}U
OXIDE DENSITY - 10.40 ± 0.06 g/cm^3
UO_2 - 1203.38 ± 4.12 g/ROD
U - 1059.64 ± 4.80 g/ROD

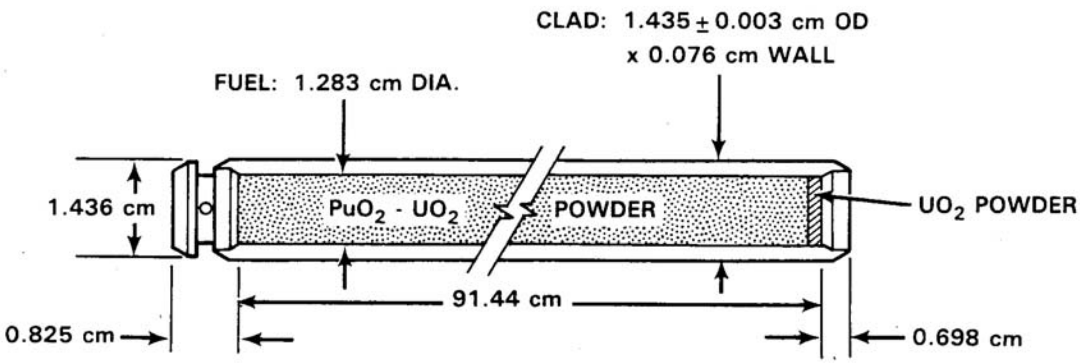
URANIUM COMPOSITION:

^{234}U - 0.022 ± 0.002
^{235}U - 4.306 ± 0.013
^{236}U - 0.022 ± 0.002
^{238}U - 95.650 ± 0.017

END CAP:

C-58 ± 1 WT%	S-1.7 ± 0.2 WT%
H-6.5 ± 0.3 WT%	0-22.1 WT% (BALANCE)
Ca-11.4 ± 1.8 WT%	Si-0.3 ± 0.1 WT%

Figure 25. Description of 4.31 wt % ^{235}U enriched UO_2 fuel rods for PNL-4976.



CLADDING: ZIRCALOY-2 TUBING WITH PLUGS SEAL WELDED AT BOTH ENDS

LOADING:

ENRICHMENT - 2.00 WT% PuO_2 IN NATURAL UO_2
OXIDE DENSITY - 9.54 g/cm^3
$PuO_2 + UO_2$ - 1128g/ROD
Pu - 20.169 ± 0.004 g/ROD
U - 970.306 ± 0.225 g/ROD
UO_2 POWDER - NATURAL URANIUM

PLUTONIUM COMPOSITION:

^{238}Pu - 0.009 ± 0.001
^{239}Pu - 91.836 ± 0.006
^{240}Pu - 7.760 ± 0.006
^{241}Pu - 0.367 ± 0.001
^{242}Pu - 0.028 ± 0.001

AMERICIUM: 64.6 ± 0.1 PARTS ^{241}Am PER MILLION PARTS $PuO_2 + UO_2$ MIXTURE BY WEIGHT

Figure 26. Description of MOX fuel rods for PNL-4976.

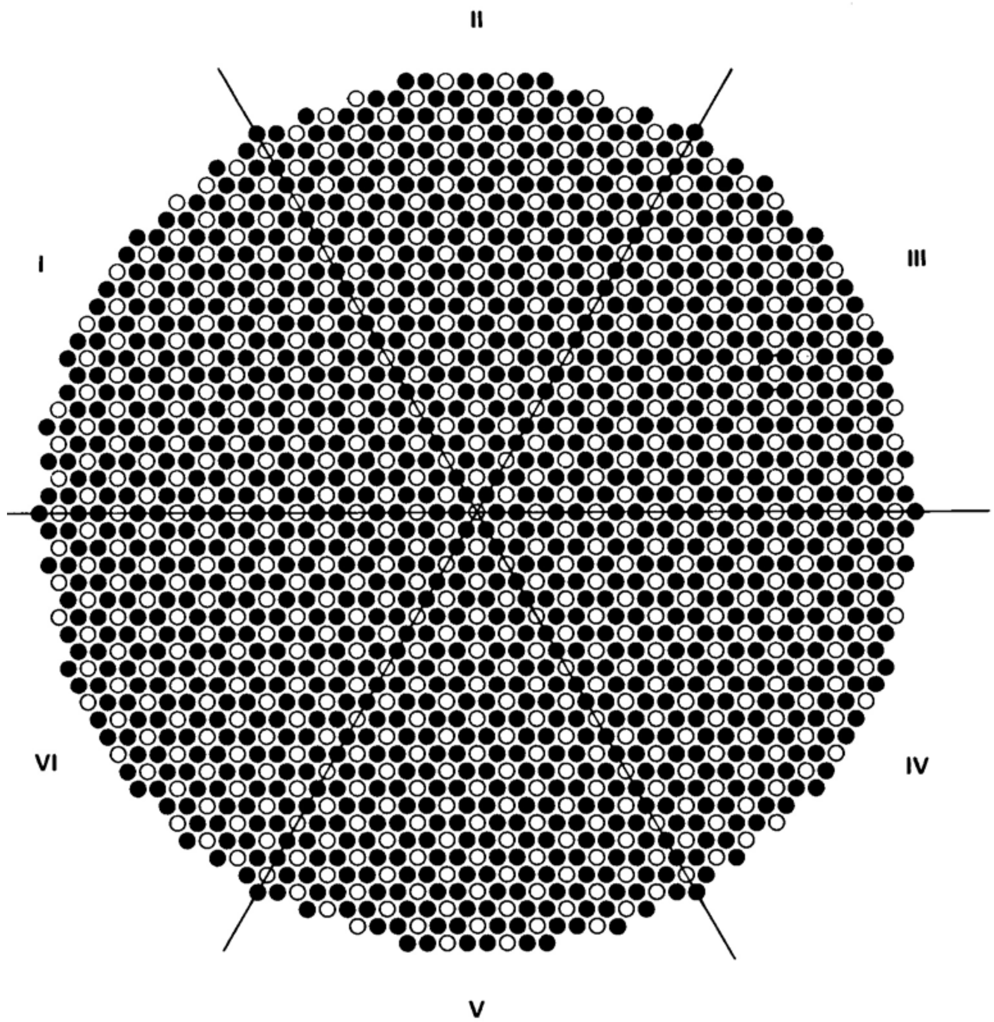


Figure 27. Loading diagram for experiment 4.3-002-196.

6.4.2 RESULTS

The critical assembly was set up and run as CSAS26 inputs having 500 generations and 4000 particles per generation for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 56 lists the calculated k_{eff} value and EALF along with the associated standard deviation for the benchmark in this section.

Table 56. Calculated k_{eff} for experiment 4.3-002-196

Case	k_{eff} (±σ)	EALF (±σ) (eV)
1	0.98530 ± 0.00051	4.60986 ± 0.01287

6.5 MIXED OXIDES RESULTS SUMMARY

Figure 28 shows the performance of MOX fuel at thermal energies. There are two types of problems in this section. MIX-COMP-THERM-002, MIX-COMP-THERM-003, and MIX-COMP-THERM-004 consist of rectangular arrays of UO_2 and UO_2-PuO_2 fuel pins surrounded by water. The fuel consisted of a combination of natural uranium as UO_2 and either 2, 3, or 6.6 wt % PuO_2. The results range from about 0.5% high to about 0.7% low with an average k_{eff} very close to 1.0.

The other problem, PNL-4976, consists of 98 wt % U(nat.)O_2 + 2 wt % PuO_2 rods interspersed between 4.3 wt % enriched UO_2 rods surrounded by water. This case calculated about 1.2% low.

These results show that MOX pins in a lattice with a water reflector produce results between 0.5% high and 0.7% low, while the only combination of MOX and UO_2 pins produces results about 1.81% low.

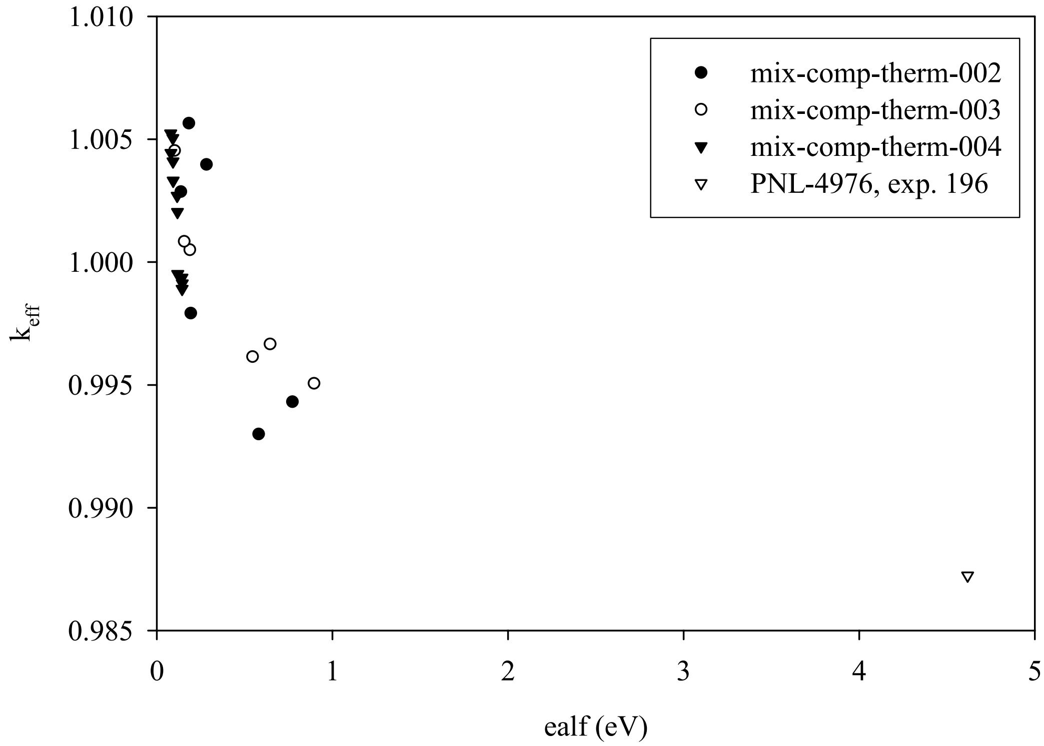


Figure 28. Summary of k_{eff} values vs EALF for mixed oxides.

7. FAST METAL PLUTONIUM EVALUATIONS

7.1 PU-MET-FAST-045 DESCRIPTION

CRITICAL EXPERIMENTS PERFORMED FOR LAMPRE, THE LOS ALAMOS MOLTEN PLUTONIUM REACTOR

7.1.1 DESCRIPTION

The text, tables, and figures in this section were taken in whole or in part from the ICSBEP handbook, identification number PU-MET-FAST-045. Section 1 in the evaluation provides an excellent, concise overall description of the experimental critical assembly configurations.[35]

This series of critical experiments, known as LCX-I, was performed using three different core compositions and three different metal reflectors (Ni, Fe, and Ni + Fe) resulting in seven critical configurations. The LCX-I core was composed of Pu-Ni discs, tantalum discs, and reduced-density aluminum discs. The dimensions and materials for the three types of discs are shown in Figure 29. The material specifications for the three types of discs are listed in Table 57.

The differences between the seven critical configurations are core type, inner reflector, and iron reflector. Three core types are described in Table 58; stacked plutonium discs, stacked Pu/Ta discs, and stacked Pu/Ta/Al discs. The models consist of fuel discs (Pu with Ni coating), tantalum discs, and aluminum discs stacked inside a core sleeve. The core sleeve rested on the lower reflector, which in turn rested on a cylindrical polyethylene block. The core was contained in a tantalum sleeve with a tantalum disc above and below the core. This was then placed in an aluminum sleeve with an aluminum disc above and below. This entire configuration was placed inside a reflector made either of nickel or iron. The combination of core, sleeves, and reflector constitute the core components. The core components could be raised into the void center of an annular tank. The tank had an iron reflector on the inside surface and was filled with water. Figure 30 depicts a cross-sectional schematic of a generic experimental setup. The material specifications for the components are contained in Table 57. The core and reflector parameters for each critical configuration are contained in Table 58.

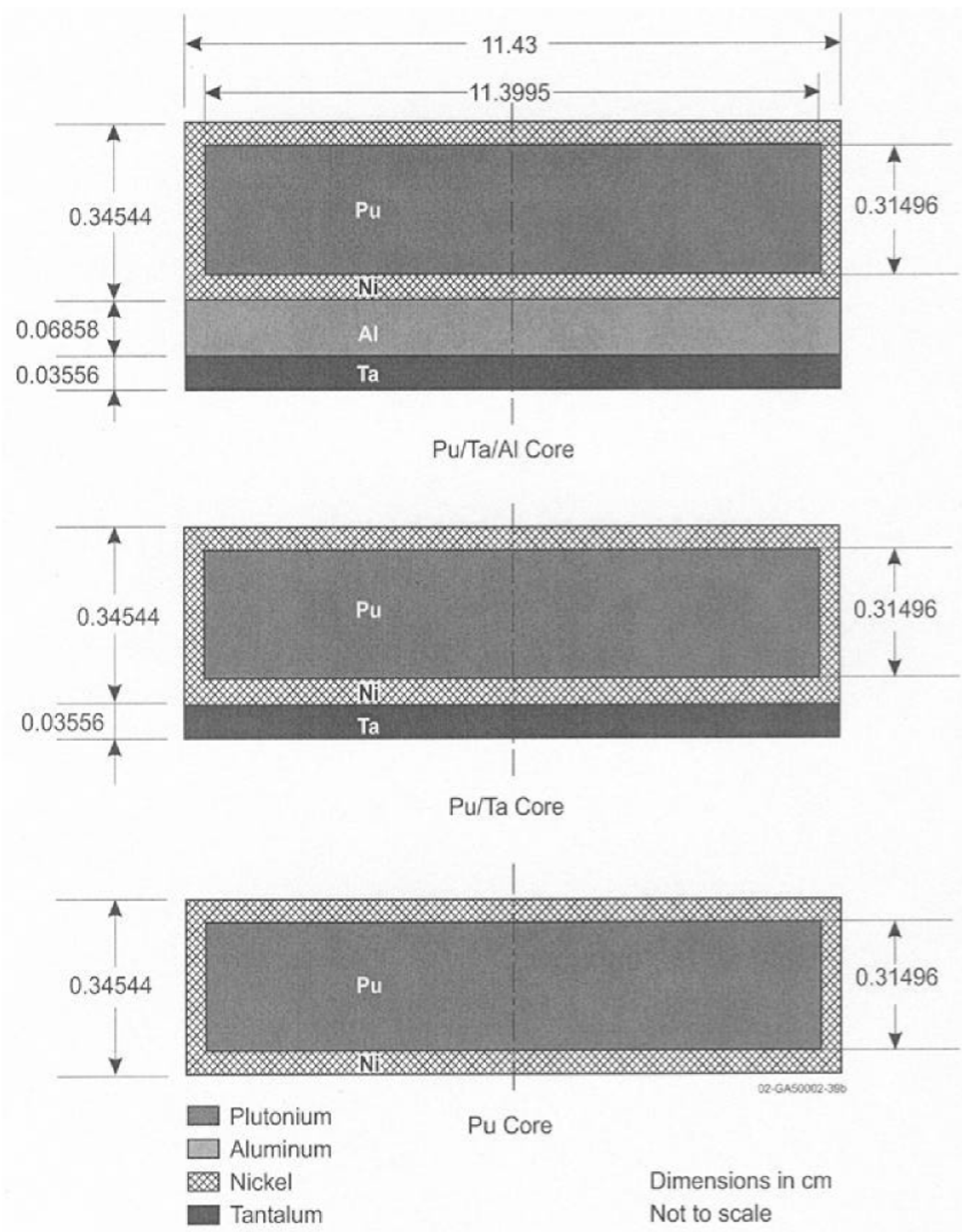


Figure 29. Experiment core discs for PU-MET-FAST-045.

Table 57. Atomic number densities, PU-MET-FAST-045

Core		
Isotope		Atoms/barn-cm
239Pu		3.9960×10^{-2}
Ni		8.8859×10^{-2}
Ta		4.8690×10^{-2}
Al		2.0087×10^{-2}
Reflectors		
Isotope		Atoms/barn-cm
Ni		8.8859×10^{-2}
Fe		8.4648×10^{-2}
Ta		4.8690×10^{-2}
Al		2.0087×10^{-2}
Water	H	6.6766×10^{-2}
	O	3.3383×10^{-2}
Polyethylene	H	7.8996×10^{-2}
	C	3.9498×10^{-2}

Table 58. Core and reflector parameters for critical configurations, PU-MET-FAST-045

Case	Reflector	Core	No. of Pu discs	Core height (cm)	Fe reflector thickness (cm)	Pu mass (g)
1	Ni	Pu/Ta/Al	29.6823	13.3443	0.6096	15135
2	Ni + Fe	Pu/Ta/Al	28.6331	12.8726	4.5720	14600
3	Ni + Fe	Pu/Ta	22.4554	8.4948	4.5720	11450
4	Ni	Pu/Ta	23.2791	8.7796	0.6096	11870
5	Ni	Pu	21.2983	7.3819	0.6096	10860
6	Fe	Pu/Ta	25.1814	9.5260	0.6096	12840
7	Fe	Pu/Ta/Al	33.2614	14.9533	0.6096	16960

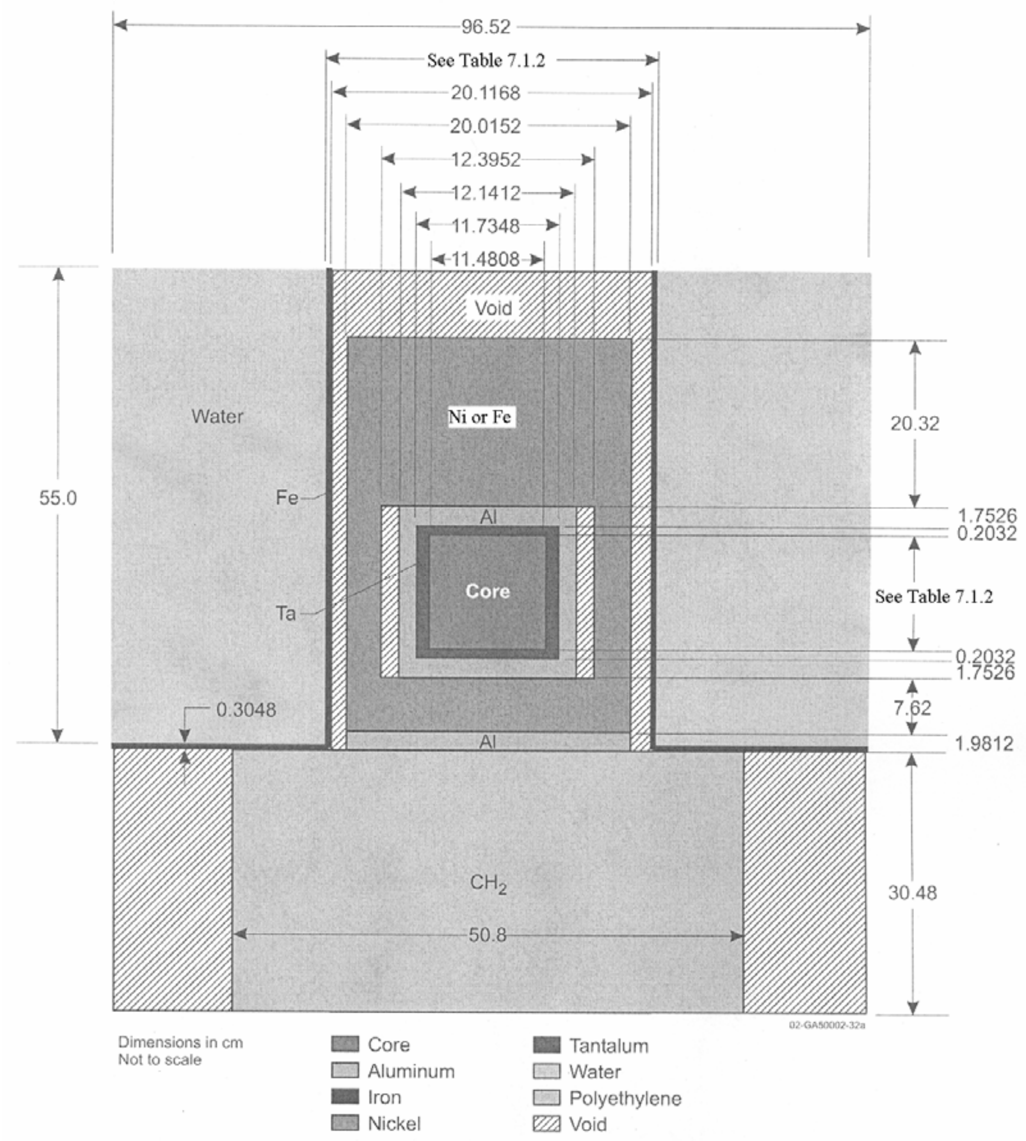


Figure 30. Schematic of experiment layout for PU-MET-FAST-045.

7.1.2 RESULTS

All cases were set up and run as CSAS26 inputs having 550 generations and 4000 particles per generation, skipping the first 50 generations, for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 59 lists calculated k_{eff} values and EALF along with the associated standard deviation for all computational benchmarks in this section. The suite of experiments has an average k_{eff} of 1.00690 ± 0.00064. These results for the first five cases agree well with the benchmark results listed in the ICSBEP benchmark evaluation. The last two cases, which have the iron reflector calculate about 2% high when compared to the benchmark results listed in the ICSBEP benchmark evaluation.

Table 59. Calculated k_{eff} and EALF for PU-MET-FAST-045

Case	k_{eff} (±σ)	EALF (±σ) (eV)	ICSBEP benchmark k_{eff} (±σ)
1	0.99833 ± 0.00062	786,711.0 ± 1190.5	1.0000 ± 0.0034
2	1.00457 ± 0.00059	855,388.0 ± 1062.4	1.0000 ± 0.0034
3	1.00140 ± 0.00066	895,608.0 ± 1142.4	1.0000 ± 0.0035
4	1.00025 ± 0.00073	840,312.0 ± 1225.5	1.0000 ± 0.0035
5	1.00462 ± 0.00061	881,026.0 ± 1241.9	1.0000 ± 0.0036
6	1.01650 ± 0.00066	647,870.0 ± 1275.8	1.0000 ± 0.0038
7	1.02268 ± 0.00067	559,965.0 ± 1161.8	1.0000 ± 0.0038

7.2 PLUTONIUM RESULTS SUMMARY

Figure 31 shows the performance of plutonium metal at high neutron energies. The evaluation involves plutonium discs encased in nickel and stacked in an array with a nickel or an iron moderator. The array consists of either Pu, Pu/Ta, or Pu/Ta/Al discs. The results show that plutonium metal calculates very well for plutonium metal with Ni or Ni+Fe reflectors. However, the two case with a pure iron reflector calculated about 2% high.

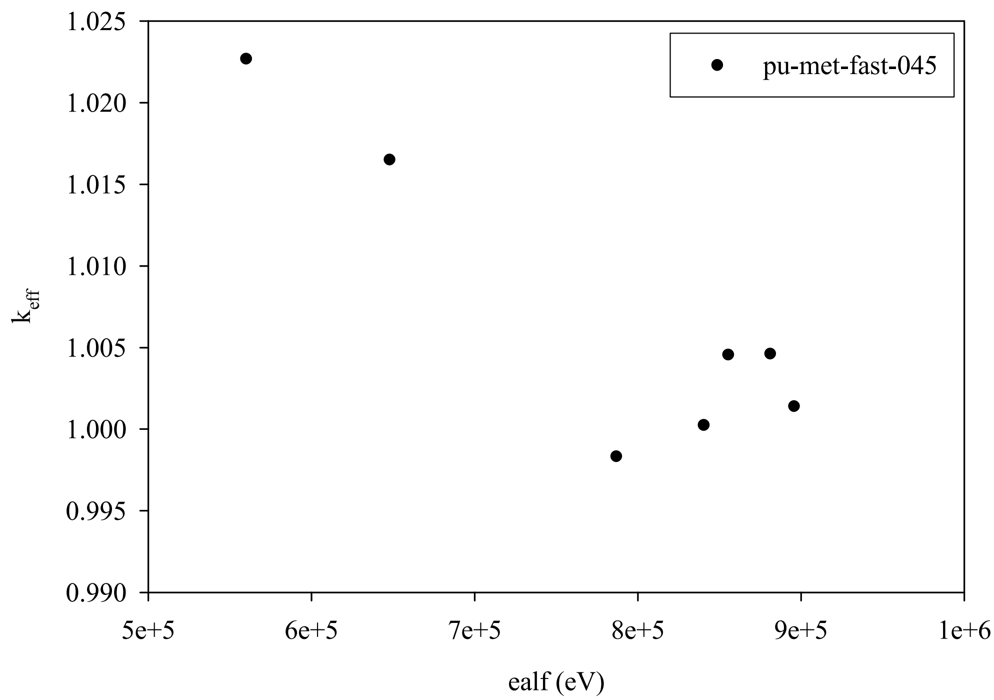


Figure 31. Summary of k_{eff} values vs EALF for plutonium.

8. U-233 SOLUTION EVALUATION

8.1 U233-SOL-INTER-001

URANYL-FLUORIDE (^{233}U) SOLUTIONS IN SPHERICAL STAINLESS STEEL VESSELS WITH REFLECTORS OF Be, CH_2, AND Be-CH_2 COMPOSITES – PART I

8.1.1 DESCRIPTION

The text, tables, and figures in this section were taken in whole or in part from the ICSBEP handbook, identification number U233-SOL-INTER-001. Section 1 in the evaluation provides an excellent, concise overall description of the experimental critical assembly configurations.[36]

A series of criticality studies were performed using aqueous solutions of ^{233}U in the form of UO_2F_2 stabilized with 0.3 wt % HF. The ^{233}U concentrations in these experiments were 567.2, 749, and 866 g/L. Seven type 347 stainless steel spheres ranging in inner radius from 7.871 to 11.414 cm were used as containers for the solutions. Table 60 lists the inner radius and measured volumes of the seven. Table 61, Table 62, and Table 63 list the atom densities for the three ^{233}U uranyl-fluoride solutions, the stainless steel, and the reflector materials, respectively.

Reflectors of beryllium, polyethylene and beryllium-polyethylene composites were placed on the outer surface of the spheres to create critical configurations using the three solutions and seven spheres. Thirty-three critical configurations were created using various combinations of solutions, spheres, and reflectors.

Table 60. Characteristics of the stainless-steel spheres, U233-SOL-INTER-001

Sphere	Inner radius (cm)	Volume (cm^3)
1	7.871	2043.82
2	8.515	2586.31
3	9.008	3061.72
4	9.663	6779.80
5	10.162	4396.27
6	10.798	5275.53
7	11.414	6230.69

Table 61. Atom densities for ^{233}U solution, U233-SOL-INTER-001

Property	567.2 g/L Solution	749 g/L Solution	866 g/L Solution
Solution density (g/cm^3)	1.6357	1.8386	1.9712
HF density (g/cm^3)	0.0049	0.0055	0.0059
UO_2F_2 density (g/cm^3)	0.7483	0.9882	1.1425
H_2O (g/cm^3)	0.8825	0.8449	0.8228
Isotope/nuclide	[atoms/(barn-cm)]	[atoms/(barn-cm)]	[atoms/(barn-cm)]
U-232	4.5608×10^{-8}	3.9445×10^{-8}	2.9871×10^{-8}
U-233	2.2379×10^{-3}	1.9355×10^{-3}	1.4657×10^{-3}
U-234	2.4316×10^{-5}	2.1030×10^{-5}	1.5925×10^{-5}
U-235	8.9598×10^{-7}	7.7491×10^{-7}	5.8682×10^{-7}
U-238	7.1284×10^{-6}	6.1652×10^{-6}	4.6687×10^{-6}
H	5.5183×10^{-2}	5.6654×10^{-2}	5.9146×10^{-2}
O	3.2043×10^{-2}	3.2171×10^{-2}	3.2474×10^{-2}
F	4.7182×10^{-3}	4.0930×10-$^{-3}$	3.1214×10^{-3}

Table 62. Atom densities for type 347 stainless steel, U233-SOL-INTER-001

Nuclide	Composition (wt %)	Atom density [atoms/(barn-cm)]
Fe	71	6.1248×10^{-2}
Cr	18	1.6678×10^{-2}
Ni	11	9.0264×10^{-3}

Table 63. Atom densities for Be and CH_2 reflectors, U233-SOL-INTER-001

Material	Nuclide	Atom density [atoms/(barn-cm)]
Beryllium	Be	1.2161×10^{-1}
Polyethylene (CH_2)	C	3.9497×10^{-2}
	H	7.8994×10^{-2}

The benchmark representation for each critical experiment is a 1-D spherical geometry model consisting of three or four uniform regions corresponding to the solution, the steel vessel, and the reflector with a vacuum boundary condition applied to the outermost (reflector) surface of the sphere. The solution vessel wall thickness was 0.0483 cm in all cases. The inner (solution) radius was based on the measured capacities given in Table 60, assuming one milliliter for each gram of water. The model dimensions vary for each experiment depending on the vessel size, the reflector material, and critical reflector thickness. The outer radii of each material region for each experiment are listed in Table 64.

Table 64. Benchmark model outer radial dimensions (cm) for U233-SOL-INTER-001

Case	Solution no.	Sphere no.	Solution	Steel	Beryllium	Polyethylene
1	1	1	7.8726	7.9209	15.9209	
2	1	2	8.5152	8.5635	14.3835	
3	1	3	9.0079	9.0562	13.7262	
4	1	3	9.0079	9.0562	10.1962	14.3062
5	1	4	9.6633	9.7116	13.2116	
6	1	4	9.6633	9.7116	10.2216	13.5316
7	1	5	10.1625	10.2107	12.9007	
8	1	5	10.1625	10.2107		13.2607
9	1	5	10.1625	10.2107	11.4807	12.9507
10	1	6	10.7992	10.8475	12.6775	
11	1	6	10.7992	10.8475	11.4875	12.8375
12	2	1	7.8726	7.9209	15.9209	
13	2	2	8.5152	8.5635	14.5035	
14	2	2	8.5152	8.5635	10.2135	15.3935
15	2	3	9.0079	9.0562	13.7562	
16	2	3	9.0079	9.0562		20.7362
17	2	3	9.0079	9.0562	10.1962	14.2562
18	2	4	9.6633	9.7116	13.1416	
19	2	5	10.1625	10.2107	12.8307	
20	2	5	10.1625	10.2107		13.2807
21	2	6	10.7992	10.8475	12.6275	
22	2	7	11.4152	11.4635	12.6435	
23	2	7	11.4152	11.4635		12.9835
24	3	1	7.8726	7.9209	16.6109	
25	3	2	8.5152	8.5635	14.7635	
26	3	3	9.0079	9.0562	14.0862	
27	3	3	9.0079	9.0562	10.1962	14.5362
28	3	4	9.6633	9.7116	13.3216	
29	3	5	10.1625	10.2107	12.9307	
30	3	5	10.1625	10.2107		13.3107
31	3	6	10.7992	10.8475	12.9275	
32	3	7	11.4152	11.4635	12.6535	
33	3	7	11.4152	11.4635		13.0635

8.1.2 RESULTS

All cases were set up and run as CSAS26 inputs having 550 generations and 4000 particles per generation, skipping the first 50 generations, for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 65 lists calculated k_{eff} values and EALF along with the associated standard deviation for all computational benchmarks in this section. The suite of experiments has an average k_{eff} of 0.98339 ± 0.00080. These consistently calculate between 0.7 and 2.5% low compared to the benchmark results listed in the ICSBEP benchmark evaluation.

Table 65. Calculated k_{eff} and EALF for U233-SOL-INTER-001

Case	k_{eff} (±σ)	EALF (±σ) (eV)	ICSBEP benchmark k_{eff} (±σ)
1	0.98739 ± 0.00076	6.77648 ± 0.01294	1.0000 ± 0.0083
2	0.98356 ± 0.00085	7.88676 ± 0.01502	1.0000 ± 0.0085
3	0.98327 ± 0.00082	8.48264 ± 0.01687	1.0000 ± 0.0066
4	0.99324 ± 0.00080	3.60013 ± 0.00801	1.0000 ± 0.0061
5	0.98721 ± 0.00087	9.06260 ± 0.01682	1.0000 ± 0.0082
6	0.98516 ± 0.00076	4.15968 ± 0.00900	1.0000 ± 0.0061
7	0.98142 ± 0.00079	9.48285 ± 0.01750	1.0000 ± 0.0059
8	0.97757 ± 0.00076	4.42786 ± 0.00957	1.0000 ± 0.0056
9	0.97846 ± 0.00085	7.22944 ± 0.01486	1.0000 ± 0.0068
10	0.97940 ± 0.00087	9.92999 ± 0.01998	1.0000 ± 0.0053
11	0.98054 ± 0.00077	7.61766 ± 0.01555	1.0000 ± 0.0057
12	0.98376 ± 0.00081	4.39034 ± 0.00821	1.0000 ± 0.0091
13	0.98419 ± 0.00079	4.99114 ± 0.00891	1.0000 ± 0.0071
14	0.99224 ± 0.00085	2.21302 ± 0.00434	1.0000 ± 0.0052
15	0.98279 ± 0.00081	5.36535 ± 0.01037	1.0000 ± 0.0075
16	0.98113 ± 0.00072	1.67963 ± 0.00366	1.0000 ± 0.0028
17	0.98945 ± 0.00079	2.47644 ± 0.00518	1.0000 ± 0.0055
18	0.97977 ± 0.00073	5.74090 ± 0.01068	1.0000 ± 0.0057
19	0.97638 ± 0.00081	5.95714 ± 0.01075	1.0000 ± 0.0083
20	0.97819 ± 0.00085	2.91082 ± 0.00558	1.0000 ± 0.0056
21	0.97297 ± 0.00083	6.25084 ± 0.01135	1.0000 ± 0.0050
22	0.97567 ± 0.00078	6.39335 ± 0.01199	1.0000 ± 0.0049
23	0.98680 ± 0.00087	4.61579 ± 0.00887	1.0000 ± 0.0047
24	0.99387 ± 0.00074	1.95184 ± 0.00312	1.0000 ± 0.0081
25	0.98633 ± 0.00080	2.22465 ± 0.00395	1.0000 ± 0.0081
26	0.98887 ± 0.00080	2.35039 ± 0.00380	1.0000 ± 0.0065
27	0.99077 ± 0.00079	1.20994 ± 0.00224	1.0000 ± 0.0051
28	0.98294 ± 0.00081	2.50173 ± 0.00428	1.0000 ± 0.0061
29	0.97731 ± 0.00078	2.60231 ± 0.00447	1.0000 ± 0.0098
30	0.97556 ± 0.00081	1.41364 ± 0.00246	1.0000 ± 0.0053
31	0.98905 ± 0.00091	2.64171 ± 0.00447	1.0000 ± 0.0071
32	0.97510 ± 0.00090	2.73980 ± 0.00476	1.0000 ± 0.0053
33	0.99155 ± 0.00084	2.03256 ± 0.00369	1.0000 ± 0.0046

8.2 U233-SOL-THERM-003 EVALUATION

PARAFFIN-REFLECTED 5-, 5.4-, 6-, 6.6-, 8-, 8.5-, 9-, AND 12-INCH-DIAMETER CYLINDERS OF ^{233}U URANYL FLUORIDE SOLUTIONS

8.2.1 DESCRIPTION

The text, tables, and figures in this section were taken in whole or in part from the ICSBEP handbook, identification number U233-SOL-THERM-003. Section 1 in the evaluation provides an excellent, concise overall description of the experimental critical assembly configurations.[37]

Eighteen experiments utilizing uranyl fluoride (UO_2F_2) solutions in 5.0-, 5.4-, 6.0-, 6.6-, 7.5-, 8.0-, 8.5-, 9.0-, and 12-in.-diameter cylinders are evaluated. The 5.0-, 5.4-, and 6.0-in.-diameter cylinders were 36 in. tall and were reflected by at least 6 in. of paraffin in the radial direction and on the bottom. The larger cylinders were approximately equilateral (H/D = 1) and were paraffin reflected in the radial direction and on the top and bottom.

The simplified model is schematically represented in Figure 32. Each model consists of a right circular cylinder of fissile solution surrounded on all sides by 0.1291 cm of aluminum. Unichrome was placed on all inside surfaces of the aluminum 5.4- and 6.6-in.-diameter cylinders, including the bottom and top of the cylinder. The inside of all other cylinders were coated with Heresite. The simplified models omit the control-rod well, the safety-blade well, and the bottom drain tube and, in their place, substitute paraffin reflector. A 15.24-cm-thick paraffin reflector is modeled on all surfaces of the vessels that are 6.6 in. in diameter or greater. The 15.24-cm-thick paraffin reflector for the smaller vessels (Cases 1–3 or Experiments 40–42) is only on the bottom and radially around the sides. The reflector-tank wall and all structures external to the paraffin reflector have been omitted from the model. The conical bottom section is replaced with an equivalent cylindrical volume of solution that was used to adjust the inside vessel heights and the experimentally measured solution heights. Critical dimensions for each experiment are listed in Table 66.

The uranyl nitrate solution contained 98.7 wt % ^{233}U ranging in density from 320 to 380 g U/l. Table 67 lists the characteristics of the solution. Table 68 lists the atom densities of the primary isotopes in the uranyl nitrate solution. Trace elements such as Al, Cr, Fe, Mg, Mo, Na, Ni, and Sn were also included in the critical benchmarks although they are not listed in Table 68.

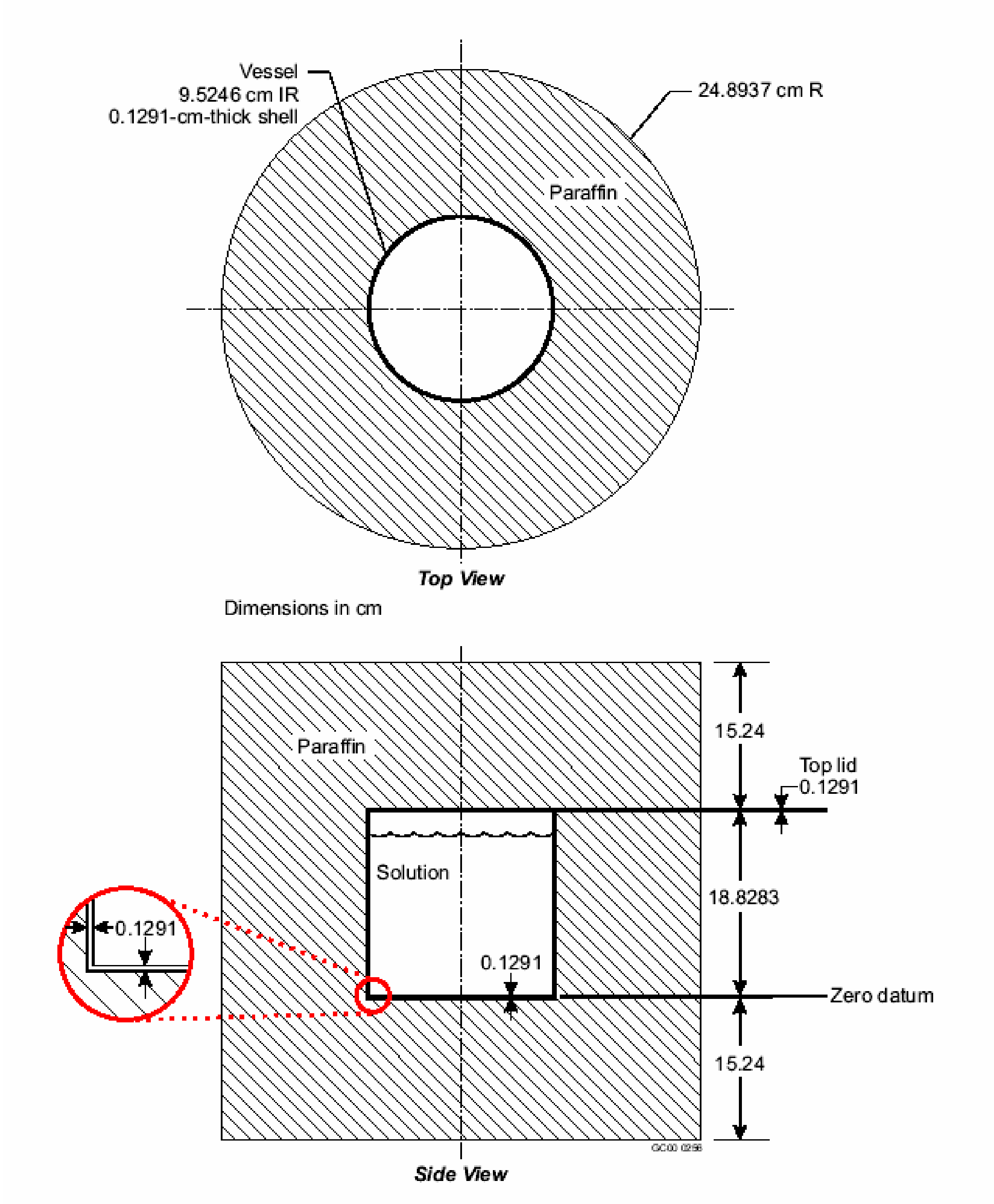


Figure 32. Experiment 57 (Case 6) simplified model, U233-SOL-THERM-003.

Table 66. Critical dimensions (cm) for experiments in U233-SOL-THERM-003

Case	Solution radius	Outer radius of unichrome	Outer radius of aluminum	Outer radius of paraffin	Adjusted solution height	Vessel inside height
1	6.3230	N/A	6.4521	21.6921	56.3528	91.2928
2	6.8265	7.0045	7.1336	22.3736	48.5411	91.2811
3	7.5589	N/A	7.6880	22.9280	23.8240	91.2640
4	8.3302	8.5082	8.6373	23.8773	16.7061	16.7061
5	8.3302	8.5082	8.6373	23.8773	16.5061	16.7061
6	9.52467	N/A	9.6537	24.8937	18.1783	18.8283
7	10.2645	N/A	10.3936	25.6336	19.9610	20.2900
8	10.7641	N/A	10.8932	26.1332	21.9494	21.9494
9	11.4351	N/A	11.5642	26.8042	22.8338	22.8338
10	15.2571	N/A	15.3862	30.6262	30.1448	30.1590

Table 67. Solution properties, U233-SOL-THERM-003

Case	Solution density (g/cm^3)	Uranium density (g U/L)	H /^{233}U
1	1.388	242.5	74.1
2	1.388	242.5	74.1
3	1.388	242.5	74.1
4	1.604	327.9	45.9
5	1.707	356.8	39.4
6	1.198	139.4	154.0
7	1.121	92.3	250.1
8	1.090	72.3	328.7
9	1.075	61.1	395.3
10	1.035	32.4	774.7

Table 68. Major solution isotope atom densities [atoms/(barn-cm)], U233-SOL-THERM-003

Case	U-233	U-234	U-238	H	O	F
1	8.5797E-04	4.0002E-06	7.6526E-06	6.3302E-02	3.3390E-02	1.8016E-03
2	8.5797E-04	4.0002E-06	7.6526E-06	6.3302E-02	3.3379E-02	1.8082E-03
3	8.5797E-04	4.0002E-06	7.6526E-06	6.3302E-02	3.3368E-02	1.8147E-03
4	1.3406E-03	6.2507E-06	1.1958E-05	6.1043E-02	3.3239E-02	2.8502E-03
5	1.5525E-03	7.2384E-06	1.3847E-05	6.0513E-02	3.3404E-02	3.3364E-03
6	4.2568E-04	1.9847E-06	3.7969E-06	6.5072E-02	3.3399E-02	1.0071E-03
7	2.6374E-04	1.2297E-06	2.3524E-06	6.5462E-02	3.3266E-02	6.7478E-04
8	2.0088E-04	9.3659E-07	1.7917E-06	6.5461E-02	3.3138E-02	6.6914E-04
9	1.6737E-04	7.8036E-07	1.4929E-06	6.5609E-02	3.3144E-02	4.9899E-04
10	8.5557E-05	3.9891E-07	7.6313E-07	6.5697E-02	3.3022E-02	3.4182E-04

8.2.2 RESULTS

All cases were set up and run as CSAS26 inputs having 500 generations and 4000 particles per generation for a total of two million particles. This was done to ensure that the cases converged and that the standard deviation was less than 0.1%. Table 69 lists calculated k_{eff} values and EALF along with the associated standard deviation for the benchmarks in this section. The suite of experiments has an average k_{eff} of 1.00886 ± 0.00076. These results tend to be about 0.7% high on average but range up to almost 2% high when compared with the benchmark results listed in the ICSBEP benchmark evaluation. Nevertheless, they show the same trend.

Table 69. Calculated k_{eff} and EALF for U233-SOL-THERM-003

Case	k_{eff} (±σ)	EALF (±σ) (eV)	ICSBEP benchmark k_{eff} (±σ)
1	1.00210 ± 0.00083	0.30283 ± 0.00041	0.9995 ± 0.0087
2	1.01619 ± 0.00077	0.33729 ± 0.00045	0.9991 ± 0.0015
3	1.00043 ± 0.00079	0.32328 ± 0.00043	1.0007 ± 0.0087
4	1.00246 ± 0.00079	0.75388 ± 0.00127	1.0015 ± 0.0013
5	1.00899 ± 0.00088	1.01444 ± 0.00182	1.0006 ± 0.0012
6	1.02030 ± 0.00079	0.12611 ± 0.00011	1.0012 ± 0.0087
7	1.01271 ± 0.00077	0.08166 ± 0.00005	1.0016 ± 0.0087
8	1.01024 ± 0.00075	0.06764 ± 0.00004	1.0016 ± 0.0087
9	1.00953 ± 0.00069	0.06074 ± 0.00003	1.0018 ± 0.0087
10	1.00572 ± 0.00061	0.04551 ± 0.00001	1.0018 ± 0.0087

8.3 U-233 RESULTS SUMMARY

Figure 33 shows the performance of high-enriched ^{233}U fuel at thermal energies. There are two types of problems in this section. U233-SOL-INTER-001 consists of a ^{233}U solution in various sizes of stainless steel spherical vessels with Be, CH_2, or Be-CH_2 reflectors. The cases consistently calculated between 2.5% and 1% low regardless of reflector or sphere size. The other type of evaluation, U233-SOL-THERM-003, consists of uranyl fluoride solutions in a tank with a paraffin reflector. These cases calculated between 0.5% low and 1.7% high, producing an average system k_{eff} of 1.00502.

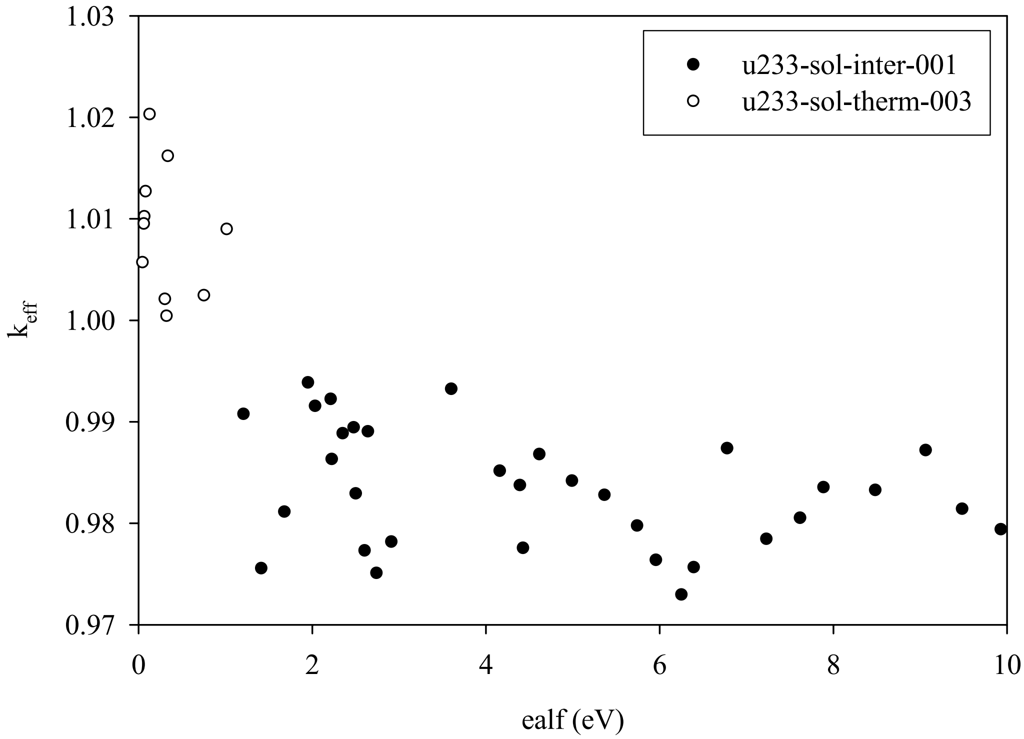


Figure 33. Summary of k_{eff} values vs EALF for ^{233}U.

9. CALCULATIONAL BENCHMARK CASES

9.1 OECD CALCULATIONAL BENCHMARKS

CALCULATION OF THE BENCHMARK 20 OF THE OECD-NEA WORKING GROUP ON CRITICALITY CALCULATIONS

9.1.1 DESCRIPTION

This section of calculational benchmarks was proposed by the OECD/NEA Nuclear Energy Agency Committee on Reactor Physics Working Group to examine the problem of uranium pellets in a dissolver environment.[38] This set of calcuations, specified as Benchmark 20, was a hypothetical problem using small UO_2 spheres, approximately the same volume as a fuel pellet or partially dissolved fuel pellet, in borated water or borated water containing UO_2. The pellet contains enriched uranium consisting of 2.5 wt % ^{235}U and 97.5 wt % ^{238}U. All the fuel is either in the fuel pellet or partially in the pellet and the rest mixed in the surrounding solution. The volume fraction of the fuel in the pellet, the volume fraction of the pellet to solution, and the boron concentration are all varied. Also, both triangular-pitched and square-pitched infinite lattices are examined. In all cases the array is assumed to be infinite in all directions.

There are five distinct cases with six variations of each case. Problem types are separated by the UO_2 volume fraction in the cell, triangular or square pitch, and cell pitch. Table 70 lists the specifications for each case. The variations in each case consist of fuel pellet diameter, percentage of total UO_2 in the fuel pellet, and boron concentration in the solution. Table 71 lists the specifications for each variation.

Table 70. Benchmark case description

Case	Cell UO_2 volume fraction	Cell type	Cell pitch (cm)
1	0.6	Triangular	1.0297
2	0.5	Triangular	1.0943
3	0.4	Triangular	1.1788
4	0.5	Square	0.9747
5	0.4	Square	1.0501

Table 71. Benchmark variation description

Variation	Pellet diameter (cm)	% UO2 in pellet	Boron in solution (ppm)
a	0.96	100	3500
b	0.96	100	1500
c	0.872	75	3500
d	0.872	75	1500
e	0.762	50	3500
f	0.762	50	1500

9.1.2 RESULTS

All critical assembly cases were set up and run as CSAS1 inputs using BONAMI and CENTRM/PMC to perform the resonance processing and XSDRNPM to solve the problem. Table 72 lists calculated values of lambda and EALF using CENTRM as well as the original results from the study, results using NITAWL, and results using MCNP. The results of the calculational benchmarks range from 0.91854 to 1.12837 for lambda and from 0.2326 eV to 3.386 eV for the EALF. The results using CENTRM agree very well with the values calculated using MCNP.

Table 72. EALF and lambda values for the OECD calculational benchmarks

Case	EALF (eV)	CENTRM / XSDRN k_{eff}	NITAWL / XSDRN k_{eff}	MCNP k_{eff} (±σ)
1a	3.137	1.00968	1.00614	1.0056 ± 0.0012
1b	2.225	1.09685	1.09290	1.0954 ± 0.0012
1c	3.329	0.99060	0.96138	0.9842 ± 0.0011
1d	2.371	1.07380	1.04123	1.0663 ± 0.0011
1e	3.386	0.98587	0.95633	0.9792 ± 0.0011
1f	2.425	1.06693	1.03403	1.0571 ± 0.0012
2a	1.264	0.99741	0.99743	0.9982 ± 0.0012
2b	0.836	1.12834	1.12836	1.1299 ± 0.0012
2c	1.327	0.97524	0.95606	0.9703 ± 0.0012
2d	0.881	1.09988	1.07758	1.0962 ± 0.0012
2e	1.330	0.97102	0.95168	0.9664 ± 0.0012
2f	0.889	1.09269	1.07019	1.0882 ± 0.0012
3a	0.627	0.94389	0.94411	0.9411 ± 0.0011
3b	0.390	1.12429	1.12457	1.1250 ± 0.0011
3c	0.648	0.92102	0.90809	0.9174 ± 0.0011
3d	0.405	1.09247	1.07662	1.0920 ± 0.0012
3e	0.641	0.91856	0.90538	0.9137 ± 0.0011
3f	0.404	1.08609	1.06995	1.0796 ± 0.0012
4a	1.264	0.99745	0.99817	0.9973 ± 0.0012
4b	0.836	1.12837	1.12922	1.1318 ± 0.0011
4c	1.327	0.97524	0.95610	0.9724 ± 0.0012
4d	0.881	1.09988	1.07762	1.0970 ± 0.0011
4e	1.330	0.97102	0.95151	0.9655 ± 0.0011
4f	0.889	1.09268	1.06999	1.0874 ± 0.0012
5a	0.628	0.94398	0.94447	0.9438 ± 0.0013
5b	0.390	1.12433	1.12495	1.1272 ± 0.0011
5c	0.649	0.92107	0.90817	0.9145 ± 0.0012
5d	0.405	1.09249	1.07667	1.0887 ± 0.0012
5e	0.641	0.91854	0.90529	0.9134 ± 0.0012
5f	0.404	1.08610	1.06986	1.0832 ± 0.0012

9.2 OECD BENCHMARK RESULTS SUMMARY

Figure 34 displays the results using CENTRM and NITAWL as the resonance processor as a difference between the respective k_{eff} values and those calculated using MCNP. As shown, the difference between CENTRM and MCNP results are always less than 1% and oscillate about zero, whereas the difference between the NITAWL and MCNP results is as much as 4%.

The CENTRM results are excellent in all cases. The NITAWL and CENTRM cases produce identical results for variation a and b for each case. This is because there is no fissile material in the solution to perturb the flux in the NITAWL calculation. Also, case variations d and f (1500 ppm boron) produce poorer results, in each case, than the c and e variations (3500 ppm boron). This is because the larger neutron absorption in the solution in the 3500 ppm boron suppresses the effects of the fissile material in the solution.

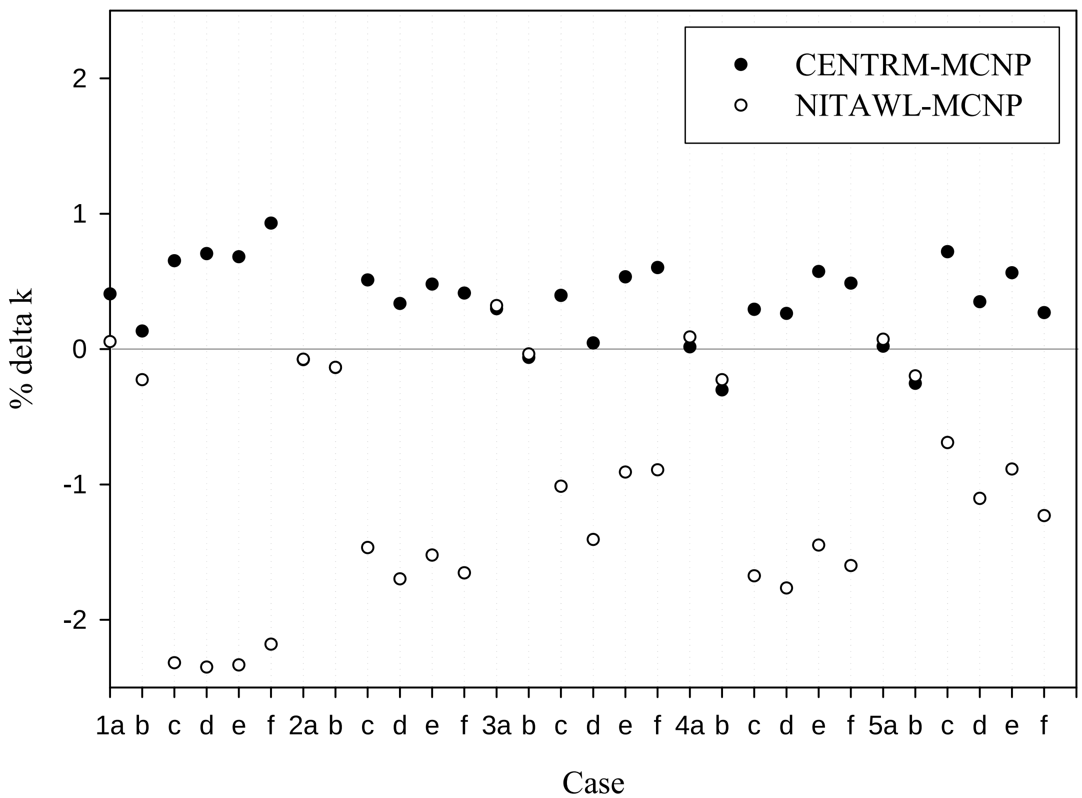


Figure 34. Summary of k_{eff} differences by case for the OECD/NEA calculational benchmarks.

10. SUMMARY AND CONCLUSIONS

This report provides detailed information about the performance of the CENTRM/PMC code system when used with the 238-group ENDF/B-V library and the NITAWL-III resonance processor. The results indicate that the performance of the code is highly dependent on the material and the configuration of the system. In most cases the results were consistent with the MCNP results reported in the ICSBEP handbook. Many of the observed discrepancies with the benchmark values are probably due to errors in the ENDF/B-V cross-section data or to uncertainties in the experimental benchmark configuration. Table 73 contains a brief synopsis of the results contained in this validation report.

Table 73. Summary of KENO-VI performance, using CENTRM/PMC cross-section processing, by system type

Problem Type	Performance
HEU thermal	Pins in water: excellent, 1.0 ± 0.1% Uranyl nitrate solution: fair, critical to 2% high
IEU thermal	Pins in water: good, critical to 1% low Uranyl sulphate solution: poor, 1% to 2% low
LEU thermal	Pins in water: fair, 1% low to 1% high Uranyl nitrate solutions: good, 0.2% to 1.0% high
MOX thermal	MOX pins in water: good, 0.7% low to 0.5% high MOX pins and UO_2 pins in water: fair, 1.8% low
Pu metal fast	Pu metal with Ni, Ta, and Al moderators: Above 0.7 MeV excellent: critical to 0.5% high Below 0.7 MeV with Fe reflector: fair, about 2% high
U-233 thermal and intermediate	Thermal uranyl fluoride: poor, critical to 2.0% high Intermediate uranyl fluoride: poor, 3% to 1.0% low
UO_2 pins in borated solution	CENTRM results in excellent agreement with MCNP results; most within 0.5%, with a few varying as much as 1% high

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APPENDIX A

HEU BENCHMARK CASES

APPENDIX A
HEU BENCHMARK CASES

```
=csas26       parm=centrm
EBOR case 1  222 fuel pins  crit h2o heigth  15.2 cm
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
end comp
read celldata
latticecell squarepitch pitch 1.242 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 2p96.52
cylinder 20  .46609  2p96.57
cuboid   30  4p.621 2p96.57
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary 30
unit 2
cuboid  10  4p.621 2p96.57
media  3 1 10
boundary 10
global unit 3
cuboid 10 18.009 -.621  18.009 -.621  2p96.57
cuboid 20 48.489 -31.101 48.489 -31.101   111.77 -117.73
array  1 10  place 1 1 1 0.0 0.0 0.0
media  3 20 -10

boundary 20
end geom
read array
ara=1   nux=15 nuy=15 nuz=1  fill
2  13r1  2
15r1
15r1
15r1
15r1
15r1
```

```
15r1
15r1
15r1
15r1
15r1
15r1
15r1
15r1
14r1  2
end fill
end array
end data
end


=csas26       parm=centrm
EBOR case 2  223 fuel pins  crit h2o heigth  -50.3 cm
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
end comp
read celldata
latticecell squarepitch pitch 1.242 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 46.27 -96.52
cylinder 20  .46609  46.27 -96.52
cuboid   30  4p.621 46.27 -96.57
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary 30
unit 2
cuboid  10  4p.621 46.27 -96.57
media  3 1 10
boundary 10

unit 3
cylinder 10 .41529   96.52 46.27
cylinder 20  .46609  96.52 46.27
cuboid   30  4p.621  96.57 46.27
media  1 1 10
```

```
media  2 1 20 -10
media  0 1 30 -20 -10
boundary 30
unit 4
cuboid  10  4p.621 96.57 46.27
media  0 1 10
boundary 10


unit 10
cuboid 10 18.009 -.621  18.009 -.621  46.27 -96.57
cuboid 20 48.489 -31.101 48.489 -31.101   46.27 -117.73
array  1 10  place 1 1 1 0.0 0.0 0.0
media  3 1 20 -10
boundary 20

unit 11
cuboid 10 18.009 -.621  18.009 -.621  96.57 46.27
cuboid 20 48.489 -31.101 48.489 -31.101   96.57 46.27
array  2 10  place 1 1 1 0.0 0.0 0.0
media  0 1 20 -10
boundary 20

global unit 30
cuboid 10 48.489  -31.101  48.489 -31.101  96.57 -96.57
array 3 10 place 1 1 1 0.0 0.0 0.0
boundary 10
end geom

read array
ara=1   nux=15 nuy=15 nuz=1  fill
2  14r1
15r1
15r1
15r1
15r1
15r1
15r1
15r1
15r1
15r1
15r1
15r1
15r1
15r1
14r1  2
end fill

ara=2   nux=15 nuy=15 nuz=1  fill
4  14r3
15r3
15r3
15r3
15r3
15r3
15r3
15r3
15r3
15r3
15r3
15r3
15r3
15r3
14r3  4
```

```
end fill

ara=3  nux=1 nuy=1 nuz=2  fill
10 11
end fill

end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26      parm=centrm
EBOR case 3  138 fuel pins  crit h2o heigth  30.8 cm
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
end comp
read celldata
latticecell squarepitch pitch 1.488 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 2p96.52
cylinder 20  .46609  2p96.57
cuboid   30  4p.744 2p96.57
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary 30
```

```
unit 2
cuboid  10  4p.744 2p96.57
media  3 1 10
boundary 10
global unit 3
cuboid 10 17.112 -.744  17.112 -.744  2p96.57
cuboid 20 47.592 -31.224 47.592 -31.224   127.37 -117.73
array  1 10  place 1 1 1 0.0 0.0 0.0
media  3 20 -10

boundary 20
end geom
read array
ara=1   nux=12 nuy=12 nuz=1  fill
2  10r1  2
11r1 2
12r1
12r1
12r1
12r1
12r1
12r1
12r1
12r1
2 11r1
2 10r1 2

end fill
end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt

end plot
end data
end


=csas26       parm=centrm
EBOR case 4  102 fuel pins  crit h2o heigth  -21.3 cm
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
```

```
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
end comp
read celldata
latticecell squarepitch pitch 1.742 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 75.27 -96.52
cylinder 20  .46609  75.27 -96.52
cuboid   30  4p.871 75.27 -96.57
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary 30
unit 2
cuboid  10  4p.871 75.27 -96.57
media  3 1 10
boundary 10

unit 3
cylinder 10 .41529   96.52 75.27
cylinder 20  .46609  96.52 75.27
cuboid   30  4p.871  96.57 75.27
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary 30
unit 4
cuboid  10  4p.871 96.57 75.27
media  0 1 10
boundary 10


unit 10
cuboid 10 18.291 -.871  18.291 -.871  75.27 -96.57
cuboid 20 48.771 -31.351 48.771 -31.351   75.27 -117.73
array  1 10  place 1 1 1 0.0 0.0 0.0
media  3 1 20 -10
boundary 20

unit 11
cuboid 10 18.291 -.871  18.291 -.871  96.57 75.27
cuboid 20 48.771 -31.351 48.771 -31.351   96.57 75.27
array  2 10  place 1 1 1 0.0 0.0 0.0
media  0 1 20 -10
boundary 20

global unit 30
cuboid 10 48.771  -31.351  48.771 -31.351  96.57 -96.57
array 3 10 place 1 1 1 0.0 0.0 0.0
boundary 10
end geom

read array
ara=1   nux=11 nuy=11 nuz=1  fill
3r2  5r1  3r2
2 9r1 2
2 9r1 2
11r1
11r1
11r1
```

```
11r1
11r1
2 9r1 2
2 9r1 2
2r2  6r1  3r2
end fill

ara=2   nux=11 nuy=11 nuz=1  fill
3r4  5r3  3r4
4 9r3 4
4 9r3 4
11r3
11r3
11r3
11r3
11r3
4 9r3 4
4 9r3 4
2r4  6r3  3r4
end fill

ara=3  nux=1 nuy=1 nuz=2  fill
10 11
end fill

end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26       parm=centrm
EBOR case 5  85 fuel pins  crit h2o heigth  15.2 cm
238gr
read comp
' ******* Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
```

```
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
end comp
read celldata
latticecell squarepitch pitch 1.999 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 2p96.52
cylinder 20  .46609  2p96.57
cuboid   30  4p.9995 2p96.57
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary 30
unit 2
cuboid  10  4p.9995 2p96.57
media  3 1 10
boundary 10
global unit 3
cuboid 10 18.9905 -.9995  18.9905 -.9995  2p96.57
cuboid 20 49.4705 -31.4795 49.4705 -31.4795   111.77 -117.73
array  1 10  place 1 1 1 0.0 0.0 0.0
media  3 20 -10

boundary 20
end geom
read array
ara=1   nux=10 nuy=10 nuz=1  fill
2r2  5r1  3r2
2 8r1 2
2 9r1
10r1
10r1
10r1
10r1
9r1 2
2 8r1 2
2r2 6r1 2r2
end fill
end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26       parm=centrm
```

```
EBOR case 6  86 fuel pins  crit h2o heigth  -60.8 cm
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
end comp
read celldata
latticecell squarepitch pitch 1.999 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 35.77 -96.52
cylinder 20  .46609  35.77 -96.52
cuboid   30  4p.9995 35.77 -96.57
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary 30
unit 2
cuboid  10  4p.9995 35.77 -96.57
media  3 1 10
boundary 10

unit 3
cylinder 10 .41529   96.52 35.77
cylinder 20  .46609  96.52 35.77
cuboid   30  4p.9995  96.57 35.77
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary 30
unit 4
cuboid  10  4p.9995 96.57 35.77
media  0 1 10
boundary 10


unit 10
cuboid 10 18.9905 -.9995  18.9905 -.9995  35.77 -96.57
cuboid 20 49.4705 -31.4795 49.4705 -31.4795   35.77 -117.73
array  1 10  place 1 1 1 0.0 0.0 0.0
media  3 1 20 -10
boundary 20
```

```
unit 11
cuboid 10 18.9905 -.9995  18.9905 -.9995  96.57 35.77
cuboid 20 49.4705 -31.4795 49.4705 -31.4795   96.57 35.77
array  2 10  place 1 1 1 0.0 0.0 0.0
media  0 1 20 -10
boundary 20

global unit 30
cuboid 10 49.4705 -31.4795 49.4705 -31.4795  96.57 -96.57
array 3 10 place 1 1 1 0.0 0.0 0.0
boundary 10
end geom

read array
ara=1   nux=10 nuy=10 nuz=1  fill
2r2  6r1 2r2
2 8r1 2
2 9r1
10r1
10r1
10r1
10r1
9r1 2
2 8r1 2
2r2 6r1 2r2
end fill

ara=2   nux=10 nuy=10 nuz=1  fill
2r4  6r3 2r4
4 8r3 4
4 9r3
10r3
10r3
10r3
10r3
9r3 4
4 8r3 4
2r4 6r3 2r4
end fill

ara=3  nux=1 nuy=1 nuz=2  fill
10 11
end fill

end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26       parm=centrm
```

```
EBOR case 7  78 fuel pins  crit h2o heigth  15.2 cm
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
end comp
read celldata
latticecell squarepitch pitch 2.276 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 2p96.52
cylinder 20  .46609  2p96.57
cuboid   30  4p1.138 2p96.57
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary 30
unit 2
cuboid  10  4p1.138 2p96.57
media  3 1 10
boundary 10
global unit 3
cuboid 10 19.346 -1.138  19.346 -1.138  2p96.57
cuboid 20 49.826 -31.618 49.826 -31.618   111.77 -117.73
array  1 10  place 1 1 1 0.0 0.0 0.0
media  3 20 -10

boundary 20
end geom
read array
ara=1   nux=9 nuy=9 nuz=1  fill
2  7r1  2
9r1
9r1
9r1
9r1
9r1
9r1
9r1
8r1 2

end fill
end array
```

```
read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26     parm=centrm
EBOR case 8  79 fuel pins  crit h2o heigth  -39.0 cm
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
end comp
read celldata
latticecell squarepitch pitch 2.276 3 fueld  0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 57.57 -96.52
cylinder 20  .46609  57.57 -96.52
cuboid   30  4p1.138 57.57 -96.57
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary 30
unit 2
cuboid  10  4p1.138 57.57 -96.57
media  3 1 10
boundary 10

unit 3
cylinder 10 .41529   96.52 57.57
```

```
cylinder 20  .46609  96.52 57.57
cuboid   30  4p1.138  96.57 57.57
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary 30
unit 4
cuboid  10  4p1.138 96.57 57.57
media  0 1 10
boundary 10


unit 10
cuboid 10 19.346 -1.138  19.346 -1.138  57.57 -96.57
cuboid 20 49.826 -31.618 49.826 -31.618   57.57 -117.73
array  1 10  place 1 1 1 0.0 0.0 0.0
media  3 1 20 -10
boundary 20

unit 11
cuboid 10 19.346 -1.138  19.346 -1.138  96.57 57.57
cuboid 20 49.826 -31.618 49.826 -31.618   96.57 57.57
array  2 10  place 1 1 1 0.0 0.0 0.0
media  0 1 20 -10
boundary 20

global unit 30
cuboid 10 49.826 -31.618 49.826 -31.618  96.57 -96.57
array 3 10 place 1 1 1 0.0 0.0 0.0
boundary 10
end geom

read array
ara=1   nux=9 nuy=9 nuz=1  fill
2  8r1
9r1
9r1
9r1
9r1
9r1
9r1
9r1
8r1 2
end fill

ara=2   nux=9 nuy=9 nuz=1  fill
4  8r3
9r3
9r3
9r3
9r3
9r3
9r3
9r3
8r3 4
end fill


ara=3  nux=1 nuy=1 nuz=2  fill
10 11
end fill

end array
```

```
read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26       parm=centrm
EBOR case 9  77 fuel pins  crit h2o heigth  -3.9 cm
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
end comp
read celldata
latticecell squarepitch pitch 2.253 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 92.67 -96.52
cylinder 20  .46609  92.67 -96.52
cuboid   30  4p1.1265 92.67 -96.57
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary 30
unit 2
cuboid  10  4p1.1265 92.67 -96.57
media  3 1 10
boundary 10

unit 3
cylinder 10 .41529   96.52 92.67
cylinder 20  .46609  96.52 92.67
```

```
cuboid   30  4p1.1265  96.57 92.67
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary 30
unit 4
cuboid  10  4p1.1265 96.57 92.67
media  0 1 10
boundary 10


unit 10
cuboid 10 21.4035 -1.1265  21.4035 -1.1265  92.67 -96.57
cuboid 20 51.8835 -31.6065 51.8835 -31.6065   92.67 -117.73
array  1 10  place 1 1 1 0.0 0.0 0.0
media  3 1 20 -10
boundary 20

unit 11
cuboid 10 21.4035 -1.1265  21.4035 -1.1265  96.57 92.67
cuboid 20 51.8835 -31.6065 51.8835 -31.6065   96.57 92.67
array  2 10  place 1 1 1 0.0 0.0 0.0
media  0 1 20 -10
boundary 20

global unit 30
cuboid 10 51.8835 -31.6065 51.8835 -31.6065  96.57 -96.57
array 3 10 place 1 1 1 0.0 0.0 0.0
boundary 10
end geom

read array
ara=1   nux=10 nuy=10 nuz=1  fill
3r2 4r1 3r2
2r2 6r1 2r2
2 8r1 2
10r1
10r1
10r1
10r1
2 8r1 2
2r2 7r1 2
3r2 4r1 3r2
end fill

ara=2   nux=10 nuy=10 nuz=1  fill
3r4 4r3 3r4
2r4 6r3 2r4
4 8r3 4
10r3
10r3
10r3
10r3
4 8r3 4
2r4 7r3 4
3r4 4r3 3r4
end fill



ara=3  nux=1 nuy=1 nuz=2  fill
10 11
end fill
```

```
end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26        parm=centrm
EBOR case 10  75 fuel pins  crit h2o heigth  15.2 cm
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
end comp
read celldata
latticecell squarepitch pitch 2.507 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 2p96.52
cylinder 20  .46609  2p96.57
cuboid   30  4p1.2535 2p96.57
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary 30
unit 2
cuboid  10  4p1.2535 2p96.57
media  3 1 10
boundary 10
global unit 3
cuboid 10 23.8165 -1.2535  23.8165 -1.2535  2p96.57
```

```
cuboid 20 54.2965 -31.7335 54.2965 -31.7335   111.77 -117.73
array  1 10  place 1 1 1 0.0 0.0 0.0
media  3 20 -10

boundary 20
end geom
read array
ara=1   nux=10 nuy=10 nuz=1  fill
3r2 4r1 3r2
2r2 6r1 2r2
2 8r1 2
10r1
10r1
10r1
10r1
2 8r1 2
2r2 6r1 2r2
3r2 3r1 4r2
end fill
end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end

=csas26     parm=centrm
EBOR case 11  76 fuel pins  crit h2o heigth  -61.3 cm
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
end comp
read celldata
```

```
latticecell squarepitch pitch 2.507 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 35.27 -96.52
cylinder 20  .46609  35.27 -96.52
cuboid   30  4p1.2535 35.27 -96.57
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary 30
unit 2
cuboid  10  4p1.2535 35.27 -96.57
media  3 1 10
boundary 10

unit 3
cylinder 10 .41529   96.52 35.27
cylinder 20  .46609  96.52 35.27
cuboid   30  4p1.2535  96.57 35.27
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary 30
unit 4
cuboid  10  4p1.2535 96.57 35.27
media  0 1 10
boundary 10


unit 10
cuboid 10 23.8165 -1.2535  23.8165 -1.2535  35.27 -96.57
cuboid 20 54.2965 -31.7335 54.2965 -31.7335   35.27 -117.73
array  1 10  place 1 1 1 0.0 0.0 0.0
media  3 1 20 -10
boundary 20

unit 11
cuboid 10 23.8165 -1.2535  23.8165 -1.2535  96.57 35.27
cuboid 20 54.2965 -31.7335 54.2965 -31.7335   96.57 35.27
array  2 10  place 1 1 1 0.0 0.0 0.0
media  0 1 20 -10
boundary 20

global unit 30
cuboid 10 54.2965 -31.7335 54.2965 -31.7335  96.57 -96.57
array 3 10 place 1 1 1 0.0 0.0 0.0
boundary 10
end geom

read array
ara=1   nux=10 nuy=10 nuz=1  fill
3r2 4r1 3r2
2r2 6r1 2r2
2 8r1 2
10r1
10r1
10r1
10r1
2 8r1 2
2r2 6r1 2r2
3r2 4r1 3r2
end fill
```

```
ara=2   nux=10 nuy=10 nuz=1  fill
3r4 4r3 3r4
2r4 6r3 2r4
4 8r3 4
10r3
10r3
10r3
10r3
4 8r3 4
2r4 6r3 2r4
3r4 4r3 3r4
end fill



ara=3  nux=1 nuy=1 nuz=2  fill
10 11
end fill

end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26     parm=centrm
EBOR case 12  77 fuel pins  crit h2o heigth  -43.2 cm
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water *********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
```

```
end comp
read celldata
latticecell squarepitch pitch 2.779 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 53.37 -96.52
cylinder 20  .46609  53.37 -96.52
cuboid   30  4p1.3895 53.37 -96.57
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary 30
unit 2
cuboid  10  4p1.3895 53.37 -96.57
media  3 1 10
boundary 10

unit 3
cylinder 10 .41529   96.52 53.37
cylinder 20  .46609  96.52 53.37
cuboid   30  4p1.3895  96.57 53.37
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary 30
unit 4
cuboid  10  4p1.3895 96.57 53.37
media  0 1 10
boundary 10


unit 10
cuboid 10 26.4005 -1.3895  26.4005 -1.3895  53.37 -96.57
cuboid 20 56.8805 -31.8695 56.8805 -31.8695   53.37 -117.73
array  1 10  place 1 1 1 0.0 0.0 0.0
media  3 1 20 -10
boundary 20

unit 11
cuboid 10 26.4005 -1.3895  26.4005 -1.3895  96.57 53.37
cuboid 20 56.8805 -31.8695 56.8805 -31.8695   96.57 53.37
array  2 10  place 1 1 1 0.0 0.0 0.0
media  0 1 20 -10
boundary 20

global unit 30
cuboid 10 56.8805 -31.8695 56.8805 -31.8695  96.57 -96.57
array 3 10 place 1 1 1 0.0 0.0 0.0
boundary 10
end geom

read array
ara=1   nux=10 nuy=10 nuz=1  fill
3r2 4r1 3r2
2r2 6r1 2r2
2 8r1 2
10r1
10r1
10r1
10r1
2 8r1 2
2r2 7r1 2
```

```
3r2 4r1 3r2
end fill

ara=2   nux=10 nuy=10 nuz=1  fill
3r4 4r3 3r4
2r4 6r3 2r4
4 8r3 4
10r3
10r3
10r3
10r3
4 8r3 4
2r4 7r3 4
3r4 4r3 3r4
end fill



ara=3  nux=1 nuy=1 nuz=2  fill
10 11
end fill

end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26     parm=centrm
EBOR case 13  83 fuel pins  crit h2o heigth  -34.1 cm
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
```

```
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
end comp
read celldata
latticecell squarepitch pitch 2.995 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 53.37 -96.52
cylinder 20  .46609  53.37 -96.52
cuboid   30  4p1.3895 53.37 -96.57
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary 30
unit 2
cuboid  10  4p1.3895 53.37 -96.57
media  3 1 10
boundary 10

unit 3
cylinder 10 .41529   96.52 53.37
cylinder 20  .46609  96.52 53.37
cuboid   30  4p1.3895  96.57 53.37
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary 30
unit 4
cuboid  10  4p1.3895 96.57 53.37
media  0 1 10
boundary 10


unit 10
cuboid 10 26.4005 -1.3895  26.4005 -1.3895  53.37 -96.57
cuboid 20 56.8805 -31.8695 56.8805 -31.8695   53.37 -117.73
array  1 10  place 1 1 1 0.0 0.0 0.0
media  3 1 20 -10
boundary 20

unit 11
cuboid 10 26.4005 -1.3895  26.4005 -1.3895  96.57 53.37
cuboid 20 56.8805 -31.8695 56.8805 -31.8695   96.57 53.37
array  2 10  place 1 1 1 0.0 0.0 0.0
media  0 1 20 -10
boundary 20

global unit 30
cuboid 10 56.8805 -31.8695 56.8805 -31.8695  96.57 -96.57
array 3 10 place 1 1 1 0.0 0.0 0.0
boundary 10
end geom

read array
ara=1   nux=10 nuy=10 nuz=1  fill
3r2 4r1 3r2
2r2 6r1 2r2
2 8r1 2
10r1
10r1
10r1
10r1
```

```
2 8r1 2
2r2 7r1 2
3r2 4r1 3r2
end fill

ara=2   nux=10 nuy=10 nuz=1  fill
3r4 4r3 3r4
2r4 6r3 2r4
4 8r3 4
10r3
10r3
10r3
10r3
4 8r3 4
2r4 7r3 4
3r4 4r3 3r4
end fill



ara=3  nux=1 nuy=1 nuz=2  fill
10 11
end fill

end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26     parm=centrm
EBOR case 14  96 fuel pins  crit h2o heigth  -10.4 cm
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
```

```
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
end comp
read celldata
latticecell squarepitch pitch 2.497 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 86.17 -96.52
cylinder 20  .46609  86.17 -96.52
cuboid   30  2p1.2485 2p1.2685 86.17 -96.57
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary 30
'unit 2
'cuboid  10  2p1.2485 2p1.2685 86.17 -96.57
'media  3 1 10
'boundary 10

unit 3
cylinder 10 .41529   96.52 86.17
cylinder 20  .46609  96.52 86.17
cuboid   30  2p1.2485  2p1.2685 96.57 86.17
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary 30
'unit 4
'cuboid  10  2p1.2485 2p1.2685 96.57 86.17
'media  0 1 10
'boundary 10


unit 10
cuboid 10 38.7035 -1.2485  13.9535 -1.2685   86.17 -96.57
cuboid 20 69.1835 -31.9775 44.4335 -31.7485   86.17 -117.73
array  1 10  place 1 1 1 0.0 0.0 0.0
media  3 1 20 -10
boundary 20

unit 11
cuboid 10 38.7035 -1.2485  13.9535  -1.2685  96.57 86.17
cuboid 20 69.1835 -31.9775 44.4335  -31.7485 96.57 86.17
array  2 10  place 1 1 1 0.0 0.0 0.0
media  0 1 20 -10
boundary 20

global unit 30
cuboid 10 69.1835 -31.9775 44.4335 -31.7485  96.57 -96.57
array 3 10 place 1 1 1 0.0 0.0 0.0
boundary 10
end geom

read array
ara=1   nux=16 nuy=6 nuz=1  fill
16r1
16r1
16r1
16r1
16r1
```

```
16r1
end fill

ara=2   nux=16 nuy=6 nuz=1  fill
16r3
16r3
16r3
16r3
16r3
16r3


end fill



ara=3  nux=1 nuy=1 nuz=2  fill
10 11
end fill

end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26     parm=centrm
EBOR case 15  75 fuel pins  crit h2o heigth  -12.2 cm
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
```

```
end comp
read celldata
latticecell triangpitch pitch 2.5878 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom

unit 1
cylinder 10 .41529 84.37 -96.52
cylinder 20  .46609  84.37 -96.52
hexprism   30  1.2939 84.37 -96.57
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary 30

unit 2
hexprism   10  1.2939 84.37 -96.57
media  3 1 10
boundary 10

unit 3
cylinder 10 .41529   96.52 84.37
cylinder 20  .46609  96.52 84.37
hexprism   30  1.2939  96.57 84.37
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary 30

unit 4
hexprism  10  1.2939 96.57 84.37
media  0 1 10
boundary 10


unit 10
hexprism 10 12.939  84.37 -96.57
hexprism 20 43.419   84.37 -117.73
array  1 10  place 1 1 1 -15.5268 -15.5268 0.0
media  3 1 20 -10
boundary 20


unit 11
hexprism 10 12.939  96.57 84.37
hexprism 20 43.419   96.57 84.37
array  2 10  place 1 1 1 -15.5268 -15.5268 0.0
media  0 1 20 -10
boundary 20

global
unit 30
hexprism 10 43.419  96.57 -96.57
array 3 10 place   1 1 1  0.0 0.0 0.0
boundary 10
end geom

read array

ara=1  typ=shex nux=13 nuy=15 nuz=1  fill
13r2
13r2
6r2 3r1 4r2
```

```
4r2 5r1 4r2
3r2 8r1 2r2
2r2 9r1 2r2
3r2 8r1 2r2
2r2 9r1 2r2
3r2 8r1 2r2
2r2 9r1 2r2
3r2 8r1 2r2
4r2 5r1 4r2
5r2 3r1 5r2
13r2
13r2
end fill

ara=2   typ=shex nux=13 nuy=15 nuz=1  fill

13r4
13r4
6r4 3r3 4r4
4r4 5r3 4r4
3r4 8r3 2r4
2r4 9r3 2r4
3r4 8r3 2r4
2r4 9r3 2r4
3r4 8r3 2r4
2r4 9r3 2r4
3r4 8r3 2r4
4r4 5r3 4r4
5r4 3r3 5r4
13r4
13r4
end fill

ara=3   typ=shex nux=1 nuy=1 nuz=2  fill
10 11
end fill

end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26     parm=centrm
EBOR case 16  99 fuel pins  crit h2o heigth
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
```

```
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
' *********stainless steel *******
fe 4 0 5.9355-2 end
cr 4 0 1.7428-2 end
ni 4 0 7.7203-3 end
mn 4 0 1.7363-3 end
end comp
read celldata
latticecell squarepitch pitch 2.48 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 86.17 -96.52
cylinder 20  .46609  86.17 -96.52
cuboid   30  2p1.24 2p1.2685 96.57 -96.57
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary 30
unit 2
cuboid  10  2p1.24 2p1.2685 96.57 -96.57
media  3 1 10
boundary 10

global unit 30
cuboid 10    18.6 -23.56   6.2 -8.68     96.57 -96.57
cylinder 20 25.4 115.9375 -115.53
cylinder 30 25.56 115.9375 -116.13
cylinder 40 56.04 115.9375 -131.33
array 1 10 place 10 4 1   0.0 0.0 0.0
media 3 1 20 -10
media 4 1 30 -20 -10
media 3 1 40 -30 -20 -10
boundary 40

end geom

read array
ara=1   nux=17 nuy=6 nuz=1  fill
16r1 2
16r1 2
16r1 2
17r1
17r1
17r1
end fill
```

```
end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26     parm=centrm
EBOR case 17  114 fuel pins   H3BO3 Aqueeous Moderator/reflector
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
' *********stainless steel *******
fe 4 0 5.9355-2 end
cr 4 0 1.7428-2 end
ni 4 0 7.7203-3 end
mn 4 0 1.7363-3 end
' ********H3BO3 *********
b-10 5 0 4.3231-7 end
b-11 5 0 1.7401-6 end
h    5 0 6.6767-2 end
o    5 0 3.3387-2 end
end comp
read celldata
latticecell squarepitch pitch 2.48 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 86.17 -96.52
cylinder 20  .46609  86.17 -96.52
cuboid   30  2p1.24 2p1.2685 96.57 -96.57
```

```
media  1 1 10
media  2 1 20 -10
media  5 1 30 -20 -10
boundary 30
unit 2
cuboid  10  2p1.24 2p1.2685 96.57 -96.57
media  5 1 10
boundary 10

global unit 30
cuboid 10    23.56 -23.56   6.2 -8.68     96.57 -96.57
cylinder 20 25.4 115.9375 -115.53
cylinder 30 25.56 115.9375 -116.13
cylinder 40 56.04 115.9375 -131.33
array 1 10 place   10 4 1   0.0 0.0 0.0
media 5 1 20 -10
media 4 1 30 -20 -10
media 3 1 40 -30 -20 -10
boundary 40

end geom

read array
ara=1   nux=19 nuy=6 nuz=1  fill
19r1
19r1
19r1
19r1
19r1
19r1
end fill

end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26     parm=centrm
EBOR case 18  113 fuel pins   H3BO3 Aqueeous Moderator/reflector
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
```

```
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
' *********stainless steel *******
fe 4 0 5.9355-2 end
cr 4 0 1.7428-2 end
ni 4 0 7.7203-3 end
mn 4 0 1.7363-3 end
' ********H3BO3 *********
b-10 5 0 4.3231-7 end
b-11 5 0 1.7401-6 end
h    5 0 6.6767-2 end
o    5 0 3.3387-2 end
end comp
read celldata
latticecell squarepitch pitch 2.48 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 86.17 -96.52
cylinder 20  .46609  86.17 -96.52
cuboid   30  2p1.24 2p1.2685 96.57 -96.57
media  1 1 10
media  2 1 20 -10
media  5 1 30 -20 -10
boundary 30
unit 2
cuboid  10  2p1.24 2p1.2685 96.57 -96.57
media  5 1 10
boundary 10

global unit 30
cuboid 10    23.56 -23.56   6.2 -8.68     96.57 -96.57
cylinder 20 25.4 115.9375 -115.53
cylinder 30 25.56 115.9375 -116.13
cylinder 40 56.04 115.9375 -131.33
array 1 10 place   10 4 1   0.0 0.0 0.0
media 5 1 20 -10
media 4 1 30 -20 -10
media 3 1 40 -30 -20 -10
boundary 40

end geom

read array
ara=1   nux=19 nuy=6 nuz=1  fill
18r1  2
19r1
19r1
19r1
19r1
19r1
end fill
```

```
end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26     parm=centrm
EBOR case 19  133 fuel pins   H3BO3 Aqueeous Moderator/reflector
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
' *********stainless steel *******
fe 4 0 5.9355-2 end
cr 4 0 1.7428-2 end
ni 4 0 7.7203-3 end
mn 4 0 1.7363-3 end
' *******H3BO3 *********
b-10 5 0 2.1061-6 end
b-11 5 0 8.4775-6 end
h    5 0 6.6761-2 end
o    5 0 3.3397-2 end
end comp
read celldata
latticecell squarepitch pitch 2.48 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 86.17 -96.52
cylinder 20  .46609  86.17 -96.52
cuboid   30  2p1.24 2p1.2685 96.57 -96.57
```

```
media  1 1 10
media  2 1 20 -10
media  5 1 30 -20 -10
boundary 30
unit 2
cuboid  10  2p1.24 2p1.2685 96.57 -96.57
media  5 1 10
boundary 10

global unit 30
cuboid 10    23.56 -23.56   8.68 -8.68     96.57 -96.57
cylinder 20 25.4 115.9375 -115.53
cylinder 30 25.56 115.9375 -116.13
cylinder 40 56.04 115.9375 -131.33
array 1 10 place   10 4 1   0.0 0.0 0.0
media 5 1 20 -10
media 4 1 30 -20 -10
media 3 1 40 -30 -20 -10
boundary 40

end geom

read array
ara=1   nux=19 nuy=7 nuz=1  fill
19r1
19r1
19r1
19r1
19r1
19r1
19r1
end fill

end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26     parm=centrm
EBOR case 20  133 fuel pins   H3BO3 Aqueeous Moderator/reflector
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
```

```
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
' *********stainless steel *******
fe 4 0 5.9355-2 end
cr 4 0 1.7428-2 end
ni 4 0 7.7203-3 end
mn 4 0 1.7363-3 end
' ********U(92.6)O2(NO3)2 *********
u-235 5 0 9.4286-6 end
u-238 5 0 7.4396-7 end
h     5 0 6.6521-2 end
o     5 0 3.3342-2 end
n     5 0 2.0345-5 end
end comp
read celldata
latticecell squarepitch pitch 2.48 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 86.17 -96.52
cylinder 20  .46609  86.17 -96.52
cuboid   30  2p1.24 2p1.2685 96.57 -96.57
media  1 1 10
media  2 1 20 -10
media  5 1 30 -20 -10
boundary 30
unit 2
cuboid  10  2p1.24 2p1.2685 96.57 -96.57
media  5 1 10
boundary 10

global unit 30
cuboid 10    21.08 -21.08   6.2 -6.2     96.57 -96.57
cylinder 20 25.4 115.9375 -115.53
cylinder 30 25.56 115.9375 -116.13
cylinder 40 56.04 115.9375 -131.33
array 1 10 place   9 3 1   0.0 0.0 0.0
media 5 1 20 -10
media 4 1 30 -20 -10
media 3 1 40 -30 -20 -10
boundary 40

end geom

read array
ara=1   nux=17 nuy=5 nuz=1  fill
16r1 2
16r1 2
17r1
17r1
17r1
```

```
end fill

end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26     parm=centrm
EBOR case-21 133 fuel pins U(92.6)O2(NO3)2 + H3BO3 Aqueeous
Moderator/reflector
238gr
read comp
' ******** Fuel ************
u-235  1 0 3.8280-3 end
u-234 1 0 2.5881-5 end
u-236 1 0 1.7715-5 end
u-238 1 0 2.2351-3 end
o     1 0 6.1599-2 end
be 1 0 4.9386-2 end
'*********  Hastelloy ********
c 2 0 6.1896-4 end
cr 2 0 2.0970-2 end
fe 2 0 1.6418-2 end
co 2 0 1.2615-3 end
ni 2 0 4.0746-2 end
mo 2 0 4.6493-3 end
w-182 2 0 4.2540-5 end
w-183 2 0 2.3098-5 end
w-184 2 0 4.9657-5 end
w-186 2 0 4.6261-5 end
' ******** water **********
h 3 0 6.6735-2 end
o 3 0 3.3368-2 end
' *********stainless steel *******
fe 4 0 5.9355-2 end
cr 4 0 1.7428-2 end
ni 4 0 7.7203-3 end
mn 4 0 1.7363-3 end
' ********U(92.6)O2(NO3)2 + H3BO3 *********
u-235 5 0 9.4286-6 end
u-238 5 0 7.4396-7 end
b-10  5 0 3.4918-6 end
b-11  5 0 1.4055-5 end
h     5 0 6.6527-2 end
o     5 0 3.3371-2 end
n     5 0 2.0345-5 end
end comp
read celldata
latticecell squarepitch pitch 2.48 3 fueld 0.83058 1 cladd 0.93218 2 end
end celldata
```

```
read param gen=503 npg=4000 end param
read geom
unit 1
cylinder 10 .41529 86.17 -96.52
cylinder 20  .46609  86.17 -96.52
cuboid   30  2p1.24 2p1.2685 96.57 -96.57
media  1 1 10
media  2 1 20 -10
media  5 1 30 -20 -10
boundary 30
unit 2
cuboid  10  2p1.24 2p1.2685 96.57 -96.57
media  5 1 10
boundary 10

global unit 30
cuboid 10    23.56 -23.56   8.68 -8.68     96.57 -96.57
cylinder 20 25.4 115.9375 -115.53
cylinder 30 25.56 115.9375 -116.13
cylinder 40 56.04 115.9375 -131.33
array 1 10 place   10 4 1   0.0 0.0 0.0
media 5 1 20 -10
media 4 1 30 -20 -10
media 3 1 40 -30 -20 -10
boundary 40

end geom

read array
ara=1   nux=19 nuy=7 nuz=1  fill
19r1
19r1
19r1
19r1
19r1
19r1
19r1
end fill

end array

read plot  scr=yes  lpi=10

ttl='x-y slice '
xul=-50 yul=50  zul=0.0
xlr=50.0 ylr=-50.0  zlr=0.0
uax=1 vdn=-1 nax=400 end plt0

ttl='y-z  '
xul=0.0  yul=-50.0  zul=130.0
xlr=0.0  ylr=50.0  zlr=-120.0
vax=1 wdn=-1 nax=400  end plt1

end plot
end data
end


=csas26        parm=centrm
heu-sol-therm-025-001
238g
read comp
solnuo2(no3)2 1 51.2 0.195 spg=1.067 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
```

```
al    1 0 1.0285e-06 end
b-10  1 0 2.6099e-09 end
b-11  1 0 1.1650e-08 end
ca    1 0 7.6933e-09 end
cd    1 0 4.1144e-09 end
cr    1 0 4.1509e-08 end
cu    1 0 4.8521e-07 end
fe    1 0 5.5210e-07 end
mg    1 0 1.9029e-07 end
mn    1 0 5.0511e-08 end
mo    1 0 6.4276e-08 end
ni    1 0 3.1521e-07 end
pb    1 0 8.9285e-09 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
read geom
global unit 1
cylinder 1  20.0  23.8   0.0
cylinder 2  20.0 119.4  23.8
cylinder 3  20.3 119.4  -0.6
cylinder 4  22.5 119.4 118.4
cuboid   5  4p20.3  118.4 117.9
cuboid   6  4p25.9  118.4 117.9
cylinder 10 29.7  29.0 -15.7
cylinder 11 29.7 103.5  29.0
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  29.6 -16.5
cylinder 21 40.0 102.7  29.6
cylinder 22 40.5 102.7 -17.3
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -61.3
cuboid   32 4p100.0  87.7 -62.8
cuboid   33 4p99.5  -62.8 -71.8
cuboid   34 4p99.5  -71.8 -181.7
cuboid   35 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 3 1 10 -3 -2 -1
media 0 1 11 -10 -3 -2 -1
media 2 1 12 -11 -10 -3 -2 -1
media 2 1 13 -12 -11 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 3 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
```

```
media 2 1 32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 33 -32
media 3 1 34 -33
media 2 1 35 -34 -33 -32
media 0 1 40 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-14.14 xsp=14.14 ysm=-14.14 ysp=14.14
zsm=0.1 zsp=23.7 end start
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.0  zul=248.5 xlr=0.0  ylr=100.0  zlr=-38.5
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on core tank'
xul=0.0  yul=-55.6  zul=70 xlr=0.0  ylr=55.6  zlr=-2
vax=1 wdn=-1 nax=400  end plt1
ttl='x-y slice at z=20  through core'
xul=-100.0 yul=100.0  zul=20.0 xlr=100.0 ylr=-100.0  zlr=20.0
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=0.5  through plate'
xul=-56.0 yul=56.0  zul=0.5 xlr=56.0 ylr=-56.0  zlr=0.5
uax=1 vdn=-1 nax=400 end plt3
end plot
end data
end
•
=csas26        parm=centrm
heu-sol-therm-025-002
238g
read comp
solnuo2(no3)2 1 51.2 0.195 spg=1.067 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
al    1 0 1.0285e-06 end
b-10  1 0 2.6099e-09 end
b-11  1 0 1.1650e-08 end
ca    1 0 7.6933e-09 end
cd    1 0 4.1144e-09 end
cr    1 0 4.1509e-08 end
cu    1 0 4.8521e-07 end
fe    1 0 5.5210e-07 end
mg    1 0 1.9029e-07 end
mn    1 0 5.0511e-08 end
mo    1 0 6.4276e-08 end
ni    1 0 3.1521e-07 end
pb    1 0 8.9285e-09 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 end parm
read geom
global unit 1
cylinder 1  20.0  23.8   0.0
cylinder 2  20.0 119.4  23.8
cylinder 3  20.3 119.4  -0.6
cylinder 4  22.5 119.4 118.4
```

```
cuboid   5  4p20.3  118.4 117.9
cuboid   6  4p25.9  118.4 117.9
cylinder 10 29.7  29.3 -15.7
cylinder 11 29.7 103.5  29.3
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  29.6 -16.5
cylinder 21 40.0 102.7  29.6
cylinder 22 40.5 102.7 -17.3
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -61.3
cuboid   32 4p100.0  87.7 -62.8
cuboid   33 4p99.5  -62.8 -71.8
cuboid   34 4p99.5  -71.8 -181.7
cuboid   35 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 3 1 10 -3 -2 -1
media 0 1 11 -10 -3 -2 -1
media 2 1 12 -11 -10 -3 -2 -1
media 2 1 13 -12 -11 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 0 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 2 1 32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 33 -32
media 3 1 34 -33
media 2 1 35 -34 -33 -32
media 0 1 40 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-14.14 xsp=14.14 ysm=-14.14 ysp=14.14
zsm=0.1 zsp=23.7 end start
end data
end
•
=csas26       parm=centrm
heu-sol-therm-025-003
238g
read comp
solnuo2(no3)2 1 50.5 0.171 spg=1.064 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
gd-152 1 0 7.9086e-10 end
gd-154 1 0 8.7445e-09 end
gd-155 1 0 5.9749e-08 end
gd-156 1 0 8.3171e-08 end
```

```
gd-157 1 0 6.3994e-08 end
gd-158 1 0 1.0222e-07 end
gd-160 1 0 9.1100e-08 end
al     1 0 1.0144e-06 end
b-10   1 0 2.5742e-09 end
b-11   1 0 1.1491e-08 end
ca     1 0 7.5881e-09 end
cd     1 0 4.0581e-09 end
cr     1 0 4.0942e-08 end
cu     1 0 4.7858e-07 end
fe     1 0 5.4455e-07 end
mg     1 0 1.8769e-07 end
mn     1 0 4.9821e-08 end
mo     1 0 6.3397e-08 end
ni     1 0 3.1090e-07 end
pb     1 0 8.8064e-09 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
read geom
global unit 1
cylinder 1  20.0  42.0   0.0
cylinder 2  20.0 119.4  42.0
cylinder 3  20.3 119.4  -0.6
cylinder 4  22.5 119.4 118.4
cuboid   5  4p20.3  118.4 117.9
cuboid   6  4p25.9  118.4 117.9
cylinder 10 29.7  49.3 -15.7
cylinder 11 29.7 103.5  49.3
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  29.6 -16.5
cylinder 21 40.0 102.7  29.6
cylinder 22 40.5 102.7 -17.3
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -61.3
cuboid   32 4p100.0  87.7 -62.8
cuboid   33 4p99.5  -62.8 -71.8
cuboid   34 4p99.5  -71.8 -181.7
cuboid   35 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 3 1 10 -3 -2 -1
media 0 1 11 -10 -3 -2 -1
media 2 1 12 -11 -10 -3 -2 -1
media 2 1 13 -12 -11 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 0 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
```

```
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 2 1 32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 33 -32
media 3 1 34 -33
media 2 1 35 -34 -33 -32
media 0 1 40 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-14.14 xsp=14.14 ysm=-14.14 ysp=14.14
zsm=0.1 zsp=41.9 end start
end data
end
•
=csas26       parm=centrm
heu-sol-therm-025-004
238g
read comp
solnuo2(no3)2 1 53.3 0.197 spg=1.072 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
al    1 0 1.0707e-06 end
b-10  1 0 2.7170e-09 end
b-11  1 0 1.2128e-08 end
ca    1 0 8.0088e-09 end
cd    1 0 4.2831e-09 end
cr    1 0 4.3212e-08 end
cu    1 0 5.0511e-07 end
fe    1 0 5.7475e-07 end
mg    1 0 1.9809e-07 end
mn    1 0 5.2583e-08 end
mo    1 0 6.6912e-08 end
ni    1 0 3.2814e-07 end
pb    1 0 9.2947e-09 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
read geom
global unit 1
cylinder 1  20.0   8.0 -15.1
cylinder 2  20.0 104.3   8.0
cylinder 3  20.3 104.3 -15.7
cylinder 4  22.5 104.3 103.3
cuboid   5  4p20.3  103.3 102.8
cuboid   6  4p25.9  103.3 102.8
cylinder 10 29.7  13.1 -15.7
cylinder 11 29.7 103.5  13.1
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  29.6 -16.5
cylinder 21 40.0 102.7  29.6
cylinder 22 40.5 102.7 -17.3
```

```
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -17.3
cuboid   32 4p99.2  -17.3 -61.3
cuboid   33 4p100.0  87.7 -62.8
cuboid   34 4p99.5  -62.8 -71.8
cuboid   35 4p99.5  -71.8 -181.7
cuboid   36 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 3 1 10 -3 -2 -1
media 0 1 11 -10 -6 -5 -4 -3 -2 -1
media 2 1 12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 13 -12 -11 -6 -5 -4 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 0 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 3 1 32 -31 -22
media 2 1 33 -32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 34 -33
media 3 1 35 -34
media 2 1 36 -35 -34 -33
media 0 1 40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-14.14 xsp=14.14 ysm=-14.14 ysp=14.14
zsm=-15.0 zsp=7.9 end start
end data
end
•
=csas26       parm=centrm
heu-sol-therm-025-005
238g
read comp
solnuo2(no3)2 1 77.2 0.114 spg=1.104 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
al    1 0 1.5507e-06 end
b-10  1 0 3.9353e-09 end
b-11  1 0 1.7566e-08 end
ca    1 0 1.1600e-08 end
cd    1 0 6.2037e-09 end
cr    1 0 6.2588e-08 end
cu    1 0 7.3161e-07 end
fe    1 0 8.3246e-07 end
mg    1 0 2.8692e-07 end
mn    1 0 7.6161e-08 end
mo    1 0 9.6916e-08 end
ni    1 0 4.7528e-07 end
pb    1 0 1.3463e-08 end
```

```
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
read geom
global unit 1
cylinder 1  20.0   3.7 -15.1
cylinder 2  20.0 104.3   3.7
cylinder 3  20.3 104.3 -15.7
cylinder 4  22.5 104.3 103.3
cuboid   5  4p20.3  103.3 102.8
cuboid   6  4p25.9  103.3 102.8
cylinder 10 29.7  13.0 -15.7
cylinder 11 29.7 103.5  13.0
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  29.6 -16.5
cylinder 21 40.0 102.7  29.6
cylinder 22 40.5 102.7 -17.3
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -17.3
cuboid   32 4p99.2  -17.3 -61.3
cuboid   33 4p100.0  87.7 -62.8
cuboid   34 4p99.5  -62.8 -71.8
cuboid   35 4p99.5  -71.8 -181.7
cuboid   36 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 3 1 10 -3 -2 -1
media 0 1 11 -10 -6 -5 -4 -3 -2 -1
media 2 1 12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 13 -12 -11 -6 -5 -4 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 0 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 3 1 32 -31 -22
media 2 1 33 -32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 34 -33
media 3 1 35 -34
media 2 1 36 -35 -34 -33
media 0 1 40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
```

```
end geom
read start nst=0 xsm=-14.14 xsp=14.14 ysm=-14.14 ysp=14.14
zsm=-15.0 zsp=3.6 end start
end data
end
•
=csas26       parm=centrm
heu-sol-therm-025-006
238g
read comp
solnuo2(no3)2 1 48.7 0.156 spg=1.064 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
gd-152 1 0 1.4043e-09 end
gd-154 1 0 1.5528e-08 end
gd-155 1 0 1.0610e-07 end
gd-156 1 0 1.4769e-07 end
gd-157 1 0 1.1363e-07 end
gd-158 1 0 1.8151e-07 end
gd-160 1 0 1.6177e-07 end
al     1 0 9.7826e-07 end
b-10   1 0 2.4825e-09 end
b-11   1 0 1.1081e-08 end
ca     1 0 7.3176e-09 end
cd     1 0 3.9135e-09 end
cr     1 0 3.9483e-08 end
cu     1 0 4.6152e-07 end
fe     1 0 5.2514e-07 end
mg     1 0 1.8100e-07 end
mn     1 0 4.8045e-08 end
mo     1 0 6.1137e-08 end
ni     1 0 2.9982e-07 end
pb     1 0 8.4926e-09 end
solnuo2(no3)2 5 50.7 0.189 spg=1.067 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
al    5 0 1.0184e-06 end
b-10  5 0 2.5844e-09 end
b-11  5 0 1.1536e-08 end
ca    5 0 7.6182e-09 end
cd    5 0 4.0742e-09 end
cr    5 0 4.1104e-08 end
cu    5 0 4.8047e-07 end
fe    5 0 5.4671e-07 end
mg    5 0 1.8843e-07 end
mn    5 0 5.0018e-08 end
mo    5 0 6.3648e-08 end
ni    5 0 3.1214e-07 end
pb    5 0 8.8413e-09 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
read geom
global unit 1
cylinder 1  20.0  21.0 -15.1
cylinder 2  20.0 104.3  21.0
cylinder 3  20.3 104.3 -15.7
cylinder 4  22.5 104.3 103.3
cuboid   5  4p20.3  103.3 102.8
cuboid   6  4p25.9  103.3 102.8
cylinder 10 29.7  21.8 -15.7
```

```
cylinder 11 29.7 103.5  21.8
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  28.5 -16.5
cylinder 21 40.0 102.7  28.5
cylinder 22 40.5 102.7 -17.3
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -17.3
cuboid   32 4p99.2  -17.3 -61.3
cuboid   33 4p100.0  87.7 -62.8
cuboid   34 4p99.5  -62.8 -71.8
cuboid   35 4p99.5  -71.8 -181.7
cuboid   36 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 5 1 10 -3 -2 -1
media 0 1 11 -10 -6 -5 -4 -3 -2 -1
media 2 1 12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 13 -12 -11 -6 -5 -4 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 3 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 3 1 32 -31 -22
media 2 1 33 -32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 34 -33
media 3 1 35 -34
media 2 1 36 -35 -34 -33
media 0 1 40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-21. xsp=21. ysm=-21. ysp=21.
zsm=-15. zsp=20. end start
end data
end
•
=csas26       parm=centrm
heu-sol-therm-025-007
238g
read comp
solnuo2(no3)2 1 67.9 0.093 spg=1.092 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
gd-152 1 0 2.1582e-09 end
gd-154 1 0 2.3864e-08 end
gd-155 1 0 1.6305e-07 end
gd-156 1 0 2.2697e-07 end
gd-157 1 0 1.7464e-07 end
```

```
gd-158 1 0 2.7896e-07 end
gd-160 1 0 2.4861e-07 end
al     1 0 1.3639e-06 end
b-10   1 0 3.4612e-09 end
b-11   1 0 1.5450e-08 end
ca     1 0 1.0203e-08 end
cd     1 0 5.4564e-09 end
cr     1 0 5.5049e-08 end
cu     1 0 6.4347e-07 end
fe     1 0 7.3218e-07 end
mg     1 0 2.5236e-07 end
mn     1 0 6.6987e-08 end
mo     1 0 8.5241e-08 end
ni     1 0 4.1803e-07 end
pb     1 0 1.1841e-08 end
solnuo2(no3)2 5 50.7 0.189 spg=1.067 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
al    5 0 1.0184e-06 end
b-10  5 0 2.5844e-09 end
b-11  5 0 1.1536e-08 end
ca    5 0 7.6182e-09 end
cd    5 0 4.0742e-09 end
cr    5 0 4.1104e-08 end
cu    5 0 4.8047e-07 end
fe    5 0 5.4671e-07 end
mg    5 0 1.8843e-07 end
mn    5 0 5.0018e-08 end
mo    5 0 6.3648e-08 end
ni    5 0 3.1214e-07 end
pb    5 0 8.8413e-09 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
read geom
global unit 1
cylinder 1  20.0  16.0 -15.1
cylinder 2  20.0 104.3  16.0
cylinder 3  20.3 104.3 -15.7
cylinder 4  22.5 104.3 103.3
cuboid   5  4p20.3  103.3 102.8
cuboid   6  4p25.9  103.3 102.8
cylinder 10 29.7  22.6 -15.7
cylinder 11 29.7 103.5  22.6
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  28.5 -16.5
cylinder 21 40.0 102.7  28.5
cylinder 22 40.5 102.7 -17.3
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -17.3
cuboid   32 4p99.2  -17.3 -61.3
cuboid   33 4p100.0  87.7 -62.8
cuboid   34 4p99.5  -62.8 -71.8
cuboid   35 4p99.5  -71.8 -181.7
cuboid   36 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
```

```
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 5 1 10 -3 -2 -1
media 0 1 11 -10 -6 -5 -4 -3 -2 -1
media 2 1 12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 13 -12 -11 -6 -5 -4 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 3 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 3 1 32 -31 -22
media 2 1 33 -32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 34 -33
media 3 1 35 -34
media 2 1 36 -35 -34 -33
media 0 1 40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-21. xsp=21. ysm=-21. ysp=21.
zsm=-15. zsp=15. end start
end data
end
•
=csas26        parm=centrm
heu-sol-therm-025-008
238g
read comp
solnuo2(no3)2 1 69.8 0.207 spg=1.092 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
gd-152 1 0 2.7939E-09 end
gd-154 1 0 3.0892E-08 end
gd-155 1 0 2.1107E-07 end
gd-156 1 0 2.9382E-07 end
gd-157 1 0 2.2607E-07 end
gd-158 1 0 3.6112E-07 end
gd-160 1 0 3.2183E-07 end
al     1 0 1.4021e-06 end
b-10   1 0 3.5580e-09 end
b-11   1 0 1.5882e-08 end
ca     1 0 1.0488e-08 end
cd     1 0 5.6091e-09 end
cr     1 0 5.6589e-08 end
cu     1 0 6.6148e-07 end
fe     1 0 7.5267e-07 end
mg     1 0 2.5942e-07 end
mn     1 0 6.8861e-08 end
mo     1 0 8.7626e-08 end
ni     1 0 4.2972e-07 end
pb     1 0 1.2172e-08 end
solnuo2(no3)2 5 50.7 0.189 spg=1.067 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
```

```
al    5 0 1.0184e-06 end
b-10  5 0 2.5844e-09 end
b-11  5 0 1.1536e-08 end
ca    5 0 7.6182e-09 end
cd    5 0 4.0742e-09 end
cr    5 0 4.1104e-08 end
cu    5 0 4.8047e-07 end
fe    5 0 5.4671e-07 end
mg    5 0 1.8843e-07 end
mn    5 0 5.0018e-08 end
mo    5 0 6.3648e-08 end
ni    5 0 3.1214e-07 end
pb    5 0 8.8413e-09 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
read geom
global unit 1
cylinder 1  20.0  23.2 -15.1
cylinder 2  20.0 104.3  23.2
cylinder 3  20.3 104.3 -15.7
cylinder 4  22.5 104.3 103.3
cuboid   5  4p20.3  103.3 102.8
cuboid   6  4p25.9  103.3 102.8
cylinder 10 29.7  23.3 -15.7
cylinder 11 29.7 103.5  23.3
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  28.5 -16.5
cylinder 21 40.0 102.7  28.5
cylinder 22 40.5 102.7 -17.3
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -17.3
cuboid   32 4p99.2  -17.3 -61.3
cuboid   33 4p100.0  87.7 -62.8
cuboid   34 4p99.5  -62.8 -71.8
cuboid   35 4p99.5  -71.8 -181.7
cuboid   36 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 5 1 10 -3 -2 -1
media 0 1 11 -10 -6 -5 -4 -3 -2 -1
media 2 1 12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 13 -12 -11 -6 -5 -4 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 3 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
```

```
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 3 1 32 -31 -22
media 2 1 33 -32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 34 -33
media 3 1 35 -34
media 2 1 36 -35 -34 -33
media 0 1 40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-21. xsp=21. ysm=-21. ysp=21.
zsm=-15.0 zsp=20. end start
end data
end
•
=csas26       parm=centrm
heu-sol-therm-025-009
238g
read comp
solnuo2(no3)2 1 95.2 0.221 spg=1.129 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
gd-152 1 0 3.0304e-09 end
gd-154 1 0 3.3507e-08 end
gd-155 1 0 2.2894e-07 end
gd-156 1 0 3.1869e-07 end
gd-157 1 0 2.4521e-07 end
gd-158 1 0 3.9169e-07 end
gd-160 1 0 3.4908e-07 end
al     1 0 1.9123e-06 end
b-10   1 0 4.8528e-09 end
b-11   1 0 2.1662e-08 end
ca     1 0 1.4305e-08 end
cd     1 0 7.6502e-09 end
cr     1 0 7.7181e-08 end
cu     1 0 9.0219e-07 end
fe     1 0 1.0266e-06 end
mg     1 0 3.5382e-07 end
mn     1 0 9.3919e-08 end
mo     1 0 1.1951e-07 end
ni     1 0 5.8610e-07 end
pb     1 0 1.6601e-08 end
solnuo2(no3)2 5 50.7 0.189 spg=1.067 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
al    5 0 1.0184e-06 end
b-10  5 0 2.5844e-09 end
b-11  5 0 1.1536e-08 end
ca    5 0 7.6182e-09 end
cd    5 0 4.0742e-09 end
cr    5 0 4.1104e-08 end
cu    5 0 4.8047e-07 end
fe    5 0 5.4671e-07 end
mg    5 0 1.8843e-07 end
mn    5 0 5.0018e-08 end
mo    5 0 6.3648e-08 end
ni    5 0 3.1214e-07 end
pb    5 0 8.8413e-09 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
```

```
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
read geom
global unit 1
cylinder 1  20.0  12.2 -15.1
cylinder 2  20.0 104.3  12.2
cylinder 3  20.3 104.3 -15.7
cylinder 4  22.5 104.3 103.3
cuboid   5  4p20.3  103.3 102.8
cuboid   6  4p25.9  103.3 102.8
cylinder 10 29.7  12.2 -15.7
cylinder 11 29.7 103.5  12.2
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  23.5 -16.5
cylinder 21 40.0 102.7  23.5
cylinder 22 40.5 102.7 -17.3
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -17.3
cuboid   32 4p99.2  -17.3 -61.3
cuboid   33 4p100.0  87.7 -62.8
cuboid   34 4p99.5  -62.8 -71.8
cuboid   35 4p99.5  -71.8 -181.7
cuboid   36 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 5 1 10 -3 -2 -1
media 0 1 11 -10 -6 -5 -4 -3 -2 -1
media 2 1 12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 13 -12 -11 -6 -5 -4 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 3 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 3 1 32 -31 -22
media 2 1 33 -32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 34 -33
media 3 1 35 -34
media 2 1 36 -35 -34 -33
media 0 1 40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-21. xsp=21. ysm=-21. ysp=21.
zsm=-15. zsp=12. end start
end data
```

```
end
•
=csas26        parm=centrm
heu-sol-therm-025-010
238g
read comp
solnuo2(no3)2 1 141.6 0.407 spg=1.198 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
gd-152 1 0 5.3438e-09 end
gd-154 1 0 5.9087e-08 end
gd-155 1 0 4.0372e-07 end
gd-156 1 0 5.6199e-07 end
gd-157 1 0 4.3241e-07 end
gd-158 1 0 6.9071e-07 end
gd-160 1 0 6.1557e-07 end
al     1 0 2.8444e-06 end
b-10   1 0 7.2180e-09 end
b-11   1 0 3.2220e-08 end
ca     1 0 2.1277e-08 end
cd     1 0 1.1379e-08 end
cr     1 0 1.1480e-07 end
cu     1 0 1.3419e-06 end
fe     1 0 1.5269e-06 end
mg     1 0 5.2627e-07 end
mn     1 0 1.3970e-07 end
mo     1 0 1.7776e-07 end
ni     1 0 8.7176e-07 end
pb     1 0 2.4693e-08 end
solnuo2(no3)2 5 50.7 0.189 spg=1.067 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
al    5 0 1.0184e-06 end
b-10  5 0 2.5844e-09 end
b-11  5 0 1.1536e-08 end
ca    5 0 7.6182e-09 end
cd    5 0 4.0742e-09 end
cr    5 0 4.1104e-08 end
cu    5 0 4.8047e-07 end
fe    5 0 5.4671e-07 end
mg    5 0 1.8843e-07 end
mn    5 0 5.0018e-08 end
mo    5 0 6.3648e-08 end
ni    5 0 3.1214e-07 end
pb    5 0 8.8413e-09 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
read geom
global unit 1
cylinder 1  20.0  11.8 -15.1
cylinder 2  20.0 104.3  11.8
cylinder 3  20.3 104.3 -15.7
cylinder 4  22.5 104.3 103.3
cuboid   5  4p20.3  103.3 102.8
cuboid   6  4p25.9  103.3 102.8
cylinder 10 29.7  12.2 -15.7
cylinder 11 29.7 103.5  12.2
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
```

```
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  23.5 -16.5
cylinder 21 40.0 102.7  23.5
cylinder 22 40.5 102.7 -17.3
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -17.3
cuboid   32 4p99.2  -17.3 -61.3
cuboid   33 4p100.0  87.7 -62.8
cuboid   34 4p99.5  -62.8 -71.8
cuboid   35 4p99.5  -71.8 -181.7
cuboid   36 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 5 1 10 -3 -2 -1
media 0 1 11 -10 -6 -5 -4 -3 -2 -1
media 2 1 12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 13 -12 -11 -6 -5 -4 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 3 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 3 1 32 -31 -22
media 2 1 33 -32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 34 -33
media 3 1 35 -34
media 2 1 36 -35 -34 -33
media 0 1 40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-21. xsp=21. ysm=-21. ysp=21.
zsm=-15. zsp=11. end start
end data
end
•
=csas26       parm=centrm
heu-sol-therm-025-011
238g
read comp
solnuo2(no3)2 1 142.4 0.390 spg=1.198 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
gd-152 1 0 6.7851e-09 end
gd-154 1 0 7.5023e-08 end
gd-155 1 0 5.1261e-07 end
gd-156 1 0 7.1356e-07 end
gd-157 1 0 5.4903e-07 end
gd-158 1 0 8.7700e-07 end
gd-160 1 0 7.8159e-07 end
al     1 0 2.8605e-06 end
b-10   1 0 7.2588e-09 end
```

```
b-11   1 0 3.2402e-08 end
ca     1 0 2.1397e-08 end
cd     1 0 1.1443e-08 end
cr     1 0 1.1545e-07 end
cu     1 0 1.3495e-06 end
fe     1 0 1.5355e-06 end
mg     1 0 5.2924e-07 end
mn     1 0 1.4048e-07 end
mo     1 0 1.7877e-07 end
ni     1 0 8.7669e-07 end
pb     1 0 2.4832e-08 end
solnuo2(no3)2 5 50.7 0.189 spg=1.067 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
al    5 0 1.0184e-06 end
b-10  5 0 2.5844e-09 end
b-11  5 0 1.1536e-08 end
ca    5 0 7.6182e-09 end
cd    5 0 4.0742e-09 end
cr    5 0 4.1104e-08 end
cu    5 0 4.8047e-07 end
fe    5 0 5.4671e-07 end
mg    5 0 1.8843e-07 end
mn    5 0 5.0018e-08 end
mo    5 0 6.3648e-08 end
ni    5 0 3.1214e-07 end
pb    5 0 8.8413e-09 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
read geom
global unit 1
cylinder 1  20.0  16.9 -15.1
cylinder 2  20.0 104.3  16.9
cylinder 3  20.3 104.3 -15.7
cylinder 4  22.5 104.3 103.3
cuboid   5  4p20.3  103.3 102.8
cuboid   6  4p25.9  103.3 102.8
cylinder 10 29.7  17.0 -15.7
cylinder 11 29.7 103.5  17.0
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  18.5 -16.5
cylinder 21 40.0 102.7  18.5
cylinder 22 40.5 102.7 -17.3
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -17.3
cuboid   32 4p99.2  -17.3 -61.3
cuboid   33 4p100.0  87.7 -62.8
cuboid   34 4p99.5  -62.8 -71.8
cuboid   35 4p99.5  -71.8 -181.7
cuboid   36 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
```

```
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 5 1 10 -3 -2 -1
media 0 1 11 -10 -6 -5 -4 -3 -2 -1
media 2 1 12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 13 -12 -11 -6 -5 -4 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 3 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 3 1 32 -31 -22
media 2 1 33 -32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 34 -33
media 3 1 35 -34
media 2 1 36 -35 -34 -33
media 0 1 40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-21. xsp=21. ysm=-21. ysp=21.
zsm=-15. zsp=16. end start
end data
end
•
=csas26        parm=centrm
heu-sol-therm-025-012
238g
read comp
solnuo2(no3)2 1 185.2 0.366 spg=1.257 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
gd-152 1 0 1.0163e-08 end
gd-154 1 0 1.1237e-07 end
gd-155 1 0 7.6780e-07 end
gd-156 1 0 1.0688e-06 end
gd-157 1 0 8.2235e-07 end
gd-158 1 0 1.3136e-06 end
gd-160 1 0 1.1707e-06 end
al     1 0 3.7202E-06 end
b-10   1 0 9.4405E-09 end
b-11   1 0 4.2141E-08 end
ca     1 0 2.7828E-08 end
cd     1 0 1.4882E-08 end
cr     1 0 1.5015E-07 end
cu     1 0 1.7551E-06 end
fe     1 0 1.9971E-06 end
mg     1 0 6.8831E-07 end
mn     1 0 1.8271E-07 end
mo     1 0 2.3250E-07 end
ni     1 0 1.1402E-06 end
pb     1 0 3.2296E-08 end
solnuo2(no3)2 5 50.7 0.189 spg=1.067 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
al    5 0 1.0184e-06 end
b-10  5 0 2.5844e-09 end
b-11  5 0 1.1536e-08 end
ca    5 0 7.6182e-09 end
```

```
cd    5 0 4.0742e-09 end
cr    5 0 4.1104e-08 end
cu    5 0 4.8047e-07 end
fe    5 0 5.4671e-07 end
mg    5 0 1.8843e-07 end
mn    5 0 5.0018e-08 end
mo    5 0 6.3648e-08 end
ni    5 0 3.1214e-07 end
pb    5 0 8.8413e-09 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
read geom
global unit 1
cylinder 1  20.0  17.1 -15.1
cylinder 2  20.0 104.3  17.1
cylinder 3  20.3 104.3 -15.7
cylinder 4  22.5 104.3 103.3
cuboid   5  4p20.3  103.3 102.8
cuboid   6  4p25.9  103.3 102.8
cylinder 10 29.7  17.2 -15.7
cylinder 11 29.7 103.5  17.2
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  25.5 -16.5
cylinder 21 40.0 102.7  25.5
cylinder 22 40.5 102.7 -17.3
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -17.3
cuboid   32 4p99.2  -17.3 -61.3
cuboid   33 4p100.0  87.7 -62.8
cuboid   34 4p99.5  -62.8 -71.8
cuboid   35 4p99.5  -71.8 -181.7
cuboid   36 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 5 1 10 -3 -2 -1
media 0 1 11 -10 -6 -5 -4 -3 -2 -1
media 2 1 12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 13 -12 -11 -6 -5 -4 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 3 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 3 1 32 -31 -22
media 2 1 33 -32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 34 -33
```

```
media 3 1 35 -34
media 2 1 36 -35 -34 -33
media 0 1 40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-21. xsp=21. ysm=-21. ysp=21.
zsm=-15. zsp=17. end start
end data
end
•
=csas26       parm=centrm
heu-sol-therm-025-013
238g
read comp
solnuo2(no3)2 1 189.2 0.292 spg=1.257 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
gd-152 1 0 1.2587e-08 end
gd-154 1 0 1.3918e-07 end
gd-155 1 0 9.5095e-07 end
gd-156 1 0 1.3237e-06 end
gd-157 1 0 1.0185e-06 end
gd-158 1 0 1.6269e-06 end
gd-160 1 0 1.4499e-06 end
al     1 0 3.8005e-06 end
b-10   1 0 9.6444e-09 end
b-11   1 0 4.3051e-08 end
ca     1 0 2.8429e-08 end
cd     1 0 1.5204e-08 end
cr     1 0 1.5339e-07 end
cu     1 0 1.7930e-06 end
fe     1 0 2.0402e-06 end
mg     1 0 7.0318e-07 end
mn     1 0 1.8665e-07 end
mo     1 0 2.3752e-07 end
ni     1 0 1.1648e-06 end
pb     1 0 3.2994e-08 end
solnuo2(no3)2 5 50.7 0.189 spg=1.067 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
al    5 0 1.0184e-06 end
b-10  5 0 2.5844e-09 end
b-11  5 0 1.1536e-08 end
ca    5 0 7.6182e-09 end
cd    5 0 4.0742e-09 end
cr    5 0 4.1104e-08 end
cu    5 0 4.8047e-07 end
fe    5 0 5.4671e-07 end
mg    5 0 1.8843e-07 end
mn    5 0 5.0018e-08 end
mo    5 0 6.3648e-08 end
ni    5 0 3.1214e-07 end
pb    5 0 8.8413e-09 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
```

```
read geom
global unit 1
cylinder 1  20.0  25.4 -15.1
cylinder 2  20.0 104.3  25.4
cylinder 3  20.3 104.3 -15.7
cylinder 4  22.5 104.3 103.3
cuboid   5  4p20.3  103.3 102.8
cuboid   6  4p25.9  103.3 102.8
cylinder 10 29.7  25.6 -15.7
cylinder 11 29.7 103.5  25.6
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  31.0 -16.5
cylinder 21 40.0 102.7  31.0
cylinder 22 40.5 102.7 -17.3
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -17.3
cuboid   32 4p99.2  -17.3 -61.3
cuboid   33 4p100.0  87.7 -62.8
cuboid   34 4p99.5  -62.8 -71.8
cuboid   35 4p99.5  -71.8 -181.7
cuboid   36 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 5 1 10 -3 -2 -1
media 0 1 11 -10 -6 -5 -4 -3 -2 -1
media 2 1 12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 13 -12 -11 -6 -5 -4 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 3 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 3 1 32 -31 -22
media 2 1 33 -32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 34 -33
media 3 1 35 -34
media 2 1 36 -35 -34 -33
media 0 1 40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-21. xsp=21. ysm=-21. ysp=21.
zsm=-15. zsp=25. end start
end data
end
•
=csas26        parm=centrm
heu-sol-therm-025-014
```

```
238g
read comp
solnuo2(no3)2 1 273.3 0.397 spg=1.380 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
gd-152 1 0 2.8530e-08 end
gd-154 1 0 3.1546e-07 end
gd-155 1 0 2.1554e-06 end
gd-156 1 0 3.0004e-06 end
gd-157 1 0 2.3086e-06 end
gd-158 1 0 3.6876e-06 end
gd-160 1 0 3.2864e-06 end
al     1 0 5.3754e-06 end
b-10   1 0 1.3641e-08 end
b-11   1 0 6.0890e-08 end
ca     1 0 4.0209e-08 end
cd     1 0 2.1504e-08 end
cr     1 0 2.1695e-07 end
cu     1 0 2.5360e-06 end
fe     1 0 2.8856e-06 end
mg     1 0 9.9456e-07 end
mn     1 0 2.6400e-07 end
mo     1 0 3.3594e-07 end
ni     1 0 1.6475e-06 end
pb     1 0 4.6665e-08 end
solnuo2(no3)2 5 77.2 0.114 spg=1.104 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
al    5 0 1.5507E-06 end
b-10  5 0 3.9353E-09 end
b-11  5 0 1.7566E-08 end
ca    5 0 1.1600E-08 end
cd    5 0 6.2037E-09 end
cr    5 0 6.2588E-08 end
cu    5 0 7.3161E-07 end
fe    5 0 8.3246E-07 end
mg    5 0 2.8692E-07 end
mn    5 0 7.6161E-08 end
mo    5 0 9.6916E-08 end
ni    5 0 4.7528E-07 end
pb    5 0 1.3463E-08 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
read geom
global unit 1
cylinder 1  20.0  20.8 -15.1
cylinder 2  20.0 104.3  20.8
cylinder 3  20.3 104.3 -15.7
cylinder 4  22.5 104.3 103.3
cuboid   5  4p20.3  103.3 102.8
cuboid   6  4p25.9  103.3 102.8
cylinder 10 29.7  20.7 -15.7
cylinder 11 29.7 103.5  20.7
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  23.5 -16.5
cylinder 21 40.0 102.7  23.5
cylinder 22 40.5 102.7 -17.3
```

```
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -17.3
cuboid   32 4p99.2  -17.3 -61.3
cuboid   33 4p100.0  87.7 -62.8
cuboid   34 4p99.5  -62.8 -71.8
cuboid   35 4p99.5  -71.8 -181.7
cuboid   36 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 5 1 10 -3 -2 -1
media 0 1 11 -10 -6 -5 -4 -3 -2 -1
media 2 1 12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 13 -12 -11 -6 -5 -4 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 3 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 3 1 32 -31 -22
media 2 1 33 -32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 34 -33
media 3 1 35 -34
media 2 1 36 -35 -34 -33
media 0 1 40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-21. xsp=21. ysm=-21. ysp=21.
zsm=-15. zsp=20. end start
end data
end
•
=csas26        parm=centrm
heu-sol-therm-025-015
238g
read comp
solnuo2(no3)2 1 267.6 0.516 spg=1.377 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
gd-152 1 0 3.5699e-08 end
gd-154 1 0 3.9473e-07 end
gd-155 1 0 2.6971e-06 end
gd-156 1 0 3.7544e-06 end
gd-157 1 0 2.8887e-06 end
gd-158 1 0 4.6143e-06 end
gd-160 1 0 4.1123e-06 end
al     1 0 3.8005e-06 end
b-10   1 0 9.6444e-09 end
b-11   1 0 4.3051e-08 end
ca     1 0 2.8429e-08 end
cd     1 0 1.5204e-08 end
cr     1 0 1.5339e-07 end
```

```
cu     1 0 1.7930e-06 end
fe     1 0 2.0402e-06 end
mg     1 0 7.0318e-07 end
mn     1 0 1.8665e-07 end
mo     1 0 2.3752e-07 end
ni     1 0 1.1648e-06 end
pb     1 0 3.2994e-08 end
solnuo2(no3)2 5 77.2 0.114 spg=1.104 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
al    5 0 1.5507E-06 end
b-10  5 0 3.9353E-09 end
b-11  5 0 1.7566E-08 end
ca    5 0 1.1600E-08 end
cd    5 0 6.2037E-09 end
cr    5 0 6.2588E-08 end
cu    5 0 7.3161E-07 end
fe    5 0 8.3246E-07 end
mg    5 0 2.8692E-07 end
mn    5 0 7.6161E-08 end
mo    5 0 9.6916E-08 end
ni    5 0 4.7528E-07 end
pb    5 0 1.3463E-08 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
read geom
global unit 1
cylinder 1  20.0  27.1 -15.1
cylinder 2  20.0 104.3  27.1
cylinder 3  20.3 104.3 -15.7
cylinder 4  22.5 104.3 103.3
cuboid   5  4p20.3  103.3 102.8
cuboid   6  4p25.9  103.3 102.8
cylinder 10 29.7  27.3 -15.7
cylinder 11 29.7 103.5  27.3
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  26.5 -16.5
cylinder 21 40.0 102.7  26.5
cylinder 22 40.5 102.7 -17.3
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -17.3
cuboid   32 4p99.2  -17.3 -61.3
cuboid   33 4p100.0  87.7 -62.8
cuboid   34 4p99.5  -62.8 -71.8
cuboid   35 4p99.5  -71.8 -181.7
cuboid   36 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 5 1 10 -3 -2 -1
```

```
media 0 1 11 -10 -6 -5 -4 -3 -2 -1
media 2 1 12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 13 -12 -11 -6 -5 -4 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 3 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 3 1 32 -31 -22
media 2 1 33 -32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 34 -33
media 3 1 35 -34
media 2 1 36 -35 -34 -33
media 0 1 40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-21. xsp=21. ysm=-21. ysp=21.
zsm=-15. zsp=27. end start
end data
end
•
=csas26        parm=centrm
heu-sol-therm-025-016
238g
read comp
solnuo2(no3)2 1 400.0 0.591 spg=1.551 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
gd-152 1 0 4.2817e-08 end
gd-154 1 0 4.7343e-07 end
gd-155 1 0 3.2348e-06 end
gd-156 1 0 4.5029e-06 end
gd-157 1 0 3.4646e-06 end
gd-158 1 0 5.5343e-06 end
gd-160 1 0 4.9322e-06 end
al     1 0 8.0350e-06 end
b-10   1 0 2.0390e-08 end
b-11   1 0 9.1017e-08 end
ca     1 0 6.0104e-08 end
cd     1 0 3.2144e-08 end
cr     1 0 3.2429e-07 end
cu     1 0 3.7907e-06 end
fe     1 0 4.3133e-06 end
mg     1 0 1.4866e-06 end
mn     1 0 3.9462e-07 end
mo     1 0 5.0216e-07 end
ni     1 0 2.4626e-06 end
pb     1 0 6.9754e-08 end
solnuo2(no3)2 5 77.2 0.114 spg=1.104 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
al    5 0 1.5507E-06 end
b-10  5 0 3.9353E-09 end
b-11  5 0 1.7566E-08 end
ca    5 0 1.1600E-08 end
cd    5 0 6.2037E-09 end
cr    5 0 6.2588E-08 end
cu    5 0 7.3161E-07 end
fe    5 0 8.3246E-07 end
```

```
mg    5 0 2.8692E-07 end
mn    5 0 7.6161E-08 end
mo    5 0 9.6916E-08 end
ni    5 0 4.7528E-07 end
pb    5 0 1.3463E-08 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
read geom
global unit 1
cylinder 1  20.0  15.6 -15.1
cylinder 2  20.0 104.3  15.6
cylinder 3  20.3 104.3 -15.7
cylinder 4  22.5 104.3 103.3
cuboid   5  4p20.3  103.3 102.8
cuboid   6  4p25.9  103.3 102.8
cylinder 10 29.7  15.5 -15.7
cylinder 11 29.7 103.5  15.5
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  33.5 -16.5
cylinder 21 40.0 102.7  33.5
cylinder 22 40.5 102.7 -17.3
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -17.3
cuboid   32 4p99.2  -17.3 -61.3
cuboid   33 4p100.0  87.7 -62.8
cuboid   34 4p99.5  -62.8 -71.8
cuboid   35 4p99.5  -71.8 -181.7
cuboid   36 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 5 1 10 -3 -2 -1
media 0 1 11 -10 -6 -5 -4 -3 -2 -1
media 2 1 12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 13 -12 -11 -6 -5 -4 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 3 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 3 1 32 -31 -22
media 2 1 33 -32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 34 -33
media 3 1 35 -34
media 2 1 36 -35 -34 -33
media 0 1 40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
```

```
media 2 1 50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-21. xsp=21. ysm=-21. ysp=21.
zsm=-15. zsp=15. end start
end data
end
•
=csas26       parm=centrm
heu-sol-therm-025-017
238g
read comp
solnuo2(no3)2 1 393.2 0.828 spg=1.552 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
gd-152 1 0 6.0150e-08 end
gd-154 1 0 6.6507e-07 end
gd-155 1 0 4.5443e-06 end
gd-156 1 0 6.3257e-06 end
gd-157 1 0 4.8671e-06 end
gd-158 1 0 7.7746e-06 end
gd-160 1 0 6.9287e-06 end
al     1 0 7.8984e-06 end
b-10   1 0 2.0043e-08 end
b-11   1 0 8.9470e-08 end
ca     1 0 5.9082e-08 end
cd     1 0 3.1597e-08 end
cr     1 0 3.1878e-07 end
cu     1 0 3.7263e-06 end
fe     1 0 4.2400e-06 end
mg     1 0 1.4614e-06 end
mn     1 0 3.8791e-07 end
mo     1 0 4.9362e-07 end
ni     1 0 2.4207e-06 end
pb     1 0 6.8568e-08 end
solnuo2(no3)2 5 77.2 0.114 spg=1.104 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
al    5 0 1.5507E-06 end
b-10  5 0 3.9353E-09 end
b-11  5 0 1.7566E-08 end
ca    5 0 1.1600E-08 end
cd    5 0 6.2037E-09 end
cr    5 0 6.2588E-08 end
cu    5 0 7.3161E-07 end
fe    5 0 8.3246E-07 end
mg    5 0 2.8692E-07 end
mn    5 0 7.6161E-08 end
mo    5 0 9.6916E-08 end
ni    5 0 4.7528E-07 end
pb    5 0 1.3463E-08 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
read geom
global unit 1
cylinder 1  20.0  21.7 -15.1
cylinder 2  20.0 104.3  21.7
```

```
cylinder 3  20.3 104.3 -15.7
cylinder 4  22.5 104.3 103.3
cuboid   5  4p20.3  103.3 102.8
cuboid   6  4p25.9  103.3 102.8
cylinder 10 29.7  21.7 -15.7
cylinder 11 29.7 103.5  21.7
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  33.5 -16.5
cylinder 21 40.0 102.7  33.5
cylinder 22 40.5 102.7 -17.3
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -17.3
cuboid   32 4p99.2  -17.3 -61.3
cuboid   33 4p100.0  87.7 -62.8
cuboid   34 4p99.5  -62.8 -71.8
cuboid   35 4p99.5  -71.8 -181.7
cuboid   36 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 5 1 10 -3 -2 -1
media 0 1 11 -10 -6 -5 -4 -3 -2 -1
media 2 1 12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 13 -12 -11 -6 -5 -4 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 3 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 3 1 32 -31 -22
media 2 1 33 -32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 34 -33
media 3 1 35 -34
media 2 1 36 -35 -34 -33
media 0 1 40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-21. xsp=21. ysm=-21. ysp=21.
zsm=-15. zsp=21. end start
end data
end
•
=csas26       parm=centrm
heu-sol-therm-025-018
238g
read comp
solnuo2(no3)2 1 395.2 0.731 spg=1.555 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
```

```
gd-152 1 0 7.6647e-08 end
gd-154 1 0 8.4748e-07 end
gd-155 1 0 5.7906e-06 end
gd-156 1 0 8.0606e-06 end
gd-157 1 0 6.2020e-06 end
gd-158 1 0 9.9069e-06 end
gd-160 1 0 8.8291e-06 end
al     1 0 7.9386e-06 end
b-10   1 0 2.0145e-08 end
b-11   1 0 8.9925e-08 end
ca     1 0 5.9383e-08 end
cd     1 0 3.1758e-08 end
cr     1 0 3.2040e-07 end
cu     1 0 3.7452e-06 end
fe     1 0 4.2615e-06 end
mg     1 0 1.4688e-06 end
mn     1 0 3.8988e-07 end
mo     1 0 4.9613e-07 end
ni     1 0 2.4331e-06 end
pb     1 0 6.8917e-08 end
solnuo2(no3)2 5 77.2 0.114 spg=1.104 1.0 293 92234 0.91 92235 89.04
            92236 0.22 92238 9.83 end
al    5 0 1.5507E-06 end
b-10  5 0 3.9353E-09 end
b-11  5 0 1.7566E-08 end
ca    5 0 1.1600E-08 end
cd    5 0 6.2037E-09 end
cr    5 0 6.2588E-08 end
cu    5 0 7.3161E-07 end
fe    5 0 8.3246E-07 end
mg    5 0 2.8692E-07 end
mn    5 0 7.6161E-08 end
mo    5 0 9.6916E-08 end
ni    5 0 4.7528E-07 end
pb    5 0 1.3463E-08 end
arbmsteel 7.93 6 0 0 1 26304 69.1 24304 18.0 28304 10.0
                       25000 1.5 14000 0.8 22000 0.6 2 end
h2o       3 1.0 end
arbmcrete 2.3  9 0 0 1 8016  49.0 20000 23.0 14000 16.0
                       6012   6.0 13027  2.0 26000  1.0
                       25055  1.0 15031  1.0 1001   1.0 4 end
end comp
read parm gen=515 npg=4000 nsk=15 tme=600 plt=no end parm
read geom
global unit 1
cylinder 1  20.0  26.1 -15.1
cylinder 2  20.0 104.3  26.1
cylinder 3  20.3 104.3 -15.7
cylinder 4  22.5 104.3 103.3
cuboid   5  4p20.3  103.3 102.8
cuboid   6  4p25.9  103.3 102.8
cylinder 10 29.7  28.1 -15.7
cylinder 11 29.7 103.5  28.1
cylinder 12 30.2 103.5 -16.5
cylinder 13 32.2 103.5 102.5
cuboid   14 2p20.3 2p25.9 102.5 102.0
cuboid   15 4p25.9        102.5 102.0
cylinder 20 40.0  33.5 -16.5
cylinder 21 40.0 102.7  33.5
cylinder 22 40.5 102.7 -17.3
cylinder 23 42.5 102.7 101.7
cuboid   31 4p99.2  101.2 -17.3
cuboid   32 4p99.2  -17.3 -61.3
cuboid   33 4p100.0  87.7 -62.8
```

```
cuboid   34 4p99.5  -62.8 -71.8
cuboid   35 4p99.5  -71.8 -181.7
cuboid   36 4p100.0 -62.8 -182.3
cuboid   40 200.0 -550.0 2p275.0 701.7 -182.3
cuboid   50 200.3 -550.3 2p275.3 101.7 -182.6
cuboid   51 215.3 -565.3 2p290.3 716.7 -197.6
media 1 1 1
media 0 1 2 -1
media 2 1 3 -2 -1
media 2 1 4 -3 -2
media 0 1 5 -4 -3 -2
media 2 1 6 -5 -4 -3 -2
media 5 1 10 -3 -2 -1
media 0 1 11 -10 -6 -5 -4 -3 -2 -1
media 2 1 12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 13 -12 -11 -6 -5 -4 -3 -2
media 0 1 14 -13 -12 -11 -3 -2
media 2 1 15 -14 -13 -12 -11 -3 -2
media 3 1 20 -12 -11 -10 -3 -2 -1
media 0 1 21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 22 -21 -20 -15 -14 -13 -12 -11 -10 -3 -2 -1
media 2 1 23 -22 -21 -15 -14 -13 -12 -11 -3 -2
media 0 1 31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 3 1 32 -31 -22
media 2 1 33 -32 -31 -22 -21 -20 -12 -11 -10 -3 -2 -1
media 0 1 34 -33
media 3 1 35 -34
media 2 1 36 -35 -34 -33
media 0 1 40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14 -13
             -12 -11 -10 -6 -5 -4 -3 -2 -1
media 2 1 50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -12 -11
             -10 -3 -2 -1
media 4 1 51 -50 -40 -36 -35 -34 -33 -32 -31 -23 -22 -21 -20 -15 -14
             -13 -12 -11 -10 -6 -5 -4 -3 -2 -1
boundary 51
end geom
read start nst=0 xsm=-21. xsp=21. ysm=-21. ysp=21.
zsm=-15. zsp=26. end start
end data
end
•
=csas26       parm=centrm
heu-sol-therm-035-001
238g
read comp
solnuo2(no3)2 1 37.51 0.190 den=1.055 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='holes in grid plate'
cylinder 10 2.775 1.7 0.0
hexprism 20 3.8 1.7 0.0
media 1 1 10
media 3 1 20 -10
```

```
boundary 20
unit 2
com='blank grid location'
hexprism 20 3.8 1.7 0.0
media 3 1 20
boundary 20
global unit 3
cylinder 10 54.8 1.7 0.0
array 1 10 place 10 10 1 0.0 0.0 0.0
cylinder 20 55.0 20.3439 0.0
cylinder 30 55.0 248.5 20.3439
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 40.0 -37.5
cylinder 60 100 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
media 1 1 20 -10
media 0 1 30
media 3 1 40 -30 -20
media 0 1 70 -40 -50
media 2 1 50 -40
media 3 1 60 -70
boundary 60
end geom
read array ara=1 typ=hexagonal nux=19 nuy=19 nuz=1
fill
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 2 2 2
2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2
2 2 2 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
end fill
end array
end geom
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.0  zul=248.5 xlr=0.0  ylr=100.0  zlr=-38.5
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on core tank'
xul=0.0  yul=-55.6  zul=70 xlr=0.0  ylr=55.6  zlr=-2
vax=1 wdn=-1 nax=400  end plt1
ttl='x-y slice at z=20  through core'
xul=-100.0 yul=100.0  zul=20.0 xlr=100.0 ylr=-100.0  zlr=20.0
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=0.5  through plate'
xul=-56.0 yul=56.0  zul=0.5 xlr=56.0 ylr=-56.0  zlr=0.5
uax=1 vdn=-1 nax=400 end plt3
end plot
end data
end
=csas26       parm=centrm
```

```
heu-sol-therm-035-002
238g
read comp
solnuo2(no3)2 1 37.51 0.190 den=1.055 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='empty lattice position'
cylinder 10 2.775 1.7 0.0
hexprism 20 3.8 1.7 0.0
hexprism 30 3.8 24.7831 1.7
hexprism 40 3.8 248.5 0.0
media 1 1 10
media 1 1 30
media 3 1 20 -10
media 0 1 40 -30 -20
boundary 40
unit 2
com='blank grid location'
hexprism 20 3.8 1.7 0.0
hexprism 30 3.8 24.7831 1.7
hexprism 40 3.8 248.5 0.0
media 1 1 30
media 3 1 20
media 0 1 40 -30 -20
boundary 40
unit 3
com='absorber rod location'
cylinder 10 2.775 1.7 0.0
hexprism 20 3.8 1.7 0.0
cylinder 30 2.75 248.5 0.0
cylinder 40 2.25 248.5 0.7
hexprism 50 3.8 248.5 0.0
hexprism 60 3.8 24.7831 1.7
media 1 1 10 -30
media 1 1 60 -30
media 3 1 20 -10
media 0 1 50 -60 -20 -30
media 4 1 40
media 3 1 30 -40
boundary 50
global unit 4
cylinder 20 54.8 248.5 0.0
cylinder 30 55.0 248.5 24.7831
cylinder 35 55.0 24.7831 0.0
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 40.0 -37.5
cylinder 60 100 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
array 1 20 place 10 10 1 0.0 0.0 0.0
media 1 1 35 -20
media 3 1 40 -30 -35
media 0 1 70 -40 -50
media 0 1 30 -20
```

```
media 2 1 50 -40
media 3 1 60 -70
boundary 60
end geom
read array ara=1 typ=hexagonal nux=19 nuy=19 nuz=1
fill
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 2 2 2
2 2 2 2 2 2 2 2 1 3 1 1 3 1 1 3 1 2 2
2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 2 1 3 1 1 3 1 1 3 1 1 3 1 2 2
2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 3 1 1 3 1 1 3 1 1 3 1 1 3 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2
2 2 1 3 1 1 3 1 1 3 1 1 3 1 2 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2
2 2 1 3 1 1 3 1 1 3 1 2 2 2 2 2 2 2 2
2 2 2 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
end fill
end array
end geom
end data
end
=csas26        parm=centrm
heu-sol-therm-035-003
238g
read comp
solnuo2(no3)2 1 37.51 0.190 den=1.055 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='empty lattice position'
cylinder 10 2.775 1.7 0.0
hexprism 20 3.8 1.7 0.0
hexprism 30 3.8 24.4979 1.7
hexprism 40 3.8 248.5 0.0
media 1 1 10
media 1 1 30
media 3 1 20 -10
media 0 1 40 -30 -20
boundary 40
unit 2
com='blank grid location'
hexprism 20 3.8 1.7 0.0
hexprism 30 3.8 24.4979 1.7
hexprism 40 3.8 248.5 0.0
media 1 1 30
```

```
media 3 1 20
media 0 1 40 -30 -20
boundary 40
unit 3
com='absorber rod location'
cylinder 10 2.775 1.7 0.0
hexprism 20 3.8 1.7 0.0
cylinder 30 2.75 248.5 0.0
cylinder 40 2.25 248.5 0.7
hexprism 50 3.8 248.5 0.0
hexprism 60 3.8 24.4979 1.7
media 1 1 10 -30
media 1 1 60 -30
media 3 1 20 -10
media 0 1 50 -60 -20 -30
media 4 1 40
media 3 1 30 -40
boundary 50
global unit 4
cylinder 20 54.8 248.5 0.0
cylinder 30 55.0 248.5 24.4979
cylinder 35 55.0 24.4979 0.0
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 40.0 -37.5
cylinder 60 100 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
array 1 20 place 10 10 1 0.0 0.0 0.0
media 1 1 35 -20
media 3 1 40 -30 -35
media 0 1 70 -40 -50
media 0 1 30 -20
media 2 1 50 -40
media 3 1 60 -70
boundary 60
end geom
read array ara=1 typ=hexagonal nux=19 nuy=19 nuz=1
fill
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 2 2 2
2 2 2 2 2 2 2 2 1 3 1 1 3 1 1 3 1 2 2
2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 2 1 3 1 1 3 1 1 3 1 1 3 1 2 2
2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 3 1 1 3 1 1 3 1 1 3 1 1 3 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2
2 2 1 3 1 1 3 1 1 3 1 1 3 1 2 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2
2 2 1 3 1 1 1 1 1 3 1 2 2 2 2 2 2 2 2
2 2 2 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
end fill
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.0  zul=248.5 xlr=0.0  ylr=100.0  zlr=-38.5
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on core tank'
xul=0.0  yul=-55.6  zul=70 xlr=0.0  ylr=55.6  zlr=-2
```

```
vax=1 wdn=-1 nax=400  end plt1
ttl='x-z slice at y=0.0 zoom on core tank'
xul=-55.6  yul=0.0  zul=70 xlr=55.6  ylr=0.0  zlr=-2
uax=1 wdn=-1 nax=400  end plt2
ttl='x-y slice at z=20  through core'
xul=-100.0 yul=100.0  zul=20.0 xlr=100.0 ylr=-100.0  zlr=20.0
uax=1 vdn=-1 nax=400 end plt3
ttl='x-y slice at z=0.8  through plate'
xul=-56.0 yul=56.0  zul=0.8 xlr=56.0 ylr=-56.0  zlr=0.8
uax=1 vdn=-1 nax=400 end plt4
end plot
end data
end
=csas26       parm=centrm
heu-sol-therm-035-004
238g
read comp
solnuo2(no3)2 1 37.51 0.190 den=1.055 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes plt=no  end param
read geometry
unit 1
com='empty lattice position'
cylinder 10 2.775 1.7 0.0
hexprism 20 3.8 1.7 0.0
hexprism 30 3.8 23.1260 1.7
hexprism 40 3.8 248.5 0.0
media 1 1 10
media 1 1 30
media 3 1 20 -10
media 0 1 40 -30 -20
boundary 40
unit 2
com='blank grid location'
hexprism 20 3.8 1.7 0.0
hexprism 30 3.8 23.1260 1.7
hexprism 40 3.8 248.5 0.0
media 1 1 30
media 3 1 20
media 0 1 40 -30 -20
boundary 40
unit 3
com='absorber rod location'
cylinder 10 2.775 1.7 0.0
hexprism 20 3.8 1.7 0.0
cylinder 30 2.75 248.5 0.0
cylinder 40 2.25 248.5 0.7
hexprism 50 3.8 248.5 0.0
hexprism 60 3.8 23.1260 1.7
media 1 1 10 -30
media 1 1 60 -30
media 3 1 20 -10
media 0 1 50 -60 -20 -30
media 4 1 40
media 3 1 30 -40
```

```
boundary 50
global unit 4
cylinder 20 54.8 248.5 0.0
cylinder 30 55.0 248.5 23.1260
cylinder 35 55.0 23.1260 0.0
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 40.0 -37.5
cylinder 60 100 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
array 1 20 place 10 10 1 0.0 0.0 0.0
media 1 1 35 -20
media 3 1 40 -30 -35
media 0 1 70 -40 -50
media 0 1 30 -20
media 2 1 50 -40
media 3 1 60 -70
boundary 60
end geom
read array ara=1 typ=hexagonal nux=19 nuy=19 nuz=1
fill
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 2 2 2
2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 1 1 1 1 1 3 3 3 1 1 1 1 1 2 2
2 2 2 1 1 1 1 1 3 3 3 3 1 1 1 1 1 2 2
2 2 2 1 1 1 1 3 3 3 3 3 1 1 1 1 2 2 2
2 2 1 1 1 1 1 3 3 3 3 1 1 1 1 1 2 2 2
2 2 1 1 1 1 1 3 3 3 1 1 1 1 1 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2
2 2 2 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
end fill
end array
end geom
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.0  zul=248.5 xlr=0.0  ylr=100.0  zlr=-38.5
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on core tank'
xul=0.0  yul=-55.6  zul=70 xlr=0.0  ylr=55.6  zlr=-2
vax=1 wdn=-1 nax=400  end plt1
ttl='x-z slice at y=0.0 zoom on core tank'
xul=-55.6  yul=0.0  zul=70 xlr=55.6  ylr=0.0  zlr=-2
uax=1 wdn=-1 nax=400  end plt2
ttl='x-y slice at z=20  through core'
xul=-100.0 yul=100.0  zul=20.0 xlr=100.0 ylr=-100.0  zlr=20.0
uax=1 vdn=-1 nax=400 end plt3
ttl='x-y slice at z=0.8  through plate'
xul=-56.0 yul=56.0  zul=0.8 xlr=56.0 ylr=-56.0  zlr=0.8
uax=1 vdn=-1 nax=400 end plt4
end plot
end data
end
=csas26       parm=centrm
heu-sol-therm-035-005
238g
```

```
read comp
solnuo2(no3)2 1 74.87 0.360 den=1.113  1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='holes in grid plate'
cylinder 10 2.775 1.7 0.0
hexprism 20 3.8 1.7 0.0
media 1 1 10
media 3 1 20 -10
boundary 20
unit 2
com='blank grid location'
hexprism 20 3.8 1.7 0.0
media 3 1 20
boundary 20
global unit 3
cylinder 10 54.8 1.7 0.0
array 1 10 place 10 10 1 0.0 0.0 0.0
cylinder 20 55.0 15.0826 0.0
cylinder 30 55.0 248.5 15.0826
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 40.0 -37.5
cylinder 60 100 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
media 1 1 20 -10
media 0 1 30
media 3 1 40 -30 -20
media 0 1 70 -40 -50
media 2 1 50 -40
media 3 1 60 -70
boundary 60
end geom
read array ara=1 typ=hexagonal nux=19 nuy=19 nuz=1
fill
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 2 2 2
2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2
2 2 2 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
```

```
end fill
end array
end geom
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.0  zul=248.5 xlr=0.0  ylr=100.0  zlr=-38.5
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on core tank'
xul=0.0  yul=-55.6  zul=70 xlr=0.0  ylr=55.6  zlr=-2
vax=1 wdn=-1 nax=400  end plt1
ttl='x-y slice at z=20  through core'
xul=-100.0 yul=100.0  zul=20.0 xlr=100.0 ylr=-100.0  zlr=20.0
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=0.5  through plate'
xul=-56.0 yul=56.0  zul=0.5 xlr=56.0 ylr=-56.0  zlr=0.5
uax=1 vdn=-1 nax=400 end plt3
end plot
end data
end
=csas26       parm=centrm
heu-sol-therm-035-006
238g
read comp
solnuo2(no3)2 1 74.87 0.360 den=1.113 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes plt=no end param
read geometry
unit 1
com='empty lattice position'
cylinder 10 2.775 1.7 0.0
hexprism 20 5.3 1.7 0.0
hexprism 30 5.3 17.5148 1.7
hexprism 40 5.3 248.5 0.0
media 1 1 10
media 1 1 30
media 3 1 20 -10
media 0 1 40 -30 -20
boundary 40
unit 2
com='blank grid location'
hexprism 20 5.3 1.7 0.0
hexprism 30 5.3 17.5148 1.7
hexprism 40 5.3 248.5 0.0
media 1 1 30
media 3 1 20
media 0 1 40 -30 -20
boundary 40
unit 3
com='absorber rod location'
cylinder 10 2.775 1.7 0.0
hexprism 20 5.3 1.7 0.0
cylinder 30 2.75 248.5 0.0
cylinder 40 2.25 248.5 0.7
hexprism 50 5.3 248.5 0.0
hexprism 60 5.3 17.5148 1.7
```

```
media 1 1 10 -30
media 1 1 60 -30
media 3 1 20 -10
media 0 1 50 -60 -20 -30
media 4 1 40
media 3 1 30 -40
boundary 50
global unit 4
cylinder 20 54.8 248.5 0.0
cylinder 30 55.0 248.5 17.5148
cylinder 35 55.0 17.5148 0.0
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 40.0 -37.5
cylinder 60 100 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
array 1 20 place 7 7 1 0.0 0.0 0.0
media 1 1 35 -20
media 3 1 40 -30 -35
media 0 1 70 -40 -50
media 0 1 30 -20
media 2 1 50 -40
media 3 1 60 -70
boundary 60
end geom
read array ara=1 typ=hexagonal nux=13 nuy=13 nuz=1
fill
2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 1 1 1 1 2 2
2 2 2 2 2 1 3 1 3 1 3 1 2
2 2 2 2 1 1 1 1 1 1 1 1 2
2 2 2 1 3 1 3 1 3 1 3 1 2
2 2 1 1 1 1 1 1 1 1 1 1 2
2 2 3 1 3 1 3 1 3 1 3 2 2
2 1 1 1 1 1 1 1 1 1 1 2 2
2 1 3 1 3 1 3 1 3 1 2 2 2
2 1 1 1 1 1 1 1 1 2 2 2 2
2 1 3 1 3 1 3 1 2 2 2 2 2
2 2 1 1 1 1 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2
end fill
end array
end geom
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.0  zul=248.5 xlr=0.0  ylr=100.0  zlr=-38.5
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on core tank'
xul=0.0  yul=-55.6  zul=70 xlr=0.0  ylr=55.6  zlr=-2
vax=1 wdn=-1 nax=400  end plt1
ttl='x-z slice at y=0.0 zoom on core tank'
xul=-55.6  yul=0.0  zul=70 xlr=55.6  ylr=0.0  zlr=-2
uax=1 wdn=-1 nax=400  end plt2
ttl='x-y slice at z=20  through core'
xul=-100.0 yul=100.0  zul=20.0 xlr=100.0 ylr=-100.0  zlr=20.0
uax=1 vdn=-1 nax=400 end plt3
ttl='x-y slice at z=0.8  through plate'
xul=-56.0 yul=56.0  zul=0.8 xlr=56.0 ylr=-56.0  zlr=0.8
uax=1 vdn=-1 nax=400 end plt4
end plot
end data
end
=csas26       parm=centrm
heu-sol-therm-035-007
238g
```

```
read comp
solnuo2(no3)2 1 152.3 0..550 den=1.225 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes end param
read geometry
global unit 1
cylinder 20 55.0 11.8906 0.0
cylinder 30 55.0 248.5 11.8906
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 95.0 -37.5
cylinder 60 100 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
media 1 1 20
media 0 1 30
media 3 1 40 -30 -20
media 0 1 70 -40 -50
media 2 1 50 -40
media 3 1 60 -70
boundary 60
end geom
end geom
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.0  zul=248.5 xlr=0.0  ylr=100.0  zlr=-38.5
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on core tank'
xul=0.0  yul=-55.6  zul=70 xlr=0.0  ylr=55.6  zlr=-2
vax=1 wdn=-1 nax=400  end plt1
ttl='x-y slice at z=20  through core'
xul=-100.0 yul=100.0  zul=20.0 xlr=100.0 ylr=-100.0  zlr=20.0
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=0.5  through plate'
xul=-56.0 yul=56.0  zul=0.5 xlr=56.0 ylr=-56.0  zlr=0.5
uax=1 vdn=-1 nax=400 end plt3
end plot
end data
end
=csas26       parm=centrm
heu-sol-therm-035-008
238g
read comp
solnuo2(no3)2 1 152.3 0.550 den=1.225 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes end param
read geometry
unit 1
```

```
com='empty lattice position'
cylinder 10 2.775 1.7 0.0
hexprism 20 5.3 1.7 0.0
hexprism 30 5.3 14.4216 1.7
hexprism 40 5.3 248.5 0.0
media 1 1 10
media 1 1 30
media 3 1 20 -10
media 0 1 40 -30 -20
boundary 40
unit 2
com='blank grid location'
hexprism 20 5.3 1.7 0.0
hexprism 30 5.3 14.4216 1.7
hexprism 40 5.3 248.5 0.0
media 1 1 30
media 3 1 20
media 0 1 40 -30 -20
boundary 40
unit 3
com='absorber rod location'
cylinder 10 2.775 1.7 0.0
hexprism 20 5.3 1.7 0.0
cylinder 30 2.75 248.5 0.0
cylinder 40 2.25 248.5 0.7
hexprism 50 5.3 248.5 0.0
hexprism 60 5.3 14.4216 1.7
media 1 1 10 -30
media 1 1 60 -30
media 3 1 20 -10
media 0 1 50 -60 -20 -30
media 4 1 40
media 3 1 30 -40
boundary 50
global unit 4
cylinder 20 54.8 248.5 0.0
cylinder 30 55.0 248.5 14.4216
cylinder 35 55.0 14.4216 0.0
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 95.0 -37.5
cylinder 60 100 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
array 1 20 place 7 7 1 0.0 0.0 0.0
media 1 1 35 -20
media 3 1 40 -30 -35
media 0 1 70 -40 -50
media 0 1 30 -20
media 2 1 50 -40
media 3 1 60 -70
boundary 60
end geom
read array ara=1 typ=hexagonal nux=13 nuy=13 nuz=1
fill
2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 1 1 1 1 2 2
2 2 2 2 2 1 3 1 3 1 3 1 2
2 2 2 2 1 1 1 1 1 1 1 1 2
2 2 2 1 3 1 3 1 3 1 3 1 2
2 2 1 1 1 1 1 1 1 1 1 1 2
2 2 3 1 3 1 3 1 3 1 3 2 2
2 1 1 1 1 1 1 1 1 1 1 2 2
2 1 3 1 3 1 3 1 3 1 2 2 2
2 1 1 1 1 1 1 1 1 2 2 2 2
2 1 3 1 3 1 3 1 2 2 2 2 2
```

```
2 2 1 1 1 1 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2
end fill
end array
end geom
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.0  zul=248.5 xlr=0.0  ylr=100.0  zlr=-38.5
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on core tank'
xul=0.0  yul=-55.6  zul=70 xlr=0.0  ylr=55.6  zlr=-2
vax=1 wdn=-1 nax=400  end plt1
ttl='x-z slice at y=0.0 zoom on core tank'
xul=-55.6  yul=0.0  zul=70 xlr=55.6  ylr=0.0  zlr=-2
uax=1 wdn=-1 nax=400  end plt2
ttl='x-y slice at z=20  through core'
xul=-100.0 yul=100.0  zul=20.0 xlr=100.0 ylr=-100.0  zlr=20.0
uax=1 vdn=-1 nax=400 end plt3
ttl='x-y slice at z=0.8  through plate'
xul=-56.0 yul=56.0  zul=0.8 xlr=56.0 ylr=-56.0  zlr=0.8
uax=1 vdn=-1 nax=400 end plt4
end plot
end data
end
=csas26        parm=centrm
heu-sol-therm-035-009
238g
read comp
solnuo2(no3)2 1 152.3 0.550 den=1.225 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='empty lattice position'
cylinder 10 2.775 1.7 0.0
hexprism 20 3.8 1.7 0.0
hexprism 30 3.8 15.6113 1.7
hexprism 40 3.8 248.5 0.0
media 1 1 10
media 1 1 30
media 3 1 20 -10
media 0 1 40 -30 -20
boundary 40
unit 2
com='blank grid location'
hexprism 20 3.8 1.7 0.0
hexprism 30 3.8 15.6113 1.7
hexprism 40 3.8 248.5 0.0
media 1 1 30
media 3 1 20
media 0 1 40 -30 -20
boundary 40
unit 3
com='absorber rod location'
cylinder 10 2.775 1.7 0.0
```

```
hexprism 20 3.8 1.7 0.0
cylinder 30 2.75 248.5 0.0
cylinder 40 2.25 248.5 0.7
hexprism 50 3.8 248.5 0.0
hexprism 60 3.8 15.6113 1.7
media 1 1 10 -30
media 1 1 60 -30
media 3 1 20 -10
media 0 1 50 -60 -20 -30
media 4 1 40
media 3 1 30 -40
boundary 50
global unit 4
cylinder 20 54.8 248.5 0.0
cylinder 30 55.0 248.5 15.6113
cylinder 35 55.0 15.6113 0.0
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 95.0 -37.5
cylinder 60 100 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
array 1 20 place 10 10 1 0.0 0.0 0.0
media 1 1 35 -20
media 3 1 40 -30 -35
media 0 1 70 -40 -50
media 0 1 30 -20
media 2 1 50 -40
media 3 1 60 -70
boundary 60
end geom
read array ara=1 typ=hexagonal nux=19 nuy=19 nuz=1
fill
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 2 2 2
2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 2 2
2 2 2 2 2 2 1 1 1 3 3 3 3 3 1 1 1 2 2
2 2 2 2 2 1 1 1 3 3 3 3 3 3 1 1 1 2 2
2 2 2 2 1 1 1 3 3 3 3 3 3 3 1 1 1 2 2
2 2 2 1 1 1 3 3 3 3 3 3 3 3 1 1 1 2 2
2 2 2 1 1 1 3 3 3 3 3 3 3 1 1 1 2 2 2
2 2 1 1 1 3 3 3 3 3 3 3 3 1 1 1 2 2 2
2 2 1 1 1 3 3 3 3 3 3 3 1 1 1 2 2 2 2
2 2 1 1 1 3 3 3 3 3 3 1 1 1 2 2 2 2 2
2 2 1 1 1 3 3 3 3 3 1 1 1 2 2 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2
2 2 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2
2 2 2 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
end fill
end array
end geom
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.0  zul=248.5 xlr=0.0  ylr=100.0  zlr=-38.5
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on core tank'
xul=0.0  yul=-55.6  zul=70 xlr=0.0  ylr=55.6  zlr=-2
vax=1 wdn=-1 nax=400  end plt1
ttl='x-z slice at y=0.0 zoom on core tank'
xul=-55.6  yul=0.0  zul=70 xlr=55.6  ylr=0.0  zlr=-2
uax=1 wdn=-1 nax=400  end plt2
ttl='x-y slice at z=20  through core'
```

```
xul=-100.0 yul=100.0  zul=20.0 xlr=100.0 ylr=-100.0  zlr=20.0
uax=1 vdn=-1 nax=400 end plt3
ttl='x-y slice at z=0.8  through plate'
xul=-56.0 yul=56.0  zul=0.8 xlr=56.0 ylr=-56.0  zlr=0.8
uax=1 vdn=-1 nax=400 end plt4
end plot
end data
end
=csas26       parm=centrm
heu-sol-therm-037-001
238g
read comp
solnuo2(no3)2 1 41.9 0.25 den=1.063 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes end param
read geometry
global unit 11
cylinder 10 80.0 198.35 17.8055
cylinder 15 80.0 17.8055 0.0
cylinder 20 80.65 198.35 -0.65
cylinder 30 84.65 150.0 -4.65
cylinder 40 85.3 150.65 -5.3
cylinder 50 99.7 198.35 -101.15
cylinder 60 100.5 198.35 -102.15
media 0 1 10
media 1 1 15
media 3 1 20 -10 -15
media 2 1 30 -20
media 3 1 40 -30 -20
media 0 1 50 -40 -20
media 3 1 60 -50
boundary 60
end geom
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.5  zul=190 xlr=0.0  ylr=100.5  zlr=-102.15
vax=1 wdn=-1 nax=400  end plt0
ttl='x-y slice at z=10'
xul=-100.5 yul=100.5  zul=10.0 xlr=100.5 ylr=-100.5  zlr=10.0
uax=1 vdn=-1 nax=400 end plt1
ttl='x-y slice at z=100  above solution'
xul=-100.5 yul=100.5  zul=100 xlr=100.5 ylr=-100.5  zlr=100
uax=1 vdn=-1 nax=400 end plt2
end plot
end data
end
=csas26       parm=centrm
heu-sol-therm-037-002
238g
read comp
solnuo2(no3)2 1 41.9 0.25 den=1.063 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
```

```
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='holes in grid plate'
cylinder 10 1.625 15.5 15.0
hexprism 20 3.0 15.5 15.0
media 1 1 10
media 3 1 20 -10
boundary 20
unit 2
com='blank grid location'
hexprism 20 3.0 15.5 15.0
media 3 1 20
boundary 20
unit 3
com='absorber rods through grid plate'
cylinder 10 1.6 15.5 15.0
cylinder 15 1.65 15.5 15.0
cylinder 20 1.35 15.5 15.0
hexprism 30 3.0 15.5 15.0
media 4 1 20
media 3 1 10 -15
media 1 1 15 -20
media 3 1 30 -15
boundary 30
unit 4
com='solution below grid plate'
hexprism 10 3.0 15.0 0.0
media 1 1 10
boundary 10
unit 5
com='void above solution'
hexprism 10 3.0 198.35 31.3895
media 0 1 10
boundary 10
unit 6
com='absorber rod below grid plate'
cylinder 10 1.6 15.0 0.0
cylinder 20 1.35 15.0 0.4
hexprism 30 3.0 15.0 0.0
media 4 1 20
media 3 1 10 -20
media 1 1 30 -10
boundary 30
unit 7
com='absorber rod above grid plate, through solution'
cylinder 10 1.6 31.3895 15.5
cylinder 20 1.35 31.3895 15.5
hexprism 30 3.0 31.3895 15.5
media 4 1 20
media 3 1 10 -20
media 1 1 30 -10
boundary 30
unit 8
com='absorber rod above solution'
cylinder 10 1.6 198.35 31.3895
cylinder 20 1.35 198.35 31.3895
hexprism 30 3.0 198.35 31.3895
```

```
media 4 1 20
media 3 1 10 -20
media 0 1 30 -10
boundary 30
unit 9
com='solution above grid plate'
hexprism 10 3.0 31.3895 15.5
media 1 1 10
boundary 10
global unit 11
cylinder  5 79.7 198.35 0.0
cylinder 10 80.0 198.35 31.3895
cylinder 15 80.0 31.3895 0.0
cylinder 20 80.65 198.35 -0.65
cylinder 30 84.65 150.0 -4.65
cylinder 40 85.3 150.65 -5.3
cylinder 50 99.7 198.35 -101.15
cylinder 60 100.5 198.35 -102.15
array 1 5 place 17 17 1 0.0 0.0 0.0
media 0 1 10 -5
media 1 1 15 -5
media 3 1 20 -10 -15
media 2 1 30 -20
media 3 1 40 -30 -20
media 0 1 50 -40 -20
media 3 1 60 -50
boundary 60
end geom
read array ara=1 typ=hexagonal nux=33 nuy=33 nuz=4
fill
33r4
33r4
33r4
33r4
33r4
33r4
18r4                       6 6 6 6 6 6 6                     8r4
16r4                    6 6 6 6 6 6 6 6 6 6                  7r4
14r4                 6 6 6 6 6 6 6 6 6 6 6 6 6               6r4
13r4                6 6 6 6 6 6 6 6 6 6 6 6 6 6              6r4
12r4               6 6 6 6 6 6 6 6 6 6 6 6 6 6 6             6r4
11r4              6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6            6r4
10r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6           6r4
9r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6          6r4
8r4            6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6         6r4
8r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6          7r4
7r4            6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6         7r4
7r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6          8r4
6r4            6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6         8r4
6r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6          9r4
6r4              6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6          10r4
6r4               6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6           11r4
6r4                6 6 6 6 6 6 6 6 6 6 6 6 6 6 6            12r4
6r4                 6 6 6 6 6 6 6 6 6 6 6 6 6 6             13r4
6r4                  6 6 6 6 6 6 6 6 6 6 6 6 6              14r4
7r4                     6 6 6 6 6 6 6 6 6 6                 16r4
8r4                        6 6 6 6 6 6 6                    18r4
33r4
33r4
33r4
33r4
33r4
33r4
```

```
33r2
33r2
33r2
33r2
18r2                     1 1 1 1 1 1 1 1 1                   6r2
16r2                  1 1 1 1 1 1 1 1 1 1 1 1                5r2
14r2               1 1 1 1 3 3 3 3 3 3 3 1 1 1 1             4r2
13r2              1 1 1 3 3 3 3 3 3 3 3 3 3 1 1 1            4r2
12r2             1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1           4r2
11r2            1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1          4r2
10r2           1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1         4r2
9r2           1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1        4r2
8r2          1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1       4r2
7r2         1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1      4r2
6r2        1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1     4r2
6r2         1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1      5r2
5r2        1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1     5r2
5r2         1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1      6r2
4r2        1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1     6r2
4r2         1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1      7r2
4r2          1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1       8r2
4r2           1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1        9r2
4r2            1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1         10r2
4r2             1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1          11r2
4r2              1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1           12r2
4r2               1 1 1 3 3 3 3 3 3 3 3 3 3 1 1 1            13r2
4r2                1 1 1 1 3 3 3 3 3 3 3 1 1 1 1             14r2
5r2                   1 1 1 1 1 1 1 1 1 1 1 1                16r2
6r2                      1 1 1 1 1 1 1 1 1                   18r2
33r2
33r2
33r2
33r2

33r9
33r9
33r9
33r9
33r9
33r9
18r9                       7 7 7 7 7 7 7                     8r9
16r9                    7 7 7 7 7 7 7 7 7 7                  7r9
14r9                 7 7 7 7 7 7 7 7 7 7 7 7 7               6r9
13r9                7 7 7 7 7 7 7 7 7 7 7 7 7 7              6r9
12r9               7 7 7 7 7 7 7 7 7 7 7 7 7 7 7             6r9
11r9              7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7            6r9
10r9             7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7           6r9
9r9             7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7          6r9
8r9            7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7         6r9
8r9             7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7          7r9
7r9            7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7         7r9
7r9             7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7          8r9
6r9            7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7         8r9
6r9             7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7          9r9
6r9              7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7          10r9
6r9               7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7           11r9
6r9                7 7 7 7 7 7 7 7 7 7 7 7 7 7 7            12r9
6r9                 7 7 7 7 7 7 7 7 7 7 7 7 7 7             13r9
6r9                  7 7 7 7 7 7 7 7 7 7 7 7 7              14r9
7r9                     7 7 7 7 7 7 7 7 7 7                 16r9
8r9                        7 7 7 7 7 7 7                    18r9
33r9
33r9
33r9
```

```
33r9
33r9
33r9

33r5
33r5
33r5
33r5
33r5
33r5
18r5                       8 8 8 8 8 8 8                     8r5
16r5                    8 8 8 8 8 8 8 8 8 8                  7r5
14r5                 8 8 8 8 8 8 8 8 8 8 8 8 8               6r5
13r5                8 8 8 8 8 8 8 8 8 8 8 8 8 8              6r5
12r5               8 8 8 8 8 8 8 8 8 8 8 8 8 8 8             6r5
11r5              8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8            6r5
10r5             8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8           6r5
9r5             8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8          6r5
8r5            8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8         6r5
8r5             8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8          7r5
7r5            8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8         7r5
7r5             8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8          8r5
6r5            8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8         8r5
6r5             8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8          9r5
6r5              8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8          10r5
6r5               8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8           11r5
6r5                8 8 8 8 8 8 8 8 8 8 8 8 8 8 8            12r5
6r5                 8 8 8 8 8 8 8 8 8 8 8 8 8 8             13r5
6r5                  8 8 8 8 8 8 8 8 8 8 8 8 8              14r5
7r5                     8 8 8 8 8 8 8 8 8 8                 16r5
8r5                        8 8 8 8 8 8 8                    18r5
33r5
33r5
33r5
33r5
33r5
33r5
end fill
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.5  zul=190 xlr=0.0  ylr=100.5  zlr=-102.15
vax=1 wdn=-1 nax=400  end plt0
ttl='x-y slice at z=10  below grid plate'
xul=-100.5 yul=100.5  zul=10.0 xlr=100.5 ylr=-100.5  zlr=10.0
uax=1 vdn=-1 nax=400 end plt1
ttl='x-y slice at z=15.2  through grid plate'
xul=-100.5 yul=100.5  zul=15.2 xlr=100.5 ylr=-100.5  zlr=15.2
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=100  above solution'
xul=-100.5 yul=100.5  zul=100 xlr=100.5 ylr=-100.5  zlr=100
uax=1 vdn=-1 nax=400 end plt4
end plot
end data
end
=csas26        parm=centrm
heu-sol-therm-037-003
238g
read comp
solnuo2(no3)2 1 61.4 0.410 den=1.096 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
```

```
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes end param
read geometry
global unit 11
cylinder 10 80.0 198.35 14.8710
cylinder 15 80.0 14.8710 0.0
cylinder 20 80.65 198.35 -0.65
cylinder 30 84.65 150.0 -4.65
cylinder 40 85.3 150.65 -5.3
cylinder 50 99.7 198.35 -101.15
cylinder 60 100.5 198.35 -102.15
media 0 1 10
media 1 1 15
media 3 1 20 -10 -15
media 2 1 30 -20
media 3 1 40 -30 -20
media 0 1 50 -40 -20
media 3 1 60 -50
boundary 60
end geom
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.5  zul=190 xlr=0.0  ylr=100.5  zlr=-102.15
vax=1 wdn=-1 nax=400  end plt0
ttl='x-y slice at z=10'
xul=-100.5 yul=100.5  zul=10.0 xlr=100.5 ylr=-100.5  zlr=10.0
uax=1 vdn=-1 nax=400 end plt1
ttl='x-y slice at z=100  above solution'
xul=-100.5 yul=100.5  zul=100 xlr=100.5 ylr=-100.5  zlr=100
uax=1 vdn=-1 nax=400 end plt2
end plot
end data
end
=csas26        parm=centrm
heu-sol-therm-037-004
238g
read comp
solnuo2(no3)2 1 61.4 0.410 den=1.096 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='holes in grid plate'
cylinder 10 1.625 15.5 15.0
hexprism 20 3.0 15.5 15.0
media 1 1 10
media 3 1 20 -10
boundary 20
unit 2
com='blank grid location'
```

```
hexprism 20 3.0 15.5 15.0
media 3 1 20
boundary 20
unit 3
com='absorber rods through grid plate'
cylinder 10 1.6 15.5 15.0
cylinder 15 1.65 15.5 15.0
cylinder 20 1.35 15.5 15.0
hexprism 30 3.0 15.5 15.0
media 4 1 20
media 3 1 10 -15
media 1 1 15 -20
media 3 1 30 -15
boundary 30
unit 4
com='solution below grid plate'
hexprism 10 3.0 15.0 0.0
media 1 1 10
boundary 10
unit 5
com='void above solution'
hexprism 10 3.0 198.35 22.5203
media 0 1 10
boundary 10
unit 6
com='absorber rod below grid plate'
cylinder 10 1.6 15.0 0.0
cylinder 20 1.35 15.0 0.4
hexprism 30 3.0 15.0 0.0
media 4 1 20
media 3 1 10 -20
media 1 1 30 -10
boundary 30
unit 7
com='absorber rod above grid plate, through solution'
cylinder 10 1.6 22.5203 15.5
cylinder 20 1.35 22.5203 15.5
hexprism 30 3.0 22.5203 15.5
media 4 1 20
media 3 1 10 -20
media 1 1 30 -10
boundary 30
unit 8
com='absorber rod above solution'
cylinder 10 1.6 198.35 22.5203
cylinder 20 1.35 198.35 22.5203
hexprism 30 3.0 198.35 22.5203
media 4 1 20
media 3 1 10 -20
media 0 1 30 -10
boundary 30
unit 9
com='solution above grid plate'
hexprism 10 3.0 22.5203 15.5
media 1 1 10
boundary 10
global unit 11
cylinder  5 79.7 198.35 0.0
cylinder 10 80.0 198.35 22.5203
cylinder 15 80.0 22.5203 0.0
cylinder 20 80.65 198.35 -0.65
cylinder 30 84.65 150.0 -4.65
cylinder 40 85.3 150.65 -5.3
cylinder 50 99.7 198.35 -101.15
```

```
cylinder 60 100.5 198.35 -102.15
array 1 5 place 17 17 1 0.0 0.0 0.0
media 0 1 10 -5
media 1 1 15 -5
media 3 1 20 -10 -15
media 2 1 30 -20
media 3 1 40 -30 -20
media 0 1 50 -40 -20
media 3 1 60 -50
boundary 60
end geom
read array ara=1 typ=hexagonal nux=33 nuy=33 nuz=4
fill
33r4
33r4
33r4
33r4
33r4
33r4
18r4                       6 6 6 6 6 6 6                     8r4
16r4                    6 6 6 6 6 6 6 6 6 6                  7r4
14r4                 6 6 6 6 6 6 6 6 6 6 6 6 6               6r4
13r4                6 6 6 6 6 6 6 6 6 6 6 6 6 6              6r4
12r4               6 6 6 6 6 6 6 6 6 6 6 6 6 6 6             6r4
11r4              6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6            6r4
10r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6           6r4
9r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6          6r4
8r4            6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6         6r4
8r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6          7r4
7r4            6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6         7r4
7r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6          8r4
6r4            6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6         8r4
6r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6          9r4
6r4              6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6          10r4
6r4               6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6           11r4
6r4                6 6 6 6 6 6 6 6 6 6 6 6 6 6 6            12r4
6r4                 6 6 6 6 6 6 6 6 6 6 6 6 6 6             13r4
6r4                  6 6 6 6 6 6 6 6 6 6 6 6 6              14r4
7r4                     6 6 6 6 6 6 6 6 6 6                 16r4
8r4                        6 6 6 6 6 6 6                    18r4
33r4
33r4
33r4
33r4
33r4
33r4

33r2
33r2
33r2
33r2
18r2                     1 1 1 1 1 1 1 1 1                   6r2
16r2                  1 1 1 1 1 1 1 1 1 1 1 1                5r2
14r2               1 1 1 1 3 3 3 3 3 3 3 1 1 1 1             4r2
13r2              1 1 1 3 3 3 3 3 3 3 3 3 3 1 1 1            4r2
12r2             1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1           4r2
11r2            1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1          4r2
10r2           1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1         4r2
9r2           1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1        4r2
8r2          1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1       4r2
7r2         1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1      4r2
6r2        1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1     4r2
6r2         1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1      5r2
5r2        1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1     5r2
```

```
5r2         1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1     6r2
4r2        1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1    6r2
4r2         1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1     7r2
4r2          1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1      8r2
4r2           1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1       9r2
4r2            1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1        10r2
4r2             1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1         11r2
4r2              1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1          12r2
4r2               1 1 1 3 3 3 3 3 3 3 3 3 3 1 1 1           13r2
4r2                1 1 1 1 3 3 3 3 3 3 3 1 1 1 1            14r2
5r2                   1 1 1 1 1 1 1 1 1 1 1 1               16r2
6r2                      1 1 1 1 1 1 1 1 1                  18r2
33r2
33r2
33r2
33r2

33r9
33r9
33r9
33r9
33r9
33r9
18r9                       7 7 7 7 7 7 7                    8r9
16r9                    7 7 7 7 7 7 7 7 7 7                 7r9
14r9                 7 7 7 7 7 7 7 7 7 7 7 7 7              6r9
13r9                7 7 7 7 7 7 7 7 7 7 7 7 7 7             6r9
12r9               7 7 7 7 7 7 7 7 7 7 7 7 7 7 7            6r9
11r9              7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7           6r9
10r9             7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7          6r9
9r9             7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7         6r9
8r9            7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7        6r9
8r9             7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7         7r9
7r9            7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7        7r9
7r9             7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7         8r9
6r9            7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7        8r9
6r9             7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7         9r9
6r9              7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7         10r9
6r9               7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7          11r9
6r9                7 7 7 7 7 7 7 7 7 7 7 7 7 7 7           12r9
6r9                 7 7 7 7 7 7 7 7 7 7 7 7 7 7            13r9
6r9                  7 7 7 7 7 7 7 7 7 7 7 7 7             14r9
7r9                     7 7 7 7 7 7 7 7 7 7                16r9
8r9                        7 7 7 7 7 7 7                   18r9
33r9
33r9
33r9
33r9
33r9
33r9

33r5
33r5
33r5
33r5
33r5
33r5
18r5                       8 8 8 8 8 8 8                    8r5
16r5                    8 8 8 8 8 8 8 8 8 8                 7r5
14r5                 8 8 8 8 8 8 8 8 8 8 8 8 8              6r5
13r5                8 8 8 8 8 8 8 8 8 8 8 8 8 8             6r5
12r5               8 8 8 8 8 8 8 8 8 8 8 8 8 8 8            6r5
11r5              8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8           6r5
10r5             8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8          6r5
```

```
9r5            8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8          6r5
8r5           8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8         6r5
8r5            8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8          7r5
7r5           8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8         7r5
7r5            8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8          8r5
6r5           8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8         8r5
6r5            8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8          9r5
6r5             8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8          10r5
6r5              8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8           11r5
6r5               8 8 8 8 8 8 8 8 8 8 8 8 8 8 8            12r5
6r5                8 8 8 8 8 8 8 8 8 8 8 8 8 8             13r5
6r5                 8 8 8 8 8 8 8 8 8 8 8 8 8              14r5
7r5                    8 8 8 8 8 8 8 8 8 8                 16r5
8r5                       8 8 8 8 8 8 8                    18r5
33r5
33r5
33r5
33r5
33r5
33r5
end fill
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.5  zul=190 xlr=0.0  ylr=100.5  zlr=-102.15
vax=1 wdn=-1 nax=400  end plt0
ttl='x-y slice at z=10  below grid plate'
xul=-100.5 yul=100.5  zul=10.0 xlr=100.5 ylr=-100.5  zlr=10.0
uax=1 vdn=-1 nax=400 end plt1
ttl='x-y slice at z=15.2  through grid plate'
xul=-100.5 yul=100.5  zul=15.2 xlr=100.5 ylr=-100.5  zlr=15.2
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=100  above solution'
xul=-100.5 yul=100.5  zul=100 xlr=100.5 ylr=-100.5  zlr=100
uax=1 vdn=-1 nax=400 end plt4
end plot
end data
end
=csas26        parm=centrm
heu-sol-therm-037-005
238g
read comp
solnuo2(no3)2 1 61.4 0.41 den=1.096 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='holes in grid plate'
cylinder 10 1.625 15.5 15.0
hexprism 20 3.0 15.5 15.0
media 1 1 10
media 3 1 20 -10
boundary 20
unit 2
com='blank grid location'
```

```
hexprism 20 3.0 15.5 15.0
media 3 1 20
boundary 20
unit 3
com='absorber rods through grid plate'
cylinder 10 1.6 15.5 15.0
cylinder 15 1.65 15.5 15.0
cylinder 20 1.35 15.5 15.0
hexprism 30 3.0 15.5 15.0
media 4 1 20
media 3 1 10 -15
media 1 1 15 -20
media 3 1 30 -15
boundary 30
unit 4
com='solution below grid plate'
hexprism 10 3.0 15.0 0.0
media 1 1 10
boundary 10
unit 5
com='void above solution'
hexprism 10 3.0 198.35 28.4972
media 0 1 10
boundary 10
unit 6
com='absorber rod below grid plate'
cylinder 10 1.6 15.0 0.0
cylinder 20 1.35 15.0 0.4
hexprism 30 3.0 15.0 0.0
media 4 1 20
media 3 1 10 -20
media 1 1 30 -10
boundary 30
unit 7
com='absorber rod above grid plate, through solution'
cylinder 10 1.6 28.4972 15.5
cylinder 20 1.35 28.4972 15.5
hexprism 30 3.0 28.4972 15.5
media 4 1 20
media 3 1 10 -20
media 1 1 30 -10
boundary 30
unit 8
com='absorber rod above solution'
cylinder 10 1.6 198.35 28.4972
cylinder 20 1.35 198.35 28.4972
hexprism 30 3.0 198.35 28.4972
media 4 1 20
media 3 1 10 -20
media 0 1 30 -10
boundary 30
unit 9
com='solution above grid plate'
hexprism 10 3.0 28.4972 15.5
media 1 1 10
boundary 10
global unit 11
cylinder  5 79.7 198.35 0.0
cylinder 10 80.0 198.35 28.4972
cylinder 15 80.0 28.4972 0.0
cylinder 20 80.65 198.35 -0.65
cylinder 30 84.65 150.0 -4.65
cylinder 40 85.3 150.65 -5.3
cylinder 50 99.7 198.35 -101.15
```

```
cylinder 60 100.5 198.35 -102.15
array 1 5 place 17 17 1 0.0 0.0 0.0
media 0 1 10 -5
media 1 1 15 -5
media 3 1 20 -10 -15
media 2 1 30 -20
media 3 1 40 -30 -20
media 0 1 50 -40 -20
media 3 1 60 -50
boundary 60
end geom
read array ara=1 typ=hexagonal nux=33 nuy=33 nuz=4
fill
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5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5
end fill
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.5  zul=190 xlr=0.0  ylr=100.5  zlr=-102.15
vax=1 wdn=-1 nax=400  end plt0
ttl='x-y slice at z=10  below grid plate'
xul=-100.5 yul=100.5  zul=10.0 xlr=100.5 ylr=-100.5  zlr=10.0
uax=1 vdn=-1 nax=400 end plt1
ttl='x-y slice at z=15.2  through grid plate'
xul=-100.5 yul=100.5  zul=15.2 xlr=100.5 ylr=-100.5  zlr=15.2
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=100  above solution'
xul=-100.5 yul=100.5  zul=100 xlr=100.5 ylr=-100.5  zlr=100
uax=1 vdn=-1 nax=400 end plt4
end plot
end data
end
=csas26         parm=centrm
heu-sol-therm-037-006
238g
read comp
solnuo2(no3)2 1 83.0 0.500 den=1.129 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o            2 den=0.9983 end
fe             3 0 5.9088e-2 end
cr             3 0 1.6532e-2 end
ni             3 0 8.1369e-3 end
mn             3 0 1.3039e-3 end
si             3 0 1.3603e-3 end
ti             3 0 5.9844e-4 end
b4c            4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes end param
read geometry
global unit 11
cylinder 10 80.0 198.35 13.5779
cylinder 15 80.0 13.5779 0.0
cylinder 20 80.65 198.35 -0.65
cylinder 30 84.65 150.0 -4.65
cylinder 40 85.3 150.65 -5.3
cylinder 50 99.7 198.35 -101.15
cylinder 60 100.5 198.35 -102.15
media 0 1 10
```

```
media 1 1 15
media 3 1 20 -10 -15
media 2 1 30 -20
media 3 1 40 -30 -20
media 0 1 50 -40 -20
media 3 1 60 -50
boundary 60
end geom
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.5  zul=190 xlr=0.0  ylr=100.5  zlr=-102.15
vax=1 wdn=-1 nax=400  end plt0
ttl='x-y slice at z=10'
xul=-100.5 yul=100.5  zul=10.0 xlr=100.5 ylr=-100.5  zlr=10.0
uax=1 vdn=-1 nax=400 end plt1
ttl='x-y slice at z=100  above solution'
xul=-100.5 yul=100.5  zul=100 xlr=100.5 ylr=-100.5  zlr=100
uax=1 vdn=-1 nax=400 end plt4
end plot
end data
end
=csas26        parm=centrm
heu-sol-therm-037-007
238g
read comp
solnuo2(no3)2 1 83.0 0.500 den=1.129 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='holes in grid plate'
cylinder 10 1.625 15.5 15.0
hexprism 20 3.0 15.5 15.0
media 1 1 10
media 3 1 20 -10
boundary 20
unit 2
com='blank grid location'
hexprism 20 3.0 15.5 15.0
media 3 1 20
boundary 20
unit 3
com='absorber rods through grid plate'
cylinder 10 1.6 15.5 15.0
cylinder 15 1.65 15.5 15.0
cylinder 20 1.35 15.5 15.0
hexprism 30 3.0 15.5 15.0
media 4 1 20
media 3 1 10 -15
media 1 1 15 -20
media 3 1 30 -15
boundary 30
unit 4
com='solution below grid plate'
hexprism 10 3.0 15.0 0.0
```

```
media 1 1 10
boundary 10
unit 5
com='void above solution'
hexprism 10 3.0 198.35 18.6542
media 0 1 10
boundary 10
unit 6
com='absorber rod below grid plate'
cylinder 10 1.6 15.0 0.0
cylinder 20 1.35 15.0 0.4
hexprism 30 3.0 15.0 0.0
media 4 1 20
media 3 1 10 -20
media 1 1 30 -10
boundary 30
unit 7
com='absorber rod above grid plate, through solution'
cylinder 10 1.6 18.6542 15.5
cylinder 20 1.35 18.6542 15.5
hexprism 30 3.0 18.6542 15.5
media 4 1 20
media 3 1 10 -20
media 1 1 30 -10
boundary 30
unit 8
com='absorber rod above solution'
cylinder 10 1.6 198.35 18.6542
cylinder 20 1.35 198.35 18.6542
hexprism 30 3.0 198.35 18.6542
media 4 1 20
media 3 1 10 -20
media 0 1 30 -10
boundary 30
unit 9
com='solution above grid plate'
hexprism 10 3.0 18.6542 15.5
media 1 1 10
boundary 10
global unit 11
cylinder  5 79.7 198.35 0.0
cylinder 10 80.0 198.35 18.6542
cylinder 15 80.0 18.6542 0.0
cylinder 20 80.65 198.35 -0.65
cylinder 30 84.65 150.0 -4.65
cylinder 40 85.3 150.65 -5.3
cylinder 50 99.7 198.35 -101.15
cylinder 60 100.5 198.35 -102.15
array 1 5 place 17 17 1 0.0 0.0 0.0
media 0 1 10 -5
media 1 1 15 -5
media 3 1 20 -10 -15
media 2 1 30 -20
media 3 1 40 -30 -20
media 0 1 50 -40 -20
media 3 1 60 -50
boundary 60
end geom
read array ara=1 typ=hexagonal nux=33 nuy=33 nuz=4
fill
33r4
33r4
33r4
33r4
```

```
33r4
33r4
18r4                       6 6 6 6 6 6 6                      8r4
16r4                    6 6 6 6 6 6 6 6 6 6                   7r4
14r4                 6 6 6 6 6 6 6 6 6 6 6 6 6                6r4
13r4                6 6 6 6 6 6 6 6 6 6 6 6 6 6               6r4
12r4               6 6 6 6 6 6 6 6 6 6 6 6 6 6 6              6r4
11r4              6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6             6r4
10r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6            6r4
9r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6           6r4
8r4            6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6          6r4
8r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6           7r4
7r4            6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6          7r4
7r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6           8r4
6r4            6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6          8r4
6r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6           9r4
6r4              6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6           10r4
6r4               6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6            11r4
6r4                6 6 6 6 6 6 6 6 6 6 6 6 6 6 6             12r4
6r4                 6 6 6 6 6 6 6 6 6 6 6 6 6 6              13r4
6r4                  6 6 6 6 6 6 6 6 6 6 6 6 6               14r4
7r4                     6 6 6 6 6 6 6 6 6 6                  16r4
8r4                        6 6 6 6 6 6 6                     18r4
33r4
33r4
33r4
33r4
33r4
33r4

33r2
33r2
33r2
33r2
18r2                     1 1 1 1 1 1 1 1 1                    6r2
16r2                  1 1 1 1 1 1 1 1 1 1 1 1                 5r2
14r2               1 1 1 1 3 3 3 3 3 3 3 1 1 1 1              4r2
13r2              1 1 1 3 3 3 3 3 3 3 3 3 3 1 1 1             4r2
12r2             1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1            4r2
11r2            1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1           4r2
10r2           1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1          4r2
9r2           1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1         4r2
8r2          1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1        4r2
7r2         1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1       4r2
6r2        1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1      4r2
6r2         1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1       5r2
5r2        1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1      5r2
5r2         1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1       6r2
4r2        1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1      6r2
4r2         1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1       7r2
4r2          1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1        8r2
4r2           1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1         9r2
4r2            1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1          10r2
4r2             1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1           11r2
4r2              1 1 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1            12r2
4r2               1 1 1 3 3 3 3 3 3 3 3 3 3 1 1 1             13r2
4r2                1 1 1 1 3 3 3 3 3 3 3 1 1 1 1              14r2
5r2                   1 1 1 1 1 1 1 1 1 1 1 1                 16r2
6r2                      1 1 1 1 1 1 1 1 1                    18r2
33r2
33r2
33r2
33r2
```

```
33r9
33r9
33r9
33r9
33r9
33r9
18r9                    7 7 7 7 7 7 7                    8r9
16r9                 7 7 7 7 7 7 7 7 7 7                 7r9
14r9              7 7 7 7 7 7 7 7 7 7 7 7 7              6r9
13r9             7 7 7 7 7 7 7 7 7 7 7 7 7 7             6r9
12r9            7 7 7 7 7 7 7 7 7 7 7 7 7 7 7            6r9
11r9           7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7           6r9
10r9          7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7          6r9
9r9          7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7         6r9
8r9         7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7        6r9
8r9          7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7         7r9
7r9         7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7        7r9
7r9          7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7         8r9
6r9         7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7        8r9
6r9          7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7         9r9
6r9           7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7         10r9
6r9            7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7          11r9
6r9             7 7 7 7 7 7 7 7 7 7 7 7 7 7 7           12r9
6r9              7 7 7 7 7 7 7 7 7 7 7 7 7 7            13r9
6r9               7 7 7 7 7 7 7 7 7 7 7 7 7             14r9
7r9                  7 7 7 7 7 7 7 7 7 7                16r9
8r9                     7 7 7 7 7 7 7                   18r9
33r9
33r9
33r9
33r9
33r9
33r9

33r5
33r5
33r5
33r5
33r5
33r5
18r5                    8 8 8 8 8 8 8                    8r5
16r5                 8 8 8 8 8 8 8 8 8 8                 7r5
14r5              8 8 8 8 8 8 8 8 8 8 8 8 8              6r5
13r5             8 8 8 8 8 8 8 8 8 8 8 8 8 8             6r5
12r5            8 8 8 8 8 8 8 8 8 8 8 8 8 8 8            6r5
11r5           8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8           6r5
10r5          8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8          6r5
9r5          8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8         6r5
8r5         8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8        6r5
8r5          8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8         7r5
7r5         8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8        7r5
7r5          8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8         8r5
6r5         8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8        8r5
6r5          8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8         9r5
6r5           8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8         10r5
6r5            8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8          11r5
6r5             8 8 8 8 8 8 8 8 8 8 8 8 8 8 8           12r5
6r5              8 8 8 8 8 8 8 8 8 8 8 8 8 8            13r5
6r5               8 8 8 8 8 8 8 8 8 8 8 8 8             14r5
7r5                  8 8 8 8 8 8 8 8 8 8                16r5
8r5                     8 8 8 8 8 8 8                   18r5
33r5
33r5
33r5
```

```
33r5
33r5
33r5
end fill
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.5  zul=190 xlr=0.0  ylr=100.5  zlr=-102.15
vax=1 wdn=-1 nax=400  end plt0
ttl='x-y slice at z=10  below grid plate'
xul=-100.5 yul=100.5  zul=10.0 xlr=100.5 ylr=-100.5  zlr=10.0
uax=1 vdn=-1 nax=400 end plt1
ttl='x-y slice at z=15.2  through grid plate'
xul=-100.5 yul=100.5  zul=15.2 xlr=100.5 ylr=-100.5  zlr=15.2
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=100  above solution'
xul=-100.5 yul=100.5  zul=100 xlr=100.5 ylr=-100.5  zlr=100
uax=1 vdn=-1 nax=400 end plt4
end plot
end data
end
=csas26        parm=centrm
heu-sol-therm-037-008
238g
read comp
solnuo2(no3)2 1 83.0 0.50 den=1.129 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='holes in grid plate'
cylinder 10 1.625 15.5 15.0
hexprism 20 3.0 15.5 15.0
media 1 1 10
media 3 1 20 -10
boundary 20
unit 2
com='blank grid location'
hexprism 20 3.0 15.5 15.0
media 3 1 20
boundary 20
unit 3
com='absorber rods through grid plate'
cylinder 10 1.6 15.5 15.0
cylinder 15 1.65 15.5 15.0
cylinder 20 1.35 15.5 15.0
hexprism 30 3.0 15.5 15.0
media 4 1 20
media 3 1 10 -15
media 1 1 15 -20
media 3 1 30 -15
boundary 30
unit 4
com='solution below grid plate'
hexprism 10 3.0 15.0 0.0
```

```
media 1 1 10
boundary 10
unit 5
com='void above solution'
hexprism 10 3.0 198.35 22.8107
media 0 1 10
boundary 10
unit 6
com='absorber rod below grid plate'
cylinder 10 1.6 15.0 0.0
cylinder 20 1.35 15.0 0.4
hexprism 30 3.0 15.0 0.0
media 4 1 20
media 3 1 10 -20
media 1 1 30 -10
boundary 30
unit 7
com='absorber rod above grid plate, through solution'
cylinder 10 1.6 22.8107 15.5
cylinder 20 1.35 22.8107 15.5
hexprism 30 3.0 22.8107 15.5
media 4 1 20
media 3 1 10 -20
media 1 1 30 -10
boundary 30
unit 8
com='absorber rod above solution'
cylinder 10 1.6 198.35 22.8107
cylinder 20 1.35 198.35 22.8107
hexprism 30 3.0 198.35 22.8107
media 4 1 20
media 3 1 10 -20
media 0 1 30 -10
boundary 30
unit 9
com='solution above grid plate'
hexprism 10 3.0 22.8107 15.5
media 1 1 10
boundary 10
global unit 11
cylinder  5 79.7 198.35 0.0
cylinder 10 80.0 198.35 22.8107
cylinder 15 80.0 22.8107 0.0
cylinder 20 80.65 198.35 -0.65
cylinder 30 84.65 150.0 -4.65
cylinder 40 85.3 150.65 -5.3
cylinder 50 99.7 198.35 -101.15
cylinder 60 100.5 198.35 -102.15
array 1 5 place 17 17 1 0.0 0.0 0.0
media 0 1 10 -5
media 1 1 15 -5
media 3 1 20 -10 -15
media 2 1 30 -20
media 3 1 40 -30 -20
media 0 1 50 -40 -20
media 3 1 60 -50
boundary 60
end geom
read array ara=1 typ=hexagonal nux=33 nuy=33 nuz=4
fill
4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
```

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5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5
end fill
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.5  zul=190 xlr=0.0  ylr=100.5  zlr=-102.15
vax=1 wdn=-1 nax=400  end plt0
ttl='x-y slice at z=10  below grid plate'
xul=-100.5 yul=100.5  zul=10.0 xlr=100.5 ylr=-100.5  zlr=10.0
uax=1 vdn=-1 nax=400 end plt1
ttl='x-y slice at z=15.2  through grid plate'
xul=-100.5 yul=100.5  zul=15.2 xlr=100.5 ylr=-100.5  zlr=15.2
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=100  above solution'
xul=-100.5 yul=100.5  zul=100 xlr=100.5 ylr=-100.5  zlr=100
uax=1 vdn=-1 nax=400 end plt4
end plot
end data
end
=csas26       parm=centrm
heu-sol-therm-037-009
238g
read comp
solnuo2(no3)2 1 83.0 0.500 den=1.129 1 293.0 92234 0.90 92235 89.08
            92236 0.21 92238 9.81 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param npg=4000 gen=520 nsk=20 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='holes in grid plate'
cylinder 10 1.625 15.5 15.0
hexprism 20 3.0 15.5 15.0
media 1 1 10
media 3 1 20 -10
boundary 20
unit 2
com='blank grid location'
hexprism 20 3.0 15.5 15.0
media 3 1 20
boundary 20
unit 3
com='absorber rods through grid plate'
cylinder 10 1.6 15.5 15.0
cylinder 15 1.65 15.5 15.0
cylinder 20 1.35 15.5 15.0
hexprism 30 3.0 15.5 15.0
media 4 1 20
media 3 1 10 -15
media 1 1 15 -20
media 3 1 30 -15
boundary 30
unit 4
com='solution below grid plate'
hexprism 10 3.0 15.0 0.0
```

```
media 1 1 10
boundary 10
unit 5
com='void above solution'
hexprism 10 3.0 198.35 35.3848
media 0 1 10
boundary 10
unit 6
com='absorber rod below grid plate'
cylinder 10 1.6 15.0 0.0
cylinder 20 1.35 15.0 0.4
hexprism 30 3.0 15.0 0.0
media 4 1 20
media 3 1 10 -20
media 1 1 30 -10
boundary 30
unit 7
com='absorber rod above grid plate, through solution'
cylinder 10 1.6 35.3848 15.5
cylinder 20 1.35 35.3848 15.5
hexprism 30 3.0 35.3848 15.5
media 4 1 20
media 3 1 10 -20
media 1 1 30 -10
boundary 30
unit 8
com='absorber rod above solution'
cylinder 10 1.6 198.35 35.3848
cylinder 20 1.35 198.35 35.3848
hexprism 30 3.0 198.35 35.3848
media 4 1 20
media 3 1 10 -20
media 0 1 30 -10
boundary 30
unit 9
com='solution above grid plate'
hexprism 10 3.0 35.3848 15.5
media 1 1 10
boundary 10
global unit 11
cylinder  5 79.7 198.35 0.0
cylinder 10 80.0 198.35 35.3848
cylinder 15 80.0 35.3848 0.0
cylinder 20 80.65 198.35 -0.65
cylinder 30 84.65 150.0 -4.65
cylinder 40 85.3 150.65 -5.3
cylinder 50 99.7 198.35 -101.15
cylinder 60 100.5 198.35 -102.15
array 1 5 place 17 17 1 0.0 0.0 0.0
media 0 1 10 -5
media 1 1 15 -5
media 3 1 20 -10 -15
media 2 1 30 -20
media 3 1 40 -30 -20
media 0 1 50 -40 -20
media 3 1 60 -50
boundary 60
end geom
read array ara=1 typ=hexagonal nux=33 nuy=33 nuz=4
fill
33r4
33r4
33r4
33r4
```

```
18r4                     6 6 6 6 6 6 6 6 6                  6r4
16r4                  6 6 6 6 6 6 6 6 6 6 6 6               5r4
14r4               6 6 6 6 6 6 6 6 6 6 6 6 6 6 6            4r4
13r4              6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6           4r4
12r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6          4r4
11r4            6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6         4r4
10r4           6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6        4r4
9r4           6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6       4r4
8r4          6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6      4r4
7r4         6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6     4r4
6r4        6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6    4r4
6r4         6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6     5r4
5r4        6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6    5r4
5r4         6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6     6r4
4r4        6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6    6r4
4r4         6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6     7r4
4r4          6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6      8r4
4r4           6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6       9r4
4r4            6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6        10r4
4r4             6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6         11r4
4r4              6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6          12r4
4r4               6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6           13r4
4r4                6 6 6 6 6 6 6 6 6 6 6 6 6 6 6            14r4
5r4                   6 6 6 6 6 6 6 6 6 6 6 6               16r4
6r4                      6 6 6 6 6 6 6 6 6                  18r4
33r4
33r4
33r4
33r4

33r2
33r2
33r2
33r2
18r2                     3 3 3 3 3 3 3 3 3                  6r2
16r2                  3 3 3 3 3 3 3 3 3 3 3 3               5r2
14r2               3 3 3 3 3 3 3 3 3 3 3 3 3 3 3            4r2
13r2              3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3           4r2
12r2             3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3          4r2
11r2            3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3         4r2
10r2           3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3        4r2
9r2           3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3       4r2
8r2          3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3      4r2
7r2         3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3     4r2
6r2        3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3    4r2
6r2         3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3     5r2
5r2        3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3    5r2
5r2         3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3     6r2
4r2        3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3    6r2
4r2         3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3     7r2
4r2          3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3      8r2
4r2           3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3       9r2
4r2            3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3        10r2
4r2             3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3         11r2
4r2              3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3          12r2
4r2               3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3           13r2
4r2                3 3 3 3 3 3 3 3 3 3 3 3 3 3 3            14r2
5r2                   3 3 3 3 3 3 3 3 3 3 3 3               16r2
6r2                      3 3 3 3 3 3 3 3 3                  18r2
33r2
33r2
33r2
33r2
```

```
33r9
33r9
33r9
33r9
18r9                     7 7 7 7 7 7 7 7 7                  6r9
16r9                  7 7 7 7 7 7 7 7 7 7 7 7               5r9
14r9               7 7 7 7 7 7 7 7 7 7 7 7 7 7 7            4r9
13r9              7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7           4r9
12r9             7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7          4r9
11r9            7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7         4r9
10r9           7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7        4r9
9r9           7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7       4r9
8r9          7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7      4r9
7r9         7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7     4r9
6r9        7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7    4r9
6r9         7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7     5r9
5r9        7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7    5r9
5r9         7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7     6r9
4r9        7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7    6r9
4r9         7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7     7r9
4r9          7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7      8r9
4r9           7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7       9r9
4r9            7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7        10r9
4r9             7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7         11r9
4r9              7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7          12r9
4r9               7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7           13r9
4r9                7 7 7 7 7 7 7 7 7 7 7 7 7 7 7            14r9
5r9                   7 7 7 7 7 7 7 7 7 7 7 7               16r9
6r9                      7 7 7 7 7 7 7 7 7                  18r9
33r9
33r9
33r9
33r9

33r5
33r5
33r5
33r5
18r5                     8 8 8 8 8 8 8 8 8                  6r5
16r5                  8 8 8 8 8 8 8 8 8 8 8 8               5r5
14r5               8 8 8 8 8 8 8 8 8 8 8 8 8 8 8            4r5
13r5              8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8           4r5
12r5             8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8          4r5
11r5            8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8         4r5
10r5           8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8        4r5
9r5           8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8       4r5
8r5          8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8      4r5
7r5         8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8     4r5
6r5        8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8    4r5
6r5         8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8     5r5
5r5        8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8    5r5
5r5         8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8     6r5
4r5        8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8    6r5
4r5         8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8     7r5
4r5          8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8      8r5
4r5           8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8       9r5
4r5            8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8        10r5
4r5             8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8         11r5
4r5              8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8          12r5
4r5               8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8           13r5
4r5                8 8 8 8 8 8 8 8 8 8 8 8 8 8 8            14r5
5r5                   8 8 8 8 8 8 8 8 8 8 8 8               16r5
6r5                      8 8 8 8 8 8 8 8 8                  18r5
33r5
```

```
33r5
33r5
33r5

end fill
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.5  zul=190 xlr=0.0  ylr=100.5  zlr=-102.15
vax=1 wdn=-1 nax=400  end plt0
ttl='x-y slice at z=10  below grid plate'
xul=-100.5 yul=100.5  zul=10.0 xlr=100.5 ylr=-100.5  zlr=10.0
uax=1 vdn=-1 nax=400 end plt1
ttl='x-y slice at z=15.2  through grid plate'
xul=-100.5 yul=100.5  zul=15.2 xlr=100.5 ylr=-100.5  zlr=15.2
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=100  above solution'
xul=-100.5 yul=100.5  zul=100 xlr=100.5 ylr=-100.5  zlr=100
uax=1 vdn=-1 nax=400 end plt4
end plot
end data
end
```

APPENDIX B

IEU BENCHMARK CASES

APPENDIX B
IEU BENCHMARK CASES

```
=csas26        parm=centrm
ieu-comp-therm-002-001
238g
read comp
h2o   1 0.9976 295.9 end
fe    2 0 5.9986e-02 295.9 end
cr    2 0 1.5724e-02 295.9 end
ni    2 0 8.5030e-03 295.9 end
mn    2 0 1.0431e-03 295.9 end
si    2 0 8.5018e-04 295.9 end
ti    2 0 4.7376e-04 295.9 end
c     2 0 4.1748e-04 295.9 end
u-234 3 0 1.6683e-05 295.9 end
u-235 3 0 1.8827e-03 295.9 end
u-238 3 0 9.0594e-03 295.9 end
o     3 0 2.2396e-02 295.9 end
fe    4 0 5.9986e-02 295.9 end
cr    4 0 1.5724e-02 295.9 end
ni    4 0 8.5030e-03 295.9 end
mn    4 0 1.0431e-03 295.9 end
si    4 0 8.5018e-04 295.9 end
ti    4 0 4.7376e-04 295.9 end
c     4 0 4.1748e-04 295.9 end
fe    5 0 5.9986e-02 295.9 end
cr    5 0 1.5724e-02 295.9 end
ni    5 0 8.5030e-03 295.9 end
mn    5 0 1.0431e-03 295.9 end
si    5 0 8.5018e-04 295.9 end
ti    5 0 4.7376e-04 295.9 end
c     5 0 4.1748e-04 295.9 end
u-234 6 0 1.6683e-05 295.9 end
u-235 6 0 1.8827e-03 295.9 end
u-238 6 0 9.0594e-03 295.9 end
o     6 0 2.2396e-02 295.9 end
fe    7 0 5.9986e-02 295.9 end
cr    7 0 1.5724e-02 295.9 end
ni    7 0 8.5030e-03 295.9 end
mn    7 0 1.0431e-03 295.9 end
si    7 0 8.5018e-04 295.9 end
ti    7 0 4.7376e-04 295.9 end
c     7 0 4.1748e-04 295.9 end
fe    8 0 5.9986e-02 295.9 end
cr    8 0 1.5724e-02 295.9 end
ni    8 0 8.5030e-03 295.9 end
mn    8 0 1.0431e-03 295.9 end
si    8 0 8.5018e-04 295.9 end
ti    8 0 4.7376e-04 295.9 end
c     8 0 4.1748e-04 295.9 end
fe    9 0 5.9986e-02 295.9 end
cr    9 0 1.5724e-02 295.9 end
ni    9 0 8.5030e-03 295.9 end
mn    9 0 1.0431e-03 295.9 end
si    9 0 8.5018e-04 295.9 end
ti    9 0 4.7376e-04 295.9 end
c     9 0 4.1748e-04 295.9 end
h2o   11 0.9976 295.9 end
h2o   12 0.9976 295.9 end
h2o   13 0.9976 295.9 end
```

```
end comp
read celldata
multiregion cylindrical right_bdy=white left_bdy=reflected end
1 1.17   2 1.2   3 1.43  4  1.46  11 1.80  5 1.83  6 2.06
7 2.09  12 2.26  8 2.29  13 3.57026 end zone
end celldata
read param npg=4000 gen=550 nsk=50 fdn=yes far=yes flx=yes plt=no end param
read geom
unit 1
com='fuel element w/o absorber rod'
cylinder 10 1.17 64.6 0.0
cylinder 20 1.20 64.6 0.0
cylinder 30 1.80 64.3 0.0
cylinder 40 1.83 64.6 0.0
cylinder 50 1.43 61.6 1.6
cylinder 60 1.46 61.9 1.3
cylinder 70 1.80 61.9 1.3
cylinder 80 2.06 61.6 1.6
cylinder 90 2.09 61.9 1.3
cylinder 100 2.26 64.3 0.0
cylinder 110 2.29 64.6 0.0
cylinder 120 0.15 0.0 -1.3
cone 130 1.17 0.0 0.5 -1.3
cylinder 140 2.29 0.0 -0.3
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.35 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
cylinder 500 1.80 61.6 61.4687611
cylinder 510 1.80 54.943 54.81176
cylinder 520 1.80 48.2864 48.15516
cylinder 530 1.80 41.62956 41.49832
cylinder 540 1.80 34.9727 34.84146
cylinder 550 1.80 28.3159 28.18466
cylinder 560 1.80 21.65912 21.52788
cylinder 570 1.80 15.0023 14.84106
cylinder 580 1.80 8.3455 8.21526
cylinder 590 1.80 1.688673 1.60
hexprism 600 3.4 66.1 -4.3
media 1 1 10
media 2 1 20 -10
media 1 1 30 -20 -70
media 5 1 40 -30 -20
media 3 1 50 -20
media 4 1 60 -50 -20
media 1 1 70 -60 -500 -510 -520 -530 -540 -550 -560 -570 -580 -590
media 4 1 500 -60
media 4 1 510 -60
media 4 1 520 -60
media 4 1 530 -60
media 4 1 540 -60
media 4 1 550 -60
media 4 1 560 -60
media 4 1 570 -60
media 4 1 580 -60
media 4 1 590 -60
media 6 1 80 -40
media 7 1 90 -80 -40
media 1 1 100 -40 -90
media 8 1 110 -100 -40
media 1 1 120
```

```
media 9 1 130 -120
media 9 1 140 -130
media 1 1 600 -110 -160 -170 -180
media 8 1 160 -300
media 1 1 300 -110
media 1 1 170 -110 -130 -140
media 9 1 180 -190 -310 -130
media 1 1 190 -130
media 1 1 310
boundary 600
unit 3
com='empty lattice position'
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.35 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
hexprism 600 3.4 66.1 -4.3
media 1 1 600 -160 -170 -180 -190 -300
media 1 1 300
media 1 1 170
media 1 1 190
media 1 1 310
media 9 1 160 -300
media 9 1 180 -190 -310
boundary 600
unit 4
com='grid plates outside of grid region'
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
hexprism 600 3.4 66.1 -4.3
media 1 1 600 -160 -170 -180
media 9 1 160
media 1 1 170
media 9 1 180
boundary 600
unit 5
com='central channel'
cylinder 10 2.5 196.7 0.0
cylinder 20 2.2 196.7 0.0
cylinder 30 1.9 196.7 0.0
cylinder 40 1.7 196.7 0.0
cylinder 50 1.5 196.7 0.0
cylinder 60 1.3 196.7 0.0
cylinder 70 1.1 196.7 0.0
cylinder 80 1.05 196.7 0.0
cylinder 90 2.5 0.0 -0.3
hexprism 150 3.4 196.7 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.53 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
hexprism 600 3.4 196.7 -4.3
media 0 1 80
media 9 1 70 -80
media 1 1  60 -70
media 9 1 50 -60
media 1 1 40 -50
```

```
media 9 1 30 -40
media 0 1 20 -30
media 9 1 10 -20
media 1 1 600 -10 -160 -170 -180
media 9 1 160 -300
media 1 1 300 -10
media 1 1 170 -10
media 9 1 180 -190 -310
media 1 1 190
media 1 1 310
boundary 600
global unit 6
cylinder 10 60.0 220.0 0.0
cylinder 20 44.0 125.0 0.0
cylinder 30 42.0 125.0 0.0
cylinder 60 40.5 19.0 0.0
cylinder 70 40.0 19.0 0.0
cylinder 80 1.0 85.8 22.5 origin Y=35.0
cylinder 90 1.0 85.8 22.5 origin Y=17.5 X=30.31
cylinder 100 1.0 85.8 22.5 origin Y=-17.5 X=30.31
cylinder 110 1.0 85.8 22.5 origin Y=-35.0
cylinder 120 1.0 85.8 22.5 origin Y=-17.5 X=-30.31
cylinder 130 1.0 85.8 22.5 origin Y=17.5 X=-30.31
cylinder 140 1.5 220.0 23.0 origin Y=13.7409 X=3.4
cylinder 150 1.2 220. 23.3 origin Y=13.7409 X=3.4
cylinder 160 1.5 220.0 23.0 origin Y=-13.7409 X=-3.4
cylinder 170 1.2 220. 23.3 origin Y=-13.7409 X=-3.4
cylinder 180 1.5 220.0 23.0 origin Y=3.92598 X=13.6
cylinder 190 1.2 220. 23.3 origin Y=3.92598 X=13.6
cylinder 200 1.5 220.0 23.0 origin Y=-3.92598 X=-13.6
cylinder 210 1.2 220. 23.3 origin Y=-3.92598 X=-13.6
cylinder 230 41.0 89.4 19.0
media 1 1 10 -20 -140 -160 -180 -200
media 9 1 20 -30
media 1 1 30 -140 -160 -180 -200 -230 -60
media 9 1 140 -150
media 0 1 150
media 9 1 160 -170
media 0 1 170
media 9 1 180 -190
media 0 1 190
media 9 1 200 -210
media 0 1 210
media 9 1 80
media 9 1 90
media 9 1 100
media 9 1 110
media 9 1 120
media 9 1 130
array 1 230 -80 -90 -100 -110 -120 -130 -140 -160 -180 -200
place 8 8 1 0.0 0.0 23.3
media 9 1 60 -70
media 1 1 70
hole 5  origin Z=23.3
boundary 10
end geom
read array ara=1 typ=hexagonal nux=15 nuy=15 nuz=1
loop
4 1 15 1 1 15 1 1 1 1
3 8 13 1 3 3 1 1 1 1
3 7 13 1 4 4 1 1 1 1
3 6 13 1 5 5 1 1 1 1
3 5 13 1 6 6 1 1 1 1
3 4 13 1 7 7 1 1 1 1
```

```
3 3 13 1 8 8 1 1 1 1
3 3 12 1 9 9 1 1 1 1
3 3 11 1 10 10 1 1 1 1
3 3 10 1 11 11 1 1 1 1
3 3 9 1 12 12 1 1 1 1
3 3 8 1 13 13 1 1 1 1
1 8 10 1 5 5 1 1 1 1
1 7 11 1 6 6 1 1 1 1
1 6 11 1 7 7 1 1 1 1
1 5 7 1 8 8 1 1 1 1
1 9 11 1 8 8 1 1 1 1
1 5 10 1 9 9 1 1 1 1
1 5 9 1 10 10 1 1 1 1
1 6 8 1 11 11 1 1 1 1
end loop
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-60.0  zul=220.0 xlr=0.0  ylr=60.0  zlr=-0.0
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on bottom plate'
xul=0.0  yul=-22.0  zul=30.0 xlr=0.0  ylr=30.0  zlr=5.0
vax=1 wdn=-1 nax=400  end plt1
ttl='x-y slice at z=50  through core'
xul=-42.0 yul=42.0  zul=50.0 xlr=42.0 ylr=-42.0  zlr=50.0
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=22.0  through lower plate'
xul=-42.0 yul=42.0  zul=22.0 xlr=42.0.0 ylr=-42.0  zlr=22.0
uax=1 vdn=-1 nax=400 end plt4
ttl='x-y slice at z=86.0  through upper plate'
xul=-42.0 yul=42.0  zul=86.0 xlr=42.0.0 ylr=-42.0  zlr=86.0
uax=1 vdn=-1 nax=400 end plt5
ttl='x-y slice at z=50  zoom on fuel pin'
xul=-0.0 yul=4.0  zul=50.0 xlr=8.0 ylr=-4.0  zlr=50.0
uax=1 vdn=-1 nax=400 end plt6
ttl='x-y slice at z=87.9  through core'
xul=-60.0 yul=60.0  zul=87.9 xlr=60.0 ylr=-60.0  zlr=87.90
uax=1 vdn=-1 nax=400 end plt7
ttl='x-z slice at y=0.0 '
xul=-60.0  yul=0.0  zul=220.0 xlr=60.0  ylr=0.0  zlr=-0.0
uax=1 wdn=-1 nax=400  end plt8
ttl='x-z slice at y=0.0 '
xul=0.0  yul=0.0  zul=88.0 xlr=42.0  ylr=0.0  zlr=-0.0
uax=1 wdn=-1 nax=400  end plt9
xul=3.4  yul=0.0  zul=25.0 xlr=10.2  ylr=0.0  zlr=18.0
uax=1 wdn=-1 nax=400  end plt10
ttl='x-y slice at z=23.1  zoom on fuel pin'
xul=-0.0 yul=4.0  zul=23.1 xlr=8.0 ylr=-4.0  zlr=23.1
uax=1 vdn=-1 nax=400 end plt11
end plot
end data
end

=csas26       parm=centrm
ieu-comp-therm-002-002
238g
read comp
h2o   1 0.8439 491.4 end
fe    2 0 5.9986e-02 491.4 end
cr    2 0 1.5724e-02 491.4 end
ni    2 0 8.5030e-03 491.4 end
mn    2 0 1.0431e-03 491.4 end
si    2 0 8.5018e-04 491.4 end
ti    2 0 4.7376e-04 491.4 end
```

```
c     2 0 4.1748e-04 491.4 end
u-234 3 0 1.6683e-05 491.4 end
u-235 3 0 1.8827e-03 491.4 end
u-238 3 0 9.0594e-03 491.4 end
o     3 0 2.2396e-02 491.4 end
fe    4 0 5.9986e-02 491.4 end
cr    4 0 1.5724e-02 491.4 end
ni    4 0 8.5030e-03 491.4 end
mn    4 0 1.0431e-03 491.4 end
si    4 0 8.5018e-04 491.4 end
ti    4 0 4.7376e-04 491.4 end
c     4 0 4.1748e-04 491.4 end
fe    5 0 5.9986e-02 491.4 end
cr    5 0 1.5724e-02 491.4 end
ni    5 0 8.5030e-03 491.4 end
mn    5 0 1.0431e-03 491.4 end
si    5 0 8.5018e-04 491.4 end
ti    5 0 4.7376e-04 491.4 end
c     5 0 4.1748e-04 491.4 end
u-234 6 0 1.6683e-05 491.4 end
u-235 6 0 1.8827e-03 491.4 end
u-238 6 0 9.0594e-03 491.4 end
o     6 0 2.2396e-02 491.4 end
fe    7 0 5.9986e-02 491.4 end
cr    7 0 1.5724e-02 491.4 end
ni    7 0 8.5030e-03 491.4 end
mn    7 0 1.0431e-03 491.4 end
si    7 0 8.5018e-04 491.4 end
ti    7 0 4.7376e-04 491.4 end
c     7 0 4.1748e-04 491.4 end
fe    8 0 5.9986e-02 491.4 end
cr    8 0 1.5724e-02 491.4 end
ni    8 0 8.5030e-03 491.4 end
mn    8 0 1.0431e-03 491.4 end
si    8 0 8.5018e-04 491.4 end
ti    8 0 4.7376e-04 491.4 end
c     8 0 4.1748e-04 491.4 end
fe    9 0 5.9986e-02 491.4 end
cr    9 0 1.5724e-02 491.4 end
ni    9 0 8.5030e-03 491.4 end
mn    9 0 1.0431e-03 491.4 end
si    9 0 8.5018e-04 491.4 end
ti    9 0 4.7376e-04 491.4 end
c     9 0 4.1748e-04 491.4 end
h2o  11 0.9179 491.4 end
h2o  12 0.9179 491.4 end
h2o  13 0.9179 491.4 end
end comp
read celldata
multiregion cylindrical right_bdy=white left_bdy=reflected end
1 1.17   2 1.2   3 1.43   4 1.46  11 1.80  5 1.83  6 2.06
7 2.09  12 2.26  8 2.29  13 3.57026 end zone
end celldata
read param npg=4000 gen=550 nsk=50 fdn=yes far=yes flx=yes plt=no end param
read geom
unit 1
com='fuel element w/o absorber rod'
cylinder 10 1.17 64.6 0.0
cylinder 20 1.20 64.6 0.0
cylinder 30 1.80 64.3 0.0
cylinder 40 1.83 64.6 0.0
cylinder 50 1.43 61.6 1.6
cylinder 60 1.46 61.9 1.3
cylinder 70 1.80 61.9 1.3
```

```
cylinder 80 2.06 61.6 1.6
cylinder 90 2.09 61.9 1.3
cylinder 100 2.26 64.3 0.0
cylinder 110 2.29 64.6 0.0
cylinder 120 0.15 0.0 -1.3
cone 130 1.17 0.0 0.5 -1.3
cylinder 140 2.29 0.0 -0.3
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.35 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
cylinder 500 1.80 61.6 61.4687611
cylinder 510 1.80 54.943 54.81176
cylinder 520 1.80 48.2864 48.15516
cylinder 530 1.80 41.62956 41.49832
cylinder 540 1.80 34.9727 34.84146
cylinder 550 1.80 28.3159 28.18466
cylinder 560 1.80 21.65912 21.52788
cylinder 570 1.80 15.0023 14.84106
cylinder 580 1.80 8.3455 8.21526
cylinder 590 1.80 1.688673 1.60
hexprism 600 3.4 66.1 -4.3
media 1 1 10
media 2 1 20 -10
media 1 1 30 -20 -70
media 5 1 40 -30 -20
media 3 1 50 -20
media 4 1 60 -50 -20
media 1 1 70 -60 -500 -510 -520 -530 -540 -550 -560 -570 -580 -590
media 4 1 500 -60
media 4 1 510 -60
media 4 1 520 -60
media 4 1 530 -60
media 4 1 540 -60
media 4 1 550 -60
media 4 1 560 -60
media 4 1 570 -60
media 4 1 580 -60
media 4 1 590 -60
media 6 1 80 -40
media 7 1 90 -80 -40
media 1 1 100 -40 -90
media 8 1 110 -100 -40
media 1 1 120
media 9 1 130 -120
media 9 1 140 -130
media 1 1 600 -110 -160 -170 -180
media 8 1 160 -300
media 1 1 300 -110
media 1 1 170 -110 -130 -140
media 9 1 180 -190 -310 -130
media 1 1 190 -130
media 1 1 310
boundary 600
unit 3
com='empty lattice position'
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.35 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
```

```
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
hexprism 600 3.4 66.1 -4.3
media 1 1 600 -160 -170 -180 -190 -300
media 1 1 300
media 1 1 170
media 1 1 190
media 1 1 310
media 9 1 160 -300
media 9 1 180 -190 -310
boundary 600
unit 4
com='grid plates outside of grid region'
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
hexprism 600 3.4 66.1 -4.3
media 1 1 600 -160 -170 -180
media 9 1 160
media 1 1 170
media 9 1 180
boundary 600
unit 5
com='central channel'
cylinder 10 2.5 196.7 0.0
cylinder 20 2.2 196.7 0.0
cylinder 30 1.9 196.7 0.0
cylinder 40 1.7 196.7 0.0
cylinder 50 1.5 196.7 0.0
cylinder 60 1.3 196.7 0.0
cylinder 70 1.1 196.7 0.0
cylinder 80 1.05 196.7 0.0
cylinder 90 2.5 0.0 -0.3
hexprism 150 3.4 196.7 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.53 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
hexprism 600 3.4 196.7 -4.3
media 0 1 80
media 9 1 70 -80
media 1 1  60 -70
media 9 1 50 -60
media 1 1 40 -50
media 9 1 30 -40
media 0 1 20 -30
media 9 1 10 -20
media 1 1 600 -10 -160 -170 -180
media 9 1 160 -300
media 1 1 300 -10
media 1 1 170 -10
media 9 1 180 -190 -310
media 1 1 190
media 1 1 310
boundary 600
global unit 6
cylinder 10 60.0 220.0 0.0
cylinder 20 44.0 125.0 0.0
cylinder 30 42.0 125.0 0.0
cylinder 60 40.5 19.0 0.0
cylinder 70 40.0 19.0 0.0
```

```
cylinder 80 1.0 85.8 22.5 origin Y=35.0
cylinder 90 1.0 85.8 22.5 origin Y=17.5 X=30.31
cylinder 100 1.0 85.8 22.5 origin Y=-17.5 X=30.31
cylinder 110 1.0 85.8 22.5 origin Y=-35.0
cylinder 120 1.0 85.8 22.5 origin Y=-17.5 X=-30.31
cylinder 130 1.0 85.8 22.5 origin Y=17.5 X=-30.31
cylinder 140 1.5 220.0 23.0 origin Y=13.7409 X=3.4
cylinder 150 1.2 220. 23.3 origin Y=13.7409 X=3.4
cylinder 160 1.5 220.0 23.0 origin Y=-13.7409 X=-3.4
cylinder 170 1.2 220. 23.3 origin Y=-13.7409 X=-3.4
cylinder 180 1.5 220.0 23.0 origin Y=3.92598 X=13.6
cylinder 190 1.2 220. 23.3 origin Y=3.92598 X=13.6
cylinder 200 1.5 220.0 23.0 origin Y=-3.92598 X=-13.6
cylinder 210 1.2 220. 23.3 origin Y=-3.92598 X=-13.6
cylinder 230 41.0 89.4 19.0
media 1 1 10 -20 -140 -160 -180 -200
media 9 1 20 -30
media 1 1 30 -140 -160 -180 -200 -230 -60
media 9 1 140 -150
media 0 1 150
media 9 1 160 -170
media 0 1 170
media 9 1 180 -190
media 0 1 190
media 9 1 200 -210
media 0 1 210
media 9 1 80
media 9 1 90
media 9 1 100
media 9 1 110
media 9 1 120
media 9 1 130
array 1 230 -80 -90 -100 -110 -120 -130 -140 -160 -180 -200
      place 8 8 1 0.0 0.0 23.3
media 9 1 60 -70
media 1 1 70
hole 5 origin Z=23.3
boundary 10
end geom
read array ara=1 typ=hexagonal nux=15 nuy=15 nuz=1
loop
4 1 15 1 1 15 1 1 1 1
3 8 13 1 3 3 1 1 1 1
3 7 13 1 4 4 1 1 1 1
3 6 13 1 5 5 1 1 1 1
3 5 13 1 6 6 1 1 1 1
3 4 13 1 7 7 1 1 1 1
3 3 13 1 8 8 1 1 1 1
3 3 12 1 9 9 1 1 1 1
3 3 11 1 10 10 1 1 1 1
3 3 10 1 11 11 1 1 1 1
3 3 9 1 12 12 1 1 1 1
3 3 8 1 13 13 1 1 1 1
1 8 10 1 5 5 1 1 1 1
1 7 11 1 6 6 1 1 1 1
1 6 11 1 7 7 1 1 1 1
1 5 7 1 8 8 1 1 1 1
1 9 11 1 8 8 1 1 1 1
1 5 10 1 9 9 1 1 1 1
1 5 9 1 10 10 1 1 1 1
1 6 8 1 11 11 1 1 1 1
end loop
end array
read plot  scr=yes  lpi=10
```

```
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-60.0  zul=220.0 xlr=0.0  ylr=60.0  zlr=-0.0
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on bottom plate'
xul=0.0  yul=-22.0  zul=30.0 xlr=0.0  ylr=30.0  zlr=5.0
vax=1 wdn=-1 nax=400  end plt1
ttl='x-y slice at z=50  through core'
xul=-42.0 yul=42.0  zul=50.0 xlr=42.0 ylr=-42.0  zlr=50.0
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=22.0  through lower plate'
xul=-42.0 yul=42.0  zul=22.0 xlr=42.0.0 ylr=-42.0  zlr=22.0
uax=1 vdn=-1 nax=400 end plt4
ttl='x-y slice at z=86.0  through upper plate'
xul=-42.0 yul=42.0  zul=86.0 xlr=42.0.0 ylr=-42.0  zlr=86.0
uax=1 vdn=-1 nax=400 end plt5
ttl='x-y slice at z=50  zoom on fuel pin'
xul=-0.0 yul=4.0  zul=50.0 xlr=8.0 ylr=-4.0  zlr=50.0
uax=1 vdn=-1 nax=400 end plt6
ttl='x-y slice at z=87.9  through core'
xul=-60.0 yul=60.0  zul=87.9 xlr=60.0 ylr=-60.0  zlr=87.90
uax=1 vdn=-1 nax=400 end plt7
ttl='x-z slice at y=0.0 '
xul=-60.0  yul=0.0  zul=220.0 xlr=60.0  ylr=0.0  zlr=-0.0
uax=1 wdn=-1 nax=400  end plt8
ttl='x-z slice at y=0.0 '
xul=0.0  yul=0.0  zul=88.0 xlr=42.0  ylr=0.0  zlr=-0.0
uax=1 wdn=-1 nax=400  end plt9
xul=3.4  yul=0.0  zul=25.0 xlr=10.2  ylr=0.0  zlr=18.0
uax=1 wdn=-1 nax=400  end plt10
ttl='x-y slice at z=23.1  zoom on fuel pin'
xul=-0.0 yul=4.0  zul=23.1 xlr=8.0 ylr=-4.0  zlr=23.1
uax=1 vdn=-1 nax=400 end plt11
end plot
end data
end


=csas26     parm=centrm
ieu-comp-therm-002-003
238g
read comp
h2o   1 0..9988 189.4 end
fe    2 0 5.9986e-02 189.4 end
cr    2 0 1.5724e-02 189.4 end
ni    2 0 8.5030e-03 189.4 end
mn    2 0 1.0431e-03 189.4 end
si    2 0 8.5018e-04 189.4 end
ti    2 0 4.7376e-04 189.4 end
c     2 0 4.1748e-04 189.4 end
u-234 3 0 1.6683e-05 189.4 end
u-235 3 0 1.8827e-03 189.4 end
u-238 3 0 9.0594e-03 189.4 end
o     3 0 2.2396e-02 189.4 end
fe    4 0 5.9986e-02 189.4 end
cr    4 0 1.5724e-02 189.4 end
ni    4 0 8.5030e-03 189.4 end
mn    4 0 1.0431e-03 189.4 end
si    4 0 8.5018e-04 189.4 end
ti    4 0 4.7376e-04 189.4 end
c     4 0 4.1748e-04 189.4 end
fe    5 0 5.9986e-02 189.4 end
cr    5 0 1.5724e-02 189.4 end
ni    5 0 8.5030e-03 189.4 end
mn    5 0 1.0431e-03 189.4 end
```

```
si    5 0 8.5018e-04 189.4 end
ti    5 0 4.7376e-04 189.4 end
c     5 0 4.1748e-04 189.4 end
u-234 6 0 1.6683e-05 189.4 end
u-235 6 0 1.8827e-03 189.4 end
u-238 6 0 9.0594e-03 189.4 end
o     6 0 2.2396e-02 189.4 end
fe    7 0 5.9986e-02 189.4 end
cr    7 0 1.5724e-02 189.4 end
ni    7 0 8.5030e-03 189.4 end
mn    7 0 1.0431e-03 189.4 end
si    7 0 8.5018e-04 189.4 end
ti    7 0 4.7376e-04 189.4 end
c     7 0 4.1748e-04 189.4 end
fe    8 0 5.9986e-02 189.4 end
cr    8 0 1.5724e-02 189.4 end
ni    8 0 8.5030e-03 189.4 end
mn    8 0 1.0431e-03 189.4 end
si    8 0 8.5018e-04 189.4 end
ti    8 0 4.7376e-04 189.4 end
c     8 0 4.1748e-04 189.4 end
fe    9 0 5.9986e-02 189.4 end
cr    9 0 1.5724e-02 189.4 end
ni    9 0 8.5030e-03 189.4 end
mn    9 0 1.0431e-03 189.4 end
si    9 0 8.5018e-04 189.4 end
ti    9 0 4.7376e-04 189.4 end
c     9 0 4.1748e-04 189.4 end
gd-152 10 0 4.3186e-6 189.4 end
gd-154 10 0 4.7073e-5 189.4 end
gd-155 10 0 3.1958e-4 189.4 end
gd-156 10 0 4.4201e-4 189.4 end
gd-157 10 0 3.3793e-4 189.4 end
gd-158 10 0 5.3637e-4 189.4 end
gd-160 10 0 4.7202e-4 189.4 end
al   10 0 1.4775e-02 189.4 end
o    10 0 2.5401e-02 189.4 end
fe   11 0 5.9986e-02 189.4 end
cr   11 0 1.5724e-02 189.4 end
ni   11 0 8.5030e-03 189.4 end
mn   11 0 1.0431e-03 189.4 end
si   11 0 8.5018e-04 189.4 end
ti   11 0 4.7376e-04 189.4 end
c    11 0 4.1748e-04 189.4 end
al   12 0 6.0262e-02 189.4 end
h2o  21 0.9179 189.4 end
h2o  22 0.9179 189.4 end
h2o  23 0.9179 189.4 end
end comp
read celldata
multiregion cylindrical right_bdy=white left_bdy=reflected end
10 0.52  11 0.55  1 1.17  2 1.2  3 1.43  4 1.46  21 1.80  5 1.83  6 2.06
7 2.09  22 2.26  8 2.29  23 3.57026 end zone
end celldata
read param npg=4000 gen=550 nsk=50 fdn=yes far=yes flx=yes
tba=5.0 plt=no end param
read geom
unit 1
com='fuel element with absorber rod'
cylinder 10 1.17 64.6 0.0
cylinder 20 1.20 64.6 0.0
cylinder 30 1.80 64.3 0.0
cylinder 40 1.83 64.6 0.0
cylinder 50 1.43 61.6 1.6
```

```
cylinder 60 1.46 61.9 1.3
cylinder 70 1.80 61.9 1.3
cylinder 80 2.06 61.6 1.6
cylinder 90 2.09 61.9 1.3
cylinder 100 2.26 64.3 0.0
cylinder 110 2.29 64.6 0.0
cylinder 120 0.15 0.0 -1.3
cone 130 1.17 0.0 0.5 -1.3
cylinder 140 2.29 0.0 -0.3
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.35 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
cylinder 200 0.3 66.1 63.6
cylinder 210 1.15 63.6 63.1
cylinder 220 0.55 63.1 56.6
cylinder 230 0.3 57.6 56.6
cylinder 240 0.55 56.6 6.6
cylinder 250 0.52 55.6 7.6
cylinder 260 0.3 6.6 5.6
cylinder 270 0.55 6.6 2.5
cylinder 280 1.15 2.5 2.0
cylinder 290 0.3 2.0 0.0
cylinder 500 1.80 61.6 61.4687611
cylinder 510 1.80 54.943 54.81176
cylinder 520 1.80 48.2864 48.15516
cylinder 530 1.80 41.62956 41.49832
cylinder 540 1.80 34.9727 34.84146
cylinder 550 1.80 28.3159 28.18466
cylinder 560 1.80 21.65912 21.52788
cylinder 570 1.80 15.0023 14.84106
cylinder 580 1.80 8.3455 8.21526
cylinder 590 1.80 1.688673 1.60
hexprism 600 3.4 66.1 -4.3
media 1 1 10 -200 -210 -220 -240 -270 -280 -290
media 2 1 20 -10
media 1 1 30 -20 -70
media 5 1 40 -30 -20
media 3 1 50 -20
media 4 1 60 -50 -20
media 1 1 70 -60 -500 -510 -520 -530 -540 -550 -560 -570 -580 -590
media 4 1 500 -60
media 4 1 510 -60
media 4 1 520 -60
media 4 1 530 -60
media 4 1 540 -60
media 4 1 550 -60
media 4 1 560 -60
media 4 1 570 -60
media 4 1 580 -60
media 4 1 590 -60
media 6 1 80 -40
media 7 1 90 -80 -40
media 1 1 100 -40 -90
media 8 1 110 -100 -40
media 1 1 120
media 9 1 130 -120
media 9 1 140 -130
media 1 1 600 -110 -160 -170 -180 -200
media 8 1 160 -300
media 1 1 300 -110
```

```
media 1 1 170 -110 -130 -140
media 9 1 180 -190 -310 -130
media 1 1 190 -130
media 1 1 310
media 12 1 200
media 12 1 210
media 12 1 220 -230
media 9 1 230
media 11 1 240 -250
media 10 1 250
media 9 1 260
media 12 1 270 -260
media 12 1 280
media 12 1 290
boundary 600
unit 3
com='empty lattice position'
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.35 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
hexprism 600 3.4 66.1 -4.3
media 1 1 600 -160 -170 -180 -190 -300
media 1 1 300
media 1 1 170
media 1 1 190
media 1 1 310
media 9 1 160 -300
media 9 1 180 -190 -310
boundary 600
unit 4
com='grid plates outside of grid region'
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
hexprism 600 3.4 66.1 -4.3
media 1 1 600 -160 -170 -180
media 9 1 160
media 1 1 170
media 9 1 180
boundary 600
unit 5
com='central channel'
cylinder 10 2.5 196.7 0.0
cylinder 20 2.2 196.7 0.0
cylinder 30 1.9 196.7 0.0
cylinder 40 1.7 196.7 0.0
cylinder 50 1.5 196.7 0.0
cylinder 60 1.3 196.7 0.0
cylinder 70 1.1 196.7 0.0
cylinder 80 1.05 196.7 0.0
cylinder 90 2.5 0.0 -0.3
hexprism 150 3.4 196.7 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.53 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
hexprism 600 3.4 196.7 -4.3
```

```
media 0 1 80
media 9 1 70 -80
media 1 1  60 -70
media 9 1 50 -60
media 1 1 40 -50
media 9 1 30 -40
media 0 1 20 -30
media 9 1 10 -20
media 1 1 600 -10 -160 -170 -180
media 9 1 160 -300
media 1 1 300 -10
media 1 1 170 -10
media 9 1 180 -190 -310
media 1 1 190
media 1 1 310
boundary 600
global unit 6
cylinder 10 60.0 220.0 0.0
cylinder 20 44.0 125.0 0.0
cylinder 30 42.0 125.0 0.0
cylinder 60 40.5 19.0 0.0
cylinder 70 40.0 19.0 0.0
cylinder 80 1.0 85.8 22.5 origin Y=35.0
cylinder 90 1.0 85.8 22.5 origin Y=17.5 X=30.31
cylinder 100 1.0 85.8 22.5 origin Y=-17.5 X=30.31
cylinder 110 1.0 85.8 22.5 origin Y=-35.0
cylinder 120 1.0 85.8 22.5 origin Y=-17.5 X=-30.31
cylinder 130 1.0 85.8 22.5 origin Y=17.5 X=-30.31
cylinder 140 1.5 220.0 23.0 origin Y=13.7409 X=3.4
cylinder 150 1.2 220. 23.3 origin Y=13.7409 X=3.4
cylinder 160 1.5 220.0 23.0 origin Y=-13.7409 X=-3.4
cylinder 170 1.2 220. 23.3 origin Y=-13.7409 X=-3.4
cylinder 180 1.5 220.0 23.0 origin Y=3.92598 X=13.6
cylinder 190 1.2 220. 23.3 origin Y=3.92598 X=13.6
cylinder 200 1.5 220.0 23.0 origin Y=-3.92598 X=-13.6
cylinder 210 1.2 220. 23.3 origin Y=-3.92598 X=-13.6
cylinder 230 41.0 89.4 19.0
media 1 1 10 -20 -140 -160 -180 -200
media 9 1 20 -30
media 1 1 30 -140 -160 -180 -200 -230 -60
media 9 1 140 -150
media 0 1 150
media 9 1 160 -170
media 0 1 170
media 9 1 180 -190
media 0 1 190
media 9 1 200 -210
media 0 1 210
media 9 1 80
media 9 1 90
media 9 1 100
media 9 1 110
media 9 1 120
media 9 1 130
array 1 230 -80 -90 -100 -110 -120 -130 -140 -160 -180 -200
place 8 8 1 0.0 0.0 23.3
media 9 1 60 -70
media 1 1 70
hole 5 origin Z=23.3
boundary 10
end geom
read array ara=1 typ=hexagonal nux=15 nuy=15 nuz=1
loop
4 1 15 1 1 15 1 1 1 1
```

```
3 8 9 1 3 3 1 1 1 1
1 10 11 1 3 3 1 1 1 1
3 12 13 1 3 3 1 1 1 1
1 7 12 1 4 4 1 1 1 1
3 13 13 1 4 4 1 1 1 1
1 6 13 1 5 5 1 1 1 1
1 5 13 1 6 6 1 1 1 1
3 4 13 1 7 7 1 1 1 1
1 5 12 1 7 7 1 1 1 1
3 3 3 1 8 8 1 1 1 1
1 4 7 1 8 8 1 1 1 1
1 9 12 1 8 8 1 1 1 1
3 13 13 1 8 8 1 1 1 1
3 3 12 1 9 9 1 1 1 1
1 4 11 1 9 9 1 1 1 1
1 3 11 1 10 10 1 1 1 1
1 3 10 1 11 11 1 1 1 1
3 3 3 1 12 12 1 1 1 1
1 4 9 1 12 12 1 1 1 1
3 3 8 1 13 13 1 1 1 1
1 5 6 1 13 13 1 1 1 1
end loop
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-60.0  zul=220.0 xlr=0.0  ylr=60.0  zlr=-0.0
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on bottom plate'
xul=0.0  yul=-22.0  zul=30.0 xlr=0.0  ylr=30.0  zlr=5.0
vax=1 wdn=-1 nax=400  end plt1
ttl='x-y slice at z=50  through core'
xul=-42.0 yul=42.0  zul=50.0 xlr=42.0 ylr=-42.0  zlr=50.0
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=22.0  through lower plate'
xul=-42.0 yul=42.0  zul=22.0 xlr=42.0.0 ylr=-42.0  zlr=22.0
uax=1 vdn=-1 nax=400 end plt4
ttl='x-y slice at z=86.0  through upper plate'
xul=-42.0 yul=42.0  zul=86.0 xlr=42.0.0 ylr=-42.0  zlr=86.0
uax=1 vdn=-1 nax=400 end plt5
ttl='x-y slice at z=50  zoom on fuel pin'
xul=-0.0 yul=4.0  zul=50.0 xlr=8.0 ylr=-4.0  zlr=50.0
uax=1 vdn=-1 nax=400 end plt6
ttl='x-y slice at z=87.9  through core'
xul=-60.0 yul=60.0  zul=87.9 xlr=60.0 ylr=-60.0  zlr=87.90
uax=1 vdn=-1 nax=400 end plt7
ttl='x-z slice at y=0.0 '
xul=-60.0  yul=0.0  zul=220.0 xlr=60.0  ylr=0.0  zlr=-0.0
uax=1 wdn=-1 nax=400  end plt8
ttl='x-z slice at y=0.0 '
xul=0.0  yul=0.0  zul=92.0 xlr=42.0  ylr=0.0  zlr=15.0
uax=1 wdn=-1 nax=400  end plt9
xul=3.4  yul=0.0  zul=25.0 xlr=10.2  ylr=0.0  zlr=18.0
uax=1 wdn=-1 nax=400  end plt10
ttl='x-y slice at z=23.1  zoom on fuel pin'
xul=-0.0 yul=4.0  zul=23.1 xlr=8.0 ylr=-4.0  zlr=23.1
uax=1 vdn=-1 nax=400 end plt11
ttl='x-z slice at y=0.0 '
xul=3.4  yul=0.0  zul=92.0 xlr=10.2  ylr=0.0  zlr=82.0
uax=1 wdn=-1 nax=400  end plt9
end plot
end data
end
=csas26     parm=centrm
ieu-comp-therm-002-004
```

```
238g
read comp
h2o    1 0.9179 324 end
fe     2 0 5.9986e-02 424.0 end
cr     2 0 1.5724e-02 424.0 end
ni     2 0 8.5030e-03 424.0 end
mn     2 0 1.0431e-03 424.0 end
si     2 0 8.5018e-04 424.0 end
ti     2 0 4.7376e-04 424.0 end
c      2 0 4.1748e-04 424.0 end
u-234 3 0 1.6683e-05 424.0 end
u-235 3 0 1.8827e-03 424.0 end
u-238 3 0 9.0594e-03 424.0 end
o      3 0 2.2396e-02 424.0 end
fe     4 0 5.9986e-02 424.0 end
cr     4 0 1.5724e-02 424.0 end
ni     4 0 8.5030e-03 424.0 end
mn     4 0 1.0431e-03 424.0 end
si     4 0 8.5018e-04 424.0 end
ti     4 0 4.7376e-04 424.0 end
c      4 0 4.1748e-04 424.0 end
fe     5 0 5.9986e-02 424.0 end
cr     5 0 1.5724e-02 424.0 end
ni     5 0 8.5030e-03 424.0 end
mn     5 0 1.0431e-03 424.0 end
si     5 0 8.5018e-04 424.0 end
ti     5 0 4.7376e-04 424.0 end
c      5 0 4.1748e-04 424.0 end
u-234 6 0 1.6683e-05 424.0 end
u-235 6 0 1.8827e-03 424.0 end
u-238 6 0 9.0594e-03 424.0 end
o      6 0 2.2396e-02 424.0 end
fe     7 0 5.9986e-02 424.0 end
cr     7 0 1.5724e-02 424.0 end
ni     7 0 8.5030e-03 424.0 end
mn     7 0 1.0431e-03 424.0 end
si     7 0 8.5018e-04 424.0 end
ti     7 0 4.7376e-04 424.0 end
c      7 0 4.1748e-04 424.0 end
fe     8 0 5.9986e-02 424.0 end
cr     8 0 1.5724e-02 424.0 end
ni     8 0 8.5030e-03 424.0 end
mn     8 0 1.0431e-03 424.0 end
si     8 0 8.5018e-04 424.0 end
ti     8 0 4.7376e-04 424.0 end
c      8 0 4.1748e-04 424.0 end
fe     9 0 5.9986e-02 424.0 end
cr     9 0 1.5724e-02 424.0 end
ni     9 0 8.5030e-03 424.0 end
mn     9 0 1.0431e-03 424.0 end
si     9 0 8.5018e-04 424.0 end
ti     9 0 4.7376e-04 424.0 end
c      9 0 4.1748e-04 424.0 end
gd-152 10 0 4.3186e-6 424.0 end
gd-154 10 0 4.7073e-5 424.0 end
gd-155 10 0 3.1958e-4 424.0 end
gd-156 10 0 4.4201e-4 424.0 end
gd-157 10 0 3.3793e-4 424.0 end
gd-158 10 0 5.3637e-4 424.0 end
gd-160 10 0 4.7202e-4 424.0 end
al    10 0 1.4775e-02 424.0 end
o     10 0 2.5401e-02 424.0 end
fe    11 0 5.9986e-02 424.0 end
cr    11 0 1.5724e-02 424.0 end
```

```
ni   11 0 8.5030e-03 424.0 end
mn   11 0 1.0431e-03 424.0 end
si   11 0 8.5018e-04 424.0 end
ti   11 0 4.7376e-04 424.0 end
c    11 0 4.1748e-04 424.0 end
al   12 0 6.0262e-02 424.0 end
h2o  21 0.9179 324 end
h2o  22 0.9179 324 end
h2o  23 0.9179 324 end
end comp
read celldata
multiregion cylindrical right_bdy=white left_bdy=reflected end
10 0.52  11 0.55  1 1.17  2 1.2  3 1.43  4 1.46  21 1.80  5 1.83  6 2.06
7 2.09  22 2.26  8 2.29  23 3.57026 end zone
end celldata
read param npg=4000 gen=550 nsk=50 fdn=yes far=yes flx=yes
tba=5.0 plt=no end param
read geom
unit 1
com='fuel element with absorber rod'
cylinder 10 1.17 64.6 0.0
cylinder 20 1.20 64.6 0.0
cylinder 30 1.80 64.3 0.0
cylinder 40 1.83 64.6 0.0
cylinder 50 1.43 61.6 1.6
cylinder 60 1.46 61.9 1.3
cylinder 70 1.80 61.9 1.3
cylinder 80 2.06 61.6 1.6
cylinder 90 2.09 61.9 1.3
cylinder 100 2.26 64.3 0.0
cylinder 110 2.29 64.6 0.0
cylinder 120 0.15 0.0 -1.3
cone 130 1.17 0.0 0.5 -1.3
cylinder 140 2.29 0.0 -0.3
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.35 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
cylinder 200 0.3 66.1 63.6
cylinder 210 1.15 63.6 63.1
cylinder 220 0.55 63.1 56.6
cylinder 230 0.3 57.6 56.6
cylinder 240 0.55 56.6 6.6
cylinder 250 0.52 55.6 7.6
cylinder 260 0.3 6.6 5.6
cylinder 270 0.55 6.6 2.5
cylinder 280 1.15 2.5 2.0
cylinder 290 0.3 2.0 0.0
cylinder 500 1.80 61.6 61.4687611
cylinder 510 1.80 54.943 54.81176
cylinder 520 1.80 48.2864 48.15516
cylinder 530 1.80 41.62956 41.49832
cylinder 540 1.80 34.9727 34.84146
cylinder 550 1.80 28.3159 28.18466
cylinder 560 1.80 21.65912 21.52788
cylinder 570 1.80 15.0023 14.84106
cylinder 580 1.80 8.3455 8.21526
cylinder 590 1.80 1.688673 1.60
hexprism 600 3.4 66.1 -4.3
media 1 1 10 -200 -210 -220 -240 -270 -280 -290
media 2 1 20 -10
```

```
media 1 1 30 -20 -70
media 5 1 40 -30 -20
media 3 1 50 -20
media 4 1 60 -50 -20
media 1 1 70 -60 -500 -510 -520 -530 -540 -550 -560 -570 -580 -590
media 4 1 500 -60
media 4 1 510 -60
media 4 1 520 -60
media 4 1 530 -60
media 4 1 540 -60
media 4 1 550 -60
media 4 1 560 -60
media 4 1 570 -60
media 4 1 580 -60
media 4 1 590 -60
media 6 1 80 -40
media 7 1 90 -80 -40
media 1 1 100 -40 -90
media 8 1 110 -100 -40
media 1 1 120
media 9 1 130 -120
media 9 1 140 -130
media 1 1 600 -110 -160 -170 -180 -200
media 8 1 160 -300
media 1 1 300 -110
media 1 1 170 -110 -130 -140
media 9 1 180 -190 -310 -130
media 1 1 190 -130
media 1 1 310
media 12 1 200
media 12 1 210
media 12 1 220 -230
media 9 1 230
media 11 1 240 -250
media 10 1 250
media 9 1 260
media 12 1 270 -260
media 12 1 280
media 12 1 290
boundary 600
unit 3
com='empty lattice position'
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.35 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
hexprism 600 3.4 66.1 -4.3
media 1 1 600 -160 -170 -180 -190 -300
media 1 1 300
media 1 1 170
media 1 1 190
media 1 1 310
media 9 1 160 -300
media 9 1 180 -190 -310
boundary 600
unit 4
com='grid plates outside of grid region'
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
```

```
hexprism 600 3.4 66.1 -4.3
media 1 1 600 -160 -170 -180
media 9 1 160
media 1 1 170
media 9 1 180
boundary 600
unit 5
com='central channel'
cylinder 10 2.5 196.7 0.0
cylinder 20 2.2 196.7 0.0
cylinder 30 1.9 196.7 0.0
cylinder 40 1.7 196.7 0.0
cylinder 50 1.5 196.7 0.0
cylinder 60 1.3 196.7 0.0
cylinder 70 1.1 196.7 0.0
cylinder 80 1.05 196.7 0.0
cylinder 90 2.5 0.0 -0.3
hexprism 150 3.4 196.7 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.53 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
hexprism 600 3.4 196.7 -4.3
media 0 1 80
media 9 1 70 -80
media 1 1  60 -70
media 9 1 50 -60
media 1 1 40 -50
media 9 1 30 -40
media 0 1 20 -30
media 9 1 10 -20
media 1 1 600 -10 -160 -170 -180
media 9 1 160 -300
media 1 1 300 -10
media 1 1 170 -10
media 9 1 180 -190 -310
media 1 1 190
media 1 1 310
boundary 600
global unit 6
cylinder 10 60.0 220.0 0.0
cylinder 20 44.0 125.0 0.0
cylinder 30 42.0 125.0 0.0
cylinder 60 40.5 19.0 0.0
cylinder 70 40.0 19.0 0.0
cylinder 80 1.0 85.8 22.5 origin Y=35.0
cylinder 90 1.0 85.8 22.5 origin Y=17.5 X=30.31
cylinder 100 1.0 85.8 22.5 origin Y=-17.5 X=30.31
cylinder 110 1.0 85.8 22.5 origin Y=-35.0
cylinder 120 1.0 85.8 22.5 origin Y=-17.5 X=-30.31
cylinder 130 1.0 85.8 22.5 origin Y=17.5 X=-30.31
cylinder 140 1.5 220.0 23.0 origin Y=13.7409 X=3.4
cylinder 150 1.2 220. 23.3 origin Y=13.7409 X=3.4
cylinder 160 1.5 220.0 23.0 origin Y=-13.7409 X=-3.4
cylinder 170 1.2 220. 23.3 origin Y=-13.7409 X=-3.4
cylinder 180 1.5 220.0 23.0 origin Y=3.92598 X=13.6
cylinder 190 1.2 220. 23.3 origin Y=3.92598 X=13.6
cylinder 200 1.5 220.0 23.0 origin Y=-3.92598 X=-13.6
cylinder 210 1.2 220. 23.3 origin Y=-3.92598 X=-13.6
cylinder 230 41.0 89.4 19.0
media 1 1 10 -20 -140 -160 -180 -200
media 9 1 20 -30
```

```
media 1 1 30 -140 -160 -180 -200 -230 -60
media 9 1 140 -150
media 0 1 150
media 9 1 160 -170
media 0 1 170
media 9 1 180 -190
media 0 1 190
media 9 1 200 -210
media 0 1 210
media 9 1 80
media 9 1 90
media 9 1 100
media 9 1 110
media 9 1 120
media 9 1 130
array 1 230 -80 -90 -100 -110 -120 -130 -140 -160 -180 -200
place 8 8 1 0.0 0.0 23.3
media 9 1 60 -70
media 1 1 70
hole 5 origin Z=23.3
boundary 10
end geom
read array ara=1 typ=hexagonal nux=15 nuy=15 nuz=1
loop
4 1 15 1 1 15 1 1 1 1
3 8 9 1 3 3 1 1 1 1
1 10 11 1 3 3 1 1 1 1
3 12 13 1 3 3 1 1 1 1
1 7 12 1 4 4 1 1 1 1
3 13 13 1 4 4 1 1 1 1
1 6 13 1 5 5 1 1 1 1
1 5 13 1 6 6 1 1 1 1
3 4 13 1 7 7 1 1 1 1
1 5 12 1 7 7 1 1 1 1
3 3 3 1 8 8 1 1 1 1
1 4 7 1 8 8 1 1 1 1
1 9 12 1 8 8 1 1 1 1
3 13 13 1 8 8 1 1 1 1
3 3 12 1 9 9 1 1 1 1
1 4 11 1 9 9 1 1 1 1
1 3 11 1 10 10 1 1 1 1
1 3 10 1 11 11 1 1 1 1
3 3 3 1 12 12 1 1 1 1
1 4 9 1 12 12 1 1 1 1
3 3 8 1 13 13 1 1 1 1
1 5 6 1 13 13 1 1 1 1
end loop
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-60.0  zul=220.0 xlr=0.0  ylr=60.0  zlr=-0.0
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on bottom plate'
xul=0.0  yul=-22.0  zul=30.0 xlr=0.0  ylr=30.0  zlr=5.0
vax=1 wdn=-1 nax=400  end plt1
ttl='x-y slice at z=50  through core'
xul=-42.0 yul=42.0  zul=50.0 xlr=42.0 ylr=-42.0  zlr=50.0
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=22.0  through lower plate'
xul=-42.0 yul=42.0  zul=22.0 xlr=42.0.0 ylr=-42.0  zlr=22.0
uax=1 vdn=-1 nax=400 end plt4
ttl='x-y slice at z=86.0  through upper plate'
xul=-42.0 yul=42.0  zul=86.0 xlr=42.0.0 ylr=-42.0  zlr=86.0
uax=1 vdn=-1 nax=400 end plt5
```

```
ttl='x-y slice at z=50  zoom on fuel pin'
xul=-0.0 yul=4.0  zul=50.0 xlr=8.0 ylr=-4.0  zlr=50.0
uax=1 vdn=-1 nax=400 end plt6
ttl='x-y slice at z=87.9  through core'
xul=-60.0 yul=60.0  zul=87.9 xlr=60.0 ylr=-60.0  zlr=87.90
uax=1 vdn=-1 nax=400 end plt7
ttl='x-z slice at y=0.0 '
xul=-60.0  yul=0.0  zul=220.0 xlr=60.0  ylr=0.0  zlr=-0.0
uax=1 wdn=-1 nax=400  end plt8
ttl='x-z slice at y=0.0 '
xul=0.0  yul=0.0  zul=92.0 xlr=42.0  ylr=0.0  zlr=15.0
uax=1 wdn=-1 nax=400  end plt9
xul=3.4  yul=0.0  zul=25.0 xlr=10.2  ylr=0.0  zlr=18.0
uax=1 wdn=-1 nax=400  end plt10
ttl='x-y slice at z=23.1  zoom on fuel pin'
xul=-0.0 yul=4.0  zul=23.1 xlr=8.0 ylr=-4.0  zlr=23.1
uax=1 vdn=-1 nax=400 end plt11
ttl='x-z slice at y=0.0 '
xul=3.4  yul=0.0  zul=92.0 xlr=10.2  ylr=0.0  zlr=82.0
uax=1 wdn=-1 nax=400  end plt9
end plot
end data
end
=csas26     parm=centrm
ieu-comp-therm-002-005
238g
read comp
h2o   1 0.9179 187.5 end
fe    2 0 5.9986e-02 187.5 end
cr    2 0 1.5724e-02 187.5 end
ni    2 0 8.5030e-03 187.5 end
mn    2 0 1.0431e-03 187.5 end
si    2 0 8.5018e-04 187.5 end
ti    2 0 4.7376e-04 187.5 end
c     2 0 4.1748e-04 187.5 end
u-234 3 0 1.6683e-05 187.5 end
u-235 3 0 1.8827e-03 187.5 end
u-238 3 0 9.0594e-03 187.5 end
o     3 0 2.2396e-02 187.5 end
fe    4 0 5.9986e-02 187.5 end
cr    4 0 1.5724e-02 187.5 end
ni    4 0 8.5030e-03 187.5 end
mn    4 0 1.0431e-03 187.5 end
si    4 0 8.5018e-04 187.5 end
ti    4 0 4.7376e-04 187.5 end
c     4 0 4.1748e-04 187.5 end
fe    5 0 5.9986e-02 187.5 end
cr    5 0 1.5724e-02 187.5 end
ni    5 0 8.5030e-03 187.5 end
mn    5 0 1.0431e-03 187.5 end
si    5 0 8.5018e-04 187.5 end
ti    5 0 4.7376e-04 187.5 end
c     5 0 4.1748e-04 187.5 end
u-234 6 0 1.6683e-05 187.5 end
u-235 6 0 1.8827e-03 187.5 end
u-238 6 0 9.0594e-03 187.5 end
o     6 0 2.2396e-02 187.5 end
fe    7 0 5.9986e-02 187.5 end
cr    7 0 1.5724e-02 187.5 end
ni    7 0 8.5030e-03 187.5 end
mn    7 0 1.0431e-03 187.5 end
si    7 0 8.5018e-04 187.5 end
ti    7 0 4.7376e-04 187.5 end
c     7 0 4.1748e-04 187.5 end
```

```
fe    8 0 5.9986e-02 187.5 end
cr    8 0 1.5724e-02 187.5 end
ni    8 0 8.5030e-03 187.5 end
mn    8 0 1.0431e-03 187.5 end
si    8 0 8.5018e-04 187.5 end
ti    8 0 4.7376e-04 187.5 end
c     8 0 4.1748e-04 187.5 end
fe    9 0 5.9986e-02 187.5 end
cr    9 0 1.5724e-02 187.5 end
ni    9 0 8.5030e-03 187.5 end
mn    9 0 1.0431e-03 187.5 end
si    9 0 8.5018e-04 187.5 end
ti    9 0 4.7376e-04 187.5 end
c     9 0 4.1748e-04 187.5 end
cd   10 0 2.3463e-03 187.5 end
al   10 0 1.4775e-02 187.5 end
o    10 0 2.4508e-02 187.5 end
fe   11 0 5.9986e-02 187.5 end
cr   11 0 1.5724e-02 187.5 end
ni   11 0 8.5030e-03 187.5 end
mn   11 0 1.0431e-03 187.5 end
si   11 0 8.5018e-04 187.5 end
ti   11 0 4.7376e-04 187.5 end
c    11 0 4.1748e-04 187.5 end
al   12 0 6.0262e-02 187.5 end
h2o  21 0.9179 187.5 end
h2o  22 0.9179 187.5 end
h2o  23 0.9179 187.5 end
end comp
read celldata
multiregion cylindrical right_bdy=white left_bdy=reflected end
10 0.52  11 0.55  1 1.17  2 1.2  3 1.43  4 1.46  21 1.80  5 1.83  6 2.06
7 2.09  22 2.26  8 2.29  23 3.57026 end zone
end celldata
read param npg=4000 gen=550 nsk=50 fdn=yes far=yes flx=yes
tba=5.0 plt=no end param
read geom
unit 1
com='fuel element with absorber rod'
cylinder 10 1.17 64.6 0.0
cylinder 20 1.20 64.6 0.0
cylinder 30 1.80 64.3 0.0
cylinder 40 1.83 64.6 0.0
cylinder 50 1.43 61.6 1.6
cylinder 60 1.46 61.9 1.3
cylinder 70 1.80 61.9 1.3
cylinder 80 2.06 61.6 1.6
cylinder 90 2.09 61.9 1.3
cylinder 100 2.26 64.3 0.0
cylinder 110 2.29 64.6 0.0
cylinder 120 0.15 0.0 -1.3
cone 130 1.17 0.0 0.5 -1.3
cylinder 140 2.29 0.0 -0.3
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.35 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
cylinder 200 0.3 66.1 63.6
cylinder 210 1.15 63.6 63.1
cylinder 220 0.55 63.1 56.6
cylinder 230 0.3 57.6 56.6
```

```
cylinder 240 0.55 56.6 6.6
cylinder 250 0.52 55.6 7.6
cylinder 260 0.3 6.6 5.6
cylinder 270 0.55 6.6 2.5
cylinder 280 1.15 2.5 2.0
cylinder 290 0.3 2.0 0.0
cylinder 500 1.80 61.6 61.4687611
cylinder 510 1.80 54.943 54.81176
cylinder 520 1.80 48.2864 48.15516
cylinder 530 1.80 41.62956 41.49832
cylinder 540 1.80 34.9727 34.84146
cylinder 550 1.80 28.3159 28.18466
cylinder 560 1.80 21.65912 21.52788
cylinder 570 1.80 15.0023 14.84106
cylinder 580 1.80 8.3455 8.21526
cylinder 590 1.80 1.688673 1.60
hexprism 600 3.4 66.1 -4.3
media 1 1 10 -200 -210 -220 -240 -270 -280 -290
media 2 1 20 -10
media 1 1 30 -20 -70
media 5 1 40 -30 -20
media 3 1 50 -20
media 4 1 60 -50 -20
media 1 1 70 -60 -500 -510 -520 -530 -540 -550 -560 -570 -580 -590
media 4 1 500 -60
media 4 1 510 -60
media 4 1 520 -60
media 4 1 530 -60
media 4 1 540 -60
media 4 1 550 -60
media 4 1 560 -60
media 4 1 570 -60
media 4 1 580 -60
media 4 1 590 -60
media 6 1 80 -40
media 7 1 90 -80 -40
media 1 1 100 -40 -90
media 8 1 110 -100 -40
media 1 1 120
media 9 1 130 -120
media 9 1 140 -130
media 1 1 600 -110 -160 -170 -180 -200
media 8 1 160 -300
media 1 1 300 -110
media 1 1 170 -110 -130 -140
media 9 1 180 -190 -310 -130
media 1 1 190 -130
media 1 1 310
media 12 1 200
media 12 1 210
media 12 1 220 -230
media 9 1 230
media 11 1 240 -250
media 10 1 250
media 9 1 260
media 12 1 270 -260
media 12 1 280
media 12 1 290
boundary 600
unit 3
com='empty lattice position'
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.35 64.5 62.5
```

```
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
hexprism 600 3.4 66.1 -4.3
media 1 1 600 -160 -170 -180 -190 -300
media 1 1 300
media 1 1 170
media 1 1 190
media 1 1 310
media 9 1 160 -300
media 9 1 180 -190 -310
boundary 600
unit 4
com='grid plates outside of grid region'
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
hexprism 600 3.4 66.1 -4.3
media 1 1 600 -160 -170 -180
media 9 1 160
media 1 1 170
media 9 1 180
boundary 600
unit 5
com='central channel'
cylinder 10 2.5 196.7 0.0
cylinder 20 2.2 196.7 0.0
cylinder 30 1.9 196.7 0.0
cylinder 40 1.7 196.7 0.0
cylinder 50 1.5 196.7 0.0
cylinder 60 1.3 196.7 0.0
cylinder 70 1.1 196.7 0.0
cylinder 80 1.05 196.7 0.0
cylinder 90 2.5 0.0 -0.3
hexprism 150 3.4 196.7 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.53 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
hexprism 600 3.4 196.7 -4.3
media 0 1 80
media 9 1 70 -80
media 1 1  60 -70
media 9 1 50 -60
media 1 1 40 -50
media 9 1 30 -40
media 0 1 20 -30
media 9 1 10 -20
media 1 1 600 -10 -160 -170 -180
media 9 1 160 -300
media 1 1 300 -10
media 1 1 170 -10
media 9 1 180 -190 -310
media 1 1 190
media 1 1 310
boundary 600
global unit 6
cylinder 10 60.0 220.0 0.0
cylinder 20 44.0 125.0 0.0
cylinder 30 42.0 125.0 0.0
```

```
cylinder 60 40.5 19.0 0.0
cylinder 70 40.0 19.0 0.0
cylinder 80 1.0 85.8 22.5 origin Y=35.0
cylinder 90 1.0 85.8 22.5 origin Y=17.5 X=30.31
cylinder 100 1.0 85.8 22.5 origin Y=-17.5 X=30.31
cylinder 110 1.0 85.8 22.5 origin Y=-35.0
cylinder 120 1.0 85.8 22.5 origin Y=-17.5 X=-30.31
cylinder 130 1.0 85.8 22.5 origin Y=17.5 X=-30.31
cylinder 140 1.5 220.0 23.0 origin Y=13.7409 X=3.4
cylinder 150 1.2 220. 23.3 origin Y=13.7409 X=3.4
cylinder 160 1.5 220.0 23.0 origin Y=-13.7409 X=-3.4
cylinder 170 1.2 220. 23.3 origin Y=-13.7409 X=-3.4
cylinder 180 1.5 220.0 23.0 origin Y=3.92598 X=13.6
cylinder 190 1.2 220. 23.3 origin Y=3.92598 X=13.6
cylinder 200 1.5 220.0 23.0 origin Y=-3.92598 X=-13.6
cylinder 210 1.2 220. 23.3 origin Y=-3.92598 X=-13.6
cylinder 230 41.0 89.4 19.0
media 1 1 10 -20 -140 -160 -180 -200
media 9 1 20 -30
media 1 1 30 -140 -160 -180 -200 -230 -60
media 9 1 140 -150
media 0 1 150
media 9 1 160 -170
media 0 1 170
media 9 1 180 -190
media 0 1 190
media 9 1 200 -210
media 0 1 210
media 9 1 80
media 9 1 90
media 9 1 100
media 9 1 110
media 9 1 120
media 9 1 130
array 1 230 -80 -90 -100 -110 -120 -130 -140 -160 -180 -200
place 8 8 1 0.0 0.0 23.3
media 9 1 60 -70
media 1 1 70
hole 5 origin Z=23.3
boundary 10
end geom
read array ara=1 typ=hexagonal nux=15 nuy=15 nuz=1
loop
4 1 15 1 1 15 1 1 1 1
3 8 9 1 3 3 1 1 1 1
1 10 11 1 3 3 1 1 1 1
3 12 13 1 3 3 1 1 1 1
1 7 12 1 4 4 1 1 1 1
3 13 13 1 4 4 1 1 1 1
3 7 7 1 4 4 1 1 1 1
1 6 13 1 5 5 1 1 1 1
3 13 13 1 5 5 1 1 1 1
1 5 13 1 6 6 1 1 1 1
3 5 5 1 6 6 1 1 1 1
3 4 13 1 7 7 1 1 1 1
1 5 12 1 7 7 1 1 1 1
3 3 3 1 8 8 1 1 1 1
1 4 7 1 8 8 1 1 1 1
1 9 12 1 8 8 1 1 1 1
3 13 13 1 8 8 1 1 1 1
3 3 12 1 9 9 1 1 1 1
1 4 11 1 9 9 1 1 1 1
1 3 11 1 10 10 1 1 1 1
3 11 11 1 10 10 1 1 1 1
```

```
1 3 10 1 11 11 1 1 1 1
3 3 3 1 11 11 1 1 1 1
3 3 3 1 12 12 1 1 1 1
1 4 9 1 12 12 1 1 1 1
3 9 9 1 12 12 1 1 1 1
3 3 8 1 13 13 1 1 1 1
1 5 6 1 13 13 1 1 1 1
end loop
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-60.0  zul=220.0 xlr=0.0  ylr=60.0  zlr=-0.0
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on bottom plate'
xul=0.0  yul=-22.0  zul=30.0 xlr=0.0  ylr=30.0  zlr=5.0
vax=1 wdn=-1 nax=400  end plt1
ttl='x-y slice at z=50  through core'
xul=-42.0 yul=42.0  zul=50.0 xlr=42.0 ylr=-42.0  zlr=50.0
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=22.0  through lower plate'
xul=-42.0 yul=42.0  zul=22.0 xlr=42.0.0 ylr=-42.0  zlr=22.0
uax=1 vdn=-1 nax=400 end plt4
ttl='x-y slice at z=86.0  through upper plate'
xul=-42.0 yul=42.0  zul=86.0 xlr=42.0.0 ylr=-42.0  zlr=86.0
uax=1 vdn=-1 nax=400 end plt5
ttl='x-y slice at z=50  zoom on fuel pin'
xul=-0.0 yul=4.0  zul=50.0 xlr=8.0 ylr=-4.0  zlr=50.0
uax=1 vdn=-1 nax=400 end plt6
ttl='x-y slice at z=87.9  through core'
xul=-60.0 yul=60.0  zul=87.9 xlr=60.0 ylr=-60.0  zlr=87.90
uax=1 vdn=-1 nax=400 end plt7
ttl='x-z slice at y=0.0 '
xul=-60.0  yul=0.0  zul=220.0 xlr=60.0  ylr=0.0  zlr=-0.0
uax=1 wdn=-1 nax=400  end plt8
ttl='x-z slice at y=0.0 '
xul=0.0  yul=0.0  zul=92.0 xlr=42.0  ylr=0.0  zlr=15.0
uax=1 wdn=-1 nax=400  end plt9
xul=3.4  yul=0.0  zul=25.0 xlr=10.2  ylr=0.0  zlr=18.0
uax=1 wdn=-1 nax=400  end plt10
ttl='x-y slice at z=23.1  zoom on fuel pin'
xul=-0.0 yul=4.0  zul=23.1 xlr=8.0 ylr=-4.0  zlr=23.1
uax=1 vdn=-1 nax=400 end plt11
ttl='x-z slice at y=0.0 '
xul=3.4  yul=0.0  zul=92.0 xlr=10.2  ylr=0.0  zlr=82.0
uax=1 wdn=-1 nax=400  end plt9
end plot
end data
end
=csas26     parm=centrm
ieu-comp-therm-002-006
238g
read comp
h2o   1 0.9179 423.6 end
fe    2 0 5.9986e-02 423.6 end
cr    2 0 1.5724e-02 423.6 end
ni    2 0 8.5030e-03 423.6 end
mn    2 0 1.0431e-03 423.6 end
si    2 0 8.5018e-04 423.6 end
ti    2 0 4.7376e-04 423.6 end
c     2 0 4.1748e-04 423.6 end
u-234 3 0 1.6683e-05 423.6 end
u-235 3 0 1.8827e-03 423.6 end
u-238 3 0 9.0594e-03 423.6 end
o     3 0 2.2396e-02 423.6 end
```

```
fe    4 0 5.9986e-02 423.6 end
cr    4 0 1.5724e-02 423.6 end
ni    4 0 8.5030e-03 423.6 end
mn    4 0 1.0431e-03 423.6 end
si    4 0 8.5018e-04 423.6 end
ti    4 0 4.7376e-04 423.6 end
c     4 0 4.1748e-04 423.6 end
fe    5 0 5.9986e-02 423.6 end
cr    5 0 1.5724e-02 423.6 end
ni    5 0 8.5030e-03 423.6 end
mn    5 0 1.0431e-03 423.6 end
si    5 0 8.5018e-04 423.6 end
ti    5 0 4.7376e-04 423.6 end
c     5 0 4.1748e-04 423.6 end
u-234 6 0 1.6683e-05 423.6 end
u-235 6 0 1.8827e-03 423.6 end
u-238 6 0 9.0594e-03 423.6 end
o     6 0 2.2396e-02 423.6 end
fe    7 0 5.9986e-02 423.6 end
cr    7 0 1.5724e-02 423.6 end
ni    7 0 8.5030e-03 423.6 end
mn    7 0 1.0431e-03 423.6 end
si    7 0 8.5018e-04 423.6 end
ti    7 0 4.7376e-04 423.6 end
c     7 0 4.1748e-04 423.6 end
fe    8 0 5.9986e-02 423.6 end
cr    8 0 1.5724e-02 423.6 end
ni    8 0 8.5030e-03 423.6 end
mn    8 0 1.0431e-03 423.6 end
si    8 0 8.5018e-04 423.6 end
ti    8 0 4.7376e-04 423.6 end
c     8 0 4.1748e-04 423.6 end
fe    9 0 5.9986e-02 423.6 end
cr    9 0 1.5724e-02 423.6 end
ni    9 0 8.5030e-03 423.6 end
mn    9 0 1.0431e-03 423.6 end
si    9 0 8.5018e-04 423.6 end
ti    9 0 4.7376e-04 423.6 end
c     9 0 4.1748e-04 423.6 end
cd   10 0 2.3463e-03 423.6 end
al   10 0 1.4775e-02 423.6 end
o    10 0 2.4508e-02 423.6 end
fe   11 0 5.9986e-02 423.6 end
cr   11 0 1.5724e-02 423.6 end
ni   11 0 8.5030e-03 423.6 end
mn   11 0 1.0431e-03 423.6 end
si   11 0 8.5018e-04 423.6 end
ti   11 0 4.7376e-04 423.6 end
c    11 0 4.1748e-04 423.6 end
al   12 0 6.0262e-02 423.6 end
h2o  21 0.9179 423.6 end
h2o  22 0.9179 423.6 end
h2o  23 0.9179 423.6 end
end comp
read celldata
multiregion cylindrical right_bdy=white left_bdy=reflected end
10 0.52  11 0.55  1 1.17  2 1.2  3 1.43  4 1.46  21 1.80  5 1.83  6 2.06
7 2.09  22 2.26  8 2.29  23 3.57026 end zone
end celldata
read param npg=4000 gen=550 nsk=50 fdn=yes far=yes flx=yes
tba=5.0 plt=no end param
read geom
unit 1
com='fuel element with absorber rod'
```

```
cylinder 10 1.17 64.6 0.0
cylinder 20 1.20 64.6 0.0
cylinder 30 1.80 64.3 0.0
cylinder 40 1.83 64.6 0.0
cylinder 50 1.43 61.6 1.6
cylinder 60 1.46 61.9 1.3
cylinder 70 1.80 61.9 1.3
cylinder 80 2.06 61.6 1.6
cylinder 90 2.09 61.9 1.3
cylinder 100 2.26 64.3 0.0
cylinder 110 2.29 64.6 0.0
cylinder 120 0.15 0.0 -1.3
cone 130 1.17 0.0 0.5 -1.3
cylinder 140 2.29 0.0 -0.3
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.35 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
cylinder 200 0.3 66.1 63.6
cylinder 210 1.15 63.6 63.1
cylinder 220 0.55 63.1 56.6
cylinder 230 0.3 57.6 56.6
cylinder 240 0.55 56.6 6.6
cylinder 250 0.52 55.6 7.6
cylinder 260 0.3 6.6 5.6
cylinder 270 0.55 6.6 2.5
cylinder 280 1.15 2.5 2.0
cylinder 290 0.3 2.0 0.0
cylinder 500 1.80 61.6 61.4687611
cylinder 510 1.80 54.943 54.81176
cylinder 520 1.80 48.2864 48.15516
cylinder 530 1.80 41.62956 41.49832
cylinder 540 1.80 34.9727 34.84146
cylinder 550 1.80 28.3159 28.18466
cylinder 560 1.80 21.65912 21.52788
cylinder 570 1.80 15.0023 14.84106
cylinder 580 1.80 8.3455 8.21526
cylinder 590 1.80 1.688673 1.60
hexprism 600 3.4 66.1 -4.3
media 1 1 10 -200 -210 -220 -240 -270 -280 -290
media 2 1 20 -10
media 1 1 30 -20 -70
media 5 1 40 -30 -20
media 3 1 50 -20
media 4 1 60 -50 -20
media 1 1 70 -60 -500 -510 -520 -530 -540 -550 -560 -570 -580 -590
media 4 1 500 -60
media 4 1 510 -60
media 4 1 520 -60
media 4 1 530 -60
media 4 1 540 -60
media 4 1 550 -60
media 4 1 560 -60
media 4 1 570 -60
media 4 1 580 -60
media 4 1 590 -60
media 6 1 80 -40
media 7 1 90 -80 -40
media 1 1 100 -40 -90
media 8 1 110 -100 -40
media 1 1 120
```

```
media 9 1 130 -120
media 9 1 140 -130
media 1 1 600 -110 -160 -170 -180 -200
media 8 1 160 -300
media 1 1 300 -110
media 1 1 170 -110 -130 -140
media 9 1 180 -190 -310 -130
media 1 1 190 -130
media 1 1 310
media 12 1 200
media 12 1 210
media 12 1 220 -230
media 9 1 230
media 11 1 240 -250
media 10 1 250
media 9 1 260
media 12 1 270 -260
media 12 1 280
media 12 1 290
boundary 600
unit 3
com='empty lattice position'
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.35 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
hexprism 600 3.4 66.1 -4.3
media 1 1 600 -160 -170 -180 -190 -300
media 1 1 300
media 1 1 170
media 1 1 190
media 1 1 310
media 9 1 160 -300
media 9 1 180 -190 -310
boundary 600
unit 4
com='grid plates outside of grid region'
hexprism 150 3.4 66.1 64.5
hexprism 160 3.4 64.5 62.5
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
hexprism 600 3.4 66.1 -4.3
media 1 1 600 -160 -170 -180
media 9 1 160
media 1 1 170
media 9 1 180
boundary 600
unit 5
com='central channel'
cylinder 10 2.5 196.7 0.0
cylinder 20 2.2 196.7 0.0
cylinder 30 1.9 196.7 0.0
cylinder 40 1.7 196.7 0.0
cylinder 50 1.5 196.7 0.0
cylinder 60 1.3 196.7 0.0
cylinder 70 1.1 196.7 0.0
cylinder 80 1.05 196.7 0.0
cylinder 90 2.5 0.0 -0.3
hexprism 150 3.4 196.7 64.5
hexprism 160 3.4 64.5 62.5
cylinder 300 2.53 64.5 62.5
```

```
hexprism 170 3.4 62.5 -0.8
hexprism 180 3.4 -0.8 -4.3
cylinder 190 0.75 -0.8 -2.8
cylinder 310 2.35 -2.8 -4.3
hexprism 600 3.4 196.7 -4.3
media 0 1 80
media 9 1 70 -80
media 1 1  60 -70
media 9 1 50 -60
media 1 1 40 -50
media 9 1 30 -40
media 0 1 20 -30
media 9 1 10 -20
media 1 1 600 -10 -160 -170 -180
media 9 1 160 -300
media 1 1 300 -10
media 1 1 170 -10
media 9 1 180 -190 -310
media 1 1 190
media 1 1 310
boundary 600
global unit 6
cylinder 10 60.0 220.0 0.0
cylinder 20 44.0 125.0 0.0
cylinder 30 42.0 125.0 0.0
cylinder 60 40.5 19.0 0.0
cylinder 70 40.0 19.0 0.0
cylinder 80 1.0 85.8 22.5 origin Y=35.0
cylinder 90 1.0 85.8 22.5 origin Y=17.5 X=30.31
cylinder 100 1.0 85.8 22.5 origin Y=-17.5 X=30.31
cylinder 110 1.0 85.8 22.5 origin Y=-35.0
cylinder 120 1.0 85.8 22.5 origin Y=-17.5 X=-30.31
cylinder 130 1.0 85.8 22.5 origin Y=17.5 X=-30.31
cylinder 140 1.5 220.0 23.0 origin Y=13.7409 X=3.4
cylinder 150 1.2 220. 23.3 origin Y=13.7409 X=3.4
cylinder 160 1.5 220.0 23.0 origin Y=-13.7409 X=-3.4
cylinder 170 1.2 220. 23.3 origin Y=-13.7409 X=-3.4
cylinder 180 1.5 220.0 23.0 origin Y=3.92598 X=13.6
cylinder 190 1.2 220. 23.3 origin Y=3.92598 X=13.6
cylinder 200 1.5 220.0 23.0 origin Y=-3.92598 X=-13.6
cylinder 210 1.2 220. 23.3 origin Y=-3.92598 X=-13.6
cylinder 230 41.0 89.4 19.0
media 1 1 10 -20 -140 -160 -180 -200
media 9 1 20 -30
media 1 1 30 -140 -160 -180 -200 -230 -60
media 9 1 140 -150
media 0 1 150
media 9 1 160 -170
media 0 1 170
media 9 1 180 -190
media 0 1 190
media 9 1 200 -210
media 0 1 210
media 9 1 80
media 9 1 90
media 9 1 100
media 9 1 110
media 9 1 120
media 9 1 130
array 1 230 -80 -90 -100 -110 -120 -130 -140 -160 -180 -200
place 8 8 1 0.0 0.0 23.3
media 9 1 60 -70
media 1 1 70
hole 5 origin Z=23.3
```

```
boundary 10
end geom
read array ara=1 typ=hexagonal nux=15 nuy=15 nuz=1
loop
4 1 15 1 1 15 1 1 1 1
3 8 9 1 3 3 1 1 1 1
1 10 11 1 3 3 1 1 1 1
3 12 13 1 3 3 1 1 1 1
1 7 12 1 4 4 1 1 1 1
3 13 13 1 4 4 1 1 1 1
3 7 7 1 4 4 1 1 1 1
1 6 13 1 5 5 1 1 1 1
3 13 13 1 5 5 1 1 1 1
1 5 13 1 6 6 1 1 1 1
3 5 5 1 6 6 1 1 1 1
3 4 13 1 7 7 1 1 1 1
1 5 12 1 7 7 1 1 1 1
3 3 3 1 8 8 1 1 1 1
1 4 7 1 8 8 1 1 1 1
1 9 12 1 8 8 1 1 1 1
3 13 13 1 8 8 1 1 1 1
3 3 12 1 9 9 1 1 1 1
1 4 11 1 9 9 1 1 1 1
1 3 11 1 10 10 1 1 1 1
3 11 11 1 10 10 1 1 1 1
1 3 10 1 11 11 1 1 1 1
3 3 3 1 11 11 1 1 1 1
3 3 3 1 12 12 1 1 1 1
1 4 9 1 12 12 1 1 1 1
3 9 9 1 12 12 1 1 1 1
3 3 8 1 13 13 1 1 1 1
1 5 6 1 13 13 1 1 1 1
end loop
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-60.0  zul=220.0 xlr=0.0  ylr=60.0  zlr=-0.0
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on bottom plate'
xul=0.0  yul=-22.0  zul=30.0 xlr=0.0  ylr=30.0  zlr=5.0
vax=1 wdn=-1 nax=400  end plt1
ttl='x-y slice at z=50  through core'
xul=-42.0 yul=42.0  zul=50.0 xlr=42.0 ylr=-42.0  zlr=50.0
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=22.0  through lower plate'
xul=-42.0 yul=42.0  zul=22.0 xlr=42.0.0 ylr=-42.0  zlr=22.0
uax=1 vdn=-1 nax=400 end plt4
ttl='x-y slice at z=86.0  through upper plate'
xul=-42.0 yul=42.0  zul=86.0 xlr=42.0.0 ylr=-42.0  zlr=86.0
uax=1 vdn=-1 nax=400 end plt5
ttl='x-y slice at z=50  zoom on fuel pin'
xul=-0.0 yul=4.0  zul=50.0 xlr=8.0 ylr=-4.0  zlr=50.0
uax=1 vdn=-1 nax=400 end plt6
ttl='x-y slice at z=87.9  through core'
xul=-60.0 yul=60.0  zul=87.9 xlr=60.0 ylr=-60.0  zlr=87.90
uax=1 vdn=-1 nax=400 end plt7
ttl='x-z slice at y=0.0 '
xul=-60.0  yul=0.0  zul=220.0 xlr=60.0  ylr=0.0  zlr=-0.0
uax=1 wdn=-1 nax=400  end plt8
ttl='x-z slice at y=0.0 '
xul=0.0  yul=0.0  zul=92.0 xlr=42.0  ylr=0.0  zlr=15.0
uax=1 wdn=-1 nax=400  end plt9
xul=3.4  yul=0.0  zul=25.0 xlr=10.2  ylr=0.0  zlr=18.0
uax=1 wdn=-1 nax=400  end plt10
```

```
ttl='x-y slice at z=23.1  zoom on fuel pin'
xul=-0.0 yul=4.0  zul=23.1 xlr=8.0 ylr=-4.0  zlr=23.1
uax=1 vdn=-1 nax=400 end plt11
ttl='x-z slice at y=0.0 '
xul=3.4  yul=0.0  zul=92.0 xlr=10.2  ylr=0.0  zlr=82.0
uax=1 wdn=-1 nax=400  end plt9
end plot
end data
end
=csas26            parm=centrm
ieu-sol-therm-001, configuration 1
238group
read comp
u-234 1 0 1.0419e-6 end
u-235 1 0 1.3972e-4 end
u-236 1 0 1.4092e-6 end
u-238 1 0 5.2571e-4 end
h     1 0 6.2040e-2 end
o     1 0 3.5118e-2 end
s     1 0 6.9799e-4 end
h     2 0 6.6735e-2 end
o     2 0 3.3367e-2 end
c     3 0 8.5235e-2 end
b-10  4 0 3.1268e-4 end
b-11  4 0 1.2665e-3 end
c     4 0 3.9354e-2 end
h     4 0 7.8708e-2 end
c     5 0 3.1687e-4 end
si    5 0 1.3551e-3 end
mn    5 0 1.7319e-3 end
cr    5 0 1.6469e-2 end
ni    5 0 8.1061e-3 end
ti    5 0 4.9681e-4 end
s     5 0 2.9669e-5 end
p     5 0 5.3759e-5 end
cu    5 0 2.2460e-4 end
fe    5 0 5.8153e-2 end
end comp
read parm gen=520 npg=4000 nsk=20 tme=900 tba=5.0 end parm
read geom
unit 1
cylinder 1   2.2     2p0.4431
cylinder 2   2.4     2p0.4431
cylinder 3   2.2     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 4   2.4     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 5   2.2     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 6   2.4     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 7   0.3     2p0.4431  origin x=-2.8211  y=10.5286
cylinder 8   0.4     2p0.4431  origin x=-2.8211  y=10.5286
cylinder 10  13.4842 2p0.2659
cylinder 20  14.0159 2p0.2659
cylinder 30  13.3069 2p0.4431
cylinder 40  14.1913 2p0.4431
media 0 1 1
media 5 1 2 -1
media 0 1 3
media 5 1 4 -3
media 0 1 5
media 5 1 6 -5
media 0 1 7
media 5 1 8 -7
media 0 1 30 -1 -2 -3 -4 -5 -6 -7 -8
media 5 1 10 -30
media 2 1 20 -10
```

```
media 5 1 40 -20 -30
boundary 40
unit 2
cylinder 1   2.2     2p0.4431
cylinder 2   2.4     2p0.4431
cylinder 3   2.2     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 4   2.4     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 5   2.2     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 6   2.4     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 7   0.3     2p0.4431  origin x=-2.8211  y=10.5286
cylinder 8   0.4     2p0.4431  origin x=-2.8211  y=10.5286
cylinder 10  13.4842 2p0.2659
cylinder 20  14.0159 2p0.2659
cylinder 30  13.3069 2p0.4431
cylinder 40  14.1913 2p0.4431
media 0 1 1
media 5 1 2 -1
media 0 1 3
media 5 1 4 -3
media 0 1 5
media 5 1 6 -5
media 0 1 7
media 5 1 8 -7
media 1 1 30 -1 -2 -3 -4 -5 -6 -7 -8
media 5 1 10 -30
media 2 1 20 -10
media 5 1 40 -20 -30
boundary 40
unit 3
cylinder 1  0.3   75.4 52.9432 origin x=2.8211  y=-10.5286
cylinder 2  0.4   75.4 52.9432 origin x=2.8211  y=-10.5286
cylinder 4  0.3   75.4 15.25   origin x=-2.8211 y=10.5286
cylinder 5  0.4   75.4 15.25   origin x=-2.8211 y=10.5286
cylinder 10 2.2   75.4 15.25
cylinder 11 2.4   75.4 15.25
cylinder 14 2.2   75.4 15.25   origin x=-5.3033  y=5.3033
cylinder 15 2.4   75.4 15.25   origin x=-5.3033  y=5.3033
cylinder 18 2.2   75.4 15.25   origin x=5.3033   y=-5.3033
cylinder 19 2.4   75.4 15.25   origin x=5.3033   y=-5.3033
cylinder 40 15.25 49.21   15.25
cylinder 20 15.25 65.6    15.25
cylinder 30 15.75 65.6    15.25
cylinder 60 15.75 71.5    15.25
cylinder 31 17.75 79.1    15.25
cylinder 71 5.7 79.1 15.25     origin x=-15.0 y=31.5
cylinder 72 5.7 79.1 15.25     origin x=5.0   y=31.5
cylinder 73 5.7 79.1 15.25     origin x=35.0  y=31.5
cylinder 74 5.7 79.1 15.25     origin x=35.0  y=11.0
cylinder 75 5.7 79.1 15.25     origin x=-62.5 y=28.5
cuboid   80 2p75.0 2p65.0    65.1 15.25
cuboid   81 2p80.0 2p68.3438 65.1 15.25
cuboid   82 2p80.0 2p68.3438 74.1 15.25
cuboid   83 2p80.0 2p68.3438 79.1 15.25
cuboid   84 2p110.0 2p105.0 297.1 15.25
media 2 1 1
media 5 1 2 -1
media 2 1 4
media 5 1 5 -4
media 0 1 10
media 0 1 14
media 0 1 18
media 5 1 11 -10
media 5 1 15 -14
media 5 1 19 -18
```

```
hole 1    origin z=+52.5
hole 1    origin z=+50.5
hole 2    origin z=+48.5
hole 2    origin z=+46.5
hole 2    origin z=+44.5
hole 2    origin z=+42.5
hole 2    origin z=+40.5
hole 2    origin z=+38.5
hole 2    origin z=+36.5
hole 2    origin z=+34.5
hole 2    origin z=+32.5
hole 2    origin z=+30.5
hole 2    origin z=+28.5
hole 2    origin z=+26.5
hole 2    origin z=+24.5
hole 2    origin z=+22.5
hole 2    origin z=+20.5
hole 2    origin z=+18.5
hole 2    origin z=+16.5
media 1 1 40 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 20 -40 -2 -4 -5 -10 -11 -14 -15 -18 -19
media 5 1 30 -20 -40 -4 -5 -10 -11 -14 -15 -18 -19
media 5 1 60 -30 -20 -40 -2 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 31 -60 -30 -20 -40 -2 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 71
media 0 1 72
media 0 1 73
media 0 1 74
media 0 1 75
media 3 1 80 -71 -72 -73 -74 -75 -31 -60 -30 -20 -40 -2 -4 -5
             -10 -11 -14 -15 -18 -19
media 4 1 81 -80 -31 -60 -30 -20 -40 -2 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 82 -81 -80 -71 -72 -73 -74 -75 -31 -60 -30 -20 -40
             -2 -4 -5 -10 -11 -14 -15 -18 -19
media 5 1 83 -82 -81 -80 -71 -72 -73 -74 -75 -31 -60 -30 -20 -40
             -2 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 84 -83 -82 -81 -80 -31 -60 -30 -20 -40 -2 -4 -5 -10 -11
             -14 -15 -18 -19
boundary 84
unit 4
cylinder 91 0.3 15.25 12.0568           origin x=-2.8211 y=10.5286
cylinder 92 0.4 15.25 12.0568           origin x=-2.8211 y=10.5286
cylinder 73 2.2 15.25 5.4
cylinder 74 2.4 15.25 5.4
cylinder 76 2.2 15.25 5.4               origin x=-5.3033 y=5.3033
cylinder 77 2.4 15.25 5.4               origin x=-5.3033 y=5.3033
cylinder 79 2.2 15.25 5.4               origin x=5.3033  y=-5.3033
cylinder 80 2.4 15.25 5.4               origin x=5.3033  y=-5.3033
sphere   82 2.2                         origin z=5.4      chord -z=0.0
sphere   83 2.4                         origin z=5.4      chord -z=0.0
sphere   85 2.2         origin x=-5.3033 y=5.3033  z=5.4  chord -z=0.0
sphere   86 2.4         origin x=-5.3033 y=5.3033  z=5.4  chord -z=0.0
sphere   88 2.2         origin x=5.3033  y=-5.3033 z=5.4  chord -z=0.0
sphere   89 2.4         origin x=5.3033  y=-5.3033 z=5.4  chord -z=0.0
sphere   70 15.25                       origin z=15.25    chord -z=0.0
sphere   90 15.75                       origin z=15.25    chord -z=0.0
cylinder 93 5.7 15.25 -9.9     origin x=-15.0 y=31.5
cylinder 94 5.7 15.25 -9.9     origin x=5.0   y=31.5
cylinder 95 5.7 15.25 -9.9     origin x=35.0  y=31.5
cylinder 96 5.7 15.25 -9.9     origin x=35.0  y=11.0
cylinder 97 5.7 15.25 -44.9    origin x=-62.5 y=28.5
cuboid   98 2p40.0 2p7.0 2p7.0 origin x=40.0 y=-25.0 z=8.1
cuboid   100 2p75.0 2p65.0    15.25 -44.9
cuboid   101 2p80.0 2p68.3438 15.25 -44.9
```

```
cuboid   102 2p80.0 2p68.3438 15.25 -45.3
cuboid   103 2p80.0 2p68.3438 15.25 -54.9
cuboid   104 2p80.0 2p68.3438 15.25 -56.1
cuboid   105 2p110.0 2p105.0  15.25 -77.9
hole 2   origin z=+14.5
hole 2   origin z=+12.5
media 0 1 73
media 5 1 74 -73
media 0 1 76
media 5 1 77 -76
media 0 1 79
media 5 1 80 -79
media 0 1 82 -74 -73
media 5 1 83 -82 -74 -73
media 0 1 85 -77 -76
media 5 1 86 -85 -77 -76
media 0 1 88 -80 -79
media 5 1 89 -88 -80 -79
media 2 1 91
media 5 1 92 -91
media 0 1 93
media 0 1 94
media 0 1 95
media 0 1 96
media 0 1 97
media 0 1 98
media 1 1 70 -73 -74 -76 -77 -79 -80 -83 -86 -89 -91 -92
media 5 1 90 -70
media 3 1 100 -90 -93 -94 -95 -96 -97 -98 -92 -91 -70 -80 -79 -77
          -76 -74 -73
media 4 1 101 -100 -90 -93 -94 -95 -96 -97 -98 -92 -91 -70 -80 -79
          -77 -76 -74 -73
media 5 1 102 -101 -100 -90 -93 -94 -95 -96 -97 -98 -92 -91 -70 -80
          -79 -77 -76 -74 -73
media 0 1 103 -102 -101 -100 -90 -93 -94 -95 -96 -97 -98 -92 -91 -70
          -80 -79 -77 -76 -74 -73
media 5 1 104 -103 -102 -101 -100 -90 -93 -94 -95 -96 -97 -98 -92 -91
          -70 -80 -79 -77 -76 -74 -73
media 0 1 105 -104 -103 -102 -101 -100 -90 -93 -94 -95 -96 -97 -98 -92
          -91 -70 -80 -79 -77 -76 -74 -73
boundary 105
global unit 5
cuboid   10 2p110. 2p105. 297.1 -77.9
array 1 10 place 1 1 1 3*0.0
boundary 10
end geom
read array ara=1 nux=1 nuy=1 nuz=2 fill 4 3 end fill end array
read bounds all=con4 end bounds
read start nst=0 xsm=-10. xsp=10. ysm=-10. ysp=10.
zsm=15.3 zsp=49.1 end start
end data
end
=csas26        parm=centrm
ieu-sol-therm-001, configuration 2
238group
read comp
u-234 1 0 1.5124e-6 end
u-235 1 0 2.0281e-4 end
u-236 1 0 2.0456e-6 end
u-238 1 0 7.6310e-4 end
h     1 0 6.0312e-2 end
o     1 0 3.6063e-2 end
s     1 0 9.9959e-4 end
h     2 0 6.6735e-2 end
```

```
o     2 0 3.3367e-2 end
c     3 0 8.5235e-2 end
b-10  4 0 3.1268e-4 end
b-11  4 0 1.2665e-3 end
c     4 0 3.9354e-2 end
h     4 0 7.8708e-2 end
c     5 0 3.1687e-4 end
si    5 0 1.3551e-3 end
mn    5 0 1.7319e-3 end
cr    5 0 1.6469e-2 end
ni    5 0 8.1061e-3 end
ti    5 0 4.9681e-4 end
s     5 0 2.9669e-5 end
p     5 0 5.3759e-5 end
cu    5 0 2.2460e-4 end
fe    5 0 5.8153e-2 end
end comp
read parm gen=530 npg=4000 nsk=20 tme=900 tba=5.0 end parm
read geom
unit 1
cylinder 1   2.2     2p0.4431
cylinder 2   2.4     2p0.4431
cylinder 3   2.2     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 4   2.4     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 5   2.2     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 6   2.4     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 7   0.3     2p0.4431  origin x=-2.8211  y=10.5286
cylinder 8   0.4     2p0.4431  origin x=-2.8211  y=10.5286
cylinder 10  13.4842 2p0.2659
cylinder 20  14.0159 2p0.2659
cylinder 30  13.3069 2p0.4431
cylinder 40  14.1913 2p0.4431
media 0 1 1
media 5 1 2 -1
media 0 1 3
media 5 1 4 -3
media 0 1 5
media 5 1 6 -5
media 0 1 7
media 5 1 8 -7
media 0 1 30 -1 -2 -3 -4 -5 -6 -7 -8
media 5 1 10 -30
media 2 1 20 -10
media 5 1 40 -20 -30
boundary 40
unit 2
cylinder 1   2.2     2p0.4431
cylinder 2   2.4     2p0.4431
cylinder 3   2.2     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 4   2.4     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 5   2.2     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 6   2.4     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 7   0.3     2p0.4431  origin x=-2.8211  y=10.5286
cylinder 8   0.4     2p0.4431  origin x=-2.8211  y=10.5286
cylinder 10  13.4842 2p0.2659
cylinder 20  14.0159 2p0.2659
cylinder 30  13.3069 2p0.4431
cylinder 40  14.1913 2p0.4431
media 0 1 1
media 5 1 2 -1
media 0 1 3
media 5 1 4 -3
media 0 1 5
media 5 1 6 -5
```

```
media 0 1 7
media 5 1 8 -7
media 1 1 30 -1 -2 -3 -4 -5 -6 -7 -8
media 5 1 10 -30
media 2 1 20 -10
media 5 1 40 -20 -30
boundary 40
unit 3
cylinder 1  0.3   75.4 52.9432 origin x=2.8211  y=-10.5286
cylinder 2  0.4   75.4 52.9432 origin x=2.8211  y=-10.5286
cylinder 4  0.3   75.4 15.25   origin x=-2.8211 y=10.5286
cylinder 5  0.4   75.4 15.25   origin x=-2.8211 y=10.5286
cylinder 10 2.2   75.4 15.25
cylinder 11 2.4   75.4 15.25
cylinder 14 2.2   75.4 15.25   origin x=-5.3033  y=5.3033
cylinder 15 2.4   75.4 15.25   origin x=-5.3033  y=5.3033
cylinder 18 2.2   75.4 15.25   origin x=5.3033   y=-5.3033
cylinder 19 2.4   75.4 15.25   origin x=5.3033   y=-5.3033
cylinder 40 15.25 33.47   15.25
cylinder 20 15.25 65.6    15.25
cylinder 30 15.75 65.6    15.25
cylinder 60 15.75 71.5    15.25
cylinder 31 17.75 79.1    15.25
cylinder 71 5.7 79.1 15.25     origin x=-15.0 y=31.5
cylinder 72 5.7 79.1 15.25     origin x=5.0   y=31.5
cylinder 73 5.7 79.1 15.25     origin x=35.0  y=31.5
cylinder 74 5.7 79.1 15.25     origin x=35.0  y=11.0
cylinder 75 5.7 79.1 15.25     origin x=-62.5 y=28.5
cuboid   80 2p75.0 2p65.0    65.1 15.25
cuboid   81 2p80.0 2p68.3438 65.1 15.25
cuboid   82 2p80.0 2p68.3438 74.1 15.25
cuboid   83 2p80.0 2p68.3438 79.1 15.25
cuboid   84 2p110.0 2p105.0 297.1 15.25
media 2 1 1
media 5 1 2 -1
media 2 1 4
media 5 1 5 -4
media 0 1 10
media 0 1 14
media 0 1 18
media 5 1 11 -10
media 5 1 15 -14
media 5 1 19 -18
hole 1    origin z=+52.5
hole 1    origin z=+50.5
hole 1    origin z=+48.5
hole 1    origin z=+46.5
hole 1    origin z=+44.5
hole 1    origin z=+42.5
hole 1    origin z=+40.5
hole 1    origin z=+38.5
hole 1    origin z=+36.5
hole 1    origin z=+34.5
hole 2    origin z=+32.5
hole 2    origin z=+30.5
hole 2    origin z=+28.5
hole 2    origin z=+26.5
hole 2    origin z=+24.5
hole 2    origin z=+22.5
hole 2    origin z=+20.5
hole 2    origin z=+18.5
hole 2    origin z=+16.5
media 1 1 40 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 20 -40 -2 -4 -5 -10 -11 -14 -15 -18 -19
```

```
media 5 1 30 -20 -40 -4 -5 -10 -11 -14 -15 -18 -19
media 5 1 60 -30 -20 -40 -2 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 31 -60 -30 -20 -40 -2 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 71
media 0 1 72
media 0 1 73
media 0 1 74
media 0 1 75
media 3 1 80 -71 -72 -73 -74 -75 -31 -60 -30 -20 -40 -2 -4 -5
             -10 -11 -14 -15 -18 -19
media 4 1 81 -80 -31 -60 -30 -20 -40 -2 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 82 -81 -80 -71 -72 -73 -74 -75 -31 -60 -30 -20 -40
             -2 -4 -5 -10 -11 -14 -15 -18 -19
media 5 1 83 -82 -81 -80 -71 -72 -73 -74 -75 -31 -60 -30 -20 -40
             -2 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 84 -83 -82 -81 -80 -31 -60 -30 -20 -40 -2 -4 -5 -10 -11
             -14 -15 -18 -19
boundary 84
unit 4
cylinder 91 0.3 15.25 12.0568           origin x=-2.8211 y=10.5286
cylinder 92 0.4 15.25 12.0568           origin x=-2.8211 y=10.5286
cylinder 73 2.2 15.25 5.4
cylinder 74 2.4 15.25 5.4
cylinder 76 2.2 15.25 5.4               origin x=-5.3033 y=5.3033
cylinder 77 2.4 15.25 5.4               origin x=-5.3033 y=5.3033
cylinder 79 2.2 15.25 5.4               origin x=5.3033  y=-5.3033
cylinder 80 2.4 15.25 5.4               origin x=5.3033  y=-5.3033
sphere   82 2.2                         origin z=5.4      chord -z=0.0
sphere   83 2.4                         origin z=5.4      chord -z=0.0
sphere   85 2.2         origin x=-5.3033 y=5.3033  z=5.4  chord -z=0.0
sphere   86 2.4         origin x=-5.3033 y=5.3033  z=5.4  chord -z=0.0
sphere   88 2.2         origin x=5.3033  y=-5.3033 z=5.4  chord -z=0.0
sphere   89 2.4         origin x=5.3033  y=-5.3033 z=5.4  chord -z=0.0
sphere   70 15.25                       origin z=15.25    chord -z=0.0
sphere   90 15.75                       origin z=15.25    chord -z=0.0
cylinder 93 5.7 15.25 -9.9     origin x=-15.0 y=31.5
cylinder 94 5.7 15.25 -9.9     origin x=5.0   y=31.5
cylinder 95 5.7 15.25 -9.9     origin x=35.0  y=31.5
cylinder 96 5.7 15.25 -9.9     origin x=35.0  y=11.0
cylinder 97 5.7 15.25 -44.9    origin x=-62.5 y=28.5
cuboid   98 2p40.0 2p7.0 2p7.0 origin x=40.0 y=-25.0 z=8.1
cuboid   100 2p75.0 2p65.0    15.25 -44.9
cuboid   101 2p80.0 2p68.3438 15.25 -44.9
cuboid   102 2p80.0 2p68.3438 15.25 -45.3
cuboid   103 2p80.0 2p68.3438 15.25 -54.9
cuboid   104 2p80.0 2p68.3438 15.25 -56.1
cuboid   105 2p110.0 2p105.0  15.25 -77.9
hole 2   origin z=+14.5
hole 2   origin z=+12.5
media 0 1 73
media 5 1 74 -73
media 0 1 76
media 5 1 77 -76
media 0 1 79
media 5 1 80 -79
media 0 1 82 -74 -73
media 5 1 83 -82 -74 -73
media 0 1 85 -77 -76
media 5 1 86 -85 -77 -76
media 0 1 88 -80 -79
media 5 1 89 -88 -80 -79
media 2 1 91
media 5 1 92 -91
media 0 1 93
```

```
media 0 1 94
media 0 1 95
media 0 1 96
media 0 1 97
media 0 1 98
media 1 1 70 -73 -74 -76 -77 -79 -80 -83 -86 -89 -91 -92
media 5 1 90 -70
media 3 1 100 -90 -93 -94 -95 -96 -97 -98 -92 -91 -70 -80 -79 -77
          -76 -74 -73
media 4 1 101 -100 -90 -93 -94 -95 -96 -97 -98 -92 -91 -70 -80 -79
          -77 -76 -74 -73
media 5 1 102 -101 -100 -90 -93 -94 -95 -96 -97 -98 -92 -91 -70 -80
          -79 -77 -76 -74 -73
media 0 1 103 -102 -101 -100 -90 -93 -94 -95 -96 -97 -98 -92 -91 -70
          -80 -79 -77 -76 -74 -73
media 5 1 104 -103 -102 -101 -100 -90 -93 -94 -95 -96 -97 -98 -92 -91
          -70 -80 -79 -77 -76 -74 -73
media 0 1 105 -104 -103 -102 -101 -100 -90 -93 -94 -95 -96 -97 -98 -92
          -91 -70 -80 -79 -77 -76 -74 -73
boundary 105
global unit 5
cuboid   10 2p110. 2p105. 297.1 -77.9
array 1 10 place 1 1 1 3*0.0
boundary 10
end geom
read array ara=1 nux=1 nuy=1 nuz=2 fill 4 3 end fill end array
read bounds all=con4 end bounds
read start nst=0 xsm=-10. xsp=10. ysm=-10. ysp=10.
zsm=15.3 zsp=49.1 end start
end data
end
=csas26        parm=centrm
ieu-sol-therm-001, configuration 3
238group
read comp
u-234 1 0 1.5124e-6 end
u-235 1 0 2.0281e-4 end
u-236 1 0 2.0456e-6 end
u-238 1 0 7.6310e-4 end
h     1 0 6.0312e-2 end
o     1 0 3.6063e-2 end
s     1 0 9.9959e-4 end
h     2 0 6.6735e-2 end
o     2 0 3.3367e-2 end
c     3 0 8.5235e-2 end
b-10  4 0 3.1268e-4 end
b-11  4 0 1.2665e-3 end
c     4 0 3.9354e-2 end
h     4 0 7.8708e-2 end
c     5 0 3.1687e-4 end
si    5 0 1.3551e-3 end
mn    5 0 1.7319e-3 end
cr    5 0 1.6469e-2 end
ni    5 0 8.1061e-3 end
ti    5 0 4.9681e-4 end
s     5 0 2.9669e-5 end
p     5 0 5.3759e-5 end
cu    5 0 2.2460e-4 end
fe    5 0 5.8153e-2 end
end comp
read parm gen=520 npg=4000 nsk=20 tme=900 tba=5.0 plt=no end parm
read geom
unit 1
cylinder 1   2.2     2p0.4431
```

```
cylinder 2   2.4     2p0.4431
cylinder 3   2.2     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 4   2.4     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 5   2.2     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 6   2.4     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 7   0.3     2p0.4431  origin x=-2.8211  y=10.5286
cylinder 8   0.4     2p0.4431  origin x=-2.8211  y=10.5286
cylinder 10  13.4842 2p0.2659
cylinder 20  14.0159 2p0.2659
cylinder 30  13.3069 2p0.4431
cylinder 40  14.1913 2p0.4431
media 0 1 1
media 5 1 2 -1
media 0 1 3
media 5 1 4 -3
media 0 1 5
media 5 1 6 -5
media 0 1 7
media 5 1 8 -7
media 0 1 30 -1 -2 -3 -4 -5 -6 -7 -8
media 5 1 10 -30
media 2 1 20 -10
media 5 1 40 -20 -30
boundary 40
unit 2
cylinder 1   2.2     2p0.4431
cylinder 2   2.4     2p0.4431
cylinder 3   2.2     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 4   2.4     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 5   2.2     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 6   2.4     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 7   0.3     2p0.4431  origin x=-2.8211  y=10.5286
cylinder 8   0.4     2p0.4431  origin x=-2.8211  y=10.5286
cylinder 10  13.4842 2p0.2659
cylinder 20  14.0159 2p0.2659
cylinder 30  13.3069 2p0.4431
cylinder 40  14.1913 2p0.4431
media 0 1 1
media 5 1 2 -1
media 0 1 3
media 5 1 4 -3
media 0 1 5
media 5 1 6 -5
media 0 1 7
media 5 1 8 -7
media 1 1 30 -1 -2 -3 -4 -5 -6 -7 -8
media 5 1 10 -30
media 2 1 20 -10
media 5 1 40 -20 -30
boundary 40
unit 3
cylinder 1   2.4     2p0.4431
cylinder 2   2.4     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 3   2.4     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 5   0.4     2p0.4431  origin x=-2.8211 y=10.5286
cylinder 10  13.4842 2p0.2659
cylinder 20  14.0159 2p0.2659
cylinder 30  14.1913 2p0.4431
cylinder 40  13.3069 2p0.4431
cylinder 50  13.3069 -0.3025 -0.4431
cylinder 60  14.1913 2p0.4431
media    5 1 10 -40 -50
media    2 1 20 -10
media    5 1 30 -20 -40
```

```
media    0 1 40 -50
media    1 1 50
media    0 1 60 -30
boundary 60 -1 -2 -3 -5
unit 4
cylinder 1  0.3   75.4 52.9432 origin x=2.8211  y=-10.5286
cylinder 2  0.4   75.4 52.9432 origin x=2.8211  y=-10.5286
cylinder 4  0.3   75.4 15.25   origin x=-2.8211 y=10.5286
cylinder 5  0.4   75.4 15.25   origin x=-2.8211 y=10.5286
cylinder 10 2.2   75.4 15.25
cylinder 11 2.4   75.4 15.25
cylinder 14 2.2   75.4 15.25   origin x=-5.3033  y=5.3033
cylinder 15 2.4   75.4 15.25   origin x=-5.3033  y=5.3033
cylinder 18 2.2   75.4 15.25   origin x=5.3033   y=-5.3033
cylinder 19 2.4   75.4 15.25   origin x=5.3033   y=-5.3033
cylinder 40 15.25 32.20   15.25
cylinder 20 15.25 65.8    15.25
cylinder 30 15.55 65.8    15.25
cylinder 60 15.55 71.7    15.25
cylinder 31 17.75 79.1    15.25
cylinder 71 5.7 79.1 15.25     origin x=-15.0 y=31.5
cylinder 72 5.7 79.1 15.25     origin x=5.0   y=31.5
cylinder 73 5.7 79.1 15.25     origin x=35.0  y=31.5
cylinder 74 5.7 79.1 15.25     origin x=35.0  y=11.0
cylinder 75 5.7 79.1 15.25     origin x=-62.5 y=28.5
cuboid   80 2p75.0 2p65.0    65.1 15.25
cuboid   81 2p80.0 2p68.3438 65.1 15.25
cuboid   82 2p80.0 2p68.3438 74.1 15.25
cuboid   83 2p80.0 2p68.3438 79.1 15.25
cuboid   84 2p110.0 2p105.0 297.1 15.25
media 2 1 1
media 5 1 2 -1
media 2 1 4
media 5 1 5 -4
media 0 1 10
media 0 1 14
media 0 1 18
media 5 1 11 -10
media 5 1 15 -14
media 5 1 19 -18
hole 1    origin z=+52.5
hole 1    origin z=+50.5
hole 1    origin z=+48.5
hole 1    origin z=+46.5
hole 1    origin z=+44.5
hole 1    origin z=+42.5
hole 1    origin z=+40.5
hole 1    origin z=+38.5
hole 1    origin z=+36.5
hole 1    origin z=+34.5
hole 3    origin z=+32.5
hole 2    origin z=+30.5
hole 2    origin z=+28.5
hole 2    origin z=+26.5
hole 2    origin z=+24.5
hole 2    origin z=+22.5
hole 2    origin z=+20.5
hole 2    origin z=+18.5
hole 2    origin z=+16.5
media 1 1 40 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 20 -40 -2 -4 -5 -10 -11 -14 -15 -18 -19
media 5 1 30 -20 -40 -4 -5 -10 -11 -14 -15 -18 -19
media 5 1 60 -30 -20 -40 -2 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 31 -60 -30 -20 -40 -2 -4 -5 -10 -11 -14 -15 -18 -19
```

```
media 0 1 71
media 0 1 72
media 0 1 73
media 0 1 74
media 0 1 75
media 3 1 80 -71 -72 -73 -74 -75 -31 -60 -30 -20 -40 -2 -4 -5
             -10 -11 -14 -15 -18 -19
media 4 1 81 -80 -31 -60 -30 -20 -40 -2 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 82 -81 -80 -71 -72 -73 -74 -75 -31 -60 -30 -20 -40
             -2 -4 -5 -10 -11 -14 -15 -18 -19
media 5 1 83 -82 -81 -80 -71 -72 -73 -74 -75 -31 -60 -30 -20 -40
             -2 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 84 -83 -82 -81 -80 -31 -60 -30 -20 -40 -2 -4 -5 -10 -11
             -14 -15 -18 -19
boundary 84
unit 5
cylinder 91 0.3 15.25 12.0568           origin x=-2.8211 y=10.5286
cylinder 92 0.4 15.25 12.0568           origin x=-2.8211 y=10.5286
cylinder 73 2.2 15.25 5.4
cylinder 74 2.4 15.25 5.4
cylinder 76 2.2 15.25 5.4               origin x=-5.3033 y=5.3033
cylinder 77 2.4 15.25 5.4               origin x=-5.3033 y=5.3033
cylinder 79 2.2 15.25 5.4               origin x=5.3033  y=-5.3033
cylinder 80 2.4 15.25 5.4               origin x=5.3033  y=-5.3033
sphere   82 2.2                         origin z=5.4      chord -z=0.0
sphere   83 2.4                         origin z=5.4      chord -z=0.0
sphere   85 2.2         origin x=-5.3033 y=5.3033  z=5.4  chord -z=0.0
sphere   86 2.4         origin x=-5.3033 y=5.3033  z=5.4  chord -z=0.0
sphere   88 2.2         origin x=5.3033  y=-5.3033 z=5.4  chord -z=0.0
sphere   89 2.4         origin x=5.3033  y=-5.3033 z=5.4  chord -z=0.0
sphere   70 15.25                       origin z=15.25    chord -z=0.0
sphere   90 15.55                       origin z=15.25    chord -z=0.0
cylinder 93 5.7 15.25 -9.9     origin x=-15.0 y=31.5
cylinder 94 5.7 15.25 -9.9     origin x=5.0   y=31.5
cylinder 95 5.7 15.25 -9.9     origin x=35.0  y=31.5
cylinder 96 5.7 15.25 -9.9     origin x=35.0  y=11.0
cylinder 97 5.7 15.25 -44.9    origin x=-62.5 y=28.5
cuboid   98 2p40.0 2p7.0 2p7.0 origin x=40.0 y=-25.0 z=8.1
cuboid   100 2p75.0 2p65.0    15.25 -44.9
cuboid   101 2p80.0 2p68.3438 15.25 -44.9
cuboid   102 2p80.0 2p68.3438 15.25 -45.3
cuboid   103 2p80.0 2p68.3438 15.25 -54.9
cuboid   104 2p80.0 2p68.3438 15.25 -56.1
cuboid   105 2p110.0 2p105.0  15.25 -77.9
hole 2   origin z=+14.5
hole 2   origin z=+12.5
media 0 1 73
media 5 1 74 -73
media 0 1 76
media 5 1 77 -76
media 0 1 79
media 5 1 80 -79
media 0 1 82 -74 -73
media 5 1 83 -82 -74 -73
media 0 1 85 -77 -76
media 5 1 86 -85 -77 -76
media 0 1 88 -80 -79
media 5 1 89 -88 -80 -79
media 2 1 91
media 5 1 92 -91
media 0 1 93
media 0 1 94
media 0 1 95
media 0 1 96
```

```
media 0 1 97
media 0 1 98
media 1 1 70 -73 -74 -76 -77 -79 -80 -83 -86 -89 -91 -92
media 5 1 90 -70
media 3 1 100 -90 -93 -94 -95 -96 -97 -98 -92 -91 -70 -80 -79 -77
          -76 -74 -73
media 4 1 101 -100 -90 -93 -94 -95 -96 -97 -98 -92 -91 -70 -80 -79
          -77 -76 -74 -73
media 5 1 102 -101 -100 -90 -93 -94 -95 -96 -97 -98 -92 -91 -70 -80
          -79 -77 -76 -74 -73
media 0 1 103 -102 -101 -100 -90 -93 -94 -95 -96 -97 -98 -92 -91 -70
          -80 -79 -77 -76 -74 -73
media 5 1 104 -103 -102 -101 -100 -90 -93 -94 -95 -96 -97 -98 -92 -91
          -70 -80 -79 -77 -76 -74 -73
media 0 1 105 -104 -103 -102 -101 -100 -90 -93 -94 -95 -96 -97 -98 -92
          -91 -70 -80 -79 -77 -76 -74 -73
boundary 105
global unit 6
cuboid   10 2p110. 2p105. 297.1 -77.9
array 1 10 place 1 1 1 3*0.0
boundary 10
end geom
read array ara=1 nux=1 nuy=1 nuz=2 fill 5 4 end fill end array
read bounds all=con4 end bounds
read plot
scr=yes
ttl='x-z slice #1 at y=0'
xul=-25. yul=0. zul=79.5 xlr=25. ylr=0. zlr=-20.
uax=1.0 wdn=-1.0 nax=480 end
end plot
read start nst=0 xsm=-10. xsp=10. ysm=-10. ysp=10.
zsm=15.3 zsp=49.1 end start
end data
end
•
=csas26      parm=centrm
ieu-sol-therm-001, configuration 4
238group
read comp
u-234 1 0 1.9983e-6 end
u-235 1 0 2.6798e-4 end
u-236 1 0 2.7028e-6 end
u-238 1 0 1.0083e-3 end
h     1 0 5.8250e-2 end
o     1 0 3.6901e-2 end
s     1 0 1.3111e-3 end
h     2 0 6.6735e-2 end
o     2 0 3.3367e-2 end
c     3 0 8.5235e-2 end
b-10  4 0 3.1268e-4 end
b-11  4 0 1.2665e-3 end
c     4 0 3.9354e-2 end
h     4 0 7.8708e-2 end
c     5 0 3.1687e-4 end
si    5 0 1.3551e-3 end
mn    5 0 1.7319e-3 end
cr    5 0 1.6469e-2 end
ni    5 0 8.1061e-3 end
ti    5 0 4.9681e-4 end
s     5 0 2.9669e-5 end
p     5 0 5.3759e-5 end
cu    5 0 2.2460e-4 end
fe    5 0 5.8153e-2 end
end comp
```

```
read parm gen=520 npg=4000 nsk=20 tme=900 tba=5.0 end parm
read geom
unit 1
cylinder 1   2.2     2p0.4431
cylinder 2   2.4     2p0.4431
cylinder 3   2.2     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 4   2.4     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 5   2.2     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 6   2.4     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 7   0.3     2p0.4431  origin x=-2.8211  y=10.5286
cylinder 8   0.4     2p0.4431  origin x=-2.8211  y=10.5286
cylinder 10  13.4842 2p0.2659
cylinder 20  14.0159 2p0.2659
cylinder 30  13.3069 2p0.4431
cylinder 40  14.1913 2p0.4431
media 0 1 1
media 5 1 2 -1
media 0 1 3
media 5 1 4 -3
media 0 1 5
media 5 1 6 -5
media 0 1 7
media 5 1 8 -7
media 0 1 30 -1 -2 -3 -4 -5 -6 -7 -8
media 5 1 10 -30
media 2 1 20 -10
media 5 1 40 -20 -30
boundary 40
unit 2
cylinder 1   2.2     2p0.4431
cylinder 2   2.4     2p0.4431
cylinder 3   2.2     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 4   2.4     2p0.4431  origin x=-5.3033  y=5.3033
cylinder 5   2.2     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 6   2.4     2p0.4431  origin x=5.3033   y=-5.3033
cylinder 7   0.3     2p0.4431  origin x=-2.8211  y=10.5286
cylinder 8   0.4     2p0.4431  origin x=-2.8211  y=10.5286
cylinder 10  13.4842 2p0.2659
cylinder 20  14.0159 2p0.2659
cylinder 30  13.3069 2p0.4431
cylinder 40  14.1913 2p0.4431
media 0 1 1
media 5 1 2 -1
media 0 1 3
media 5 1 4 -3
media 0 1 5
media 5 1 6 -5
media 0 1 7
media 5 1 8 -7
media 1 1 30 -1 -2 -3 -4 -5 -6 -7 -8
media 5 1 10 -30
media 2 1 20 -10
media 5 1 40 -20 -30
boundary 40
unit 3
cylinder 1  0.3   75.4 52.9432 origin x=2.8211  y=-10.5286
cylinder 2  0.4   75.4 52.9432 origin x=2.8211  y=-10.5286
cylinder 4  0.3   75.4 15.25   origin x=-2.8211 y=10.5286
cylinder 5  0.4   75.4 15.25   origin x=-2.8211 y=10.5286
cylinder 10 2.2   75.4 15.25
cylinder 11 2.4   75.4 15.25
cylinder 14 2.2   75.4 15.25   origin x=-5.3033  y=5.3033
cylinder 15 2.4   75.4 15.25   origin x=-5.3033  y=5.3033
cylinder 18 2.2   75.4 15.25   origin x=5.3033   y=-5.3033
```

```
cylinder 19 2.4   75.4 15.25   origin x=5.3033   y=-5.3033
cylinder 40 15.25 29.05   15.25
cylinder 20 15.25 65.6    15.25
cylinder 30 15.75 65.6    15.25
cylinder 60 15.75 71.5    15.25
cylinder 31 17.75 79.1    15.25
cylinder 71 5.7 79.1 15.25     origin x=-15.0 y=31.5
cylinder 72 5.7 79.1 15.25     origin x=5.0   y=31.5
cylinder 73 5.7 79.1 15.25     origin x=35.0  y=31.5
cylinder 74 5.7 79.1 15.25     origin x=35.0  y=11.0
cylinder 75 5.7 79.1 15.25     origin x=-62.5 y=28.5
cuboid   80 2p75.0 2p65.0    65.1 15.25
cuboid   81 2p80.0 2p68.3438 65.1 15.25
cuboid   82 2p80.0 2p68.3438 74.1 15.25
cuboid   83 2p80.0 2p68.3438 79.1 15.25
cuboid   84 2p110.0 2p105.0 297.1 15.25
media 2 1 1
media 5 1 2 -1
media 2 1 4
media 5 1 5 -4
media 0 1 10
media 0 1 14
media 0 1 18
media 5 1 11 -10
media 5 1 15 -14
media 5 1 19 -18
hole 1    origin z=+52.5
hole 1    origin z=+50.5
hole 1    origin z=+48.5
hole 1    origin z=+46.5
hole 1    origin z=+44.5
hole 1    origin z=+42.5
hole 1    origin z=+40.5
hole 1    origin z=+38.5
hole 1    origin z=+36.5
hole 1    origin z=+34.5
hole 1    origin z=+32.5
hole 1    origin z=+30.5
hole 2    origin z=+28.5
hole 2    origin z=+26.5
hole 2    origin z=+24.5
hole 2    origin z=+22.5
hole 2    origin z=+20.5
hole 2    origin z=+18.5
hole 2    origin z=+16.5
media 1 1 40 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 20 -40 -2 -4 -5 -10 -11 -14 -15 -18 -19
media 5 1 30 -20 -40 -4 -5 -10 -11 -14 -15 -18 -19
media 5 1 60 -30 -20 -40 -2 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 31 -60 -30 -20 -40 -2 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 71
media 0 1 72
media 0 1 73
media 0 1 74
media 0 1 75
media 3 1 80 -71 -72 -73 -74 -75 -31 -60 -30 -20 -40 -2 -4 -5
             -10 -11 -14 -15 -18 -19
media 4 1 81 -80 -31 -60 -30 -20 -40 -2 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 82 -81 -80 -71 -72 -73 -74 -75 -31 -60 -30 -20 -40
             -2 -4 -5 -10 -11 -14 -15 -18 -19
media 5 1 83 -82 -81 -80 -71 -72 -73 -74 -75 -31 -60 -30 -20 -40
             -2 -4 -5 -10 -11 -14 -15 -18 -19
media 0 1 84 -83 -82 -81 -80 -31 -60 -30 -20 -40 -2 -4 -5 -10 -11
             -14 -15 -18 -19
```

```
boundary 84
unit 4
cylinder 91 0.3 15.25 12.0568           origin x=-2.8211 y=10.5286
cylinder 92 0.4 15.25 12.0568           origin x=-2.8211 y=10.5286
cylinder 73 2.2 15.25 5.4
cylinder 74 2.4 15.25 5.4
cylinder 76 2.2 15.25 5.4               origin x=-5.3033 y=5.3033
cylinder 77 2.4 15.25 5.4               origin x=-5.3033 y=5.3033
cylinder 79 2.2 15.25 5.4               origin x=5.3033  y=-5.3033
cylinder 80 2.4 15.25 5.4               origin x=5.3033  y=-5.3033
sphere   82 2.2                         origin z=5.4      chord -z=0.0
sphere   83 2.4                         origin z=5.4      chord -z=0.0
sphere   85 2.2         origin x=-5.3033 y=5.3033  z=5.4  chord -z=0.0
sphere   86 2.4         origin x=-5.3033 y=5.3033  z=5.4  chord -z=0.0
sphere   88 2.2         origin x=5.3033  y=-5.3033 z=5.4  chord -z=0.0
sphere   89 2.4         origin x=5.3033  y=-5.3033 z=5.4  chord -z=0.0
sphere   70 15.25                       origin z=15.25    chord -z=0.0
sphere   90 15.75                       origin z=15.25    chord -z=0.0
cylinder 93 5.7 15.25 -9.9     origin x=-15.0 y=31.5
cylinder 94 5.7 15.25 -9.9     origin x=5.0   y=31.5
cylinder 95 5.7 15.25 -9.9     origin x=35.0  y=31.5
cylinder 96 5.7 15.25 -9.9     origin x=35.0  y=11.0
cylinder 97 5.7 15.25 -44.9    origin x=-62.5 y=28.5
cuboid   98 2p40.0 2p7.0 2p7.0 origin x=40.0 y=-25.0 z=8.1
cuboid   100 2p75.0 2p65.0    15.25 -44.9
cuboid   101 2p80.0 2p68.3438 15.25 -44.9
cuboid   102 2p80.0 2p68.3438 15.25 -45.3
cuboid   103 2p80.0 2p68.3438 15.25 -54.9
cuboid   104 2p80.0 2p68.3438 15.25 -56.1
cuboid   105 2p110.0 2p105.0  15.25 -77.9
hole 2   origin z=+14.5
hole 2   origin z=+12.5
media 0 1 73
media 5 1 74 -73
media 0 1 76
media 5 1 77 -76
media 0 1 79
media 5 1 80 -79
media 0 1 82 -74 -73
media 5 1 83 -82 -74 -73
media 0 1 85 -77 -76
media 5 1 86 -85 -77 -76
media 0 1 88 -80 -79
media 5 1 89 -88 -80 -79
media 2 1 91
media 5 1 92 -91
media 0 1 93
media 0 1 94
media 0 1 95
media 0 1 96
media 0 1 97
media 0 1 98
media 1 1 70 -73 -74 -76 -77 -79 -80 -83 -86 -89 -91 -92
media 5 1 90 -70
media 3 1 100 -90 -93 -94 -95 -96 -97 -98 -92 -91 -70 -80 -79 -77
          -76 -74 -73
media 4 1 101 -100 -90 -93 -94 -95 -96 -97 -98 -92 -91 -70 -80 -79
          -77 -76 -74 -73
media 5 1 102 -101 -100 -90 -93 -94 -95 -96 -97 -98 -92 -91 -70 -80
          -79 -77 -76 -74 -73
media 0 1 103 -102 -101 -100 -90 -93 -94 -95 -96 -97 -98 -92 -91 -70
          -80 -79 -77 -76 -74 -73
media 5 1 104 -103 -102 -101 -100 -90 -93 -94 -95 -96 -97 -98 -92 -91
          -70 -80 -79 -77 -76 -74 -73
```

```
media 0 1 105 -104 -103 -102 -101 -100 -90 -93 -94 -95 -96 -97 -98 -92
          -91 -70 -80 -79 -77 -76 -74 -73
boundary 105
global unit 5
cuboid   10 2p110. 2p105. 297.1 -77.9
array 1 10 place 1 1 1 3*0.0
boundary 10
end geom
read array ara=1 nux=1 nuy=1 nuz=2 fill 4 3 end fill end array
read bounds all=con4 end bounds
read start nst=0 xsm=-10. xsp=10. ysm=-10. ysp=10.
zsm=15.3 zsp=49.1 end start
end data
end •
```

APPENDIX C

LEU BENCHMARK CASES

APPENDIX C
LEU BENCHMARK CASES

```
=csas26        parm=centrm
LEU-COMP-THERM-031, Case #1
238g   lat
u-234 1 0 6.3924e-6 end
u-235 1 0 1.0432e-3 end
u-236 1 0 6.3924e-6 end
u-238 1 0 1.9565e-2 end
o     1 0 4.1241e-2 end
zr    2 0 4.2071e-2 end
nb    2 0 4.1743e-4 end
h     3 0 6.6736e-2 end
o     3 0 3.3368e-2 end
al    4 0 5.6526e-2 end
fe    4 0 2.0380e-4 end
cu    4 0 1.1003e-3 end
mg    4 0 4.0139e-4 end
mn    4 0 1.7758e-4 end
c     5 0 1.0028e-3 end
si    5 0 2.9161e-4 end
al    5 0 1.7855e-4 end
fe    5 0 8.5276e-2 end
mn    5 0 1.2277e-4 end
ti    5 0 4.6285e-4 end
end comp
triangpitch 0.8 0.46 1 3 0.61 2 end
read param run=yes gen=520 npg=4000 nsk=20 tba=10.0  end param
read geom
unit 1
cylinder 10  0.155 29.83  -29.83
cylinder 20  0.155 30.17  -29.83
cylinder 30  0.155 32.17  -31.83
cylinder 40  0.23  29.83  -29.83
cylinder 50  0.23  31.595 -31.255
cylinder 60  0.23  32.17  -31.83
cylinder 70  0.305 31.67  -31.33
hexprism 80  0.4  -30.83  -31.33
hexprism 90  0.4   30.17   29.17
hexprism 100 0.4    3.93  -31.83
hexprism 110 0.4   32.17    3.93
hexprism 120 0.4   32.17  -31.83
media 1 1 10
media 0 1 20 -10
media 2 1 30 -20 -10
media 1 1 40 -30 -20 -10
media 0 1 50 -40 -30 -20 -10
media 2 1 60 -50 -40 -30 -20 -10
media 2 1 70 -60 -50 -40 -30 -20 -10
media 4 1 80 -70 -60 -40 -30 -20
media 4 1 90 -70 -60 -50 -30 -20
media 3 1 100 -80 -70 -60 -50 -40 -30 -20 -10
media 0 1 110 -100 -90 -70 -60 -50 -40 -30 -20 -10
media 0 1 120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
boundary 120
unit 2
hexprism 10  0.4   32.17    3.93
hexprism 20  0.4   32.17  -31.83
hexprism 30  0.4   32.17  -31.83
media 0 1 10
```

```
media 3 1 20 -10
media 0 1 30 -20 -10
boundary 30
global unit 3
cylinder 10 26.5   32.17  -31.83
array 1 10 place 39 39 1 0 0 0
cylinder 20 66.5  -31.83  -35.33
cylinder 30 66.5  -30.83  -31.33
cylinder 40 66.5    3.93  -75.33
cylinder 50 66.5   30.17   29.17
cylinder 60 66.5   32.17    3.93
cylinder 70 66.5   32.17  -75.33
media 5 1  20 -10
media 4 1  30 -20 -10
media 3 1  40 -30 -20 -10
media 4 1  50 -10
media 0 1  60 -50 -40 -10
media 0 1  70 -60 -40
boundary 70
end geom
read array
gbl=1 typ=triangular nux=77 nuy=77 nuz=1 fill
154r2
51r2 11r1 15r2
46r2 20r1 11r2
42r2 27r1  8r2
39r2 32r1  6r2
37r2 35r1  5r2
36r2 36r1  5r2
34r2 39r1  4r2
33r2 40r1  4r2
32r2 41r1  4r2
30r2 44r1  3r2
29r2 45r1  3r2
28r2 46r1  3r2
26r2 49r1  2r2
25r2 50r1  2r2
24r2 51r1  2r2
23r2 52r1  2r2
22r2 53r1  2r2
21r2 54r1  2r2
20r2 55r1  2r2
19r2 56r1  2r2
18r2 57r1  2r2
17r2 58r1  2r2
16r2 59r1  2r2
15r2 60r1  2r2
14r2 61r1  2r2
14r2 60r1  3r2
13r2 61r1  3r2
12r2 62r1  3r2
11r2 63r1  3r2
11r2 62r1  4r2
10r2 63r1  4r2
 9r2 64r1  4r2
 8r2 65r1  4r2
 8r2 64r1  5r2
 7r2 65r1  5r2
 6r2 66r1  5r2
 6r2 65r1  6r2
 5r2 66r1  6r2
 5r2 65r1  7r2
 5r2 64r1  8r2
 4r2 65r1  8r2
```

```
 4r2 64r1  9r2
 4r2 63r1 10r2
 4r2 62r1 11r2
 3r2 63r1 11r2
 3r2 62r1 12r2
 3r2 61r1 13r2
 3r2 60r1 14r2
 2r2 61r1 14r2
 2r2 60r1 15r2
 2r2 59r1 16r2
 2r2 58r1 17r2
 2r2 57r1 18r2
 2r2 56r1 19r2
 2r2 55r1 20r2
 2r2 54r1 21r2
 2r2 53r1 22r2
 2r2 52r1 23r2
 2r2 51r1 24r2
 2r2 50r1 25r2
 2r2 49r1 26r2
 3r2 46r1 28r2
 3r2 45r1 29r2
 3r2 44r1 30r2
 4r2 41r1 32r2
 4r2 40r1 33r2
 4r2 39r1 34r2
 5r2 36r1 36r2
 5r2 35r1 37r2
 6r2 32r1 39r2
 8r2 27r1 42r2
11r2 20r1 46r2
15r2 11r1 51r2
154r2  end fill
end array
read start nst=1 xsm=-26.5 xsp=26.5 ysm=-26.5 ysp=26.5
zsm=-31.83 zsp=32.17 rfl=no end start
end data
end
•
=csas26        parm=centrm
LEU-COMP-THERM-031, Case #2
238g   lat
u-234 1 0 6.3924e-6 end
u-235 1 0 1.0432e-3 end
u-236 1 0 6.3924e-6 end
u-238 1 0 1.9565e-2 end
o     1 0 4.1241e-2 end
zr    2 0 4.2071e-2 end
nb    2 0 4.1743e-4 end
h     3 0 6.6736e-2 end
o     3 0 3.3368e-2 end
al    4 0 5.6526e-2 end
fe    4 0 2.0380e-4 end
cu    4 0 1.1003e-3 end
mg    4 0 4.0139e-4 end
mn    4 0 1.7758e-4 end
c     5 0 1.0028e-3 end
si    5 0 2.9161e-4 end
al    5 0 1.7855e-4 end
fe    5 0 8.5276e-2 end
mn    5 0 1.2277e-4 end
ti    5 0 4.6285e-4 end
end comp
triangpitch 0.8 0.46 1 3 0.61 2 end
```

```
read param run=yes gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
unit 1
cylinder 10  0.155 29.83  -29.83
cylinder 20  0.155 30.17  -29.83
cylinder 30  0.155 32.17  -31.83
cylinder 40  0.23  29.83  -29.83
cylinder 50  0.23  31.595 -31.255
cylinder 60  0.23  32.17  -31.83
cylinder 70  0.305 31.67  -31.33
hexprism 80  0.4  -30.83  -31.33
hexprism 90  0.4   30.17   29.17
hexprism 100 0.4    4.66  -31.83
hexprism 110 0.4   32.17    4.66
hexprism 120 0.4   32.17  -31.83
media 1 1 10
media 0 1 20 -10
media 2 1 30 -20 -10
media 1 1 40 -30 -20 -10
media 0 1 50 -40 -30 -20 -10
media 2 1 60 -50 -40 -30 -20 -10
media 2 1 70 -60 -50 -40 -30 -20 -10
media 4 1 80 -70 -60 -40 -30 -20
media 4 1 90 -70 -60 -50 -30 -20
media 3 1 100 -80 -70 -60 -50 -40 -30 -20 -10
media 0 1 110 -100 -90 -70 -60 -50 -40 -30 -20 -10
media 0 1 120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
boundary 120
unit 2
hexprism 10  0.4   32.17    4.66
hexprism 20  0.4   32.17  -31.83
hexprism 30  0.4   32.17  -31.83
media 0 1 10
media 3 1 20 -10
media 0 1 30 -20 -10
boundary 30
global unit 3
cylinder 10 26.5   32.17  -31.83
array 1 10 place 39 39 1 0 0 0
cylinder 20 66.5  -31.83  -35.33
cylinder 30 66.5  -30.83  -31.33
cylinder 40 66.5    4.66  -75.33
cylinder 50 66.5   30.17   29.17
cylinder 60 66.5   32.17    4.66
cylinder 70 66.5   32.17  -75.33
media 5 1  20 -10
media 4 1  30 -20 -10
media 3 1  40 -30 -20 -10
media 4 1  50 -10
media 0 1  60 -50 -40 -10
media 0 1  70 -60 -40
boundary 70
end geom
read array
gbl=1 typ=triangular nux=77 nuy=77 nuz=1 fill
154r2
48r2 16r1 13r2
46r2 20r1 11r2
43r2 25r1  9r2
40r2 30r1  7r2
38r2 33r1  6r2
36r2 36r1  5r2
35r2 37r1  5r2
33r2 40r1  4r2
```

32r2	41r1	4r2
30r2	44r1	3r2
29r2	45r1	3r2
27r2	48r1	2r2
26r2	49r1	2r2
25r2	50r1	2r2
24r2	51r1	2r2
23r2	52r1	2r2
22r2	53r1	2r2
21r2	54r1	2r2
20r2	55r1	2r2
19r2	56r1	2r2
18r2	57r1	2r2
17r2	58r1	2r2
16r2	59r1	2r2
15r2	60r1	2r2
14r2	61r1	2r2
13r2	62r1	2r2
13r2	61r1	3r2
12r2	62r1	3r2
11r2	63r1	3r2
11r2	62r1	4r2
10r2	63r1	4r2
9r2	64r1	4r2
9r2	63r1	5r2
8r2	64r1	5r2
7r2	65r1	5r2
7r2	64r1	6r2
6r2	65r1	6r2
6r2	64r1	7r2
5r2	65r1	7r2
5r2	64r1	8r2
5r2	63r1	9r2
4r2	64r1	9r2
4r2	63r1	10r2
4r2	62r1	11r2
3r2	63r1	11r2
3r2	62r1	12r2
3r2	61r1	13r2
2r2	62r1	13r2
2r2	61r1	14r2
2r2	60r1	15r2
2r2	59r1	16r2
2r2	58r1	17r2
2r2	57r1	18r2
2r2	56r1	19r2
2r2	55r1	20r2
2r2	54r1	21r2
2r2	53r1	22r2
2r2	52r1	23r2
2r2	51r1	24r2
2r2	50r1	25r2
2r2	49r1	26r2
2r2	48r1	27r2
3r2	45r1	29r2
3r2	44r1	30r2
4r2	41r1	32r2
4r2	40r1	33r2
5r2	37r1	35r2
5r2	36r1	36r2
6r2	33r1	38r2
7r2	30r1	40r2
9r2	25r1	43r2
11r2	20r1	46r2

```
13r2 15r1 49r2
154r2  end fill
end array
read start nst=1 xsm=-26.5 xsp=26.5 ysm=-26.5 ysp=26.5
zsm=-31.83 zsp=32.17 rfl=no end start
end data
end
•
=csas26        parm=centrm
LEU-COMP-THERM-031, Case #3
238g   lat
u-234 1 0 6.3924e-6 end
u-235 1 0 1.0432e-3 end
u-236 1 0 6.3924e-6 end
u-238 1 0 1.9565e-2 end
o     1 0 4.1241e-2 end
zr    2 0 4.2071e-2 end
nb    2 0 4.1743e-4 end
h     3 0 6.6736e-2 end
o     3 0 3.3368e-2 end
al    4 0 5.6526e-2 end
fe    4 0 2.0380e-4 end
cu    4 0 1.1003e-3 end
mg    4 0 4.0139e-4 end
mn    4 0 1.7758e-4 end
c     5 0 1.0028e-3 end
si    5 0 2.9161e-4 end
al    5 0 1.7855e-4 end
fe    5 0 8.5276e-2 end
mn    5 0 1.2277e-4 end
ti    5 0 4.6285e-4 end
end comp
triangpitch 0.8 0.46 1 3 0.61 2 end
read param run=yes gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
unit 1
cylinder 10  0.155 29.83  -29.83
cylinder 20  0.155 30.17  -29.83
cylinder 30  0.155 32.17  -31.83
cylinder 40  0.23  29.83  -29.83
cylinder 50  0.23  31.595 -31.255
cylinder 60  0.23  32.17  -31.83
cylinder 70  0.305 31.67  -31.33
hexprism 80  0.4  -30.83  -31.33
hexprism 90  0.4   30.17   29.17
hexprism 100 0.4   10.94  -31.83
hexprism 110 0.4   32.17   10.94
hexprism 120 0.4   32.17  -31.83
media 1 1 10
media 0 1 20 -10
media 2 1 30 -20 -10
media 1 1 40 -30 -20 -10
media 0 1 50 -40 -30 -20 -10
media 2 1 60 -50 -40 -30 -20 -10
media 2 1 70 -60 -50 -40 -30 -20 -10
media 4 1 80 -70 -60 -40 -30 -20
media 4 1 90 -70 -60 -50 -30 -20
media 3 1 100 -80 -70 -60 -50 -40 -30 -20 -10
media 0 1 110 -100 -90 -70 -60 -50 -40 -30 -20 -10
media 0 1 120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
boundary 120
unit 2
hexprism 10  0.4   32.17   10.94
hexprism 20  0.4   32.17  -31.83
```

```
hexprism 30  0.4   32.17  -31.83
media 0 1 10
media 3 1 20 -10
media 0 1 30 -20 -10
boundary 30
global unit 3
cylinder 10 24.45  32.17  -31.83
array 1 10 place 36 36 1 0 0 0
cylinder 20 64.45 -31.83  -35.33
cylinder 30 64.45 -30.83  -31.33
cylinder 40 64.45  10.94  -75.33
cylinder 50 64.45  30.17   29.17
cylinder 60 64.45  32.17   10.94
cylinder 70 64.45  32.17  -75.33
media 5 1  20 -10
media 4 1  30 -20 -10
media 3 1  40 -30 -20 -10
media 4 1  50 -10
media 0 1  60 -50 -40 -10
media 0 1  70 -60 -40
boundary 70
end geom
read array
gbl=1 typ=triangular nux=71 nuy=71 nuz=1 fill
142r2
49r2  6r1 16r2
44r2 15r1 12r2
41r2 20r1 10r2
38r2 25r1  8r2
35r2 30r1  6r2
34r2 31r1  6r2
32r2 34r1  5r2
31r2 35r1  5r2
29r2 38r1  4r2
28r2 39r1  4r2
26r2 42r1  3r2
25r2 43r1  3r2
24r2 44r1  3r2
22r2 47r1  2r2
21r2 48r1  2r2
20r2 49r1  2r2
19r2 50r1  2r2
18r2 51r1  2r2
17r2 52r1  2r2
16r2 53r1  2r2
16r2 52r1  3r2
15r2 53r1  3r2
14r2 54r1  3r2
13r2 55r1  3r2
12r2 56r1  3r2
12r2 55r1  4r2
11r2 56r1  4r2
10r2 57r1  4r2
10r2 56r1  5r2
 9r2 57r1  5r2
 8r2 58r1  5r2
 8r2 57r1  6r2
 7r2 58r1  6r2
 6r2 59r1  6r2
 6r2 58r1  7r2
 6r2 57r1  8r2
 5r2 58r1  8r2
 5r2 57r1  9r2
 5r2 56r1 10r2
```

```
 4r2 57r1 10r2
 4r2 56r1 11r2
 4r2 55r1 12r2
 3r2 56r1 12r2
 3r2 55r1 13r2
 3r2 54r1 14r2
 3r2 53r1 15r2
 3r2 52r1 16r2
 2r2 53r1 16r2
 2r2 52r1 17r2
 2r2 51r1 18r2
 2r2 50r1 19r2
 2r2 49r1 20r2
 2r2 48r1 21r2
 2r2 47r1 22r2
 3r2 44r1 24r2
 3r2 43r1 25r2
 3r2 42r1 26r2
 4r2 39r1 28r2
 4r2 38r1 29r2
 5r2 35r1 31r2
 5r2 34r1 32r2
 6r2 31r1 34r2
 6r2 30r1 35r2
 8r2 25r1 38r2
10r2 20r1 41r2
12r2 15r1 44r2
16r2  6r1 49r2
142r2  end fill
end array
read start nst=1 xsm=-24.45 xsp=24.45 ysm=-24.45 ysp=24.45
zsm=-31.83 zsp=32.17 rfl=no end start
end data
end
•
=csas26       parm=centrm
LEU-COMP-THERM-031, Case #4
238g   lat
u-234 1 0 6.3924e-6 end
u-235 1 0 1.0432e-3 end
u-236 1 0 6.3924e-6 end
u-238 1 0 1.9565e-2 end
o     1 0 4.1241e-2 end
zr    2 0 4.2071e-2 end
nb    2 0 4.1743e-4 end
h     3 0 6.6736e-2 end
o     3 0 3.3368e-2 end
al    4 0 5.6526e-2 end
fe    4 0 2.0380e-4 end
cu    4 0 1.1003e-3 end
mg    4 0 4.0139e-4 end
mn    4 0 1.7758e-4 end
c     5 0 1.0028e-3 end
si    5 0 2.9161e-4 end
al    5 0 1.7855e-4 end
fe    5 0 8.5276e-2 end
mn    5 0 1.2277e-4 end
ti    5 0 4.6285e-4 end
end comp
triangpitch 0.8 0.46 1 3 0.61 2 end
read param run=yes gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
unit 1
cylinder 10  0.155 29.83  -29.83
```

```
cylinder 20  0.155 30.17  -29.83
cylinder 30  0.155 32.17  -31.83
cylinder 40  0.23  29.83  -29.83
cylinder 50  0.23  31.595 -31.255
cylinder 60  0.23  32.17  -31.83
cylinder 70  0.305 31.67  -31.33
hexprism 80  0.4  -30.83  -31.33
hexprism 90  0.4   30.17   29.17
hexprism 100 0.4   11.06  -31.83
hexprism 110 0.4   32.17   11.06
hexprism 120 0.4   32.17  -31.83
media 1 1 10
media 0 1 20 -10
media 2 1 30 -20 -10
media 1 1 40 -30 -20 -10
media 0 1 50 -40 -30 -20 -10
media 2 1 60 -50 -40 -30 -20 -10
media 2 1 70 -60 -50 -40 -30 -20 -10
media 4 1 80 -70 -60 -40 -30 -20
media 4 1 90 -70 -60 -50 -30 -20
media 3 1 100 -80 -70 -60 -50 -40 -30 -20 -10
media 0 1 110 -100 -90 -70 -60 -50 -40 -30 -20 -10
media 0 1 120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
boundary 120
unit 2
hexprism 10  0.4   32.17   11.06
hexprism 20  0.4   32.17  -31.83
hexprism 30  0.4   32.17  -31.83
media 0 1 10
media 3 1 20 -10
media 0 1 30 -20 -10
boundary 30
global unit 3
cylinder 10 24.45  32.17  -31.83
array 1 10 place 36 36 1 0 0 0
cylinder 20 64.45 -31.83  -35.33
cylinder 30 64.45 -30.83  -31.33
cylinder 40 64.45  11.06  -75.33
cylinder 50 64.45  30.17   29.17
cylinder 60 64.45  32.17   11.06
cylinder 70 64.45  32.17  -75.33
media 5 1  20 -10
media 4 1  30 -20 -10
media 3 1  40 -30 -20 -10
media 4 1  50 -10
media 0 1  60 -50 -40 -10
media 0 1  70 -60 -40
boundary 70
end geom
read array
gbl=1 typ=triangular nux=71 nuy=71 nuz=1 fill
142r2
51r2  3r1 17r2
46r2 11r1 14r2
43r2 16r1 12r2
40r2 21r1 10r2
37r2 26r1  8r2
35r2 29r1  7r2
33r2 32r1  6r2
32r2 33r1  6r2
30r2 36r1  5r2
29r2 37r1  5r2
27r2 40r1  4r2
26r2 41r1  4r2
```

```
24r2 44r1  3r2
23r2 45r1  3r2
22r2 46r1  3r2
20r2 49r1  2r2
19r2 50r1  2r2
18r2 51r1  2r2
17r2 52r1  2r2
17r2 51r1  3r2
16r2 52r1  3r2
15r2 53r1  3r2
14r2 54r1  3r2
14r2 53r1  4r2
13r2 54r1  4r2
12r2 55r1  4r2
12r2 54r1  5r2
11r2 55r1  5r2
10r2 56r1  5r2
10r2 55r1  6r2
 9r2 56r1  6r2
 8r2 57r1  6r2
 8r2 56r1  7r2
 7r2 57r1  7r2
 7r2 56r1  8r2
 6r2 57r1  8r2
 6r2 56r1  9r2
 6r2 55r1 10r2
 5r2 56r1 10r2
 5r2 55r1 11r2
 5r2 54r1 12r2
 4r2 55r1 12r2
 4r2 54r1 13r2
 4r2 53r1 14r2
 3r2 54r1 14r2
 3r2 53r1 15r2
 3r2 52r1 16r2
 3r2 51r1 17r2
 2r2 52r1 17r2
 2r2 51r1 18r2
 2r2 50r1 19r2
 2r2 49r1 20r2
 3r2 46r1 22r2
 3r2 45r1 23r2
 3r2 44r1 24r2
 4r2 41r1 26r2
 4r2 40r1 27r2
 5r2 37r1 29r2
 5r2 36r1 30r2
 6r2 33r1 32r2
 6r2 32r1 33r2
 7r2 29r1 35r2
 8r2 26r1 37r2
10r2 21r1 40r2
12r2 16r1 43r2
14r2 11r1 46r2
17r2  3r1 51r2
142r2  end fill
end array
read start nst=1 xsm=-24.45 xsp=24.45 ysm=-24.45 ysp=24.45
zsm=-31.83 zsp=32.17 rfl=no end start
end data
end
•
=csas26       parm=centrm
LEU-COMP-THERM-031, Case #5
```

```
238g   lat
u-234 1 0 6.3924e-6 end
u-235 1 0 1.0432e-3 end
u-236 1 0 6.3924e-6 end
u-238 1 0 1.9565e-2 end
o     1 0 4.1241e-2 end
zr    2 0 4.2071e-2 end
nb    2 0 4.1743e-4 end
h     3 0 6.6736e-2 end
o     3 0 3.3368e-2 end
al    4 0 5.6526e-2 end
fe    4 0 2.0380e-4 end
cu    4 0 1.1003e-3 end
mg    4 0 4.0139e-4 end
mn    4 0 1.7758e-4 end
c     5 0 1.0028e-3 end
si    5 0 2.9161e-4 end
al    5 0 1.7855e-4 end
fe    5 0 8.5276e-2 end
mn    5 0 1.2277e-4 end
ti    5 0 4.6285e-4 end
end comp
triangpitch 0.8 0.46 1 3 0.61 2 end
read param run=yes gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
unit 1
cylinder 10  0.155 29.83  -29.83
cylinder 20  0.155 30.17  -29.83
cylinder 30  0.155 32.17  -31.83
cylinder 40  0.23  29.83  -29.83
cylinder 50  0.23  31.595 -31.255
cylinder 60  0.23  32.17  -31.83
cylinder 70  0.305 31.67  -31.33
hexprism 80  0.4  -30.83  -31.33
hexprism 90  0.4   30.17   29.17
hexprism 100 0.4   11.60  -31.83
hexprism 110 0.4   32.17   11.60
hexprism 120 0.4   32.17  -31.83
media 1 1 10
media 0 1 20 -10
media 2 1 30 -20 -10
media 1 1 40 -30 -20 -10
media 0 1 50 -40 -30 -20 -10
media 2 1 60 -50 -40 -30 -20 -10
media 2 1 70 -60 -50 -40 -30 -20 -10
media 4 1 80 -70 -60 -40 -30 -20
media 4 1 90 -70 -60 -50 -30 -20
media 3 1 100 -80 -70 -60 -50 -40 -30 -20 -10
media 0 1 110 -100 -90 -70 -60 -50 -40 -30 -20 -10
media 0 1 120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
boundary 120
unit 2
hexprism 10  0.4   32.17   11.60
hexprism 20  0.4   32.17  -31.83
hexprism 30  0.4   32.17  -31.83
media 0 1 10
media 3 1 20 -10
media 0 1 30 -20 -10
boundary 30
global unit 3
cylinder 10 23.70  32.17  -31.83
array 1 10 place 35 35 1 0 0 0
cylinder 20 63.70 -31.83  -35.33
cylinder 30 63.70 -30.83  -31.33
```

```
cylinder 40 63.70  11.60  -75.33
cylinder 50 63.70  30.17   29.17
cylinder 60 63.70  32.17   11.60
cylinder 70 63.70  32.17  -75.33
media 5 1  20 -10
media 4 1  30 -20 -10
media 3 1  40 -30 -20 -10
media 4 1  50 -10
media 0 1  60 -50 -40 -10
media 0 1  70 -60 -40
boundary 70
end geom
read array
gbl=1 typ=triangular nux=69 nuy=69 nuz=1 fill
138r2
46r2  9r1 14r2
42r2 16r1 11r2
39r2 21r1  9r2
36r2 26r1  7r2
34r2 29r1  6r2
32r2 32r1  5r2
31r2 33r1  5r2
29r2 36r1  4r2
28r2 37r1  4r2
26r2 40r1  3r2
25r2 41r1  3r2
23r2 44r1  2r2
22r2 45r1  2r2
21r2 46r1  2r2
20r2 47r1  2r2
19r2 48r1  2r2
18r2 49r1  2r2
17r2 50r1  2r2
16r2 51r1  2r2
15r2 52r1  2r2
14r2 53r1  2r2
13r2 54r1  2r2
13r2 53r1  3r2
12r2 54r1  3r2
11r2 55r1  3r2
11r2 54r1  4r2
10r2 55r1  4r2
 9r2 56r1  4r2
 9r2 55r1  5r2
 8r2 56r1  5r2
 7r2 57r1  5r2
 7r2 56r1  6r2
 6r2 57r1  6r2
 6r2 56r1  7r2
 5r2 57r1  7r2
 5r2 56r1  8r2
 5r2 55r1  9r2
 4r2 56r1  9r2
 4r2 55r1 10r2
 4r2 54r1 11r2
 3r2 55r1 11r2
 3r2 54r1 12r2
 3r2 53r1 13r2
 2r2 54r1 13r2
 2r2 53r1 14r2
 2r2 52r1 15r2
 2r2 51r1 16r2
 2r2 50r1 17r2
 2r2 49r1 18r2
```

```
 2r2 48r1 19r2
 2r2 47r1 20r2
 2r2 46r1 21r2
 2r2 45r1 22r2
 2r2 44r1 23r2
 3r2 41r1 25r2
 3r2 40r1 26r2
 4r2 37r1 28r2
 4r2 36r1 29r2
 5r2 33r1 31r2
 5r2 32r1 32r2
 6r2 29r1 34r2
 7r2 26r1 36r2
 9r2 21r1 39r2
11r2 16r1 42r2
14r2  9r1 46r2
138r2  end fill
end array
read start nst=1 xsm=-23.7  xsp=23.7  ysm=-23.7  ysp=23.7
zsm=-31.83 zsp=32.17 rfl=no end start
end data
end
•
=csas26       parm=centrm
LEU-COMP-THERM-031, Case #6
238g   lat
u-234 1 0 6.3924e-6 end
u-235 1 0 1.0432e-3 end
u-236 1 0 6.3924e-6 end
u-238 1 0 1.9565e-2 end
o     1 0 4.1241e-2 end
zr    2 0 4.2071e-2 end
nb    2 0 4.1743e-4 end
h     3 0 6.6736e-2 end
o     3 0 3.3368e-2 end
al    4 0 5.6526e-2 end
fe    4 0 2.0380e-4 end
cu    4 0 1.1003e-3 end
mg    4 0 4.0139e-4 end
mn    4 0 1.7758e-4 end
c     5 0 1.0028e-3 end
si    5 0 2.9161e-4 end
al    5 0 1.7855e-4 end
fe    5 0 8.5276e-2 end
mn    5 0 1.2277e-4 end
ti    5 0 4.6285e-4 end
end comp
triangpitch 0.8 0.46 1 3 0.61 2 end
read param run=yes gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
unit 1
cylinder 10  0.155 29.83  -29.83
cylinder 20  0.155 30.17  -29.83
cylinder 30  0.155 32.17  -31.83
cylinder 40  0.23  29.83  -29.83
cylinder 50  0.23  31.595 -31.255
cylinder 60  0.23  32.17  -31.83
cylinder 70  0.305 31.67  -31.33
hexprism 80  0.4  -30.83  -31.33
hexprism 90  0.4   30.17   29.17
hexprism 100 0.4   15.40  -31.83
hexprism 110 0.4   32.17   15.40
hexprism 120 0.4   32.17  -31.83
media 1 1 10
```

```
media 0 1 20 -10
media 2 1 30 -20 -10
media 1 1 40 -30 -20 -10
media 0 1 50 -40 -30 -20 -10
media 2 1 60 -50 -40 -30 -20 -10
media 2 1 70 -60 -50 -40 -30 -20 -10
media 4 1 80 -70 -60 -40 -30 -20
media 4 1 90 -70 -60 -50 -30 -20
media 3 1 100 -80 -70 -60 -50 -40 -30 -20 -10
media 0 1 110 -100 -90 -70 -60 -50 -40 -30 -20 -10
media 0 1 120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
boundary 120
unit 2
hexprism 10  0.4   32.17   15.40
hexprism 20  0.4   32.17  -31.83
hexprism 30  0.4   32.17  -31.83
media 0 1 10
media 3 1 20 -10
media 0 1 30 -20 -10
boundary 30
global unit 3
cylinder 10 23.00  32.17  -31.83
array 1 10 place 34 34 1 0 0 0
cylinder 20 63.00 -31.83  -35.33
cylinder 30 63.00 -30.83  -31.33
cylinder 40 63.00  15.40  -75.33
cylinder 50 63.00  30.17   29.17
cylinder 60 63.00  32.17   15.40
cylinder 70 63.00  32.17  -75.33
media 5 1  20 -10
media 4 1  30 -20 -10
media 3 1  40 -30 -20 -10
media 4 1  50 -10
media 0 1  60 -50 -40 -10
media 0 1  70 -60 -40
boundary 70
end geom
read array
gbl=1 typ=triangular nux=67 nuy=67 nuz=1 fill
134r2
46r2  5r1 16r2
42r2 13r1 12r2
38r2 20r1  9r2
35r2 25r1  7r2
33r2 28r1  6r2
31r2 31r1  5r2
30r2 32r1  5r2
28r2 35r1  4r2
27r2 36r1  4r2
26r2 37r1  4r2
24r2 40r1  3r2
23r2 41r1  3r2
22r2 42r1  3r2
21r2 44r1  2r2
19r2 46r1  2r2
18r2 47r1  2r2
17r2 48r1  2r2
16r2 49r1  2r2
15r2 50r1  2r2
15r2 49r1  3r2
14r2 50r1  3r2
13r2 51r1  3r2
12r2 52r1  3r2
12r2 51r1  4r2
```

```
11r2 52r1  4r2
10r2 53r1  4r2
 9r2 54r1  4r2
 9r2 53r1  5r2
 8r2 54r1  5r2
 7r2 55r1  5r2
 7r2 54r1  6r2
 6r2 55r1  6r2
 6r2 54r1  7r2
 5r2 55r1  7r2
 5r2 54r1  8r2
 5r2 53r1  9r2
 4r2 54r1  9r2
 4r2 53r1 10r2
 4r2 52r1 11r2
 4r2 51r1 12r2
 3r2 52r1 12r2
 3r2 51r1 13r2
 3r2 50r1 14r2
 3r2 49r1 15r2
 2r2 50r1 15r2
 2r2 49r1 16r2
 2r2 48r1 17r2
 2r2 47r1 18r2
 2r2 46r1 19r2
 2r2 44r1 21r2
 3r2 42r1 22r2
 3r2 41r1 23r2
 3r2 40r1 24r2
 4r2 37r1 26r2
 4r2 36r1 27r2
 4r2 35r1 28r2
 5r2 32r1 30r2
 5r2 31r1 31r2
 6r2 28r1 33r2
 7r2 25r1 35r2
 9r2 20r1 38r2
12r2 13r1 42r2
16r2  5r1 46r2
134r2  end fill
end array
read start nst=1 xsm=-23.0  xsp=23.0  ysm=-23.0  ysp=23.0
zsm=-31.83 zsp=32.17 rfl=no end start
end data
end
•
=csas26        parm=centrm
LEU-COMP-THERM-032, Case #1
238g   lat
u-234 1 0 1.7636e-5 end
u-235 1 0 2.1577e-3 end
u-236 1 0 1.5300e-5 end
u-238 1 0 1.9510e-2 end
o     1 0 4.4661e-2 end
fe    2 0 5.8894e-2 end
cr    2 0 1.6469e-2 end
ni    2 0 8.1061e-3 end
si    2 0 1.3551e-3 end
mn    2 0 1.2990e-3 end
c     2 0 2.3766e-4 end
ti    2 0 4.4713e-4 end
fe    3 0 5.8843e-2 end
cr    3 0 1.6469e-2 end
ni    3 0 8.1061e-3 end
```

```
si    3 0 1.3551e-3 end
mn    3 0 1.2990e-3 end
c     3 0 4.7531e-4 end
ti    3 0 4.4713e-4 end
h     4 0 6.6736e-2 end
o     4 0 3.3368e-2 end
fe    5 0 3.3364e-2 end
cr    5 0 9.3379e-3 end
ni    5 0 4.5962e-3 end
si    5 0 7.6834e-4 end
mn    5 0 7.3653e-4 end
c     5 0 2.6950e-4 end
ti    5 0 2.5352e-4 end
h     5 0 2.8897e-2 end
o     5 0 1.4448e-2 end
end comp
triangpitch 0.7 0.416 1 4 0.51 2 0.43 0 end
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
unit 1
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.4   -1.1
cylinder 3  0.100 86.7   -4.8
cylinder 4  0.100 86.7   -6.9
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.6   -0.3
cylinder 13 0.208 86.7   -4.8
cylinder 14 0.208 86.7   -6.9
cylinder 21 0.215 85.6   -0.3
cylinder 22 0.215 86.7   -1.9
cylinder 23 0.215 86.7   -3.6
cylinder 24 0.215 86.7   -6.9
cylinder 31 0.255 85.6   -1.9
cylinder 32 0.255 86.7   -4.4
cylinder 33 0.255 86.7   -6.9
cylinder 41 0.260 -3.5   -3.6
hexprism 42 0.350 -3.5   -3.6
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 86.18  86.10
cylinder 71 0.300 86.7   -5.4
cylinder 72 0.300 86.7   -6.9
hexprism 81 0.350 86.7   -6.9
hexprism 82 0.350 87.15  -7.2
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
```

```
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 2
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.7   -0.8
cylinder 3  0.100 90.4   -1.1
cylinder 4  0.100 92.5   -1.1
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.9    0.0
cylinder 13 0.208 90.4   -1.1
cylinder 14 0.208 92.5   -1.1
cylinder 21 0.215 85.9    0.0
cylinder 22 0.215 87.5   -1.1
cylinder 23 0.215 89.2   -1.1
cylinder 24 0.215 92.5   -1.1
cylinder 31 0.255 85.9    0.0
cylinder 32 0.255 90.0   -1.1
cylinder 33 0.255 92.5   -1.1
cylinder 41 0.260 87.15  87.00
hexprism 42 0.350 87.15  87.00
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 -0.60  -0.70
cylinder 71 0.300 91.00  -1.1
cylinder 72 0.300 92.50  -1.1
hexprism 81 0.350 92.50  -1.1
hexprism 82 0.350 92.50  -1.5
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
```

```
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 3
cylinder  1 0.260 87.15  87.00
hexprism  2 0.350 87.15  87.00
cylinder 11 0.260 42.85  42.75
hexprism 12 0.350 42.85  42.75
cylinder 21 0.205 -0.60  -0.70
hexprism 22 0.350 -0.60  -0.70
hexprism 31 0.350 105.6  -20.0
media 4 1 1
media 3 1 2 -1
media 4 1 11
media 3 1 12 -11
media 4 1 21
media 3 1 22 -21
media 4 1 31 -22 -21 -12 -11 -2 -1
boundary 31
global unit 4
cylinder 1  23.05 105.6 -20.0
array 1 1 place 39 40 1 3*0.0
cylinder 2  32.00 87.15 87.00
cylinder 3  53.53 105.6 -20.0
media 5 1 2 -1
media 4 1 3 -2 -1
boundary 3
end geom
read array ara=1 typ=triangular nux=79 nuy=79 nuz=1 fill
948r3
50r3       5r1      24r3
45r3      13r1      21r3
42r3      18r1      19r3
40r3      21r1      18r3
38r3      24r1      17r3
36r3      27r1      16r3
34r3      30r1      15r3
33r3      31r1      15r3
31r3      34r1      14r3
30r3      35r1      14r3
29r3      36r1      14r3
27r3      39r1      13r3
26r3      40r1      13r3
25r3      41r1      13r3
24r3      42r1      13r3
23r3 15r2 13r1 15r2 13r3
22r3 15r2 14r1 15r2 13r3
22r3 14r2 15r1 14r2 14r3
21r3 14r2 16r1 14r2 14r3
20r3 14r2 17r1 14r2 14r3
19r3 14r2 18r1 14r2 14r3
19r3 13r2 19r1 13r2 15r3
18r3 13r2 20r1 13r2 15r3
17r3 13r2 21r1 13r2 15r3
17r3 12r2 22r1 12r2 16r3
16r3 12r2 23r1 12r2 16r3
16r3 11r2 24r1 11r2 17r3
15r3 11r2 25r1 11r2 17r3
15r3 11r2 24r1 11r2 18r3
14r3 12r2 23r1 12r2 18r3
14r3 12r2 22r1 12r2 19r3
13r3 13r2 21r1 13r2 19r3
```

```
13r3 13r2 20r1 13r2 20r3
13r3 13r2 19r1 13r2 21r3
12r3 14r2 18r1 14r2 21r3
12r3 14r2 17r1 14r2 22r3
12r3 14r2 16r1 14r2 23r3
12r3 14r2 15r1 14r2 24r3
11r3 15r2 14r1 14r2 25r3
11r3 15r2 13r1 15r2 25r3
11r3      42r1      26r3
11r3      41r1      27r3
11r3      40r1      28r3
12r3      38r1      29r3
12r3      36r1      31r3
12r3      35r1      32r3
12r3      34r1      33r3
13r3      31r1      35r3
13r3      30r1      36r3
14r3      27r1      38r3
15r3      24r1      40r3
16r3      21r1      42r3
17r3      18r1      44r3
19r3      13r1      47r3
22r3       6r1      51r3
948r3
end fill
end array
read start nst=1  xsm=-16.45 xsp=16.45 ysm=-16.45 ysp=16.45
zsm=0.0  zsp=85.6 end start
end data
end
•
=csas26       parm=centrm
LEU-COMP-THERM-032, Case #2
238g   lat
u-234 1 0 1.7636e-5 end
u-235 1 0 2.1577e-3 end
u-236 1 0 1.5300e-5 end
u-238 1 0 1.9510e-2 end
o     1 0 4.4661e-2 end
fe    2 0 5.8894e-2 end
cr    2 0 1.6469e-2 end
ni    2 0 8.1061e-3 end
si    2 0 1.3551e-3 end
mn    2 0 1.2990e-3 end
c     2 0 2.3766e-4 end
ti    2 0 4.4713e-4 end
fe    3 0 5.8843e-2 end
cr    3 0 1.6469e-2 end
ni    3 0 8.1061e-3 end
si    3 0 1.3551e-3 end
mn    3 0 1.2990e-3 end
c     3 0 4.7531e-4 end
ti    3 0 4.4713e-4 end
h     4 0 6.0827e-2 end
o     4 0 3.0414e-2 end
fe    5 0 3.3364e-2 end
cr    5 0 9.3379e-3 end
ni    5 0 4.5962e-3 end
si    5 0 7.6834e-4 end
mn    5 0 7.3653e-4 end
c     5 0 2.6950e-4 end
ti    5 0 2.5352e-4 end
h     5 0 2.6338e-2 end
o     5 0 1.3169e-2 end
```

```
end comp
triangpitch 0.7 0.416 1 4 0.51 2 0.43 0 end
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
unit 1
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.4   -1.1
cylinder 3  0.100 86.7   -4.8
cylinder 4  0.100 86.7   -6.9
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.6   -0.3
cylinder 13 0.208 86.7   -4.8
cylinder 14 0.208 86.7   -6.9
cylinder 21 0.215 85.6   -0.3
cylinder 22 0.215 86.7   -1.9
cylinder 23 0.215 86.7   -3.6
cylinder 24 0.215 86.7   -6.9
cylinder 31 0.255 85.6   -1.9
cylinder 32 0.255 86.7   -4.4
cylinder 33 0.255 86.7   -6.9
cylinder 41 0.260 -3.5   -3.6
hexprism 42 0.350 -3.5   -3.6
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 86.18  86.10
cylinder 71 0.300 86.7   -5.4
cylinder 72 0.300 86.7   -6.9
hexprism 81 0.350 86.7   -6.9
hexprism 82 0.350 87.15  -7.2
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 2
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.7   -0.8
```

```
cylinder 3  0.100 90.4   -1.1
cylinder 4  0.100 92.5   -1.1
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.9    0.0
cylinder 13 0.208 90.4   -1.1
cylinder 14 0.208 92.5   -1.1
cylinder 21 0.215 85.9    0.0
cylinder 22 0.215 87.5   -1.1
cylinder 23 0.215 89.2   -1.1
cylinder 24 0.215 92.5   -1.1
cylinder 31 0.255 85.9    0.0
cylinder 32 0.255 90.0   -1.1
cylinder 33 0.255 92.5   -1.1
cylinder 41 0.260 87.15  87.00
hexprism 42 0.350 87.15  87.00
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 -0.60  -0.70
cylinder 71 0.300 91.00  -1.1
cylinder 72 0.300 92.50  -1.1
hexprism 81 0.350 92.50  -1.1
hexprism 82 0.350 92.50  -1.5
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 3
cylinder  1 0.260 87.15  87.00
hexprism  2 0.350 87.15  87.00
cylinder 11 0.260 42.85  42.75
hexprism 12 0.350 42.85  42.75
cylinder 21 0.205 -0.60  -0.70
hexprism 22 0.350 -0.60  -0.70
hexprism 31 0.350 105.6  -20.0
media 4 1 1
media 3 1 2 -1
```

```
media 4 1 11
media 3 1 12 -11
media 4 1 21
media 3 1 22 -21
media 4 1 31 -22 -21 -12 -11 -2 -1
boundary 31
global unit 4
cylinder 1  23.05 105.6 -20.0
array 1 1 place 41 45 1 3*0.0
cylinder 2  32.00 87.15 87.00
cylinder 3  53.53 105.6 -20.0
media 5 1 2 -1
media 4 1 3 -2 -1
boundary 3
end geom
read array ara=1 typ=triangular nux=89 nuy=89 nuz=1 fill
1335r3
52r3       6r1      31r3
48r3      13r1      28r3
44r3      20r1      25r3
42r3      23r1      24r3
40r3      26r1      23r3
38r3      29r1      22r3
36r3      32r1      21r3
35r3      33r1      21r3
34r3      34r1      21r3
32r3      37r1      20r3
31r3      38r1      20r3
30r3      39r1      20r3
28r3      42r1      19r3
27r3      43r1      19r3
26r3      44r1      19r3
25r3      45r1      19r3
24r3      46r1      19r3
23r3 17r2 13r1 17r2 19r3
23r3 16r2 14r1 16r2 20r3
22r3 16r2 15r1 16r2 20r3
21r3 16r2 16r1 16r2 20r3
20r3 16r2 17r1 16r2 20r3
20r3 15r2 18r1 15r2 21r3
19r3 15r2 19r1 15r2 21r3
18r3 15r2 20r1 15r2 21r3
17r3 15r2 21r1 15r2 21r3
17r3 14r2 22r1 14r2 22r3
16r3 14r2 23r1 14r2 22r3
16r3 13r2 24r1 13r2 23r3
15r3 13r2 25r1 13r2 23r3
15r3 13r2 24r1 13r2 24r3
14r3 14r2 23r1 14r2 24r3
14r3 14r2 22r1 14r2 25r3
13r3 15r2 21r1 15r2 25r3
13r3 15r2 20r1 15r2 26r3
13r3 15r2 19r1 15r2 27r3
13r3 15r2 18r1 15r2 28r3
12r3 16r2 17r1 16r2 28r3
12r3 16r2 16r1 16r2 29r3
12r3 16r2 15r1 16r2 30r3
12r3 16r2 14r1 16r2 31r3
11r3 17r2 13r1 17r2 31r3
11r3      46r1      32r3
11r3      45r1      33r3
11r3      44r1      34r3
11r3      43r1      35r3
11r3      42r1      36r3
```

```
12r3      39r1      38r3
12r3      38r1      39r3
12r3      37r1      40r3
13r3      34r1      42r3
13r3      33r1      43r3
13r3      32r1      44r3
14r3      29r1      46r3
15r3      26r1      48r3
16r3      23r1      50r3
17r3      20r1      52r3
20r3      13r1      56r3
23r3       6r1      60r3
1335r3
end fill
end array
read start nst=1  xsm=-17.85 xsp=17.85 ysm=-17.85 ysp=17.85
zsm=0.0  zsp=85.6 end start
end data
end
•
=csas26        parm=centrm
LEU-COMP-THERM-032, Case #3
238g   lat
u-234 1 0 1.7636e-5 end
u-235 1 0 2.1577e-3 end
u-236 1 0 1.5300e-5 end
u-238 1 0 1.9510e-2 end
o     1 0 4.4661e-2 end
fe    2 0 5.8894e-2 end
cr    2 0 1.6469e-2 end
ni    2 0 8.1061e-3 end
si    2 0 1.3551e-3 end
mn    2 0 1.2990e-3 end
c     2 0 2.3766e-4 end
ti    2 0 4.4713e-4 end
fe    3 0 5.8843e-2 end
cr    3 0 1.6469e-2 end
ni    3 0 8.1061e-3 end
si    3 0 1.3551e-3 end
mn    3 0 1.2990e-3 end
c     3 0 4.7531e-4 end
ti    3 0 4.4713e-4 end
h     4 0 5.2913e-2 end
o     4 0 2.6456e-2 end
fe    5 0 3.3364e-2 end
cr    5 0 9.3379e-3 end
ni    5 0 4.5962e-3 end
si    5 0 7.6834e-4 end
mn    5 0 7.3653e-4 end
c     5 0 2.6950e-4 end
ti    5 0 2.5352e-4 end
h     5 0 2.2911e-2 end
o     5 0 1.1455e-2 end
end comp
triangpitch 0.7 0.416 1 4 0.51 2 0.43 0 end
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
unit 1
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.4   -1.1
cylinder 3  0.100 86.7   -4.8
cylinder 4  0.100 86.7   -6.9
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.6   -0.3
```

```
cylinder 13 0.208 86.7   -4.8
cylinder 14 0.208 86.7   -6.9
cylinder 21 0.215 85.6   -0.3
cylinder 22 0.215 86.7   -1.9
cylinder 23 0.215 86.7   -3.6
cylinder 24 0.215 86.7   -6.9
cylinder 31 0.255 85.6   -1.9
cylinder 32 0.255 86.7   -4.4
cylinder 33 0.255 86.7   -6.9
cylinder 41 0.260 -3.5   -3.6
hexprism 42 0.350 -3.5   -3.6
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 86.18  86.10
cylinder 71 0.300 86.7   -5.4
cylinder 72 0.300 86.7   -6.9
hexprism 81 0.350 86.7   -6.9
hexprism 82 0.350 87.15  -7.2
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 2
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.7   -0.8
cylinder 3  0.100 90.4   -1.1
cylinder 4  0.100 92.5   -1.1
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.9    0.0
cylinder 13 0.208 90.4   -1.1
cylinder 14 0.208 92.5   -1.1
cylinder 21 0.215 85.9    0.0
cylinder 22 0.215 87.5   -1.1
cylinder 23 0.215 89.2   -1.1
cylinder 24 0.215 92.5   -1.1
cylinder 31 0.255 85.9    0.0
```

```
cylinder 32 0.255 90.0   -1.1
cylinder 33 0.255 92.5   -1.1
cylinder 41 0.260 87.15  87.00
hexprism 42 0.350 87.15  87.00
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 -0.60  -0.70
cylinder 71 0.300 91.00  -1.1
cylinder 72 0.300 92.50  -1.1
hexprism 81 0.350 92.50  -1.1
hexprism 82 0.350 92.50  -1.5
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 3
cylinder  1 0.260 87.15  87.00
hexprism  2 0.350 87.15  87.00
cylinder 11 0.260 42.85  42.75
hexprism 12 0.350 42.85  42.75
cylinder 21 0.205 -0.60  -0.70
hexprism 22 0.350 -0.60  -0.70
hexprism 31 0.350 105.6  -20.0
media 4 1 1
media 3 1 2 -1
media 4 1 11
media 3 1 12 -11
media 4 1 21
media 3 1 22 -21
media 4 1 31 -22 -21 -12 -11 -2 -1
boundary 31
global unit 4
cylinder 1  23.05 105.6 -20.0
array 1 1 place 40 44 1 3*0.0
cylinder 2  32.00 87.15 87.00
cylinder 3  53.53 105.6 -20.0
```

```
media 5 1 2 -1
media 4 1 3 -2 -1
boundary 3
end geom
read array ara=1 typ=triangular nux=87 nuy=87 nuz=1 fill
870r3
50r3      11r1      26r3
47r3      17r1      23r3
44r3      22r1      21r3
42r3      25r1      20r3
39r3      30r1      18r3
38r3      31r1      18r3
36r3      34r1      17r3
34r3      37r1      16r3
33r3      38r1      16r3
31r3      41r1      15r3
30r3      42r1      15r3
29r3      44r1      14r3
28r3      45r1      14r3
26r3      47r1      14r3
25r3      48r1      14r3
24r3      49r1      14r3
23r3      50r1      14r3
22r3      51r1      14r3
21r3      52r1      14r3
20r3      53r1      14r3
19r3      54r1      14r3
18r3 21r2 13r1 20r2 15r3
17r3 21r2 14r1 20r2 15r3
17r3 20r2 15r1 20r2 15r3
16r3 20r2 16r1 20r2 15r3
15r3 20r2 17r1 20r2 15r3
15r3 19r2 18r1 19r2 16r3
14r3 19r2 19r1 19r2 16r3
13r3 19r2 20r1 19r2 16r3
13r3 18r2 21r1 18r2 17r3
12r3 18r2 22r1 18r2 17r3
12r3 17r2 23r1 17r2 18r3
11r3 17r2 24r1 17r2 18r3
10r3 17r2 25r1 17r2 18r3
10r3 17r2 24r1 17r2 19r3
10r3 17r2 23r1 17r2 20r3
 9r3 18r2 22r1 18r2 20r3
 9r3 18r2 21r1 18r2 21r3
 8r3 19r2 20r1 19r2 21r3
 8r3 19r2 19r1 19r2 22r3
 8r3 19r2 18r1 19r2 23r3
 7r3 20r2 17r1 20r2 23r3
 7r3 20r2 16r1 20r2 24r3
 7r3 20r2 15r1 20r2 25r3
 7r3 20r2 14r1 21r2 25r3
 6r3 21r2 13r1 21r2 26r3
 6r3      54r1      27r3
 6r3      53r1      28r3
 6r3      52r1      29r3
 6r3      51r1      30r3
 6r3      50r1      31r3
 6r3      49r1      32r3
 6r3      48r1      33r3
 6r3      47r1      34r3
 6r3      46r1      35r3
 6r3      44r1      37r3
 7r3      42r1      38r3
 7r3      41r1      39r3
```

```
 8r3      38r1      41r3
 8r3      37r1      42r3
 9r3      34r1      44r3
10r3      31r1      46r3
10r3      30r1      47r3
12r3      25r1      50r3
13r3      22r1      52r3
15r3      17r1      55r3
19r3      10r1      58r3
870r3
end fill
end array
read start nst=1  xsm=-14.36 xsp=14.36 ysm=-14.36 ysp=14.36
zsm=0.0  zsp=85.6 end start
end data
end
•
=csas26        parm=centrm
LEU-COMP-THERM-032, Case #4
238g   lat
u-234 1 0 1.7636e-5 end
u-235 1 0 2.1577e-3 end
u-236 1 0 1.5300e-5 end
u-238 1 0 1.9510e-2 end
o     1 0 4.4661e-2 end
fe    2 0 5.8894e-2 end
cr    2 0 1.6469e-2 end
ni    2 0 8.1061e-3 end
si    2 0 1.3551e-3 end
mn    2 0 1.2990e-3 end
c     2 0 2.3766e-4 end
ti    2 0 4.4713e-4 end
fe    3 0 5.8843e-2 end
cr    3 0 1.6469e-2 end
ni    3 0 8.1061e-3 end
si    3 0 1.3551e-3 end
mn    3 0 1.2990e-3 end
c     3 0 4.7531e-4 end
ti    3 0 4.4713e-4 end
h     4 0 6.6736e-2 end
o     4 0 3.3368e-2 end
fe    5 0 3.3364e-2 end
cr    5 0 9.3379e-3 end
ni    5 0 4.5962e-3 end
si    5 0 7.6834e-4 end
mn    5 0 7.3653e-4 end
c     5 0 2.6950e-4 end
ti    5 0 2.5352e-4 end
h     5 0 2.8897e-2 end
o     5 0 1.4448e-2 end
end comp
triangpitch 0.7 0.416 1 4 0.51 2 0.43 0 end
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
unit 1
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.4   -1.1
cylinder 3  0.100 86.7   -4.8
cylinder 4  0.100 86.7   -6.9
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.6   -0.3
cylinder 13 0.208 86.7   -4.8
cylinder 14 0.208 86.7   -6.9
cylinder 21 0.215 85.6   -0.3
```

```
cylinder 22 0.215 86.7   -1.9
cylinder 23 0.215 86.7   -3.6
cylinder 24 0.215 86.7   -6.9
cylinder 31 0.255 85.6   -1.9
cylinder 32 0.255 86.7   -4.4
cylinder 33 0.255 86.7   -6.9
cylinder 41 0.260 -3.5   -3.6
hexprism 42 0.350 -3.5   -3.6
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 86.18  86.10
cylinder 71 0.300 86.7   -5.4
cylinder 72 0.300 86.7   -6.9
hexprism 81 0.350 86.7   -6.9
hexprism 82 0.350 87.15  -7.2
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 2
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.7   -0.8
cylinder 3  0.100 90.4   -1.1
cylinder 4  0.100 92.5   -1.1
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.9    0.0
cylinder 13 0.208 90.4   -1.1
cylinder 14 0.208 92.5   -1.1
cylinder 21 0.215 85.9    0.0
cylinder 22 0.215 87.5   -1.1
cylinder 23 0.215 89.2   -1.1
cylinder 24 0.215 92.5   -1.1
cylinder 31 0.255 85.9    0.0
cylinder 32 0.255 90.0   -1.1
cylinder 33 0.255 92.5   -1.1
cylinder 41 0.260 87.15  87.00
```

```
hexprism 42 0.350 87.15  87.00
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 -0.60  -0.70
cylinder 71 0.300 91.00  -1.1
cylinder 72 0.300 92.50  -1.1
hexprism 81 0.350 92.50  -1.1
hexprism 82 0.350 92.50  -1.5
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 3
cylinder  1 0.260 87.15  87.00
hexprism  2 0.350 87.15  87.00
cylinder 11 0.260 42.85  42.75
hexprism 12 0.350 42.85  42.75
cylinder 21 0.205 -0.60  -0.70
hexprism 22 0.350 -0.60  -0.70
hexprism 31 0.350 92.50  -1.1
hexprism 32 0.350 92.50  -1.5
hexprism 33 0.350 105.6  -20.0
media 4 1 1
media 3 1 2 -1
media 4 1 11
media 3 1 12 -11
media 4 1 21
media 3 1 22 -21
media 4 1 31 -22 -21 -12 -11 -2 -1
media 3 1 32 -31 -22 -21 -12 -11 -2 -1
media 4 1 33 -32 -31 -22 -21 -12 -11 -2 -1
boundary 33
unit 4
cylinder  1 0.205 86.18  86.10
hexprism  2 0.350 86.18  86.10
cylinder 11 0.260 42.85  42.75
```

```
hexprism 12 0.350 42.85  42.75
cylinder 21 0.260 -3.50  -3.60
hexprism 22 0.350 -3.50  -3.60
hexprism 31 0.350 86.7   -6.9
hexprism 32 0.350 87.15  -7.2
hexprism 33 0.350 105.6  -20.0
media 4 1 1
media 3 1 2 -1
media 4 1 11
media 3 1 12 -11
media 4 1 21
media 3 1 22 -21
media 4 1 31 -22 -21 -12 -11 -2 -1
media 3 1 32 -31 -22 -21 -12 -11 -2 -1
media 4 1 33 -32 -31 -22 -21 -12 -11 -2 -1
boundary 33
global unit 5
cylinder 1  23.05 105.6 -20.0
array 1 1 place 40 41 1 3*0.0
cylinder 2  32.00 87.15 87.00
cylinder 3  53.53 105.6 -20.0
media 5 1 2 -1
media 4 1 3 -2 -1
boundary 3
end geom
read array ara=1 typ=triangular nux=81 nuy=81 nuz=1 fill
1296r3
47r3    1r2 1r3  3q2 1r2  25r3
81r3
41r3    1r2 1r3  8q2 1r2  21r3
81r3
37r3    1r2 1r3 11q2 1r2  19r3
81r3
35r3    1r2 1r3 12q2 1r2  19r3
81r3
31r3    1r2 1r3 15q2 1r2  17r3
81r3
29r3    1r2 1r3 16q2 1r2  17r3
81r3
27r3    1r2 1r3  5q2   1r1 1r4  5q2 1r1   1r3 1r2 1r3  5q2  16r3
38r3 14r4  29r3
25r3    1r2 1r3  5q2   1r1 1r4  6q2 1r1   1r3 1r2 1r3  5q2  16r3
36r3 16r4  29r3
23r3    1r2 1r3  5q2   1r1 1r4  7q2 1r1   1r3 1r2 1r3  5q2  16r3
34r3 18r4  29r3
23r3    1r2 1r3  4q2   1r1 1r4  8q2 1r1   1r3 1r2 1r3  4q2  18r3
32r3 20r4  29r3
21r3    1r2 1r3  4q2   1r1 1r4  9q2 1r1   1r3 1r2 1r3  4q2  18r3
30r3 22r4  29r3
19r3    1r2 1r3  4q2   1r1 1r4 10q2 1r1   1r3 1r2 1r3  4q2  18r3
28r3 24r4  29r3
19r3    1r2 1r3  3q2   1r1 1r4 11q2 1r1   1r3 1r2 1r3  3q2  20r3
27r3 24r4  30r3
17r3    1r2 1r3  4q2   1r1 1r4 10q2 1r1   1r3 1r2 1r3  4q2  20r3
27r3 22r4  32r3
17r3    1r2 1r3  4q2   1r1 1r4  9q2 1r1   1r3 1r2 1r3  4q2  22r3
27r3 20r4  34r3
17r3    1r2 1r3  4q2   1r1 1r4  8q2 1r1   1r3 1r2 1r3  4q2  24r3
27r3 18r4  36r3
15r3    1r2 1r3  5q2   1r1 1r4  7q2 1r1   1r3 1r2 1r3  5q2  24r3
27r3 16r4  38r3
15r3    1r2 1r3  5q2   1r1 1r4  6q2 1r1   1r3 1r2 1r3  5q2  26r3
27r3 14r4  40r3
15r3    1r2 1r3  5q2   1r1 1r4  5q2 1r1   1r3 1r2 1r3  5q2  28r3
```

```
81r3
15r3    1r2 1r3 16q2 1r2  31r3
81r3
15r3    1r2 1r3 15q2 1r2  33r3
81r3
17r3    1r2 1r3 12q2 1r2  37r3
81r3
17r3    1r2 1r3 11q2 1r2  39r3
81r3
19r3    1r2 1r3  8q2 1r2  43r3
81r3
23r3    1r2 1r3  3q2 1r2  49r3
1296r3
end fill
end array
read start nst=1  xsm=-14.7  xsp=14.7  ysm=-14.7  ysp=14.7
zsm=0.0  zsp=85.6 end start
end data
end
•
=csas26        parm=centrm
LEU-COMP-THERM-032, Case #5
238g   lat
u-234 1 0 1.7636e-5 end
u-235 1 0 2.1577e-3 end
u-236 1 0 1.5300e-5 end
u-238 1 0 1.9510e-2 end
o     1 0 4.4661e-2 end
fe    2 0 5.8894e-2 end
cr    2 0 1.6469e-2 end
ni    2 0 8.1061e-3 end
si    2 0 1.3551e-3 end
mn    2 0 1.2990e-3 end
c     2 0 2.3766e-4 end
ti    2 0 4.4713e-4 end
fe    3 0 5.8843e-2 end
cr    3 0 1.6469e-2 end
ni    3 0 8.1061e-3 end
si    3 0 1.3551e-3 end
mn    3 0 1.2990e-3 end
c     3 0 4.7531e-4 end
ti    3 0 4.4713e-4 end
h     4 0 5.8004e-2 end
o     4 0 2.9002e-2 end
fe    5 0 3.3364e-2 end
cr    5 0 9.3379e-3 end
ni    5 0 4.5962e-3 end
si    5 0 7.6834e-4 end
mn    5 0 7.3653e-4 end
c     5 0 2.6950e-4 end
ti    5 0 2.5352e-4 end
h     5 0 2.5116e-2 end
o     5 0 1.2558e-2 end
end comp
triangpitch 0.7 0.416 1 4 0.51 2 0.43 0 end
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
unit 1
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.4   -1.1
cylinder 3  0.100 86.7   -4.8
cylinder 4  0.100 86.7   -6.9
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.6   -0.3
```

```
cylinder 13 0.208 86.7   -4.8
cylinder 14 0.208 86.7   -6.9
cylinder 21 0.215 85.6   -0.3
cylinder 22 0.215 86.7   -1.9
cylinder 23 0.215 86.7   -3.6
cylinder 24 0.215 86.7   -6.9
cylinder 31 0.255 85.6   -1.9
cylinder 32 0.255 86.7   -4.4
cylinder 33 0.255 86.7   -6.9
cylinder 41 0.260 -3.5   -3.6
hexprism 42 0.350 -3.5   -3.6
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 86.18  86.10
cylinder 71 0.300 86.7   -5.4
cylinder 72 0.300 86.7   -6.9
hexprism 81 0.350 86.7   -6.9
hexprism 82 0.350 87.15  -7.2
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 2
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.7   -0.8
cylinder 3  0.100 90.4   -1.1
cylinder 4  0.100 92.5   -1.1
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.9    0.0
cylinder 13 0.208 90.4   -1.1
cylinder 14 0.208 92.5   -1.1
cylinder 21 0.215 85.9    0.0
cylinder 22 0.215 87.5   -1.1
cylinder 23 0.215 89.2   -1.1
cylinder 24 0.215 92.5   -1.1
cylinder 31 0.255 85.9    0.0
```

```
cylinder 32 0.255 90.0   -1.1
cylinder 33 0.255 92.5   -1.1
cylinder 41 0.260 87.15  87.00
hexprism 42 0.350 87.15  87.00
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 -0.60  -0.70
cylinder 71 0.300 91.00  -1.1
cylinder 72 0.300 92.50  -1.1
hexprism 81 0.350 92.50  -1.1
hexprism 82 0.350 92.50  -1.5
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 3
cylinder  1 0.260 87.15  87.00
hexprism  2 0.350 87.15  87.00
cylinder 11 0.260 42.85  42.75
hexprism 12 0.350 42.85  42.75
cylinder 21 0.205 -0.60  -0.70
hexprism 22 0.350 -0.60  -0.70
hexprism 31 0.350 92.50  -1.1
hexprism 32 0.350 92.50  -1.5
hexprism 33 0.350 105.6  -20.0
media 4 1 1
media 3 1 2 -1
media 4 1 11
media 3 1 12 -11
media 4 1 21
media 3 1 22 -21
media 4 1 31 -22 -21 -12 -11 -2 -1
media 3 1 32 -31 -22 -21 -12 -11 -2 -1
media 4 1 33 -32 -31 -22 -21 -12 -11 -2 -1
boundary 33
unit 4
```

```
cylinder  1 0.205 86.18  86.10
hexprism  2 0.350 86.18  86.10
cylinder 11 0.260 42.85  42.75
hexprism 12 0.350 42.85  42.75
cylinder 21 0.260 -3.50  -3.60
hexprism 22 0.350 -3.50  -3.60
hexprism 31 0.350 86.7   -6.9
hexprism 32 0.350 87.15  -7.2
hexprism 33 0.350 105.6  -20.0
media 4 1 1
media 3 1 2 -1
media 4 1 11
media 3 1 12 -11
media 4 1 21
media 3 1 22 -21
media 4 1 31 -22 -21 -12 -11 -2 -1
media 3 1 32 -31 -22 -21 -12 -11 -2 -1
media 4 1 33 -32 -31 -22 -21 -12 -11 -2 -1
boundary 33
global unit 5
cylinder 1  23.05 105.6 -20.0
array 1 1 place 40 41 1 3*0.0
cylinder 2  32.00 87.15 87.00
cylinder 3  53.53 105.6 -20.0
media 5 1 2 -1
media 4 1 3 -2 -1
boundary 3
end geom
read array ara=1 typ=triangular nux=81 nuy=81 nuz=1 fill
1134r3
49r3    1r2 1r3  3q2 1r2  23r3
81r3
45r3    1r2 1r3  7q2 1r2  19r3
81r3
41r3    1r2 1r3 10q2 1r2  17r3
81r3
37r3    1r2 1r3 13q2 1r2  15r3
81r3
33r3    1r2 1r3 15q2 1r2  15r3
81r3
29r3    1r2 1r3 17q2 1r2  15r3
81r3
27r3    1r2 1r3 18q2 1r2  15r3
81r3
25r3    1r2 1r3  6q2   1r1 1r4  5q2 1r1   1r3 1r2  6q2  15r3
38r3 14r4  29r3
23r3    1r2 1r3  6q2   1r1 1r4  6q2 1r1   1r3 1r2  6q2  15r3
36r3 16r4  29r3
21r3    1r2 1r3  6q2   1r1 1r4  7q2 1r1   1r3 1r2  5q2  17r3
34r3 18r4  29r3
21r3    1r2 1r3  5q2   1r1 1r4  8q2 1r1   1r3 1r2  5q2  17r3
32r3 20r4  29r3
19r3    1r2 1r3  5q2   1r1 1r4  9q2 1r1   1r3 1r2  5q2  17r3
30r3 22r4  29r3
19r3    1r2 1r3  4q2   1r1 1r4 10q2 1r1   1r3 1r2  4q2  19r3
28r3 24r4  29r3
17r3    1r2 1r3  4q2   1r1 1r4 11q2 1r1   1r3 1r2  4q2  19r3
27r3 24r4  30r3
17r3    1r2 1r3  4q2   1r1 1r4 10q2 1r1   1r3 1r2  4q2  21r3
27r3 22r4  32r3
15r3    1r2 1r3  5q2   1r1 1r4  9q2 1r1   1r3 1r2  5q2  21r3
27r3 20r4  34r3
15r3    1r2 1r3  5q2   1r1 1r4  8q2 1r1   1r3 1r2  5q2  23r3
27r3 18r4  36r3
```

```
15r3    1r2 1r3  5q2   1r1 1r4  7q2 1r1   1r3 1r2  6q2  23r3
27r3 16r4  38r3
13r3    1r2 1r3  6q2   1r1 1r4  6q2 1r1   1r3 1r2  6q2  25r3
27r3 14r4  40r3
13r3    1r2 1r3  6q2   1r1 1r4  5q2 1r1   1r3 1r2  6q2  27r3
81r3
13r3    1r2 1r3 18q2 1r2  29r3
81r3
13r3    1r2 1r3 17q2 1r2  31r3
81r3
13r3    1r2 1r3 15q2 1r2  35r3
81r3
15r3    1r2 1r3 13q2 1r2  37r3
81r3
17r3    1r2 1r3 10q2 1r2  41r3
81r3
19r3    1r2 1r3  7q2 1r2  45r3
81r3
23r3    1r2 1r3  3q2 1r2  49r3
1134r3
end fill
end array
read start nst=1  xsm=-16.1  xsp=16.1  ysm=-16.1  ysp=16.1
zsm=0.0  zsp=85.6 end start
end data
end
•
=csas26        parm=centrm
LEU-COMP-THERM-032, Case #6
238g   lat
u-234 1 0 1.7636e-5 end
u-235 1 0 2.1577e-3 end
u-236 1 0 1.5300e-5 end
u-238 1 0 1.9510e-2 end
o     1 0 4.4661e-2 end
fe    2 0 5.8894e-2 end
cr    2 0 1.6469e-2 end
ni    2 0 8.1061e-3 end
si    2 0 1.3551e-3 end
mn    2 0 1.2990e-3 end
c     2 0 2.3766e-4 end
ti    2 0 4.4713e-4 end
fe    3 0 5.8843e-2 end
cr    3 0 1.6469e-2 end
ni    3 0 8.1061e-3 end
si    3 0 1.3551e-3 end
mn    3 0 1.2990e-3 end
c     3 0 4.7531e-4 end
ti    3 0 4.4713e-4 end
h     4 0 5.1717e-2 end
o     4 0 2.5859e-2 end
fe    5 0 3.3364e-2 end
cr    5 0 9.3379e-3 end
ni    5 0 4.5962e-3 end
si    5 0 7.6834e-4 end
mn    5 0 7.3653e-4 end
c     5 0 2.6950e-4 end
ti    5 0 2.5352e-4 end
h     5 0 2.2393e-2 end
o     5 0 1.1197e-2 end
end comp
triangpitch 0.7 0.416 1 4 0.51 2 0.43 0 end
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
```

```
unit 1
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.4   -1.1
cylinder 3  0.100 86.7   -4.8
cylinder 4  0.100 86.7   -6.9
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.6   -0.3
cylinder 13 0.208 86.7   -4.8
cylinder 14 0.208 86.7   -6.9
cylinder 21 0.215 85.6   -0.3
cylinder 22 0.215 86.7   -1.9
cylinder 23 0.215 86.7   -3.6
cylinder 24 0.215 86.7   -6.9
cylinder 31 0.255 85.6   -1.9
cylinder 32 0.255 86.7   -4.4
cylinder 33 0.255 86.7   -6.9
cylinder 41 0.260 -3.5   -3.6
hexprism 42 0.350 -3.5   -3.6
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 86.18  86.10
cylinder 71 0.300 86.7   -5.4
cylinder 72 0.300 86.7   -6.9
hexprism 81 0.350 86.7   -6.9
hexprism 82 0.350 87.15  -7.2
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 2
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.7   -0.8
cylinder 3  0.100 90.4   -1.1
cylinder 4  0.100 92.5   -1.1
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.9    0.0
```

```
cylinder 13 0.208 90.4   -1.1
cylinder 14 0.208 92.5   -1.1
cylinder 21 0.215 85.9    0.0
cylinder 22 0.215 87.5   -1.1
cylinder 23 0.215 89.2   -1.1
cylinder 24 0.215 92.5   -1.1
cylinder 31 0.255 85.9    0.0
cylinder 32 0.255 90.0   -1.1
cylinder 33 0.255 92.5   -1.1
cylinder 41 0.260 87.15  87.00
hexprism 42 0.350 87.15  87.00
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 -0.60  -0.70
cylinder 71 0.300 91.00  -1.1
cylinder 72 0.300 92.50  -1.1
hexprism 81 0.350 92.50  -1.1
hexprism 82 0.350 92.50  -1.5
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 3
cylinder  1 0.260 87.15  87.00
hexprism  2 0.350 87.15  87.00
cylinder 11 0.260 42.85  42.75
hexprism 12 0.350 42.85  42.75
cylinder 21 0.205 -0.60  -0.70
hexprism 22 0.350 -0.60  -0.70
hexprism 31 0.350 92.50  -1.1
hexprism 32 0.350 92.50  -1.5
hexprism 33 0.350 105.6  -20.0
media 4 1 1
media 3 1 2 -1
media 4 1 11
media 3 1 12 -11
```

```
media 4 1 21
media 3 1 22 -21
media 4 1 31 -22 -21 -12 -11 -2 -1
media 3 1 32 -31 -22 -21 -12 -11 -2 -1
media 4 1 33 -32 -31 -22 -21 -12 -11 -2 -1
boundary 33
unit 4
cylinder  1 0.205 86.18  86.10
hexprism  2 0.350 86.18  86.10
cylinder 11 0.260 42.85  42.75
hexprism 12 0.350 42.85  42.75
cylinder 21 0.260 -3.50  -3.60
hexprism 22 0.350 -3.50  -3.60
hexprism 31 0.350 86.7   -6.9
hexprism 32 0.350 87.15  -7.2
hexprism 33 0.350 105.6  -20.0
media 4 1 1
media 3 1 2 -1
media 4 1 11
media 3 1 12 -11
media 4 1 21
media 3 1 22 -21
media 4 1 31 -22 -21 -12 -11 -2 -1
media 3 1 32 -31 -22 -21 -12 -11 -2 -1
media 4 1 33 -32 -31 -22 -21 -12 -11 -2 -1
boundary 33
global unit 5
cylinder 1  23.05 105.6 -20.0
array 1 1 place 42 41 1 3*0.0
cylinder 2  32.00 87.15 87.00
cylinder 3  53.53 105.6 -20.0
media 5 1 2 -1
media 4 1 3 -2 -1
boundary 3
end geom
read array ara=1 typ=triangular nux=81 nuy=81 nuz=1 fill
972r3
49r3    1r2 1r3  4q2 1r2  21r3
81r3
45r3    1r2 1r3  8q2 1r2  17r3
81r3
41r3    1r2 1r3 11q2 1r2  15r3
81r3
37r3    1r2 1r3 14q2 1r2  13r3
81r3
35r3    1r2 1r3 16q2 1r2  11r3
81r3
31r3    1r2 1r3 18q2 1r2  11r3
81r3
29r3    1r2 1r3 19q2 1r2  11r3
81r3
27r3    1r2 1r3 20q2 1r2  11r3
81r3
25r3    1r2 1r3  7q2   1r1 1r4  5q2 1r1   1r3 1r2  7q2  11r3
40r3 14r4  27r3
23r3    1r2 1r3  7q2   1r1 1r4  6q2 1r1   1r3 1r2  7q2  11r3
38r3 16r4  27r3
21r3    1r2 1r3  7q2   1r1 1r4  7q2 1r1   1r3 1r2  6q2  13r3
36r3 18r4  27r3
21r3    1r2 1r3  6q2   1r1 1r4  8q2 1r1   1r3 1r2  6q2  13r3
34r3 20r4  27r3
19r3    1r2 1r3  6q2   1r1 1r4  9q2 1r1   1r3 1r2  6q2  13r3
32r3 22r4  27r3
19r3    1r2 1r3  5q2   1r1 1r4 10q2 1r1   1r3 1r2  5q2  15r3
```

```
30r3 24r4  27r3
17r3    1r2 1r3  5q2   1r1 1r4 11q2 1r1   1r3 1r2  5q2  15r3
29r3 24r4  28r3
17r3    1r2 1r3  5q2   1r1 1r4 10q2 1r1   1r3 1r2  5q2  17r3
29r3 22r4  30r3
15r3    1r2 1r3  6q2   1r1 1r4  9q2 1r1   1r3 1r2  6q2  17r3
29r3 20r4  32r3
15r3    1r2 1r3  6q2   1r1 1r4  8q2 1r1   1r3 1r2  6q2  19r3
29r3 18r4  34r3
15r3    1r2 1r3  6q2   1r1 1r4  7q2 1r1   1r3 1r2  7q2  19r3
29r3 16r4  36r3
13r3    1r2 1r3  7q2   1r1 1r4  6q2 1r1   1r3 1r2  7q2  21r3
29r3 14r4  38r3
13r3    1r2 1r3  7q2   1r1 1r4  5q2 1r1   1r3 1r2  7q2  23r3
81r3
13r3    1r2 1r3 20q2 1r2  25r3
81r3
13r3    1r2 1r3 19q2 1r2  27r3
81r3
13r3    1r2 1r3 18q2 1r2  29r3
81r3
13r3    1r2 1r3 16q2 1r2  33r3
81r3
15r3    1r2 1r3 14q2 1r2  35r3
81r3
17r3    1r2 1r3 11q2 1r2  39r3
81r3
19r3    1r2 1r3  8q2 1r2  43r3
81r3
23r3    1r2 1r3  4q2 1r2  47r3
972r3
end fill
end array
read start nst=1  xsm=-14.8  xsp=14.8  ysm=-14.8  ysp=14.9
zsm=0.0  zsp=85.6 end start
end data
end
•
=csas26       parm=centrm
LEU-COMP-THERM-032, Case #7
238g   lat
u-234 1 0 1.7636e-5 end
u-235 1 0 2.1577e-3 end
u-236 1 0 1.5300e-5 end
u-238 1 0 1.9510e-2 end
o     1 0 4.4661e-2 end
fe    2 0 5.8894e-2 end
cr    2 0 1.6469e-2 end
ni    2 0 8.1061e-3 end
si    2 0 1.3551e-3 end
mn    2 0 1.2990e-3 end
c     2 0 2.3766e-4 end
ti    2 0 4.4713e-4 end
fe    3 0 5.8843e-2 end
cr    3 0 1.6469e-2 end
ni    3 0 8.1061e-3 end
si    3 0 1.3551e-3 end
mn    3 0 1.2990e-3 end
c     3 0 4.7531e-4 end
ti    3 0 4.4713e-4 end
h     4 0 6.6736e-2 end
o     4 0 3.3368e-2 end
fe    5 0 3.3364e-2 end
cr    5 0 9.3379e-3 end
```

```
ni    5 0 4.5962e-3 end
si    5 0 7.6834e-4 end
mn    5 0 7.3653e-4 end
c     5 0 2.6950e-4 end
ti    5 0 2.5352e-4 end
h     5 0 2.8897e-2 end
o     5 0 1.4448e-2 end
end comp
triangpitch 0.7 0.416 1 4 0.51 2 0.43 0 end
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
unit 1
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.4   -1.1
cylinder 3  0.100 86.7   -4.8
cylinder 4  0.100 86.7   -6.9
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.6   -0.3
cylinder 13 0.208 86.7   -4.8
cylinder 14 0.208 86.7   -6.9
cylinder 21 0.215 85.6   -0.3
cylinder 22 0.215 86.7   -1.9
cylinder 23 0.215 86.7   -3.6
cylinder 24 0.215 86.7   -6.9
cylinder 31 0.255 85.6   -1.9
cylinder 32 0.255 86.7   -4.4
cylinder 33 0.255 86.7   -6.9
cylinder 41 0.260 -3.5   -3.6
hexprism 42 0.350 -3.5   -3.6
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 86.18  86.10
cylinder 71 0.300 86.7   -5.4
cylinder 72 0.300 86.7   -6.9
hexprism 81 0.350 86.7   -6.9
hexprism 82 0.350 87.15  -7.2
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
```

```
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 2
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.7   -0.8
cylinder 3  0.100 90.4   -1.1
cylinder 4  0.100 92.5   -1.1
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.9    0.0
cylinder 13 0.208 90.4   -1.1
cylinder 14 0.208 92.5   -1.1
cylinder 21 0.215 85.9    0.0
cylinder 22 0.215 87.5   -1.1
cylinder 23 0.215 89.2   -1.1
cylinder 24 0.215 92.5   -1.1
cylinder 31 0.255 85.9    0.0
cylinder 32 0.255 90.0   -1.1
cylinder 33 0.255 92.5   -1.1
cylinder 41 0.260 87.15  87.00
hexprism 42 0.350 87.15  87.00
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 -0.60  -0.70
cylinder 71 0.300 91.00  -1.1
cylinder 72 0.300 92.50  -1.1
hexprism 81 0.350 92.50  -1.1
hexprism 82 0.350 92.50  -1.5
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 3
cylinder  1 0.260 87.15  87.00
hexprism  2 0.350 87.15  87.00
```

```
cylinder 11 0.260 42.85  42.75
hexprism 12 0.350 42.85  42.75
cylinder 21 0.205 -0.60  -0.70
hexprism 22 0.350 -0.60  -0.70
hexprism 31 0.350 92.50  -1.1
hexprism 32 0.350 92.50  -1.5
hexprism 33 0.350 105.6  -20.0
media 4 1 1
media 3 1 2 -1
media 4 1 11
media 3 1 12 -11
media 4 1 21
media 3 1 22 -21
media 4 1 31 -22 -21 -12 -11 -2 -1
media 3 1 32 -31 -22 -21 -12 -11 -2 -1
media 4 1 33 -32 -31 -22 -21 -12 -11 -2 -1
boundary 33
unit 4
cylinder  1 0.205 86.18  86.10
hexprism  2 0.350 86.18  86.10
cylinder 11 0.260 42.85  42.75
hexprism 12 0.350 42.85  42.75
cylinder 21 0.260 -3.50  -3.60
hexprism 22 0.350 -3.50  -3.60
hexprism 31 0.350 86.7   -6.9
hexprism 32 0.350 87.15  -7.2
hexprism 33 0.350 105.6  -20.0
media 4 1 1
media 3 1 2 -1
media 4 1 11
media 3 1 12 -11
media 4 1 21
media 3 1 22 -21
media 4 1 31 -22 -21 -12 -11 -2 -1
media 3 1 32 -31 -22 -21 -12 -11 -2 -1
media 4 1 33 -32 -31 -22 -21 -12 -11 -2 -1
boundary 33
global unit 5
cylinder 1  23.05 105.6 -20.0
array 1 1 place 45 45 1 3*0.0
cylinder 2  32.00 87.15 87.00
cylinder 3  53.53 105.6 -20.0
media 5 1 2 -1
media 4 1 3 -2 -1
boundary 3
end geom
read array ara=1 typ=triangular nux=89 nuy=89 nuz=1 fill
623r3
61r3   2            27r3
56r3   2 6r3     2  25r3
58r3   2 6r3     2  23r3
53r3   2 6r3 1q7 2  21r3
48r3   2 6r3 2q7 2  19r3
50r3   2 6r3 2q7 2  17r3
45r3   2 6r3 3q7 2  15r3
47r3   2 6r3 3q7 2  13r3
42r3   2 6r3 4q7 2  11r3
44r3   2 6r3 3q7 2  16r3
39r3   2 6r3 4q7 2  14r3
41r3   2 6r3 4q7 2  12r3
36r3   2 6r3 5q7 2  10r3
38r3   2 6r3 5q7 2   8r3
33r3   2 6r3 5q7 2  13r3
35r3   2 6r3 5q7 2  11r3
```

```
30r3   2 6r3 6q7 2   9r3
32r3   2 6r3 6q7 2   7r3
27r3   2 6r3 6q7 2  12r3
29r3   2 6r3 6q7 2  10r3
24r3   2 6r3 7q7 2   8r3
26r3   2 6r3 6q7 2  13r3
28r3   2 6r3 6q7 2  11r3
23r3   2 6r3 7q7 2   9r3
25r3   2 6r3 6q7 2  14r3
20r3   2 6r3 2q7 2 2r3   4r4 1 6r4     1 1r4   5r3 2 6r3 1q7 2   12r3
22r3   2 6r3 2q7             1 6r4 1q7             2 6r3 2q7 2   10r3
24r3   2 6r3 1q7 2 3r3   3r4 1 6r4     1 4r4   2r3 2 6r3 1q7 2   15r3
19r3   2 6r3 2q7 2       6r4 1 6r4     1 2r4   4r3 2 6r3 1q7 2   13r3
21r3   2 6r3 1q7 2 4r3   2r4 1 6r4 1q7 1       6r3 2 6r3 1q7 2   11r3
23r3   2 6r3 1q7 2 1r3   5r4 1 6r4     1 5r4   1r3 2 6r3 1q7 2   16r3
18r3   2 6r3 1q7 2 5r3   1r4 1 6r4 1q7 1 3r4   3r3 2 6r3 1q7 2   14r3
20r3   2 6r3 1q7 2 2r3   4r4 1 6r4 1q7 1 1r4   5r3 2 6r3 1q7 2   12r3
15r3   2 6r3 2q7             1 6r4 2q7             2 6r3 1q7 2   17r3
17r3   2 6r3 1q7 2 3r3   3r4 1 6r4 1q7 1 4r4   2r3 2 6r3 1q7 2   15r3
19r3   2 6r3 1q7 2       6r4 1 6r4 1q7 1 2r4   4r3 2 6r3 1q7 2   13r3
14r3   2 6r3 1q7 2 4r3   2r4 1 6r4 2q7 1       6r3 2 6r3     2   18r3
16r3   2 6r3 1q7 2 1r3   5r4 1 6r4 1q7 1 5r4   1r3 2 6r3 1q7 2   16r3
18r3   2 6r3 1q7             1 6r4 2q7 1 2r4   4r3 2 6r3 1q7 2   14r3
13r3   2 6r3 1q7 2 4r3   2r4 1 6r4 2q7             2 6r3 1q7 2   19r3
15r3   2 6r3 1q7 2 2r3   4r4 1 6r4 1q7 1 3r4   3r3 2 6r3 1q7 2   17r3
17r3   2 6r3 1q7 2       6r4 1 6r4 1q7 1       6r3 2 6r3 1q7 2   15r3
12r3   2 6r3 1q7 2 5r3   1r4 1 6r4 1q7 1 4r4   2r3 2 6r3 1q7 2   20r3
14r3   2 6r3 1q7 2 3r3   3r4 1 6r4 1q7 1 1r4   5r3 2 6r3 1q7 2   18r3
16r3   2 6r3 1q7 2 1r3   5r4 1 6r4     1 5r4   1r3 2 6r3 1q7 2   23r3
11r3   2 6r3 2q7             1 6r4 1q7 1 2r4   4r3 2 6r3 1q7 2   21r3
13r3   2 6r3 1q7 2 4r3   2r4 1 6r4 1q7             2 6r3 2q7 2   19r3
15r3   2 6r3 1q7 2 2r3   4r4 1 6r4     1 3r4   3r3 2 6r3 1q7 2   24r3
10r3   2 6r3 2q7 2       6r4 1 6r4     1       6r3 2 6r3 1q7 2   22r3
12r3   2 6r3 1q7 2 5r3   1r4 1 6r4     1 4r4   2r3 2 6r3 2q7 2   20r3
14r3   2 6r3 6q7 2  25r3
 9r3   2 6r3 7q7 2  23r3
11r3   2 6r3 6q7 2  28r3
13r3   2 6r3 6q7 2  26r3
 8r3   2 6r3 7q7 2  24r3
10r3   2 6r3 6q7 2  29r3
12r3   2 6r3 6q7 2  27r3
 7r3   2 6r3 6q7 2  32r3
 9r3   2 6r3 6q7 2  30r3
11r3   2 6r3 5q7 2  35r3
13r3   2 6r3 5q7 2  33r3
 8r3   2 6r3 5q7 2  38r3
10r3   2 6r3 5q7 2  36r3
12r3   2 6r3 4q7 2  41r3
14r3   2 6r3 4q7 2  39r3
16r3   2 6r3 3q7 2  44r3
11r3   2 6r3 4q7 2  42r3
13r3   2 6r3 3q7 2  47r3
15r3   2 6r3 3q7 2  45r3
17r3   2 6r3 2q7 2  50r3
19r3   2 6r3 2q7 2  48r3
21r3   2 6r3 1q7 2  53r3
23r3   2 6r3     2  58r3
25r3   2 6r3     2  56r3
27r3   2            61r3
623r3
end fill
end array
read start nst=1  xsm=-14.8  xsp=14.8  ysm=-14.8  ysp=14.9
zsm=0.0  zsp=85.6 end start
```

```
end data
end
•
=csas26       parm=centrm
LEU-COMP-THERM-032, Case #8
238g   lat
u-234 1 0 1.7636e-5 end
u-235 1 0 2.1577e-3 end
u-236 1 0 1.5300e-5 end
u-238 1 0 1.9510e-2 end
o     1 0 4.4661e-2 end
fe    2 0 5.8894e-2 end
cr    2 0 1.6469e-2 end
ni    2 0 8.1061e-3 end
si    2 0 1.3551e-3 end
mn    2 0 1.2990e-3 end
c     2 0 2.3766e-4 end
ti    2 0 4.4713e-4 end
fe    3 0 5.8843e-2 end
cr    3 0 1.6469e-2 end
ni    3 0 8.1061e-3 end
si    3 0 1.3551e-3 end
mn    3 0 1.2990e-3 end
c     3 0 4.7531e-4 end
ti    3 0 4.4713e-4 end
h     4 0 5.8977e-2 end
o     4 0 2.9488e-2 end
fe    5 0 3.3364e-2 end
cr    5 0 9.3379e-3 end
ni    5 0 4.5962e-3 end
si    5 0 7.6834e-4 end
mn    5 0 7.3653e-4 end
c     5 0 2.6950e-4 end
ti    5 0 2.5352e-4 end
h     5 0 2.5537e-2 end
o     5 0 1.2768e-2 end
end comp
triangpitch 0.7 0.416 1 4 0.51 2 0.43 0 end
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
unit 1
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.4   -1.1
cylinder 3  0.100 86.7   -4.8
cylinder 4  0.100 86.7   -6.9
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.6   -0.3
cylinder 13 0.208 86.7   -4.8
cylinder 14 0.208 86.7   -6.9
cylinder 21 0.215 85.6   -0.3
cylinder 22 0.215 86.7   -1.9
cylinder 23 0.215 86.7   -3.6
cylinder 24 0.215 86.7   -6.9
cylinder 31 0.255 85.6   -1.9
cylinder 32 0.255 86.7   -4.4
cylinder 33 0.255 86.7   -6.9
cylinder 41 0.260 -3.5   -3.6
hexprism 42 0.350 -3.5   -3.6
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 86.18  86.10
cylinder 71 0.300 86.7   -5.4
cylinder 72 0.300 86.7   -6.9
hexprism 81 0.350 86.7   -6.9
```

```
hexprism 82 0.350 87.15  -7.2
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 2
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.7   -0.8
cylinder 3  0.100 90.4   -1.1
cylinder 4  0.100 92.5   -1.1
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.9    0.0
cylinder 13 0.208 90.4   -1.1
cylinder 14 0.208 92.5   -1.1
cylinder 21 0.215 85.9    0.0
cylinder 22 0.215 87.5   -1.1
cylinder 23 0.215 89.2   -1.1
cylinder 24 0.215 92.5   -1.1
cylinder 31 0.255 85.9    0.0
cylinder 32 0.255 90.0   -1.1
cylinder 33 0.255 92.5   -1.1
cylinder 41 0.260 87.15  87.00
hexprism 42 0.350 87.15  87.00
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 -0.60  -0.70
cylinder 71 0.300 91.00  -1.1
cylinder 72 0.300 92.50  -1.1
hexprism 81 0.350 92.50  -1.1
hexprism 82 0.350 92.50  -1.5
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
```

```
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 3
cylinder  1 0.260 87.15  87.00
hexprism  2 0.350 87.15  87.00
cylinder 11 0.260 42.85  42.75
hexprism 12 0.350 42.85  42.75
cylinder 21 0.205 -0.60  -0.70
hexprism 22 0.350 -0.60  -0.70
hexprism 31 0.350 92.50  -1.1
hexprism 32 0.350 92.50  -1.5
hexprism 33 0.350 105.6  -20.0
media 4 1 1
media 3 1 2 -1
media 4 1 11
media 3 1 12 -11
media 4 1 21
media 3 1 22 -21
media 4 1 31 -22 -21 -12 -11 -2 -1
media 3 1 32 -31 -22 -21 -12 -11 -2 -1
media 4 1 33 -32 -31 -22 -21 -12 -11 -2 -1
boundary 33
unit 4
cylinder  1 0.205 86.18  86.10
hexprism  2 0.350 86.18  86.10
cylinder 11 0.260 42.85  42.75
hexprism 12 0.350 42.85  42.75
cylinder 21 0.260 -3.50  -3.60
hexprism 22 0.350 -3.50  -3.60
hexprism 31 0.350 86.7   -6.9
hexprism 32 0.350 87.15  -7.2
hexprism 33 0.350 105.6  -20.0
media 4 1 1
media 3 1 2 -1
media 4 1 11
media 3 1 12 -11
media 4 1 21
media 3 1 22 -21
media 4 1 31 -22 -21 -12 -11 -2 -1
media 3 1 32 -31 -22 -21 -12 -11 -2 -1
```

```
media 4 1 33 -32 -31 -22 -21 -12 -11 -2 -1
boundary 33
global unit 5
cylinder 1  23.05 105.6 -20.0
array 1 1 place 45 45 1 3*0.0
cylinder 2  32.00 87.15 87.00
cylinder 3  53.53 105.6 -20.0
media 5 1 2 -1
media 4 1 3 -2 -1
boundary 3
end geom
read array ara=1 typ=triangular nux=89 nuy=89 nuz=1 fill
623r3
61r3   2            27r3
56r3   2 6r3     2  25r3
58r3   2 6r3     2  23r3
53r3   2 6r3 1q7 2  21r3
48r3   2 6r3 2q7 2  19r3
50r3   2 6r3 2q7 2  17r3
45r3   2 6r3 3q7 2  15r3
47r3   2 6r3 3q7 2  13r3
42r3   2 6r3 4q7 2  11r3
44r3   2 6r3 3q7 2  16r3
39r3   2 6r3 4q7 2  14r3
41r3   2 6r3 4q7 2  12r3
36r3   2 6r3 5q7 2  10r3
38r3   2 6r3 5q7 2   8r3
33r3   2 6r3 5q7 2  13r3
35r3   2 6r3 5q7 2  11r3
30r3   2 6r3 6q7 2   9r3
32r3   2 6r3 6q7 2   7r3
27r3   2 6r3 6q7 2  12r3
29r3   2 6r3 6q7 2  10r3
24r3   2 6r3 7q7 2   8r3
26r3   2 6r3 6q7 2  13r3
28r3   2 6r3 6q7 2  11r3
23r3   2 6r3 7q7 2   9r3
25r3   2 6r3 6q7 2  14r3
20r3   2 6r3 2q7 2 2r3   4r4 1 6r4     1 1r4   5r3 2 6r3 1q7 2   12r3
22r3   2 6r3 2q7             1 6r4 1q7             2 6r3 2q7 2   10r3
24r3   2 6r3 1q7 2 3r3   3r4 1 6r4     1 4r4   2r3 2 6r3 1q7 2   15r3
19r3   2 6r3 2q7 2       6r4 1 6r4     1 2r4   4r3 2 6r3 1q7 2   13r3
21r3   2 6r3 1q7 2 4r3   2r4 1 6r4 1q7 1       6r3 2 6r3 1q7 2   11r3
23r3   2 6r3 1q7 2 1r3   5r4 1 6r4     1 5r4   1r3 2 6r3 1q7 2   16r3
18r3   2 6r3 1q7 2 5r3   1r4 1 6r4 1q7 1 3r4   3r3 2 6r3 1q7 2   14r3
20r3   2 6r3 1q7 2 2r3   4r4 1 6r4 1q7 1 1r4   5r3 2 6r3 1q7 2   12r3
15r3   2 6r3 2q7             1 6r4 2q7             2 6r3 1q7 2   17r3
17r3   2 6r3 1q7 2 3r3   3r4 1 6r4 1q7 1 4r4   2r3 2 6r3 1q7 2   15r3
19r3   2 6r3 1q7 2       6r4 1 6r4 1q7 1 2r4   4r3 2 6r3 1q7 2   13r3
14r3   2 6r3 1q7 2 4r3   2r4 1 6r4 2q7 1       6r3 2 6r3     2   18r3
16r3   2 6r3 1q7 2 1r3   5r4 1 6r4 1q7 1 5r4   1r3 2 6r3 1q7 2   16r3
18r3   2 6r3 1q7             1 6r4 2q7 1 2r4   4r3 2 6r3 1q7 2   14r3
13r3   2 6r3 1q7 2 4r3   2r4 1 6r4 2q7             2 6r3 1q7 2   19r3
15r3   2 6r3 1q7 2 2r3   4r4 1 6r4 1q7 1 3r4   3r3 2 6r3 1q7 2   17r3
17r3   2 6r3 1q7 2       6r4 1 6r4 1q7 1       6r3 2 6r3 1q7 2   15r3
12r3   2 6r3 1q7 2 5r3   1r4 1 6r4 1q7 1 4r4   2r3 2 6r3 1q7 2   20r3
14r3   2 6r3 1q7 2 3r3   3r4 1 6r4 1q7 1 1r4   5r3 2 6r3 1q7 2   18r3
16r3   2 6r3 1q7 2 1r3   5r4 1 6r4     1 5r4   1r3 2 6r3 1q7 2   23r3
11r3   2 6r3 2q7             1 6r4 1q7 1 2r4   4r3 2 6r3 1q7 2   21r3
13r3   2 6r3 1q7 2 4r3   2r4 1 6r4 1q7             2 6r3 2q7 2   19r3
15r3   2 6r3 1q7 2 2r3   4r4 1 6r4     1 3r4   3r3 2 6r3 1q7 2   24r3
10r3   2 6r3 2q7 2       6r4 1 6r4     1       6r3 2 6r3 1q7 2   22r3
12r3   2 6r3 1q7 2 5r3   1r4 1 6r4     1 4r4   2r3 2 6r3 2q7 2   20r3
14r3   2 6r3 6q7 2  25r3
```

```
 9r3   2 6r3 7q7 2  23r3
11r3   2 6r3 6q7 2  28r3
13r3   2 6r3 6q7 2  26r3
 8r3   2 6r3 7q7 2  24r3
10r3   2 6r3 6q7 2  29r3
12r3   2 6r3 6q7 2  27r3
 7r3   2 6r3 6q7 2  32r3
 9r3   2 6r3 6q7 2  30r3
11r3   2 6r3 5q7 2  35r3
13r3   2 6r3 5q7 2  33r3
 8r3   2 6r3 5q7 2  38r3
10r3   2 6r3 5q7 2  36r3
12r3   2 6r3 4q7 2  41r3
14r3   2 6r3 4q7 2  39r3
16r3   2 6r3 3q7 2  44r3
11r3   2 6r3 4q7 2  42r3
13r3   2 6r3 3q7 2  47r3
15r3   2 6r3 3q7 2  45r3
17r3   2 6r3 2q7 2  50r3
19r3   2 6r3 2q7 2  48r3
21r3   2 6r3 1q7 2  53r3
23r3   2 6r3     2  58r3
25r3   2 6r3     2  56r3
27r3   2            61r3
623r3
end fill
end array
read start nst=1  xsm=-14.8  xsp=14.8  ysm=-14.8  ysp=14.9
zsm=0.0  zsp=85.6 end start
end data
end
•
=csas26       parm=centrm
LEU-COMP-THERM-032, Case #9
238g   lat
u-234 1 0 1.7636e-5 end
u-235 1 0 2.1577e-3 end
u-236 1 0 1.5300e-5 end
u-238 1 0 1.9510e-2 end
o     1 0 4.4661e-2 end
fe    2 0 5.8894e-2 end
cr    2 0 1.6469e-2 end
ni    2 0 8.1061e-3 end
si    2 0 1.3551e-3 end
mn    2 0 1.2990e-3 end
c     2 0 2.3766e-4 end
ti    2 0 4.4713e-4 end
fe    3 0 5.8843e-2 end
cr    3 0 1.6469e-2 end
ni    3 0 8.1061e-3 end
si    3 0 1.3551e-3 end
mn    3 0 1.2990e-3 end
c     3 0 4.7531e-4 end
ti    3 0 4.4713e-4 end
h     4 0 5.2913e-2 end
o     4 0 2.6456e-2 end
fe    5 0 3.3364e-2 end
cr    5 0 9.3379e-3 end
ni    5 0 4.5962e-3 end
si    5 0 7.6834e-4 end
mn    5 0 7.3653e-4 end
c     5 0 2.6950e-4 end
ti    5 0 2.5352e-4 end
h     5 0 2.2911e-2 end
```

```
o     5 0 1.1455e-2 end
end comp
triangpitch 0.7 0.416 1 4 0.51 2 0.43 0 end
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
unit 1
cylinder 1  0.100 85.6    0.0
cylinder 2  0.100 86.4   -1.1
cylinder 3  0.100 86.7   -4.8
cylinder 4  0.100 86.7   -6.9
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.6   -0.3
cylinder 13 0.208 86.7   -4.8
cylinder 14 0.208 86.7   -6.9
cylinder 21 0.215 85.6   -0.3
cylinder 22 0.215 86.7   -1.9
cylinder 23 0.215 86.7   -3.6
cylinder 24 0.215 86.7   -6.9
cylinder 31 0.255 85.6   -1.9
cylinder 32 0.255 86.7   -4.4
cylinder 33 0.255 86.7   -6.9
cylinder 41 0.260 -3.5   -3.6
hexprism 42 0.350 -3.5   -3.6
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 86.18  86.10
cylinder 71 0.300 86.7   -5.4
cylinder 72 0.300 86.7   -6.9
hexprism 81 0.350 86.7   -6.9
hexprism 82 0.350 87.15  -7.2
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 2
cylinder 1  0.100 85.6    0.0
```

```
cylinder 2  0.100 86.7   -0.8
cylinder 3  0.100 90.4   -1.1
cylinder 4  0.100 92.5   -1.1
cylinder 11 0.208 85.6    0.0
cylinder 12 0.208 85.9    0.0
cylinder 13 0.208 90.4   -1.1
cylinder 14 0.208 92.5   -1.1
cylinder 21 0.215 85.9    0.0
cylinder 22 0.215 87.5   -1.1
cylinder 23 0.215 89.2   -1.1
cylinder 24 0.215 92.5   -1.1
cylinder 31 0.255 85.9    0.0
cylinder 32 0.255 90.0   -1.1
cylinder 33 0.255 92.5   -1.1
cylinder 41 0.260 87.15  87.00
hexprism 42 0.350 87.15  87.00
cylinder 51 0.260 42.85  42.75
hexprism 52 0.350 42.85  42.75
hexprism 61 0.350 -0.60  -0.70
cylinder 71 0.300 91.00  -1.1
cylinder 72 0.300 92.50  -1.1
hexprism 81 0.350 92.50  -1.1
hexprism 82 0.350 92.50  -1.5
hexprism 83 0.350 105.6  -20.0
media 1 1 1
media 0 1 2  -1
media 2 1 3  -2  -1
media 4 1 4  -3  -2  -1
media 1 1 11 -4  -3  -2  -1
media 0 1 12 -11 -4  -3  -2 -1
media 2 1 13 -12 -11 -4  -3 -2 -1
media 4 1 14 -13 -12 -11 -4 -3 -2 -1
media 0 1 21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 41 -33 -32 -24 -23 -14 -13 -4 -3
media 3 1 42 -41 -33 -32 -24 -23 -14 -13 -4 -3
media 4 1 51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 52 -51 -33 -32 -31 -24 -23 -22 -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 61 -33 -32 -24 -23 -22 -14 -13 -4 -3 -2
media 4 1 71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 2 1 72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 3 1 82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
media 4 1 83 -82 -81 -72 -71 -61 -52 -51 -42 -41 -33 -32 -31 -24 -23 -22
             -21 -14 -13 -12 -11 -4 -3 -2 -1
boundary 83
unit 3
cylinder  1 0.260 87.15  87.00
hexprism  2 0.350 87.15  87.00
cylinder 11 0.260 42.85  42.75
hexprism 12 0.350 42.85  42.75
cylinder 21 0.205 -0.60  -0.70
hexprism 22 0.350 -0.60  -0.70
hexprism 31 0.350 92.50  -1.1
hexprism 32 0.350 92.50  -1.5
```

```
hexprism 33 0.350 105.6  -20.0
media 4 1 1
media 3 1 2 -1
media 4 1 11
media 3 1 12 -11
media 4 1 21
media 3 1 22 -21
media 4 1 31 -22 -21 -12 -11 -2 -1
media 3 1 32 -31 -22 -21 -12 -11 -2 -1
media 4 1 33 -32 -31 -22 -21 -12 -11 -2 -1
boundary 33
unit 4
cylinder  1 0.205 86.18  86.10
hexprism  2 0.350 86.18  86.10
cylinder 11 0.260 42.85  42.75
hexprism 12 0.350 42.85  42.75
cylinder 21 0.260 -3.50  -3.60
hexprism 22 0.350 -3.50  -3.60
hexprism 31 0.350 86.7   -6.9
hexprism 32 0.350 87.15  -7.2
hexprism 33 0.350 105.6  -20.0
media 4 1 1
media 3 1 2 -1
media 4 1 11
media 3 1 12 -11
media 4 1 21
media 3 1 22 -21
media 4 1 31 -22 -21 -12 -11 -2 -1
media 3 1 32 -31 -22 -21 -12 -11 -2 -1
media 4 1 33 -32 -31 -22 -21 -12 -11 -2 -1
boundary 33
global unit 5
cylinder 1  23.05 105.6 -20.0
array 1 1 place 45 45 1 3*0.0
cylinder 2  32.00 87.15 87.00
cylinder 3  53.53 105.6 -20.0
media 5 1 2 -1
media 4 1 3 -2 -1
boundary 3
end geom
read array ara=1 typ=triangular nux=89 nuy=89 nuz=1 fill
623r3
61r3   2 6r3     2  20r3
56r3   2 6r3 1q7 2  18r3
51r3   2 6r3 2q7 2  16r3
53r3   2 6r3 2q7 2  14r3
48r3   2 6r3 3q7 2  12r3
43r3   2 6r3 3q7 2  17r3
45r3   2 6r3 3q7 2  15r3
40r3   2 6r3 4q7 2  13r3
42r3   2 6r3 4q7 2  11r3
37r3   2 6r3 5q7 2   9r3
39r3   2 6r3 4q7 2  14r3
34r3   2 6r3 5q7 2  12r3
36r3   2 6r3 5q7 2  10r3
31r3   2 6r3 6q7 2   8r3
33r3   2 6r3 5q7 2  13r3
35r3   2 6r3 5q7 2  11r3
30r3   2 6r3 6q7 2   9r3
32r3   2 6r3 6q7 2   7r3
27r3   2 6r3 6q7 2  12r3
29r3   2 6r3 6q7 2  10r3
24r3   2 6r3 7q7 2   8r3
26r3   2 6r3 6q7 2  13r3
```

```
28r3   2 6r3 6q7 2  11r3
23r3   2 6r3 7q7 2   9r3
25r3   2 6r3 1q7 2 4r3   2r4 1 6r4     1 4r4   2r3 2 6r3 2q7 2    7r3
20r3   2 6r3 2q7 2 1r3   5r4 1 6r4     1 2r4   4r3 2 6r3 1q7 2   12r3
22r3   2 6r3 1q7 2 5r3   1r4 1 6r4 1q7 1       6r3 2 6r3 1q7 2   10r3
24r3   2 6r3 1q7 2 2r3   4r4 1 6r4     1 5r4   1r3 2 6r3 2q7 2    8r3
19r3   2 6r3 2q7             1 6r4 1q7 1 3r4   3r3 2 6r3 1q7 2   13r3
21r3   2 6r3 1q7 2 3r3   3r4 1 6r4 1q7 1 1r4   5r3 2 6r3 1q7 2   11r3
16r3   2 6r3 2q7 2       6r4 1 6r4 1q7             2 6r3 2q7 2    9r3
18r3   2 6r3 1q7 2 4r3   2r4 1 6r4 1q7 1 4r4   2r3 2 6r3 1q7 2   14r3
20r3   2 6r3 1q7 2 1r3   5r4 1 6r4 1q7 1 2r4   4r3 2 6r3 1q7 2   12r3
15r3   2 6r3 1q7 2 5r3   1r4 1 6r4 2q7 1       6r3 2 6r3 1q7 2   10r3
17r3   2 6r3 1q7 2 2r3   4r4 1 6r4 1q7 1 5r4   1r3 2 6r3 1q7 2   15r3
19r3   2 6r3 1q7             1 6r4 2q7 1 3r4   3r3 2 6r3 1q7 2   13r3
14r3   2 6r3 1q7 2 3r3   3r4 1 6r4 2q7 1 1r4   5r3 2 6r3 1q7 2   11r3
16r3   2 6r3 1q7 2       6r4 1 6r4 1q7 1 6r4       2 6r3 1q7 2   16r3
11r3   2 6r3 1q7 2 5r3   1r4 1 6r4 2q7 1 3r4   3r3 2 6r3 1q7 2   14r3
13r3   2 6r3 1q7 2 3r3   3r4 1 6r4 2q7 1       6r3 2 6r3     2   19r3
15r3   2 6r3 1q7 2 1r3   5r4 1 6r4 1q7 1 4r4   2r3 2 6r3 1q7 2   17r3
10r3   2 6r3 1q7 2 6r3       1 6r4 2q7 1 1r4   5r3 2 6r3 1q7 2   15r3
12r3   2 6r3 1q7 2 4r3   2r4 1 6r4 1q7 1 5r4   1r3 2 6r3 1q7 2   20r3
14r3   2 6r3 1q7 2 2r3   4r4 1 6r4 1q7 1 2r4   4r3 2 6r3 1q7 2   18r3
 9r3   2 6r3 2q7 2       6r4 1 6r4 1q7             2 6r3 2q7 2   16r3
11r3   2 6r3 1q7 2 5r3   1r4 1 6r4 1q7 1 3r4   3r3 2 6r3 1q7 2   21r3
13r3   2 6r3 1q7 2 3r3   3r4 1 6r4 1q7 1       6r3 2 6r3 1q7 2   19r3
 8r3   2 6r3 2q7 2 1r3   5r4 1 6r4     1 4r4   2r3 2 6r3 1q7 2   24r3
10r3   2 6r3 2q7             1 6r4 1q7 1 1r4   5r3 2 6r3 1q7 2   22r3
12r3   2 6r3 1q7 2 4r3   2r4 1 6r4     1 5r4   1r3 2 6r3 2q7 2   20r3
 7r3   2 6r3 2q7 2 2r3   4r4 1 6r4     1 2r4   4r3 2 6r3 1q7 2   25r3
 9r3   2 6r3 7q7 2  23r3
11r3   2 6r3 6q7 2  28r3
13r3   2 6r3 6q7 2  26r3
 8r3   2 6r3 7q7 2  24r3
10r3   2 6r3 6q7 2  29r3
12r3   2 6r3 6q7 2  27r3
 7r3   2 6r3 6q7 2  32r3
 9r3   2 6r3 6q7 2  30r3
11r3   2 6r3 5q7 2  35r3
13r3   2 6r3 5q7 2  33r3
 8r3   2 6r3 6q7 2  31r3
10r3   2 6r3 5q7 2  36r3
12r3   2 6r3 5q7 2  34r3
14r3   2 6r3 4q7 2  39r3
 9r3   2 6r3 5q7 2  37r3
11r3   2 6r3 4q7 2  42r3
13r3   2 6r3 4q7 2  40r3
15r3   2 6r3 3q7 2  45r3
17r3   2 6r3 3q7 2  43r3
12r3   2 6r3 3q7 2  48r3
14r3   2 6r3 2q7 2  53r3
16r3   2 6r3 2q7 2  51r3
18r3   2 6r3 1q7 2  56r3
20r3   2 6r3     2  61r3
623r3
end fill
end array
read start nst=1  xsm=-20.0  xsp=20.0  ysm=-20.0  ysp=20.0
zsm=0.0  zsp=85.6 end start
end data
end
•
=csas26        parm=centrm
leu-sol-therm-005-001
238g
```

```
read comp
solnuo2(no3)2 1 400.2 1.6 den=1.590 1 293.0 92234 0.03 92235 5.64
            92236 0.05 92238 94.28 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='holes in grid plate'
cylinder 10 2.775 1.7 0.0
hexprism 20 5.3 1.7 0.0
media 1 1 10
media 3 1 20 -10
boundary 20
unit 2
com='blank grid location'
hexprism 20 5.3 1.7 0.0
media 3 1 20
boundary 20
global unit 3
cylinder 10 54.8 1.7 0.0
array 1 10 place 7 7 1 0.0 0.0 0.0
cylinder 20 55.0 58.9839 0.0
cylinder 30 55.0 248.5 58.9839
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 108.0 -37.5
cylinder 60 100 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
media 1 1 20 -10
media 0 1 30
media 3 1 40 -30 -20
media 0 1 70 -40 -50
media 2 1 50 -40
media 3 1 60 -70
boundary 60
end geom
read array ara=1 typ=hexagonal nux=13 nuy=13 nuz=1
loop
2  1 13 1 1 13 1 1 1 1
1  7  7 1 7  7 1 1 1 1
1  5  9 1 4 10 1 1 1 1
1  3  6 1 6 12 1 1 1 1
1  2  8 1 8 11 1 1 1 1
1  8 11 1 2  8 1 1 1 1
1  6 12 1 3  6 1 1 1 1
1  4  4 1 5  5 1 1 1 1
1 10 10 1 9  9 1 1 1 1
end loop
end array
end geom
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.0  zul=248.5 xlr=0.0  ylr=100.0  zlr=-38.5
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on core tank'
xul=0.0  yul=-55.6  zul=70 xlr=0.0  ylr=55.6  zlr=-2
vax=1 wdn=-1 nax=400  end plt1
```

```
ttl='x-y slice at z=20  through core'
xul=-100.0 yul=100.0  zul=20.0 xlr=100.0 ylr=-100.0  zlr=20.0
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=0.5  through plate'
xul=-56.0 yul=56.0  zul=0.5 xlr=56.0 ylr=-56.0  zlr=0.5
uax=1 vdn=-1 nax=400 end plt3
end plot
end data
end
=csas26        parm=centrm
leu-sol-therm-005-002
238g
read comp
solnuo2(no3)2 1 400.2 1.6 den=1.590 1 293.0 92234 0.03 92235 5.64
            92236 0.05 92238 94.28 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='holes in grid plate'
cylinder 10 2.775 1.7 0.0
hexprism 20 5.3 1.7 0.0
media 1 1 10
media 3 1 20 -10
boundary 20
unit 2
com='blank grid location'
hexprism 20 5.3 1.7 0.0
media 3 1 20
boundary 20
unit 3
com='absorber rods'
cylinder 10 2.75 248.5 0.0
cylinder 20 2.25 248.5 0.7
media 4 1 20
media 3 1 10 -20
boundary 10
global unit 4
cylinder 10 54.8 1.7 0.0
cylinder 20 55.0 65.2501 0.0
cylinder 30 55.0 248.5 65.2501
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 108.0 -37.5
cylinder 60 100 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
cylinder 80 2.75 248.5 0.0
array 1 10 -80 place 7 7 1 0.0 0.0 0.0
media 1 1 20 -10 -80
media 0 1 30 -80
media 3 1 40 -30 -20
media 0 1 70 -40 -50
media 2 1 50 -40
media 3 1 60 -70
hole  3 80
boundary 60
end geom
```

```
read array ara=1 typ=hexagonal nux=13 nuy=13 nuz=1
loop
2  1 13 1 1 13 1 1 1 1
1  7  7 1 7  7 1 1 1 1
1  5  9 1 4 10 1 1 1 1
1  3  6 1 6 12 1 1 1 1
1  2  8 1 8 11 1 1 1 1
1  8 11 1 2  8 1 1 1 1
1  6 12 1 3  6 1 1 1 1
1  4  4 1 5  5 1 1 1 1
1 10 10 1 9  9 1 1 1 1
end loop
end array
end geom
end data
end
=csas26        parm=centrm
leu-sol-therm-005-003
238g
read comp
solnuo2(no3)2 1 400.2 1.6 den=1.590 1 293.0 92234 0.03 92235 5.64
            92236 0.05 92238 94.28 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='holes in grid plate'
cylinder 10 2.775 1.7 0.0
hexprism 20 5.3 1.7 0.0
media 1 1 10
media 3 1 20 -10
boundary 20
unit 2
com='blank grid location'
hexprism 20 5.3 1.7 0.0
media 3 1 20
boundary 20
unit 3
com='absorber rods'
cylinder 10 2.75 248.5 0.0
cylinder 20 2.25 248.5 0.7
media 4 1 20
media 3 1 10 -20
boundary 10
global unit 4
cylinder 10 54.8 1.7 0.0
cylinder 20 55.0 106.6233 0.0
cylinder 30 55.0 248.5 106.6233
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 108.0 -37.5
cylinder 60 100.0 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
cylinder 80 2.75 248.5 0.0
cylinder 90 2.75 248.5 0.0 origin x=10.6
cylinder 100 2.75 248.5 0.0 origin x=5.3 y=-9.1799
cylinder 110 2.75 248.5 0.0 origin x=-5.3 y=-9.1799
```

```
cylinder 120 2.75 248.5 0.0 origin x=-10.6
cylinder 130 2.75 248.5 0.0 origin x=-5.3 y=9.1799
cylinder 140 2.75 248.5 0.0 origin x=5.3 y=9.1799
array 1 10 -80 -90 -100 -110 -120 -130 -140 place 7 7 1 0.0 0.0 0.0
media 1 1 20 -10 -80 -90 -100 -110 -120 -130 -140
media 0 1 30 -80 -90 -100 -110 -120 -130 -140
media 3 1 40 -30 -20
media 0 1 70 -40 -50
media 2 1 50 -40
media 3 1 60 -70
hole  3 80
hole  3 90 origin x=10.6
hole  3 100 origin x=5.3 y=-9.1799
hole  3 110 origin x=-5.3 y=-9.1799
hole  3 120 origin x=-10.6
hole  3 130 origin x=-5.3 y=9.1799
hole  3 140 origin x=5.3 y=9.1799
boundary 60
end geom
read array ara=1 typ=hexagonal nux=13 nuy=13 nuz=1
loop
2  1 13 1 1 13 1 1 1 1
1  7  7 1 7  7 1 1 1 1
1  5  9 1 4 10 1 1 1 1
1  3  6 1 6 12 1 1 1 1
1  2  8 1 8 11 1 1 1 1
1  8 11 1 2  8 1 1 1 1
1  6 12 1 3  6 1 1 1 1
1  4  4 1 5  5 1 1 1 1
1 10 10 1 9  9 1 1 1 1
end loop
end array
end geom
end data
end
=csas26        parm=centrm
leu-sol-therm-006-001
238g
read comp
solnuo2(no3)2 1 420.5 0.400 den=1.581 1 293.0 92234 0.09 92235 10.19
            92238 89.72 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='holes in grid plate'
cylinder 10 2.775 1.7 0.0
hexprism 20 5.3 1.7 0.0
media 1 1 10
media 3 1 20 -10
boundary 20
unit 2
com='blank grid location'
hexprism 20 5.3 1.7 0.0
media 3 1 20
boundary 20
```

```
global unit 3
cylinder 10 54.8 1.7 0.0
array 1 10 place 7 7 1 0.0 0.0 0.0
cylinder 20 55.0 23.4174 0.0
cylinder 30 55.0 248.5 23.4174
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 40.0 -37.5
cylinder 60 100 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
media 1 1 20 -10
media 0 1 30
media 3 1 40 -30 -20
media 0 1 70 -40 -50
media 2 1 50 -40
media 3 1 60 -70
boundary 60
end geom
read array ara=1 typ=hexagonal nux=13 nuy=13 nuz=1
fill
2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 1 1 1 1 2 2
  2 2 2 2 2 1 1 1 1 1 1 1 2
   2 2 2 2 1 1 1 1 1 1 1 1 2
    2 2 2 1 1 1 1 1 1 1 1 1 2
     2 2 1 1 1 1 1 1 1 1 1 1 2
      2 2 1 1 1 1 1 1 1 1 1 2 2
       2 1 1 1 1 1 1 1 1 1 1 2 2
        2 1 1 1 1 1 1 1 1 1 2 2 2
         2 1 1 1 1 1 1 1 1 2 2 2 2
          2 1 1 1 1 1 1 1 2 2 2 2 2
           2 2 1 1 1 1 2 2 2 2 2 2 2
            2 2 2 2 2 2 2 2 2 2 2 2 2
end fill
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.0  zul=248.5 xlr=0.0  ylr=100.0  zlr=-38.5
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on core tank'
xul=0.0  yul=-55.6  zul=70 xlr=0.0  ylr=55.6  zlr=-2
vax=1 wdn=-1 nax=400  end plt1
ttl='x-y slice at z=20  through core'
xul=-100.0 yul=100.0  zul=20.0 xlr=100.0 ylr=-100.0  zlr=20.0
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=0.5  through plate'
xul=-56.0 yul=56.0  zul=0.5 xlr=56.0 ylr=-56.0  zlr=0.5
uax=1 vdn=-1 nax=400 end plt3
end plot
end data
end
=csas26         parm=centrm
leu-sol-therm-006-002
238g
read comp
solnuo2(no3)2 1 420.5 0.400 den=1.581 1 293.0 92234 0.09 92235 10.19
            92238 89.72 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
```

```
end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='empty lattice position'
cylinder 10 2.775 1.7 0.0
hexprism 20 5.3 1.7 0.0
hexprism 30 5.3 26.1371 1.7
hexprism 40 5.3 248.5 0.0
media 1 1 10
media 1 1 30
media 3 1 20 -10
media 0 1 40 -30 -20
boundary 40
unit 2
com='blank grid location'
hexprism 20 5.3 1.7 0.0
hexprism 30 5.3 26.1371 1.7
hexprism 40 5.3 248.5 0.0
media 1 1 30
media 3 1 20
media 0 1 40 -30 -20
boundary 40
unit 3
com='absorber rod location'
cylinder 10 2.775 1.7 0.0
hexprism 20 5.3 1.7 0.0
cylinder 30 2.75 248.5 0.0
cylinder 40 2.25 248.5 0.7
hexprism 50 5.3 248.5 0.0
hexprism 60 5.3 26.1371 1.7
media 1 1 10 -30
media 1 1 60 -30
media 3 1 20 -10
media 0 1 50 -60 -20 -30
media 4 1 40
media 3 1 30 -40
boundary 50
global unit 4
cylinder 20 54.8 248.5 0.0
cylinder 30 55.0 248.5 26.1371
cylinder 35 55.0 26.1371 0.0
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 95.0 -37.5
cylinder 60 100 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
array 1 20 place 7 7 1 0.0 0.0 0.0
media 1 1 35 -20
media 3 1 40 -30 -35
media 0 1 70 -40 -50
media 0 1 30 -20
media 2 1 50 -40
media 3 1 60 -70
boundary 60
end geom
read array ara=1 typ=hexagonal nux=13 nuy=13 nuz=1
fill
2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 1 1 1 1 2 2
  2 2 2 2 2 1 1 1 1 1 1 1 2
   2 2 2 2 1 1 3 1 1 3 1 1 2
    2 2 2 1 1 1 1 1 1 1 1 1 2
     2 2 1 1 1 1 1 1 1 1 1 1 2
      2 2 1 3 1 1 3 1 1 3 1 2 2
```

```
       2 1 1 1 1 1 1 1 1 1 1 2 2
        2 1 1 1 1 1 1 1 1 1 2 2 2
         2 1 1 3 1 1 3 1 1 2 2 2 2
          2 1 1 1 1 1 1 1 2 2 2 2 2
           2 2 1 1 1 1 2 2 2 2 2 2 2
            2 2 2 2 2 2 2 2 2 2 2 2 2
end fill
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.0  zul=240 xlr=0.0  ylr=100.0  zlr=-38.5
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on core tank'
xul=0.0  yul=-55.6  zul=70 xlr=0.0  ylr=55.6  zlr=-2
vax=1 wdn=-1 nax=400  end plt1
ttl='x-y slice at z=20  through core'
xul=-100.0 yul=100.0  zul=20.0 xlr=100.0 ylr=-100.0  zlr=20.0
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=0.5  through plate'
xul=-56.0 yul=56.0  zul=0.5 xlr=56.0 ylr=-56.0  zlr=0.5
uax=1 vdn=-1 nax=400 end plt3
end plot
end data
end
=csas26       parm=centrm
leu-sol-therm-006-003
238g
read comp
solnuo2(no3)2 1 420.5 0.400 den=1.581 1 293.0 92234 0.09 92235 10.19
            92238 89.72 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='empty lattice position'
cylinder 10 2.775 1.7 0.0
hexprism 20 3.8 1.7 0.0
hexprism 30 3.8 28.7180 1.7
hexprism 40 3.8 248.5 0.0
media 1 1 10
media 1 1 30
media 3 1 20 -10
media 0 1 40 -30 -20
boundary 40
unit 2
com='blank grid location'
hexprism 20 3.8 1.7 0.0
hexprism 30 3.8 28.7180 1.7
hexprism 40 3.8 248.5 0.0
media 1 1 30
media 3 1 20
media 0 1 40 -30 -20
boundary 40
unit 3
com='absorber rod location'
cylinder 10 2.775 1.7 0.0
```

```
hexprism 20 3.8 1.7 0.0
cylinder 30 2.75 248.5 0.0
cylinder 40 2.25 248.5 0.7
hexprism 50 3.8 248.5 0.0
hexprism 60 3.8 28.7180 1.7
media 1 1 10 -30
media 1 1 60 -30
media 3 1 20 -10
media 0 1 50 -60 -20 -30
media 4 1 40
media 3 1 30 -40
boundary 50
global unit 4
cylinder 20 54.8 248.5 0.0
cylinder 30 55.0 248.5 28.7180
cylinder 35 55.0 28.7180 0.0
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 40.0 -37.5
cylinder 60 100 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
array 1 20 place 10 10 1 0.0 0.0 0.0
media 1 1 35 -20
media 3 1 40 -30 -35
media 0 1 70 -40 -50
media 0 1 30 -20
media 2 1 50 -40
media 3 1 60 -70
boundary 60
end geom
read array ara=1 typ=hexagonal nux=19 nuy=19 nuz=1
fill
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
  2 2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 2 2 2
   2 2 2 2 2 2 2 2 2 1 3 1 1 1 1 1 3 1 2 2
    2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 2 2
     2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 2 2
      2 2 2 2 2 1 3 1 1 3 1 1 3 1 1 3 1 2 2
       2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2
        2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2
         2 2 2 3 1 1 3 1 1 3 1 1 3 1 1 3 2 2 2
          2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2
           2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2
            2 2 1 3 1 1 3 1 1 3 1 1 3 1 2 2 2 2 2
             2 2 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2
              2 2 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2
               2 2 1 3 1 1 3 1 1 3 1 2 2 2 2 2 2 2 2
                2 2 2 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2
                 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
                  2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
end fill
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.0  zul=248 xlr=0.0  ylr=100.0  zlr=-38.5
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on core tank'
xul=0.0  yul=-55.6  zul=70 xlr=0.0  ylr=55.6  zlr=-2
vax=1 wdn=-1 nax=400  end plt1
ttl='x-y slice at z=20  through core'
xul=-100.0 yul=100.0  zul=20.0 xlr=100.0 ylr=-100.0  zlr=20.0
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=0.5  through plate'
xul=-56.0 yul=56.0  zul=0.5 xlr=56.0 ylr=-56.0  zlr=0.5
```

```
uax=1 vdn=-1 nax=400 end plt3
end plot
end data
end
=csas26        parm=centrm
leu-sol-therm-006-004
238g
read comp
solnuo2(no3)2 1 420.5 0.400 den=1.581 1 293.0 92234 0.09 92235 10.19
            92238 89.72 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 far=yes flx=yes fdn=yes end param
read geometry
unit 1
com='empty lattice position'
cylinder 10 2.775 1.7 0.0
hexprism 20 3.8 1.7 0.0
hexprism 30 3.8 29.2573 1.7
hexprism 40 3.8 248.5 0.0
media 1 1 10
media 1 1 30
media 3 1 20 -10
media 0 1 40 -30 -20
boundary 40
unit 2
com='blank grid location'
hexprism 20 3.8 1.7 0.0
hexprism 30 3.8 29.2573 1.7
hexprism 40 3.8 248.5 0.0
media 1 1 30
media 3 1 20
media 0 1 40 -30 -20
boundary 40
unit 3
com='absorber rod location'
cylinder 10 2.775 1.7 0.0
hexprism 20 3.8 1.7 0.0
cylinder 30 2.75 248.5 0.0
cylinder 40 2.25 248.5 0.7
hexprism 50 3.8 248.5 0.0
hexprism 60 3.8 29.2573 1.7
media 1 1 10 -30
media 1 1 60 -30
media 3 1 20 -10
media 0 1 50 -60 -20 -30
media 4 1 40
media 3 1 30 -40
boundary 50
global unit 4
cylinder 20 54.8 248.5 0.0
cylinder 30 55.0 248.5 29.2573
cylinder 35 55.0 29.2573 0.0
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 40.0 -37.5
cylinder 60 100 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
```

```
array 1 20 place 10 10 1 0.0 0.0 0.0
media 1 1 35 -20
media 3 1 40 -30 -35
media 0 1 70 -40 -50
media 0 1 30 -20
media 2 1 50 -40
media 3 1 60 -70
boundary 60
end geom
read array ara=1 typ=hexagonal nux=19 nuy=19 nuz=1
fill
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
  2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 2 2 2
   2 2 2 2 2 2 2 2 2 1 3 1 1 3 1 1 3 1 2 2
    2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 2 2
     2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 2 2
      2 2 2 2 2 2 1 3 1 1 3 1 1 3 1 1 3 1 2 2
       2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2
        2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2
         2 2 2 3 1 1 3 1 1 3 1 1 3 1 1 3 2 2 2
          2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2
           2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2
            2 2 1 3 1 1 3 1 1 3 1 1 3 1 2 2 2 2 2
             2 2 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2
              2 2 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2
               2 2 1 3 1 1 3 1 1 3 1 2 2 2 2 2 2 2 2
                2 2 2 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2
                 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
                  2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
end fill
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.0  zul=248 xlr=0.0  ylr=100.0  zlr=-38.5
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on core tank'
xul=0.0  yul=-55.6  zul=70 xlr=0.0  ylr=55.6  zlr=-2
vax=1 wdn=-1 nax=400  end plt1
ttl='x-y slice at z=20  through core'
xul=-100.0 yul=100.0  zul=20.0 xlr=100.0 ylr=-100.0  zlr=20.0
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=0.5  through plate'
xul=-56.0 yul=56.0  zul=0.5 xlr=56.0 ylr=-56.0  zlr=0.5
uax=1 vdn=-1 nax=400 end plt3
end plot
end data
end
=csas26         parm=centrm
leu-sol-therm-006-005
238g
read comp
solnuo2(no3)2 1 420.5 0.400 den=1.581 1 293.0 92234 0.09 92235 10.19
            92238 89.72 end
h2o           2 den=0.9983 end
fe            3 0 5.9088e-2 end
cr            3 0 1.6532e-2 end
ni            3 0 8.1369e-3 end
mn            3 0 1.3039e-3 end
si            3 0 1.3603e-3 end
ti            3 0 5.9844e-4 end
b4c           4 den=1.25 end
end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 far=yes flx=yes fdn=yes end param
```

```
read geometry
unit 1
com='empty lattice position'
cylinder 10 2.775 1.7 0.0
hexprism 20 5.3 1.7 0.0
hexprism 30 5.3 36.3693 1.7
hexprism 40 5.3 248.5 0.0
media 1 1 10
media 1 1 30
media 3 1 20 -10
media 0 1 40 -30 -20
boundary 40
unit 2
com='blank grid location'
hexprism 20 5.3 1.7 0.0
hexprism 30 5.3 36.3693 1.7
hexprism 40 5.3 248.5 0.0
media 1 1 30
media 3 1 20
media 0 1 40 -30 -20
boundary 40
unit 3
com='absorber rod location'
cylinder 10 2.775 1.7 0.0
hexprism 20 5.3 1.7 0.0
cylinder 30 2.75 248.5 0.0
cylinder 40 2.25 248.5 0.7
hexprism 50 5.3 248.5 0.0
hexprism 60 5.3 36.3693 1.7
media 1 1 10 -30
media 1 1 60 -30
media 3 1 20 -10
media 0 1 50 -60 -20 -30
media 4 1 40
media 3 1 30 -40
boundary 50
global unit 4
cylinder 20 54.8 248.5 0.0
cylinder 30 55.0 248.5 36.3693
cylinder 35 55.0 36.3693 0.0
cylinder 40 55.6 248.5 -1.5
cylinder 50 99.2 95.0 -37.5
cylinder 60 100 248.5 -38.5
cylinder 70 99.2 248.5 -37.5
array 1 20 place 7 7 1 0.0 0.0 0.0
media 1 1 35 -20
media 3 1 40 -30 -35
media 0 1 70 -40 -50
media 0 1 30 -20
media 2 1 50 -40
media 3 1 60 -70
boundary 60
end geom
read array ara=1 typ=hexagonal nux=13 nuy=13 nuz=1
fill
2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 3 1 1 3 2 2
  2 2 2 2 2 3 1 1 3 1 1 3 2
   2 2 2 2 1 1 3 1 1 3 1 1 2
    2 2 2 1 3 1 1 3 1 1 3 1 2
     2 2 3 1 1 3 1 1 3 1 1 3 2
      2 2 1 3 1 1 3 1 1 3 1 2 2
       2 3 1 1 3 1 1 3 1 1 3 2 2
        2 1 3 1 1 3 1 1 3 1 2 2 2
```

```
         2 1 1 3 1 1 3 1 1 2 2 2 2
          2 3 1 1 3 1 1 3 2 2 2 2 2
           2 2 3 1 1 3 2 2 2 2 2 2 2
            2 2 2 2 2 2 2 2 2 2 2 2 2
end fill
end array
read plot  scr=yes  lpi=10
ttl='y-z slice at x=0.0 '
xul=0.0  yul=-100.0  zul=248 xlr=0.0  ylr=100.0  zlr=-38.5
vax=1 wdn=-1 nax=400  end plt0
ttl='y-z slice at x=0.0 zoom on core tank'
xul=0.0  yul=-55.6  zul=70 xlr=0.0  ylr=55.6  zlr=-2
vax=1 wdn=-1 nax=400  end plt1
ttl='x-y slice at z=20  through core'
xul=-100.0 yul=100.0  zul=20.0 xlr=100.0 ylr=-100.0  zlr=20.0
uax=1 vdn=-1 nax=400 end plt2
ttl='x-y slice at z=0.5  through plate'
xul=-56.0 yul=56.0  zul=0.5 xlr=56.0 ylr=-56.0  zlr=0.5
uax=1 vdn=-1 nax=400 end plt3
end plot
end data
end
```

APPENDIX D

MOX BENCHMARK CASES

APPENDIX D
MOX BENCHMARK CASES

```
=csas26        parm=centrm
PNL-30
238group
read comp
'MOX fuel
u-235 1 0 1.4886-4  295  end
u-238  1  0  2.0611-2  295  end
o  1  0  4.3779-2  295  end
u-234  1  0  1.2458-6  295  end
u-236  1  0  2.0936-9  295  end
pu-238  1  0  3.8836-8  295  end
pu-239  1  0  3.9262-4  295  end
pu-240  1  0  3.3206-5  295  end
pu-241  1  0  1.6081-6  295  end
pu-242  1  0  1.1882-7  295  end
am-241  1 0 1.4891-6  295  end
'clad (ZR-2)
zr  2  0  4.2621-2  295  end
sn  2 0 4.8328-4  295  end
ni  2  0  3.0336-5  295  end
cr  2  0  7.6093-5  295  end
fe  2  0  9.5642-5  295  end
'water(Refletor)
h     3  0  6.6706-2  295  end
o     3  0  3.3353-2  295  end
b-10  3  0  1.8706-8  295  end
b-11  3  0  7.5770-8  295  end
'Eggcrate
si  4  0  3.4607-4  295  end
fe  4  0  1.0152-4  295  end
cu  4  0  6.3731-5  295  end
mn  4  0  2.2115-5  295  end
mg  4  0  6.6651-4  295  end
cr  4  0  6.2310-5  295  end
'zn  4  0  3.0967-5  295  end
ti  4  0  2.5375-5  295  end
al  4  0  5.8433-2  295  end
'UO2
u-234  5 0  1.2406-6  295  end
u-235  5  0  1.4824-4  295  end
u-236  5  0  2.0848-9  295  end
u-238  5  0  2.0525-2  295  end
o  5  0  4.1943-2  295  end
'Aluminum
si  6  0  3.4607-4  295  end
fe  6 0 1.0152-4  295  end
cu  6 0 6.3731-5  295  end
mn  6 0 2.2115-5  295  end
mg  6 0 6.6651-4  295  end
cr  6 0 6.2310-5  295  end
ti  6  0  2.5375-5  295  end
al  6  0  5.8433-2  295  end
'lead
pb  7  0  3.2174-2  295  end
end comp
read celldata
latticecell squarepitch
pitch=1.778 3  fueld=1.2827 1  cladd=1.4351 2  end
end celldata
```

```
read param   gen=520 npg=4000 nsk=20 tba=10.0  end param
read geometry
unit 1
com='Alum'
cuboid 10 4p0.889 2.8575 0.
media  6 1 10
boundary 10
unit 2
com='Clad+Modera'
cylinder 10 0.7176 3.175 2.8575
cuboid   20 4p0.889 3.175 2.8575
media  2 1 10
media  3 1 20 -10
boundary 20
unit 3
com='Clad+(Modera+EGG)'
cylinder 10 0.7176 3.556 3.175
cuboid   20  4p0.73025  3.556  3.175
cuboid   30  4p0.889 3.556 3.175
media  2 1 10
media  3 1 20 -10
media  4 1 30 -20 -10
boundary 30
unit 4
com='UO2+Clad+(Modera+EGG)'
cylinder 10 0.6414 4.056 3.556
cylinder 20 0.7176 4.056 3.556
cuboid   30 4p.73025  4.056  3.556
cuboid   40 4p0.889 4.056 3.556
media  5 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40

unit 5
com='(PuO2+UO2)+Clad+(Modera+EGG)'
cylinder 10  0.6414 5.715 4.056
cylinder 20  0.7176 5.715 4.056
cuboid   30  4p0.73025  5.715  4.056
cuboid   40  4p0.889 5.715 4.056
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
unit 6
com='(PuO2+UO2)+Clad+Modera'
cylinder 10  0.6414 92.3925 5.715
cylinder 20  0.7176 92.3925 5.715
cuboid   30  4p0.889 92.3925 5.715
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 7
com='(PuO2+UO2)+Clad+(Modera+EGG)'
cylinder 10  0.6414 94.9325 92.3925
cylinder 20  0.7176 94.9325 92.3925
cuboid   30   4p0.73025  94.9325  92.3925
cuboid   40 4p0.889 94.9325 92.3925
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
```

```
media  4 1 40 -30 -20 -10
boundary  40
unit 8
com='(PuO2+UO2)+Clad+Modera'
cylinder 10  0.6414 94.996 94.9325
cylinder 20  0.7176 94.996 94.9325
cuboid 30  4p0.889 94.996 94.9325
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 9
com='Clad+Modera'
cylinder 10  0.7176 95.8215 94.996
cuboid 20  4p0.889 95.8215 94.996
media  2 1 10
media  3 1 20 -10
boundary 20
unit 10
com='Lead'
cuboid 10 4p0.889 96.774 95.8215
media  7 1 10
boundary 10
unit 11
com='Water cell'
cuboid 10 4p0.889 96.774 0.
media  3 1 10
boundary 10
unit 12
com='Cell'
cuboid  10  4p.889  96.774  0.0
array 1 10        place 1 1 1       3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10 4p20.447 96.774  0.0
cuboid  20 4p41. 112.014 -20.
array 2 10 place 12 12 1  3*0.0
media  3 1 20 -10
boundary 20

end geometry
read array
ara=1 nux=1 nuy=1 nuz=10
fill
1 2 3 4 5 6 7 8 9 10
end fill
ara=2 nux=23 nuy=23 nuz=1
fill
11 11 11 11 11 12 12 12 12 12 12 12 12 12 12 12 12 12 11 11 11 11 11
11 11 11 11 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 11 11 11 11
11 11 11 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 11 11 11
11 11 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 11 11
11 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 11
12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12
12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12
12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12
12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12
12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12
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12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12
12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12
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12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12
12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12
12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12
11 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 11
11 11 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 11 11
11 11 11 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 11 11 11
11 11 11 11 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 11 11 11 11
11 11 11 11 11 12 12 12 12 12 12 12 12 12 12 12 12 12 11 11 11 11 11
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.   zul= 102.5
xlr= 41.0  ylr= 0.   zlr= -20.
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 25.
xlr= 41.0  ylr= -41.  zlr= 25.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
=csas26         parm=centrm
PNL-31
238group
read comp
'MOX fuel
u-235 1 0 1.4886-4  295  end
u-238  1  0  2.0611-2  295  end
o  1  0  4.3779-2  295  end
u-234  1  0  1.2458-6  295  end
u-236  1  0  2.0936-9  295  end
pu-238  1  0  3.8836-8  295  end
pu-239  1  0  3.9262-4  295  end
pu-240  1  0  3.3206-5  295  end
pu-241  1  0  1.6081-6  295  end
pu-242  1  0  1.1882-7  295  end
am-241  1 0 1.4891-6  295  end
'clad (ZR-2)
zr  2  0  4.2621-2  295  end
sn  2 0 4.8328-4  295  end
ni  2  0  3.0336-5  295  end
cr  2  0  7.6093-5  295  end
fe  2  0  9.5642-5  295  end
'water(Refletor)
h     3  0  6.6685-2  295  end
o     3  0  3.34-2    295  end
b-10  3  0  7.5838-6  295  end
b-11  3  0  3.0718-5  295  end
'Eggcrate
si  4  0  3.4607-4  295  end
fe  4  0  1.0152-4  295  end
cu  4  0  6.3731-5  295  end
mn  4  0  2.2115-5  295  end
mg  4  0  6.6651-4  295  end
cr  4  0  6.2310-5  295  end
'zn  4  0  3.0967-5  295  end
ti  4  0  2.5375-5  295  end
```

```
al  4  0  5.8433-2  295  end
'UO2
u-234  5 0  1.2406-6  295  end
u-235  5  0  1.4824-4  295  end
u-236  5  0  2.0848-9  295  end
u-238  5  0  2.0525-2  295  end
o  5  0  4.1943-2  295  end
'Aluminum
si  6  0  3.4607-4  295  end
fe  6 0 1.0152-4  295  end
cu  6 0 6.3731-5  295  end
mn  6 0 2.2115-5  295  end
mg  6 0 6.6651-4  295  end
cr  6 0 6.2310-5  295  end
ti  6  0  2.5375-5  295  end
al  6  0  5.8433-2  295  end
'lead
pb  7  0  3.2174-2  295  end
end comp
read celldata
latticecell squarepitch
pitch=1.778 3  fueld=1.2827 1  cladd=1.4351 2  end
end celldata
read param   gen=520 npg=4000 nsk=20 tba=10.0    end param
read geometry
unit 1
com='Alum'
cuboid 10 4p0.889 2.8575 0.
media  6 1 10
boundary 10
unit 2
com='Clad+Modera'
cylinder 10 0.7176 3.175 2.8575
cuboid   20 4p0.889 3.175 2.8575
media  2 1 10
media  3 1 20 -10
boundary 20
unit 3
com='Clad+(Modera+EGG)'
cylinder 10 0.7176 3.556 3.175
cuboid   20  4p0.73025  3.556  3.175
cuboid   30  4p0.889 3.556 3.175
media  2 1 10
media  3 1 20 -10
media  4 1 30 -20 -10
boundary 30
unit 4
com='UO2+Clad+(Modera+EGG)'
cylinder 10 0.6414 4.056 3.556
cylinder 20 0.7176 4.056 3.556
cuboid   30 4p.73025  4.056  3.556
cuboid   40 4p0.889 4.056 3.556
media  5 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40

unit 5
com='(PuO2+UO2)+Clad+(Modera+EGG)'
cylinder 10  0.6414 5.715 4.056
cylinder 20  0.7176 5.715 4.056
cuboid   30  4p0.73025  5.715  4.056
cuboid   40  4p0.889 5.715 4.056
```

```
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
unit 6
com='(PuO2+UO2)+Clad+Modera'
cylinder 10  0.6414 92.3925 5.715
cylinder 20  0.7176 92.3925 5.715
cuboid   30  4p0.889 92.3925 5.715
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 7
com='(PuO2+UO2)+Clad+(Modera+EGG)'
cylinder 10  0.6414 94.9325 92.3925
cylinder 20  0.7176 94.9325 92.3925
cuboid   30   4p0.73025  94.9325  92.3925
cuboid   40 4p0.889 94.9325 92.3925
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
unit 8
com='(PuO2+UO2)+Clad+Modera'
cylinder 10  0.6414 94.996 94.9325
cylinder 20  0.7176 94.996 94.9325
cuboid 30  4p0.889 94.996 94.9325
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 9
com='Clad+Modera'
cylinder 10  0.7176 95.8215 94.996
cuboid 20  4p0.889 95.8215 94.996
media  2 1 10
media  3 1 20 -10
boundary 20
unit 10
com='Lead'
cuboid 10 4p0.889 96.774 95.8215
media  7 1 10
boundary 10
unit 11
com='Water cell'
cuboid 10 4p0.889 96.774 0.
media  3 1 10
boundary 10
unit 12
com='Cell'
cuboid  10  4p.889  96.774  0.0
array 1 10        place 1 1 1       3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10 4p27.559 96.774  0.0
cuboid  20 4p58. 112.014 -30.
array 2 10 place 16 16 1  3*0.0
media  3 1 20 -10
boundary 20
end geometry
```

```
read array
ara=1 nux=1 nuy=1 nuz=10
fill
1 2 3 4 5 6 7 8 9 10
end fill
ara=2 nux=31 nuy=31 nuz=1
fill
11 11 11 11 11 11 11 11 11 11 11 11 12 12 12 12 12 12 12 11 11 11 11 11 11 11
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11 11 11 11 11 11 11 11 11 12 12 12 12 12 12 12 12 12 12 12 12 12 11 11 11 11
 11 11 11 11 11
11 11 11 11 11 11 11 11 11 11 11 11 12 12 12 12 12 12 12 11 11 11 11 11 11 11
 11 11 11 11 11
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -50.0  yul= 0.   zul= 112.1
xlr= 50.0  ylr= 0.   zlr= -20.
uax=1.0 wdn=-1.0
nax=800
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -50.0  yul= 50.   zul= 25.
xlr= 50.0  ylr= -50.  zlr= 25.
uax=1.0 vdn=-1.0
nax=800 end
end plot
end data
end
=csas26        parm=centrm
PNL-32
238group
read comp
'MOX fuel
u-235 1 0 1.4886-4  295  end
u-238  1  0  2.0611-2  295  end
o  1  0  4.3779-2  295  end
u-234  1  0  1.2458-6  295  end
u-236  1  0  2.0936-9  295  end
pu-238  1  0  3.8836-8  295  end
pu-239  1  0  3.9262-4  295  end
pu-240  1  0  3.3206-5  295  end
pu-241  1  0  1.6081-6  295  end
pu-242  1  0  1.1882-7  295  end
am-241  1 0 1.4891-6  295  end
'clad (ZR-2)
zr  2  0  4.2621-2  295  end
sn  2 0 4.8328-4  295  end
ni  2  0  3.0336-5  295  end
cr  2  0  7.6093-5  295  end
fe  2  0  9.5642-5  295  end
'water(Refletor)
h     3  0  6.6706-2  295  end
o     3  0  3.3353-2  295  end
b-10  3  0  9.9034-9  295  end
b-11  3  0  4.0114-8  295  end
'Eggcrate
si  4  0  3.4607-4  295  end
fe  4  0  1.0152-4  295  end
cu  4  0  6.3731-5  295  end
mn  4  0  2.2115-5  295  end
mg  4  0  6.6651-4  295  end
cr  4  0  6.2310-5  295  end
'zn  4  0  3.0967-5  295  end
ti  4  0  2.5375-5  295  end
al  4  0  5.8433-2  295  end
'UO2
u-234  5 0  1.2406-6  295  end
```

```
u-235  5  0  1.4824-4  295  end
u-236  5  0  2.0848-9  295  end
u-238  5  0  2.0525-2  295  end
o  5  0  4.1943-2  295  end
'Aluminum
si  6  0  3.4607-4  295  end
fe  6 0 1.0152-4  295  end
cu  6 0 6.3731-5  295  end
mn  6 0 2.2115-5  295  end
mg  6 0 6.6651-4  295  end
cr  6 0 6.2310-5  295  end
ti  6  0  2.5375-5  295  end
al  6  0  5.8433-2  295  end
'lead
pb  7  0  3.2174-2  295  end
end comp
read celldata
latticecell squarepitch
pitch=2.20914 3  fueld=1.2827 1  cladd=1.4351 2  end
end celldata
read param    gen=520 npg=4000 nsk=20 tba=10.0   end param
read geometry
unit 1
com='Alum'
cuboid 10 4p1.10457 2.8575 0.
media  6 1 10
boundary 10
unit 2
com='Clad+Modera'
cylinder 10 0.7176 3.175 2.8575
cuboid   20 4p1.10457 3.175 2.8575
media  2 1 10
media  3 1 20 -10
boundary 20
unit 3
com='Clad+(Modera+EGG)'
cylinder 10 0.7176 3.556 3.175
cuboid   20  4p.94582  3.556  3.175
cuboid   30 4p1.10457 3.556 3.175
media  2 1 10
media  3 1 20 -10
media  4 1 30 -20 -10
boundary 30
unit 4
com='UO2+Clad+(Modera+EGG)'
cylinder 10 0.6414 4.056 3.556
cylinder 20 0.7176 4.056 3.556
cuboid   30  4p.94582  4.056  3.556
cuboid   40 4p1.10457 4.056 3.556
media  5 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
unit 5
com='(PuO2+UO2)+Clad+(Modera+EGG)'
cylinder 10 0.6414 5.715 4.056
cylinder 20 0.7176 5.715 4.056
cuboid   30  4p.94582  5.715  4.056
cuboid   40 4p1.10457 5.715 4.056
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
```

```
boundary  40
unit 6
com='(PuO2+UO2)+Clad+Modera'
cylinder 10 0.6414 92.3925 5.715
cylinder 20 0.7176 92.3925 5.715
cuboid   30 4p1.10457 92.3925 5.715
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 7
com='(PuO2+UO2)+Clad+(Modera+EGG)'
cylinder 10 0.6414 94.9325 92.3925
cylinder 20  0.7176 94.9325 92.3925
cuboid   30    4p.94582   94.9325  92.3925
cuboid   40  4p1.10457 94.9325 92.3925
media  1 1 10
media  2 1 20  -10
media  3 1 30  -20 -10
media  4 1 40  -30 -20 -10
boundary  40
unit 8
com='(PuO2+UO2)+Clad+Modera'
cylinder 10  0.6414 94.996 94.9325
cylinder 20  0.7176 94.996 94.9325
cuboid   30  4p1.10457 94.996 94.9325
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 9
com='Clad+Modera'
cylinder 10  0.7176 95.8215 94.996
cuboid   20 4p1.10457 95.8215 94.996
media  2 1 10
media  3 1 20 -10
boundary 20
unit 10
com='Lead'
cuboid 10 4p1.10457 96.774 95.8215
media  7 1 10
boundary 10
unit 11
com='Water cell'
cuboid 10 4p1.10457 96.774 0.
media  3 1 10
boundary 10
unit 12
com='Cell'
cuboid  10  4p1.10457  96.774  0.0
array 1 10        place 1 1  1       3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10 4p18.77769  96.774  0.0
cuboid  20 4p40.987    102.49 -20.
array 2 10        place 9 9 1         3*0.0
media  3 1 20 -10
boundary 20
end geometry
read array
ara=1 nux=1 nuy=1 nuz=10
fill
1 2 3 4 5 6 7 8 9 10
```

```
end fill
ara=2 nux=17 nuy=17 nuz=1
fill
11 11 11 11 11 11 11 12 12 12 11 11 11 11 11 11 11
11 11 11 11 11 11 12 12 12 12 12 12 11 11 11 11 11
11 11 11 11 12 12 12 12 12 12 12 12 12 11 11 11 11
11 11 11 12 12 12 12 12 12 12 12 12 12 12 11 11 11
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11 11 11 11 12 12 12 12 12 12 12 12 12 11 11 11 11
11 11 11 11 11 12 12 12 12 12 12 11 11 11 11 11 11
11 11 11 11 11 11 11 12 12 12 11 11 11 11 11 11 11
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.   zul= 102.5
xlr= 41.0  ylr= 0.   zlr= -20.
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 25.
xlr= 41.0  ylr= -41.  zlr= 25.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
=csas26        parm=centrm
PNL-33
238group
read comp
'MOX fuel
u-235 1 0 1.4886-4  295  end
u-238  1  0  2.0611-2  295  end
o  1  0  4.3779-2  295  end
u-234  1  0  1.2458-6  295  end
u-236  1  0  2.0936-9  295  end
pu-238  1  0  3.8836-8  295  end
pu-239  1  0  3.9262-4  295  end
pu-240  1  0  3.3206-5  295  end
pu-241  1  0  1.6081-6  295  end
pu-242  1  0  1.1882-7  295  end
am-241  1 0 1.4891-6  295  end
'clad (ZR-2)
zr  2  0  4.2621-2  295  end
sn  2 0 4.8328-4  295  end
ni  2  0  3.0336-5  295  end
cr  2  0  7.6093-5  295  end
fe  2  0  9.5642-5  295  end
'water(Refletor)
h     3  0  6.6672-2  295  end
```

```
o     3  0  3.3427-2  295  end
b-10  3  0  1.2034-5  295  end
b-11  3  0  4.8746-5  295  end
'Eggcrate
si  4  0  3.4607-4  295  end
fe  4  0  1.0152-4  295  end
cu  4  0  6.3731-5  295  end
mn  4  0  2.2115-5  295  end
mg  4  0  6.6651-4  295  end
cr  4  0  6.2310-5  295  end
'zn  4  0  3.0967-5  295  end
ti  4  0  2.5375-5  295  end
al  4  0  5.8433-2  295  end
'UO2
u-234  5 0  1.2406-6  295  end
u-235  5  0  1.4824-4  295  end
u-236  5  0  2.0848-9  295  end
u-238  5  0  2.0525-2  295  end
o  5  0  4.1943-2  295  end
'Aluminum
si  6  0  3.4607-4  295  end
fe  6 0 1.0152-4  295  end
cu  6 0 6.3731-5  295  end
mn  6 0 2.2115-5  295  end
mg  6 0 6.6651-4  295  end
cr  6 0 6.2310-5  295  end
ti  6  0  2.5375-5  295  end
al  6  0  5.8433-2  295  end
'lead
pb  7  0  3.2174-2  295  end
end comp
read celldata
latticecell squarepitch
pitch=2.20914 3  fueld=1.2827 1  cladd=1.4351 2  end
end celldata
read param  gen=520 npg=4000 nsk=20 tba=10.0   end param
read geometry
unit 1
com='Alum'
cuboid 10 4p1.10457 2.8575 0.
media  6 1 10
boundary 10
unit 2
com='Clad+Modera'
cylinder 10 0.7176 3.175 2.8575
cuboid   20 4p1.10457 3.175 2.8575
media  2 1 10
media  3 1 20 -10
boundary 20
unit 3
com='Clad+(Modera+EGG)'
cylinder 10 0.7176 3.556 3.175
cuboid   20  4p.94582  3.556  3.175
cuboid   30 4p1.10457 3.556 3.175
media  2 1 10
media  3 1 20 -10
media  4 1 30 -20 -10
boundary 30
unit 4
com='UO2+Clad+(Modera+EGG)'
cylinder 10 0.6414 4.056 3.556
cylinder 20 0.7176 4.056 3.556
cuboid   30  4p.94582  4.056  3.556
cuboid   40 4p1.10457 4.056 3.556
```

```
media  5 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
unit 5
com='(PuO2+UO2)+Clad+(Modera+EGG)'
cylinder 10 0.6414 5.715 4.056
cylinder 20 0.7176 5.715 4.056
cuboid   30  4p.94582  5.715  4.056
cuboid   40 4p1.10457 5.715 4.056
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
unit 6
com='(PuO2+UO2)+Clad+Modera'
cylinder 10 0.6414 92.3925 5.715
cylinder 20 0.7176 92.3925 5.715
cuboid   30 4p1.10457 92.3925 5.715
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 7
com='(PuO2+UO2)+Clad+(Modera+EGG)'
cylinder 10 0.6414 94.9325 92.3925
cylinder 20  0.7176 94.9325 92.3925
cuboid   30    4p.94582   94.9325  92.3925
cuboid   40  4p1.10457 94.9325 92.3925
media  1 1 10
media  2 1 20  -10
media  3 1 30  -20 -10
media  4 1 40  -30 -20 -10
boundary  40
unit 8
com='(PuO2+UO2)+Clad+Modera'
cylinder 10  0.6414 94.996 94.9325
cylinder 20  0.7176 94.996 94.9325
cuboid   30  4p1.10457 94.996 94.9325
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 9
com='Clad+Modera'
cylinder 10  0.7176 95.8215 94.996
cuboid   20 4p1.10457 95.8215 94.996
media  2 1 10
media  3 1 20 -10
boundary 20
unit 10
com='Lead'
cuboid 10 4p1.10457 96.774 95.8215
media  7 1 10
boundary 10
unit 11
com='Water cell'
cuboid 10 4p1.10457 96.774 0.
media  3 1 10
boundary 10
unit 12
com='Cell'
```

```
cuboid  10  4p1.10457  96.774  0.0
array 1 10        place 1 1 1       3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10 4p34.24167  96.774  0.0
cuboid  20 4p55    112.014 -20.
array 2 10        place 16 16 1         3*0.0
media  3 1 20 -10
boundary 20

end geometry
read array
ara=1 nux=1 nuy=1 nuz=10
fill
1 2 3 4 5 6 7 8 9 10
end fill
ara=2 nux=31 nuy=31 nuz=1
fill
11 11 11 11 11 11 11 11 11 11 11 11 12 12 12 12 12 12 12 11 11 11 11 11 11 11
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11 11 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12
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 11 11 11 11 11
11 11 11 11 11 11 11 11 11 11 11 11 12 12 12 12 12 12 12 11 11 11 11 11 11 11
 11 11 11 11 11
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.   zul= 102.5
xlr= 41.0  ylr= 0.   zlr= -20.
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 25.
xlr= 41.0  ylr= -41.  zlr= 25.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
=csas26        parm=centrm
PNL-34
238group
read comp
'MOX fuel
u-235 1 0 1.4886-4  295  end
u-238  1  0  2.0611-2  295  end
o  1  0  4.3779-2  295  end
u-234  1  0  1.2458-6  295  end
u-236  1  0  2.0936-9  295  end
pu-238  1  0  3.8836-8  295  end
pu-239  1  0  3.9262-4  295  end
pu-240  1  0  3.3206-5  295  end
pu-241  1  0  1.6081-6  295  end
pu-242  1  0  1.1882-7  295  end
am-241  1 0 1.4891-6  295  end
'clad (ZR-2)
zr  2  0  4.2621-2  295  end
sn  2 0 4.8328-4  295  end
ni  2  0  3.0336-5  295  end
cr  2  0  7.6093-5  295  end
fe  2  0  9.5642-5  295  end
'water(Refletor)
h     3  0  6.6706-2  295  end
o     3  0  3.3353-2  295  end
b-10  3  0  1.7606-8  295  end
b-11  3  0  7.1313-8  295  end
```

```
'Eggcrate
si  4  0  3.4607-4  295  end
fe  4  0  1.0152-4  295  end
cu  4  0  6.3731-5  295  end
mn  4  0  2.2115-5  295  end
mg  4  0  6.6651-4  295  end
cr  4  0  6.2310-5  295  end
'zn  4  0  3.0967-5  295  end
ti  4  0  2.5375-5  295  end
al  4  0  5.8433-2  295  end
'UO2
u-234  5 0  1.2406-6  295  end
u-235  5  0  1.4824-4  295  end
u-236  5  0  2.0848-9  295  end
u-238  5  0  2.0525-2  295  end
o  5  0  4.1943-2  295  end
'Aluminum
si  6  0  3.4607-4  295  end
fe  6 0 1.0152-4  295  end
cu  6 0 6.3731-5  295  end
mn  6 0 2.2115-5  295  end
mg  6 0 6.6651-4  295  end
cr  6 0 6.2310-5  295  end
ti  6  0  2.5375-5  295  end
al  6  0  5.8433-2  295  end
'lead
pb  7  0  3.2174-2  295  end
end comp
read celldata
latticecell squarepitch
pitch=2.51447 3 fueld=1.2827 1  cladd=1.4351 2  end
end celldata
read param  gen=520 npg=4000 nsk=20 tba=10.0   end param
read geometry
unit 1
com='Alum'
cuboid 10 4p1.257235 2.8575 0.
media  6 1 10
boundary 10
unit 2
com='Clad+Modera'
cylinder 10 0.7176 3.175 2.8575
cuboid   20 4p1.257235 3.175 2.8575
media  2 1 10
media  3 1 20 -10
boundary 20
unit 3
com='Clad+(Modera+EGG)'
cylinder 10 0.7176 3.556 3.175
cuboid   20  4p1.098485 3.556  3.175
cuboid   30 4p1.257235 3.556 3.175
media  2 1 10
media  3 1 20 -10
media  4 1 30 -20 -10
boundary 30
unit 4
com='UO2+Clad+(Modera+EGG)'
cylinder 10 0.6414 4.056 3.556
cylinder 20 0.7176 4.056 3.556
cuboid   30    4p1.098485  4.056  3.556
cuboid   40  4p1.257235 4.056 3.556
media  5 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
```

```
media  4 1 40 -30 -20 -10
boundary  40
unit 5
com='(PuO2+UO2)+Clad+(Modera+EGG)'
cylinder 10  0.6414 5.715 4.056
cylinder 20  0.7176 5.715 4.056
cuboid   30    4p1.098485  5.715  4.056
cuboid   40  4p1.257235 5.715 4.056
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
unit 6
com='(PuO2+UO2)+Clad+Modera'
cylinder 10  0.6414 92.3925 5.715
cylinder 20  0.7176 92.3925 5.715
cuboid   30  4p1.257235 92.3925 5.715
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 7
com='(PuO2+UO2)+Clad+(Modera+EGG)'
cylinder 10  0.6414 94.9325 92.3925
cylinder 20  0.7176 94.9325 92.3925
cuboid   30    4p1.098485 94.9325  92.3925
cuboid   40  4p1.257235 94.9325 92.3925
media  1 1 10
media  2 1 20  -10
media  3 1 30  -20 -10
media  4 1 40  -30 -20 -10
boundary  40
unit 8
com='(PuO2+UO2)+Clad+Modera'
cylinder 10  0.6414 94.996 94.9325
cylinder 20  0.7176 94.996 94.9325
cuboid   30  4p1.257235 94.996 94.9325
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 9
com='Clad+Modera'
cylinder 10  0.7176 95.8215 94.996
cuboid   20  4p1.257235 95.8215 94.996
media  2 1 10
media  3 1 20 -10
boundary 20
unit 10
com='Lead'
cuboid 10 4p1.257235 96.774 95.8215
media  7 1 10
boundary 10
unit 11
com='Water cell'
cuboid 10 4p1.257235 96.774 0.
media  3 1 10
boundary 10
unit 12
com='Cell'
cuboid  10  4p1.257235  96.774  0.0
array 1 10        place 1 1 1       3*0.0
boundary 10
```

```
global unit 13
com='Cells in assembly'
cuboid  10 4p21.372995  96.774  0.0
cuboid  20 4p42    99.064 -20.
array 2 10        place 9 9 1         3*0.0
media  3 1 20 -10
boundary 20
end geometry
read array
ara=1 nux=1 nuy=1 nuz=10
fill
1 2 3 4 5 6 7 8 9 10
end fill
ara=2 nux=17 nuy=17 nuz=1
fill
11 11 11 11 11 11 11 11 12 11 11 11 11 11 11 11 11
11 11 11 11 11 11 11 12 12 12 11 11 11 11 11 11 11
11 11 11 11 11 12 12 12 12 12 12 12 11 11 11 11 11
11 11 11 11 12 12 12 12 12 12 12 12 12 11 11 11 11
11 11 11 12 12 12 12 12 12 12 12 12 12 12 11 11 11
11 11 12 12 12 12 12 12 12 12 12 12 12 12 12 11 11
11 11 12 12 12 12 12 12 12 12 12 12 12 12 12 11 11
11 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 11
12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12
11 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 11
11 11 12 12 12 12 12 12 12 12 12 12 12 12 12 11 11
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11 11 11 12 12 12 12 12 12 12 12 12 12 12 11 11 11
11 11 11 11 12 12 12 12 12 12 12 12 12 11 11 11 11
11 11 11 11 11 12 12 12 12 12 12 12 11 11 11 11 11
11 11 11 11 11 11 11 12 12 12 11 11 11 11 11 11 11
11 11 11 11 11 11 11 11 12 11 11 11 11 11 11 11 11
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -50.0  yul= 0.   zul= 102.5
xlr= 50.0  ylr= 0.   zlr= -20.
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -50.0  yul= 50.   zul= 50.
xlr= 50.0  ylr= -50.  zlr= 50.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
=csas26        parm=centrm
PNL-34
238group
read comp
'MOX fuel
u-235 1 0 1.4886-4  295  end
u-238  1  0  2.0611-2  295  end
o  1  0  4.3779-2  295  end
u-234  1  0  1.2458-6  295  end
u-236  1  0  2.0936-9  295  end
pu-238  1  0  3.8836-8  295  end
pu-239  1  0  3.9262-4  295  end
```

```
pu-240  1  0  3.3206-5  295  end
pu-241  1  0  1.6081-6  295  end
pu-242  1  0  1.1882-7  295  end
am-241  1 0 1.4891-6  295  end
'clad (ZR-2)
zr  2  0  4.2621-2  295  end
sn  2 0 4.8328-4  295  end
ni  2  0  3.0336-5  295  end
cr  2  0  7.6093-5  295  end
fe  2  0  9.5642-5  295  end
'water(Refletor)
h     3  0  6.6682-2  295  end
o     3  0  3.3405-2  295  end
b-10  3  0  8.4597-6  295  end
b-11  3  0  3.4266-5  295  end
'Eggcrate
si  4  0  3.4607-4  295  end
fe  4  0  1.0152-4  295  end
cu  4  0  6.3731-5  295  end
mn  4  0  2.2115-5  295  end
mg  4  0  6.6651-4  295  end
cr  4  0  6.2310-5  295  end
'zn  4  0  3.0967-5  295  end
ti  4  0  2.5375-5  295  end
al  4  0  5.8433-2  295  end
'UO2
u-234  5 0  1.2406-6  295  end
u-235  5  0  1.4824-4  295  end
u-236  5  0  2.0848-9  295  end
u-238  5  0  2.0525-2  295  end
o  5  0  4.1943-2  295  end
'Aluminum
si  6  0  3.4607-4  295  end
fe  6 0 1.0152-4  295  end
cu  6 0 6.3731-5  295  end
mn  6 0 2.2115-5  295  end
mg  6 0 6.6651-4  295  end
cr  6 0 6.2310-5  295  end
ti  6  0  2.5375-5  295  end
al  6  0  5.8433-2  295  end
'lead
pb  7  0  3.2174-2  295  end
end comp
read celldata
latticecell squarepitch
pitch=2.51447 3  fueld=1.2827 1  cladd=1.4351 2  end
end celldata
read param  gen=520 npg=4000 nsk=20 tba=10.0   end param
read geometry
unit 1
com='Alum'
cuboid 10 4p1.257235 2.8575 0.
media  6 1 10
boundary 10
unit 2
com='Clad+Modera'
cylinder 10 0.7176 3.175 2.8575
cuboid   20 4p1.257235 3.175 2.8575
media  2 1 10
media  3 1 20 -10
boundary 20
unit 3
com='Clad+(Modera+EGG)'
cylinder 10 0.7176 3.556 3.175
```

```
cuboid   20  4p1.098485 3.556  3.175
cuboid   30 4p1.257235 3.556 3.175
media  2 1 10
media  3 1 20 -10
media  4 1 30 -20 -10
boundary 30
unit 4
com='UO2+Clad+(Modera+EGG)'
cylinder 10 0.6414 4.056 3.556
cylinder 20 0.7176 4.056 3.556
cuboid   30    4p1.098485  4.056  3.556
cuboid   40  4p1.257235 4.056 3.556
media  5 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
unit 5
com='(PuO2+UO2)+Clad+(Modera+EGG)'
cylinder 10  0.6414 5.715 4.056
cylinder 20  0.7176 5.715 4.056
cuboid   30    4p1.098485  5.715  4.056
cuboid   40  4p1.257235 5.715 4.056
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
unit 6
com='(PuO2+UO2)+Clad+Modera'
cylinder 10  0.6414 92.3925 5.715
cylinder 20  0.7176 92.3925 5.715
cuboid   30  4p1.257235 92.3925 5.715
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 7
com='(PuO2+UO2)+Clad+(Modera+EGG)'
cylinder 10  0.6414 94.9325 92.3925
cylinder 20  0.7176 94.9325 92.3925
cuboid   30    4p1.098485 94.9325  92.3925
cuboid   40  4p1.257235 94.9325 92.3925
media  1 1 10
media  2 1 20  -10
media  3 1 30  -20 -10
media  4 1 40  -30 -20 -10
boundary  40
unit 8
com='(PuO2+UO2)+Clad+Modera'
cylinder 10  0.6414 94.996 94.9325
cylinder 20  0.7176 94.996 94.9325
cuboid   30  4p1.257235 94.996 94.9325
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 9
com='Clad+Modera'
cylinder 10  0.7176 95.8215 94.996
cuboid   20  4p1.257235 95.8215 94.996
media  2 1 10
media  3 1 20 -10
boundary 20
```

```
unit 10
com='Lead'
cuboid 10 4p1.257235 96.774 95.8215
media  7 1 10
boundary 10
unit 11
com='Water cell'
cuboid 10 4p1.257235 96.774 0.
media  3 1 10
boundary 10
unit 12
com='Cell'
cuboid  10  4p1.257235  96.774  0.0
array 1 10        place 1 1 1       3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10 4p36.459815  96.774  0.0
cuboid  20 4p57    112.01 -20.
array 2 10        place 15 15 1         3*0.0
media  3 1 20 -10
boundary 20
end geometry
read array
ara=1 nux=1 nuy=1 nuz=10
fill
1 2 3 4 5 6 7 8 9 10
end fill
ara=2 nux=29 nuy=29 nuz=1
fill
11 11 11 11 11 11 11 11 11 12 12 12 12 12 12 12 12 12 12 12 11 11 11 11 11 11
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11 11 11 11 11 11 11 11 11 12 12 12 12 12 12 12 12 12 12 12 11 11 11 11 11 11
 11 11 11
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -50.0  yul= 0.   zul= 102.5
xlr= 50.0  ylr= 0.   zlr= -20.
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -50.0  yul= 50.   zul= 50.
xlr= 50.0  ylr= -50.  zlr= 50.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
=csas26       parm=centrm
Saxton 1
238group
read comp
'MOX fuel
pu-239  1  0  1.3526-3  295  end
pu-240  1  0  1.2759-4  295  end
pu-241  1  0  1.1407-5  295  end
pu-242  1  0  6.0318-7  295  end
am-241  1  0  1.7783-6  295  end
u-234   1  0  1.1688-6  295  end
u-235   1  0  1.5301-4  295  end
u-238   1  0  2.1097-2  295  end
o       1  0  4.5155-2  295  end
'clad (ZR-2)
zr      2  0  4.2517-2   295  end
sn      2  0  4.6590-4   295  end
cr      2  0  7.5977-5   295  end
fe      2  0  1.4148-4   295  end
o       2  0  2.9630-4   295  end
```

```
'water(Refletor)
h     3  0  6.6643-2  295  end
o     3  0  3.3322-2  295  end
'b-10  3  0  1.7606-8  295  end
'b-11  3  0  7.1313-8  295  end
'Middle Grid and H2O
al   4  .8004  295  end
h2o  4  .1996  295  end
'Aluminum
al  5  0  6.0039-2  295  end
end comp
read celldata
latticecell  squarepitch
pitch=1.3208 3 fueld=.856996 1 cladd=.99314 2 gapd=.87503  0  end
end celldata
read param gen=520 npg=4000 nsk=20 tba=10.0  end param
read geometry
unit 1
com='Alum-H2O-Alum'
cuboid  10  4p.6604   5.08   0.0
cuboid  20  4p.6604   11.43  0.0
cuboid  30  4p.6604   13.97  0.0
media  5 1 10
media  3 1 20 -10
media  5 1 30 -20 -10
boundary  30
unit  2
com='Clad+Mod+AL Grid'
cylinder  10  0.49657  14.603  13.97
cylinder  20  0.50419  14.603  13.97
cuboid    30  4p.6604  14.603  13.97
media  2 1 10
media  3 1 20 -10
media  5 1 30 -20 -10
boundary  30
unit 3
com='Clad+(Modera)'
cylinder 10 0.49657 15.875 14.603
cuboid   20 4p.6604 15.875 14.603
media  2 1 10
media  3 1 20 -10
boundary 20
unit 4
com='Fuel+Gap+Clad+(Modera)'
cylinder   10    0.428498 61.595 15.875
cylinder   20    0.437515 61.595 15.875
cylinder   30    0.49657  61.595 15.875
cuboid     40    4p.6604  61.595 15.875
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
boundary  40
unit  5
com='(Fuel+Gap+Clad+(Middle Grid+moder))'
cylinder   10    0.428498 62.23  61.595
cylinder   20    0.437515 62.23  61.595
cylinder   30    0.49657  62.23  61.595
cylinder   40    0.50419  62.23  61.595
cuboid     50    4p.6604  62.23  61.595
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
```

```
media   4 1 50 -40 -30 -20 -10
boundary  50
unit 6
com='(Fuel+Gap+Clad+moder)'
cylinder   10    0.428498 98.775 62.23
cylinder   20    0.437515 98.775 62.23
cylinder   30    0.49657  98.775 62.23
cuboid     40    4p.6604  98.775 62.23
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
boundary  40
unit 7
com='(Fuel+Gap+Clad+Air)'
cylinder   10    0.428498 108.839 98.775
cylinder   20    0.437515 108.839 98.775
cylinder   30    0.49657  108.839 98.775
cuboid     40    4p.6604  108.839 98.775
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   0 1 40 -30 -20 -10
boundary  40
unit 8
com='Clad+(Air)'
cylinder 10 0.49657 109.855 108.839
cuboid   20 4p.6604 109.855 108.839
media   2 1 10
media   0 1 20 -10
boundary  20
unit 9
com='Clad+Mod+AL grid'
cylinder 10 0.49657 111.125 109.855
cylinder 20 0.50419 111.125 109.855
cuboid   30 4p.6604 111.125 109.855
media   2 1 10
media   0 1 20 -10
media   5 1 30 -20 -10
boundary  30
unit  10
com='Clad+(Air)'
cylinder 10 0.49657 113.159 111.125
cuboid   20 4p.6604 113.159 111.125
media   2 1 10
media   0 1 20 -10
boundary  20
unit 12
com='Cell'
cuboid  10 4p.6604  113.159  0.0
array 1 10  place 1 1 1  3*0.0
boundar 10
global unit 13
com='Cells in assembly'
cuboid  10  29.718 -.6604 28.3972 -.6604    113.159  0.0
cuboid  20 58.3972  -30.6604 59.718  -30.6604  143.150 -30.0
array  2 10  place 1 1 1  3*0.0
media  3 1 20 -10
boundary  20
end geometry
read array
ara=1 nux=1 nuy=1 nuz=10
fill
1 2 3 4 5 6 7 8 9 10
```

```
end fill
ara=2 nux=23 nuy=22 nuz=1
fill f12 end fill
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.6   zul= 115
xlr= 41.0  ylr= 0.6   zlr= -10
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 25.
xlr= 41.0  ylr= -41.  zlr= 25.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
=csas26        parm=centrm
Saxton 2
238group
read comp
'MOX fuel
pu-239  1  0  1.3526-3  295  end
pu-240  1  0  1.2759-4  295  end
pu-241  1  0  1.1407-5  295  end
pu-242  1  0  6.0318-7  295  end
am-241  1  0  1.7783-6  295  end
u-234   1  0  1.1688-6  295  end
u-235   1  0  1.5301-4  295  end
u-238   1  0  2.1097-2  295  end
o       1  0  4.5155-2  295  end
'clad (ZR-2)
zr      2  0  4.2517-2   295  end
sn      2  0  4.6590-4   295  end
cr      2  0  7.5977-5   295  end
fe      2  0  1.4148-4   295  end
o       2  0  2.9630-4   295  end
'water(Refletor)
h     3  0  6.6781-2  295  end
o     3  0  3.3390-2  295  end
'b-10  3  0  1.7606-8  295  end
'b-11  3  0  7.1313-8  295  end
'Middle Grid and H2O
al   4  .8458 295  end
h2o  4  .1542  295  end
'Aluminum
al  5  0  6.0039-2  295  end
end comp
read celldata
latticecell  squarepitch
pitch=1.4224 3 fueld=.856996 1 cladd=.99314 2 gapd=.87503  0  end
end celldata
read param gen=520 npg=4000 nsk=20 tba=10.0  end param
read geometry
unit 1
com='Alum-H2O-Alum'
cuboid  10  4p.7112   5.08   0.0
cuboid  20  4p.7112   11.43  0.0
```

```
cuboid  30  4p.7112   13.97  0.0
media  5 1 10
media  3 1 20 -10
media  5 1 30 -20 -10
boundary  30
unit  2
com='Clad+Mod+AL Grid'
cylinder  10  0.49657  14.603  13.97
cylinder  20  0.50419  14.603  13.97
cuboid    30  4p.7112  14.603  13.97
media  2 1 10
media  3 1 20 -10
media  5 1 30 -20 -10
boundary  30
unit 3
com='Clad+(Modera)'
cylinder 10 0.49657 15.875 14.603
cuboid   20 4p.7112 15.875 14.603
media  2 1 10
media  3 1 20 -10
boundary 20
unit 4
com='Fuel+Gap+Clad+(Modera)'
cylinder   10    0.428498 61.595 15.875
cylinder   20    0.437515 61.595 15.875
cylinder   30    0.49657  61.595 15.875
cuboid     40    4p.7112  61.595 15.875
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
boundary  40
unit  5
com='(Fuel+Gap+Clad+(Middle Grid+moder))'
cylinder   10    0.428498 62.23  61.595
cylinder   20    0.437515 62.23  61.595
cylinder   30    0.49657  62.23  61.595
cylinder   40    0.50419  62.23  61.595
cuboid     50    4p.7112  62.23  61.595
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
media   4 1 50 -40 -30 -20 -10
boundary  50
unit 6
com='(Fuel+Gap+Clad+moder)'
cylinder   10    0.428498 96.675 62.23
cylinder   20    0.437515 96.675 62.23
cylinder   30    0.49657  96.675 62.23
cuboid     40    4p.7112  96.675 62.23
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
boundary  40
unit 7
com='(Fuel+Gap+Clad+Air)'
cylinder   10    0.428498 108.839 96.675
cylinder   20    0.437515 108.839 96.675
cylinder   30    0.49657  108.839 96.675
cuboid     40    4p.7112  108.839 96.675
media   1 1 10
media   0 1 20 -10
```

```
media   2 1 30 -20 -10
media   0 1 40 -30 -20 -10
boundary  40
unit 8
com='Clad+(Air)'
cylinder 10 0.49657 109.855 108.839
cuboid   20 4p.7112 109.855 108.839
media   2 1 10
media   0 1 20 -10
boundary  20
unit 9
com='Clad+Mod+AL grid'
cylinder 10 0.49657 111.125 109.855
cylinder 20 0.50419 111.125 109.855
cuboid   30 4p.7112 111.125 109.855
media   2 1 10
media   0 1 20 -10
media   5 1 30 -20 -10
boundary  30
unit  10
com='Clad+(Air)'
cylinder 10 0.49657 113.159 111.125
cuboid   20 4p.7112 113.159 111.125
media   2 1 10
media   0 1 20 -10
boundary  20
unit 12
com='Cell'
cuboid  10 4p.7112  113.159  0.0
array 1 10  place 1 1 1  3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10  4p13.5128    113.159  0.0
cuboid  20 4p43.5128 143.159  -30.0
array  2 10  place 10 10 1  3*0.0
media  3 1 20 -10
boundary  20
end geometry
read array
ara=1 nux=1 nuy=1 nuz=10
fill
1 2 3 4 5 6 7 8 9 10
end fill
ara=2 nux=19 nuy=19 nuz=1
fill f12 end fill
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.6   zul= 130
xlr= 41.0  ylr= 0.6   zlr= -40
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 25.
xlr= 41.0  ylr= -41.  zlr= 25.
uax=1.0 vdn=-1.0
nax=400 end
end plot
```

```
end data
end
=csas26       parm=centrm
Saxton 3
238group
read comp
'MOX fuel
pu-239  1  0  1.3526-3  295  end
pu-240  1  0  1.2759-4  295  end
pu-241  1  0  1.1407-5  295  end
pu-242  1  0  6.0318-7  295  end
am-241  1  0  1.7783-6  295  end
u-234   1  0  1.1688-6  295  end
u-235   1  0  1.5301-4  295  end
u-238   1  0  2.1097-2  295  end
o       1  0  4.5155-2  295  end
'clad (ZR-2)
zr      2  0  4.2517-2   295  end
sn      2  0  4.6590-4   295  end
cr      2  0  7.5977-5   295  end
fe      2  0  1.4148-4   295  end
o       2  0  2.9630-4   295  end
'water(Refletor)
h     3  0  6.6751-2  295  end
o     3  0  3.3404-2  295  end
b-10  3  0  3.7338-6  295  end
b-11  3  0  1.5029-5  295  end
'Middle Grid and H2O
al   4  .8458  295  end
h2o  4  .1542  295  end
'Aluminum
al  5  0  6.0039-2  295  end
end comp
read celldata
latticecell  squarepitch
pitch=1.4224 3 fueld=.856996 1 cladd=.99314 2 gapd=.87503  0  end
end celldata
read param   gen=520 npg=4000 nsk=20 tba=10.0  end param
read geometry
unit 1
com='Alum-H2O-Alum'
cuboid  10  4p.7112   5.08   0.0
cuboid  20  4p.7112   11.43  0.0
cuboid  30  4p.7112   13.97  0.0
media  5 1 10
media  3 1 20 -10
media  5 1 30 -20 -10
boundary  30
unit  2
com='Clad+Mod+AL Grid'
cylinder  10  0.49657  14.603  13.97
cylinder  20  0.50419  14.603  13.97
cuboid    30  4p.7112  14.603  13.97
media  2 1 10
media  3 1 20 -10
media  5 1 30 -20 -10
boundary  30
unit 3
com='Clad+(Modera)'
cylinder 10 0.49657 15.875 14.603
cuboid   20 4p.7112 15.875 14.603
media  2 1 10
media  3 1 20 -10
boundary 20
```

```
unit 4
com='Fuel+Gap+Clad+(Modera)'
cylinder   10    0.428498 61.595 15.875
cylinder   20    0.437515 61.595 15.875
cylinder   30    0.49657  61.595 15.875
cuboid     40    4p.7112  61.595 15.875
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
boundary  40
unit  5
com='(Fuel+Gap+Clad+(Middle Grid+moder))'
cylinder   10    0.428498 62.23  61.595
cylinder   20    0.437515 62.23  61.595
cylinder   30    0.49657  62.23  61.595
cylinder   40    0.50419  62.23  61.595
cuboid     50    4p.7112  62.23  61.595
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
media   4 1 50 -40 -30 -20 -10
boundary  50
unit 6
com='(Fuel+Gap+Clad+moder)'
cylinder   10    0.428498 103.935 62.23
cylinder   20    0.437515 103.935 62.23
cylinder   30    0.49657  103.935 62.23
cuboid     40    4p.7112  103.935 62.23
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
boundary  40
unit 7
com='(Fuel+Gap+Clad+Air)'
cylinder   10    0.428498 108.839 103.935
cylinder   20    0.437515 108.839 103.935
cylinder   30    0.49657  108.839 103.935
cuboid     40    4p.7112  108.839 103.935
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   0 1 40 -30 -20 -10
boundary  40
unit 8
com='Clad+(Air)'
cylinder 10 0.49657 109.855 108.839
cuboid   20 4p.7112 109.855 108.839
media   2 1 10
media   0 1 20 -10
boundary  20
unit 9
com='Clad+Mod+AL grid'
cylinder 10 0.49657 111.125 109.855
cylinder 20 0.50419 111.125 109.855
cuboid   30 4p.7112 111.125 109.855
media   2 1 10
media   0 1 20 -10
media   5 1 30 -20 -10
boundary  30
unit  10
com='Clad+(Air)'
```

```
cylinder 10 0.49657 113.159 111.125
cuboid   20 4p.7112 113.159 111.125
media   2 1 10
media   0 1 20 -10
boundary  20
unit 12
com='Cell'
cuboid  10 4p.7112  113.159  0.0
array 1 10  place 1 1 1  3*0.0
boundar 10
global unit 13
com='Cells in assembly'
cuboid  10  4p14.9352    113.159  0.0
cuboid  20 4p44.9352 143.159  -30.0
array  2 10  place 11 11 1  3*0.0
media  3 1 20 -10
boundary  20
end geometry
read array
ara=1 nux=1 nuy=1 nuz=10
fill
1 2 3 4 5 6 7 8 9 10
end fill
ara=2 nux=21 nuy=21 nuz=1
fill f12 end fill
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.0   zul= 140
xlr= 41.0  ylr= 0.0  zlr= -40
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 25.
xlr= 41.0  ylr= -41.  zlr= 25.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
=csas26         parm=centrm
Saxton 4
238group
read comp
'MOX fuel
pu-239  1  0  1.3526-3  295  end
pu-240  1  0  1.2759-4  295  end
pu-241  1  0  1.1407-5  295  end
pu-242  1  0  6.0318-7  295  end
am-241  1  0  1.7783-6  295  end
u-234   1  0  1.1688-6  295  end
u-235   1  0  1.5301-4  295  end
u-238   1  0  2.1097-2  295  end
o       1  0  4.5155-2  295  end
'clad (ZR-2)
zr      2  0  4.2517-2   295  end
sn      2  0  4.6590-4   295  end
cr      2  0  7.5977-5   295  end
fe      2  0  1.4148-4   295  end
```

```
o       2  0  2.9630-4   295  end
'water(Refletor)
h     3  0  6.6673-2  295  end
o     3  0  3.3336-2  295  end
'b-10  3  0  3.7338-6  295  end
'b-11  3  0  1.5029-5  295  end
'Middle Grid and H2O
al   4  .93  295  end
h2o  4  .07  295  end
'Aluminum
al  5  0  6.0039-2  295  end
end comp
read celldata
latticecell  squarepitch
pitch=1.8679 3 fueld=.856996 1 cladd=.99314 2 gapd=.87503  0  end
end celldata
read param  gen=520 npg=4000 nsk=20 tba=10.0  end param
read geometry
unit 1
com='Alum-H2O-Alum'
cuboid  10  4p.93395   5.08   0.0
cuboid  20  4p.93395   11.43  0.0
cuboid  30  4p.93395   13.97  0.0
media  5 1 10
media  3 1 20 -10
media  5 1 30 -20 -10
boundary  30
unit  2
com='Clad+Mod+AL Grid'
cylinder  10  0.49657  14.603  13.97
cylinder  20  0.50419  14.603  13.97
cuboid    30  4p.93395  14.603  13.97
media  2 1 10
media  3 1 20 -10
media  5 1 30 -20 -10
boundary  30
unit 3
com='Clad+(Modera)'
cylinder 10 0.49657 15.875 14.603
cuboid   20 4p.93395 15.875 14.603
media  2 1 10
media  3 1 20 -10
boundary 20
unit 4
com='Fuel+Gap+Clad+(Modera)'
cylinder   10    0.428498 61.595 15.875
cylinder   20    0.437515 61.595 15.875
cylinder   30    0.49657  61.595 15.875
cuboid     40    4p.93395  61.595 15.875
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
boundary  40
unit  5
com='(Fuel+Gap+Clad+(Middle Grid+moder))'
cylinder   10    0.428498 62.23  61.595
cylinder   20    0.437515 62.23  61.595
cylinder   30    0.49657  62.23  61.595
cylinder   40    0.50419  62.23  61.595
cuboid     50    4p.93395  62.23  61.595
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
```

```
media   3 1 40 -30 -20 -10
media   4 1 50 -40 -30 -20 -10
boundary  50
unit 6
com='(Fuel+Gap+Clad+moder)'
cylinder   10    0.428498 84.285 62.23
cylinder   20    0.437515 84.285 62.23
cylinder   30    0.49657  84.285 62.23
cuboid     40    4p.93395  84.285 62.23
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
boundary  40
unit 7
com='(Fuel+Gap+Clad+Air)'
cylinder   10    0.428498 108.839 84.285
cylinder   20    0.437515 108.839 84.285
cylinder   30    0.49657  108.839 84.285
cuboid     40    4p.93395  108.839 84.285
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   0 1 40 -30 -20 -10
boundary  40
unit 8
com='Clad+(Air)'
cylinder 10 0.49657 109.855 108.839
cuboid   20 4p.93395 109.855 108.839
media   2 1 10
media   0 1 20 -10
boundary  20
unit 9
com='Clad+Mod+AL grid'
cylinder 10 0.49657 111.125 109.855
cylinder 20 0.50419 111.125 109.855
cuboid   30 4p.93395 111.125 109.855
media   2 1 10
media   0 1 20 -10
media   5 1 30 -20 -10
boundary  30
unit  10
com='Clad+(Air)'
cylinder 10 0.49657 113.159 111.125
cuboid   20 4p.93395 113.159 111.125
media   2 1 10
media   0 1 20 -10
boundary  20
unit 12
com='Cell'
cuboid  10 4p.93395  113.159  0.0
array 1 10  place 1 1 1  3*0.0
boundar 10
global unit 13
com='Cells in assembly'
cuboid  10  4p12.14135    113.159    0.0
cuboid  20  4p42.14135    143.159  -30.0
array  2 10  place 7 7 1  3*0.0
media  3 1 20 -10
boundary  20
end geometry
read array
ara=1 nux=1 nuy=1 nuz=10
fill
```

```
1 2 3 4 5 6 7 8 9 10
end fill
ara=2 nux=13 nuy=13 nuz=1
fill f12 end fill
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.0   zul= 115
xlr= 41.0  ylr= 0.0   zlr= -10
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 50.
xlr= 41.0  ylr= -41.  zlr= 50.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
=csas26        parm=centrm
Saxton 5
238group
read comp
'MOX fuel
pu-239  1  0  1.3526-3  295  end
pu-240  1  0  1.2759-4  295  end
pu-241  1  0  1.1407-5  295  end
pu-242  1  0  6.0318-7  295  end
am-241  1  0  1.7783-6  295  end
u-234   1  0  1.1688-6  295  end
u-235   1  0  1.5301-4  295  end
u-238   1  0  2.1097-2  295  end
o       1  0  4.5155-2  295  end
'clad (ZR-2)
zr      2  0  4.2517-2   295  end
sn      2  0  4.6590-4   295  end
cr      2  0  7.5977-5   295  end
fe      2  0  1.4148-4   295  end
o       2  0  2.9630-4   295  end
'water(Refletor)
h     3  0  6.6783-2  295  end
o     3  0  3.3392-2  295  end
'b-10  3  0  3.7338-6  295  end
'b-11  3  0  1.5029-5  295  end
'Middle Grid and H2O
al   4  .942  295  end
h2o  4  .058  295  end
'Aluminum
al  5  0  6.0039-2  295  end
end comp
read celldata
latticecell  squarepitch
pitch=2.01158 3 fueld=.856996  1  cladd=.99314 2 gapd=.87503  0  end
end celldata
read param   gen=520 npg=4000 nsk=20 tba=10.0  end param
read geometry
unit 1
com='Alum-H2O-Alum'
cuboid  10  4p1.00579   5.08   0.0
```

```
cuboid  20  4p1.00579   11.43  0.0
cuboid  30  4p1.00579   13.97  0.0
media  5 1 10
media  3 1 20 -10
media  5 1 30 -20 -10
boundary  30
unit  2
com='Clad+Mod+AL Grid'
cylinder  10  0.49657  14.603  13.97
cylinder  20  0.50419  14.603  13.97
cuboid    30  4p1.00579  14.603  13.97
media  2 1 10
media  3 1 20 -10
media  5 1 30 -20 -10
boundary  30
unit 3
com='Clad+(Modera)'
cylinder 10 0.49657 15.875 14.603
cuboid   20 4p1.00579 15.875 14.603
media  2 1 10
media  3 1 20 -10
boundary 20
unit 4
com='Fuel+Gap+Clad+(Modera)'
cylinder   10    0.428498 61.595 15.875
cylinder   20    0.437515 61.595 15.875
cylinder   30    0.49657  61.595 15.875
cuboid     40    4p1.00579  61.595 15.875
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
boundary  40
unit  5
com='(Fuel+Gap+Clad+(Middle Grid+moder))'
cylinder   10    0.428498 62.23  61.595
cylinder   20    0.437515 62.23  61.595
cylinder   30    0.49657  62.23  61.595
cylinder   40    0.50419  62.23  61.595
cuboid     50    4p1.00579  62.23  61.595
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
media   4 1 50 -40 -30 -20 -10
boundary  50
unit 6
com='(Fuel+Gap+Clad+moder)'
cylinder   10    0.428498 92.635 62.23
cylinder   20    0.437515 92.635 62.23
cylinder   30    0.49657  92.635 62.23
cuboid     40    4p1.00579  92.635 62.23
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
boundary  40
unit 7
com='(Fuel+Gap+Clad+Air)'
cylinder   10    0.428498 108.839 92.635
cylinder   20    0.437515 108.839 92.635
cylinder   30    0.49657  108.839 92.635
cuboid     40    4p1.00579  108.839 92.635
media   1 1 10
```

```
media   0 1 20 -10
media   2 1 30 -20 -10
media   0 1 40 -30 -20 -10
boundary  40
unit 8
com='Clad+(Air)'
cylinder 10 0.49657 109.855 108.839
cuboid   20 4p1.00579 109.855 108.839
media   2 1 10
media   0 1 20 -10
boundary  20
unit 9
com='Clad+Mod+AL grid'
cylinder 10 0.49657 111.125 109.855
cylinder 20 0.50419 111.125 109.855
cuboid   30 4p1.00579 111.125 109.855
media   2 1 10
media   0 1 20 -10
media   5 1 30 -20 -10
boundary  30
unit  10
com='Clad+(Air)'
cylinder 10 0.49657 113.159 111.125
cuboid   20 4p1.00579 113.159 111.125
media   2 1 10
media   0 1 20 -10
boundary  20
unit 12
com='Cell'
cuboid  10 4p1.00579  113.159  0.0
array 1 10  place 1 1 1  3*0.0
boundar 10
global unit 13
com='Cells in assembly'
cuboid  10  23.13317 -1.00579   23.13317 -1.00579      113.159    0.0
cuboid  20  53.13317 -31.00579  53.13317 -31.00579     143.159  -30.0
array  2 10  place 1 1 1  3*0.0
media  3 1 20 -10
boundary  20
end geometry
read array
ara=1 nux=1 nuy=1 nuz=10
fill
1 2 3 4 5 6 7 8 9 10
end fill
ara=2 nux=12 nuy=12 nuz=1
fill f12 end fill
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.0   zul= 115
xlr= 41.0  ylr= 0.0   zlr= -10
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 50.
xlr= 41.0  ylr= -41.  zlr= 50.
uax=1.0 vdn=-1.0
nax=400 end
```

```
end plot
end data
end
=csas26        parm=centrm
Saxton 6
238group
read comp
'MOX fuel
pu-239  1  0  1.3526-3  295  end
pu-240  1  0  1.2759-4  295  end
pu-241  1  0  1.1407-5  295  end
pu-242  1  0  6.0318-7  295  end
am-241  1  0  1.7783-6  295  end
u-234   1  0  1.1688-6  295  end
u-235   1  0  1.5301-4  295  end
u-238   1  0  2.1097-2  295  end
o       1  0  4.5155-2  295  end
'clad (ZR-2)
zr      2  0  4.2517-2   295  end
sn      2  0  4.6590-4   295  end
cr      2  0  7.5977-5   295  end
fe      2  0  1.4148-4   295  end
o       2  0  2.9630-4   295  end
'water(Refletor)
h     3  0  6.6737-2  295  end
o     3  0  3.3368-2  295  end
'b-10  3  0  3.7338-6  295  end
'b-11  3  0  1.5029-5  295  end
'Middle Grid and H2O
al   4  .969  295  end
h2o  4  .031  295  end
'Aluminum
al  5  0  6.0039-2  295  end
end comp
read celldata
latticecell  squarepitch
pitch=2.6416 3 fueld=.856996  1  cladd=.99314 2 gapd=.87503  0  end
end celldata
read param gen=520 npg=4000 nsk=20 tba=10.0   end param
read geometry
unit 1
com='Alum-H2O-Alum'
cuboid  10  4p1.3208   5.08   0.0
cuboid  20  4p1.3208   11.43  0.0
cuboid  30  4p1.3208   13.97  0.0
media  5 1 10
media  3 1 20 -10
media  5 1 30 -20 -10
boundary  30
unit  2
com='Clad+Mod+AL Grid'
cylinder  10  0.49657  14.603  13.97
cylinder  20  0.50419  14.603  13.97
cuboid    30  4p1.3208  14.603  13.97
media  2 1 10
media  3 1 20 -10
media  5 1 30 -20 -10
boundary  30
unit 3
com='Clad+(Modera)'
cylinder 10 0.49657 15.875 14.603
cuboid   20 4p1.3208 15.875 14.603
media  2 1 10
media  3 1 20 -10
```

```
boundary 20
unit 4
com='Fuel+Gap+Clad+(Modera)'
cylinder   10    0.428498 61.595 15.875
cylinder   20    0.437515 61.595 15.875
cylinder   30    0.49657  61.595 15.875
cuboid     40    4p1.3208  61.595 15.875
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
boundary  40
unit  5
com='(Fuel+Gap+Clad+(Middle Grid+moder))'
cylinder   10    0.428498 62.23  61.595
cylinder   20    0.437515 62.23  61.595
cylinder   30    0.49657  62.23  61.595
cylinder   40    0.50419  62.23  61.595
cuboid     50    4p1.3208  62.23  61.595
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
media   4 1 50 -40 -30 -20 -10
boundary  50
unit 6
com='(Fuel+Gap+Clad+moder)'
cylinder   10    0.428498 95.375 62.23
cylinder   20    0.437515 95.375 62.23
cylinder   30    0.49657  95.375 62.23
cuboid     40    4p1.3208  95.375 62.23
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   3 1 40 -30 -20 -10
boundary  40
unit 7
com='(Fuel+Gap+Clad+Air)'
cylinder   10    0.428498 108.839 95.375
cylinder   20    0.437515 108.839 95.375
cylinder   30    0.49657  108.839 95.375
cuboid     40    4p1.3208  108.839 95.375
media   1 1 10
media   0 1 20 -10
media   2 1 30 -20 -10
media   0 1 40 -30 -20 -10
boundary  40
unit 8
com='Clad+(Air)'
cylinder 10 0.49657 109.855 108.839
cuboid   20 4p1.3208 109.855 108.839
media   2 1 10
media   0 1 20 -10
boundary  20
unit 9
com='Clad+Mod+AL grid'
cylinder 10 0.49657 111.125 109.855
cylinder 20 0.50419 111.125 109.855
cuboid   30 4p1.3208 111.125 109.855
media   2 1 10
media   0 1 20 -10
media   5 1 30 -20 -10
boundary  30
unit  10
```

```
com='Clad+(Air)'
cylinder 10 0.49657 113.159 111.125
cuboid   20 4p1.3208 113.159 111.125
media   2 1 10
media   0 1 20 -10
boundary  20
unit 12
com='Cell'
cuboid  10 4p1.3208  113.159  0.0
array 1 10  place 1 1 1  3*0.0
boundar 10
global unit 13
com='Cells in assembly'
cuboid  10  4p14.5288     113.159    0.0
cuboid  20  4p44.5288      143.159  -30.0
array  2 10  place 6 6 1  3*0.0
media  3 1 20 -10
boundary  20
end geometry
read array
ara=1 nux=1 nuy=1 nuz=10
fill
1 2 3 4 5 6 7 8 9 10
end fill
ara=2 nux=11 nuy=11 nuz=1
fill f12 end fill
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.0  zul= 130
xlr= 41.0  ylr= 0.0  zlr= -40
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 50.
xlr= 41.0  ylr= -41.  zlr= 50.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
=csas26        parm=centrm
TCA         *****case 1 *********
238group
read comp
'MOX fuel
u-234   1  0  7.1749-7  295  end
u-235   1  0  9.3926-5  295  end
u-238   1  0  1.2951-2  295  end
pu-238  1  0  2.0003-6  295  end
pu-239  1  0  2.7491-4  295  end
pu-240  1  0  8.8417-5  295  end
'***********  pu-241 varies *****************
pu-241  1  0  2.7923-5  295  end
pu-242  1  0  8.1234-6  295  end
'*****am-241 varies********
am-241  1  0  1.3531-6  295  end
o       1  0  2.7837-2  295  end
b-10    1  0  6.0418-8  295  end
```

```
b-11    1  0  2.4319-7  295  end
'clad (ZR-2)
zr      2  0  3.7772-2   295  end
sn      2  0  4.3737-4   295  end
cr      2  0  8.8570-5   295  end
fe      2  0  6.6119-5   295  end
o       2  0  3.5864-5   295  end
'water(Refletor)
h     3  0  6.6735-2  295  end
o     3  0  3.3368-2  295  end
'Al
Al    4  0  6.0224-2  295  end
'Stainless Steel
c     5  0  1.1928-4  295  end
si    5  0  1.7003-3  295  end
mn    5  0  1.7385-3  295  end
p     5  0  6.9381-5  295  end
s     5  0  4.4673-5  295  end
ni    5  0  8.9506-3  295  end
cr    5  0  1.7450-2  295  end
fe    5  0  5.7202-2  295  end
'ordinary concrete
h     6  0  1.3742-2  295  end
o     6  0  4.5919-2  295  end
c     6  0  1.1532-4  295  end
na    6  0  9.6395-4  295  end
mg    6  0  1.2388-4  295  end
al    6  0  1.7409-3  295  end
si    6  0  1.6617-2  295  end
k     6  0  4.6052-4  295  end
ca    6  0  1.5025-3  295  end
fe    6  0  3.4492-4  295  end
end comp
read celldata
latticecell
squarepitch  pitch=1.825 3  fueld=1.065  1   cladd=1.223  2  end
end celldata
read param gen=520 npg=4000 nsk=20 tba=10.0  end param
read geometry
unit 1
com='concrete, SS,H2O, SS, Al'
cuboid  10  4p.9125  13.5   13.0
cuboid  20  4p.9125  27.3   13.0
cuboid  30  4p.9125  29.5   13.0
cuboid  40  4p.9125  30.77  13.0
media   5 1 10
media   3 1 20 -10
media   5 1 30 -20 -10
media   4 1 40 -30 -20 -10
boundary  40
unit  2
com='h2o and end plug'
cylinder  10  0.6115  35.215  30.77
cuboid    20   4p.9125   35.215  30.77
media  4 1 10
media  3 1 20 -10
boundary  20
unit 3
com='Lower al grid '
cylinder 10 0.6115  35.816  35.215
cuboid   20 4p.9125 35.816  35.215
media  4 1 10
media  4 1 20 -10
boundary  20
```

```
unit 4
com='h2o and end plug'
cylinder  10  0.6115   47.6  35.816
cuboid    20  4p.9125  47.6  35.816
media  4 1 10
media  3 1 20 -10
boundary  20
unit  5
com='(Fuel+Clad+H2O)'
cylinder  10  0.5325     107.15  47.6
cylinder  20  0.6115     107.15  47.6
cuboid    30  4p0.9125   107.15  47.6
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 6
com='(Fuel+Clad+Void)'
cylinder  10  .5325  118.2   107.15
cylinder  20  .6115  118.2   107.15
cuboid    30   4p.9125 118.2  107.15
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary  30
unit 12
com='Cell'
cuboid  10 4p.9125 118.2  13.0
array 1 10    place 1 1 1    3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10  4p20.9875   118.20 13.0
cuboid  20  4p50.9875   148.2 13.0
cuboid  30  4p50.9875   148.2 -49.0
array 2 10 place 12 12 1 3*0.0
media  3 1 20 -10
media  6 1 30 -20 -10
boundary  30
end geometry
read array
ara=1 nux=1 nuy=1 nuz=6
fill
1 2 3 4 5 6
end fill
ara=2 nux=23 nuy=23  nuz=1
fill f12 end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.6   zul= 130
xlr= 41.0  ylr= 0.6   zlr= -40
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul=50.
xlr= 41.0  ylr= -41.  zlr=50.
uax=1.0 vdn=-1.0
nax=400 end
end plot
```

```
end data
end
=csas26        parm=centrm
TCA         *****case 2 *********
238group
read comp
'MOX fuel
u-234   1  0  7.1749-7  295  end
u-235   1  0  9.3926-5  295  end
u-238   1  0  1.2951-2  295  end
pu-238  1  0  2.0003-6  295  end
pu-239  1  0  2.7491-4  295  end
pu-240  1  0  8.8417-5  295  end
'***********  pu-241 varies *****************
pu-241  1  0  2.6701-5  295  end
pu-242  1  0  8.1234-6  295  end
'*****am-241 varies********
am-241  1  0  2.5812-6  295  end
o       1  0  2.7837-2  295  end
b-10    1  0  6.0418-8  295  end
b-11    1  0  2.4319-7  295  end
'clad (ZR-2)
zr      2  0  3.7772-2   295  end
sn      2  0  4.3737-4   295  end
cr      2  0  8.8570-5   295  end
fe      2  0  6.6119-5   295  end
o       2  0  3.5864-5   295  end
'water(Refletor)
h     3  0  6.6735-2  295  end
o     3  0  3.3368-2  295  end
'Al
Al    4  0  6.0224-2  295  end
'Stainless Steel
c     5  0  1.1928-4  295  end
si    5  0  1.7003-3  295  end
mn    5  0  1.7385-3  295  end
p     5  0  6.9381-5  295  end
s     5  0  4.4673-5  295  end
ni    5  0  8.9506-3  295  end
cr    5  0  1.7450-2  295  end
fe    5  0  5.7202-2  295  end
'ordinary concrete
h     6  0  1.3742-2  295  end
o     6  0  4.5919-2  295  end
c     6  0  1.1532-4  295  end
na    6  0  9.6395-4  295  end
mg    6  0  1.2388-4  295  end
al    6  0  1.7409-3  295  end
si    6  0  1.6617-2  295  end
k     6  0  4.6052-4  295  end
ca    6  0  1.5025-3  295  end
fe    6  0  3.4492-4  295  end
end comp
read celldata
latticecell
squarepitch  pitch=1.825 3  fueld=1.065  1   cladd=1.223  2  end
end celldata
read param gen=520 npg=4000 nsk=20 tba=10.0  end param
read geometry
unit 1
com='concrete, SS,H2O, SS, Al'
cuboid  10  4p.9125  13.5   13.0
cuboid  20  4p.9125  27.3   13.0
cuboid  30  4p.9125  29.5   13.0
```

```
cuboid  40  4p.9125  30.77  13.0
media   5 1 10
media   3 1 20 -10
media   5 1 30 -20 -10
media   4 1 40 -30 -20 -10
boundary  40
unit  2
com='h2o and end plug'
cylinder  10  0.6115  35.215  30.77
cuboid    20   4p.9125   35.215  30.77
media  4 1 10
media  3 1 20 -10
boundary  20
unit 3
com='Lower al grid '
cylinder 10 0.6115  35.816  35.215
cuboid   20 4p.9125 35.816  35.215
media  4 1 10
media  4 1 20 -10
boundary  20
unit 4
com='h2o and end plug'
cylinder  10  0.6115   47.6  35.816
cuboid    20  4p.9125  47.6  35.816
media  4 1 10
media  3 1 20 -10
boundary  20
unit  5
com='(Fuel+Clad+H2O)'
cylinder  10  0.5325     109.59  47.6
cylinder  20  0.6115     109.59  47.6
cuboid    30  4p0.9125   109.59  47.6
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 6
com='(Fuel+Clad+Void)'
cylinder  10  .5325  118.2   109.59
cylinder  20  .6115  118.2   109.59
cuboid    30   4p.9125 118.2  109.59
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary  30
unit 12
com='Cell'
cuboid  10 4p.9125 118.2  13.0
array 1 10    place 1 1 1    3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10  4p20.9875   118.20 13.0
cuboid  20  4p50.9875   148.2 13.0
cuboid  30  4p50.9875   148.2 -49.0
array 2 10 place 12 12 1 3*0.0
media  3 1 20 -10
media  6 1 30 -20 -10
boundary  30
end geometry
read array
ara=1 nux=1 nuy=1 nuz=6
fill
1 2 3 4 5 6
```

```
end fill
ara=2 nux=23 nuy=23  nuz=1
fill f12 end fill
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.6   zul= 130
xlr= 41.0  ylr= 0.6   zlr= -40
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 50.
xlr= 41.0  ylr= -41.  zlr= 50.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
=csas26        parm=centrm
TCA         *****case 3 *********
238group
read comp
'MOX fuel
u-234   1  0  7.1749-7  295  end
u-235   1  0  9.3926-5  295  end
u-238   1  0  1.2951-2  295  end
pu-238  1  0  2.0003-6  295  end
pu-239  1  0  2.7491-4  295  end
pu-240  1  0  8.8417-5  295  end
'***********  pu-241 varies *****************
pu-241  1  0  2.5447-5  295  end
pu-242  1  0  8.1234-6  295  end
'*****am-241 varies********
am-241  1  0  3.8361-6  295  end
o       1  0  2.7837-2  295  end
b-10    1  0  6.0418-8  295  end
b-11    1  0  2.4319-7  295  end
'clad (ZR-2)
zr      2  0  3.7772-2   295  end
sn      2  0  4.3737-4   295  end
cr      2  0  8.8570-5   295  end
fe      2  0  6.6119-5   295  end
o       2  0  3.5864-5   295  end
'water(Refletor)
h     3  0  6.6735-2  295  end
o     3  0  3.3368-2  295  end
'Al
Al    4  0  6.0224-2  295  end
'Stainless Steel
c     5  0  1.1928-4  295  end
si    5  0  1.7003-3  295  end
mn    5  0  1.7385-3  295  end
p     5  0  6.9381-5  295  end
s     5  0  4.4673-5  295  end
ni    5  0  8.9506-3  295  end
cr    5  0  1.7450-2  295  end
fe    5  0  5.7202-2  295  end
'ordinary concrete
h     6  0  1.3742-2  295  end
```

```
o     6  0  4.5919-2  295  end
c     6  0  1.1532-4  295  end
na    6  0  9.6395-4  295  end
mg    6  0  1.2388-4  295  end
al    6  0  1.7409-3  295  end
si    6  0  1.6617-2  295  end
k     6  0  4.6052-4  295  end
ca    6  0  1.5025-3  295  end
fe    6  0  3.4492-4  295  end
end comp
read celldata
latticecell
squarepitch  pitch=1.825 3  fueld=1.065  1   cladd=1.223  2  end
end celldata
read param  gen=520 npg=4000 nsk=20 tba=10.0  end param
read geometry
unit 1
com='concrete, SS,H2O, SS, Al'
cuboid  10  4p.9125  13.5   13.0
cuboid  20  4p.9125  27.3   13.0
cuboid  30  4p.9125  29.5   13.0
cuboid  40  4p.9125  30.77  13.0
media   5 1 10
media   3 1 20 -10
media   5 1 30 -20 -10
media   4 1 40 -30 -20 -10
boundary  40
unit  2
com='h2o and end plug'
cylinder  10  0.6115  35.215  30.77
cuboid    20   4p.9125   35.215  30.77
media  4 1 10
media  3 1 20 -10
boundary  20
unit 3
com='Lower al grid '
cylinder 10 0.6115  35.816  35.215
cuboid   20 4p.9125 35.816  35.215
media  4 1 10
media  4 1 20 -10
boundary  20
unit 4
com='h2o and end plug'
cylinder  10  0.6115   47.6  35.816
cuboid    20  4p.9125  47.6  35.816
media  4 1 10
media  3 1 20 -10
boundary  20
unit  5
com='(Fuel+Clad+H2O)'
cylinder  10  0.5325     111.6  47.6
cylinder  20  0.6115     111.6  47.6
cuboid    30  4p0.9125   111.6  47.6
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 6
com='(Fuel+Clad+Void)'
cylinder  10  .5325  118.2   111.6
cylinder  20  .6115  118.2   111.6
cuboid    30   4p.9125 118.2  111.6
media  1 1 10
media  2 1 20 -10
```

```
media  0 1 30 -20 -10
boundary  30
unit 12
com='Cell'
cuboid  10 4p.9125 118.2  13.0
array 1 10    place 1 1 1    3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10  4p20.9875   118.20 13.0
cuboid  20  4p50.9875   148.2 13.0
cuboid  30  4p50.9875   148.2 -49.0
array 2 10 place 12 12 1 3*0.0
media  3 1 20 -10
media  6 1 30 -20 -10
boundary  30
end geometry
read array
ara=1 nux=1 nuy=1 nuz=6
fill
1 2 3 4 5 6
end fill
ara=2 nux=23 nuy=23  nuz=1
fill f12 end fill
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.6   zul= 130
xlr= 41.0  ylr= 0.6   zlr= -40
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 50.
xlr= 41.0  ylr= -41.  zlr= 50.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
=csas26       parm=centrm
TCA         *****case 4 *********
238group
read comp
'MOX fuel
u-234   1  0  7.1749-7  295  end
u-235   1  0  9.3926-5  295  end
u-238   1  0  1.2951-2  295  end
pu-238  1  0  2.0003-6  295  end
pu-239  1  0  2.7491-4  295  end
pu-240  1  0  8.8417-5  295  end
'***********  pu-241 varies *****************
pu-241  1  0  2.8003-5  295  end
pu-242  1  0  8.1234-6  295  end
'*****am-241 varies********
am-241  1  0  1.2793-6  295  end
o       1  0  2.7837-2  295  end
b-10    1  0  6.0418-8  295  end
b-11    1  0  2.4319-7  295  end
'clad (ZR-2)
```

```
zr      2  0  3.7772-2   295  end
sn      2  0  4.3737-4   295  end
cr      2  0  8.8570-5   295  end
fe      2  0  6.6119-5   295  end
o       2  0  3.5864-5   295  end
'water(Refletor)
h     3  0  6.6735-2  295  end
o     3  0  3.3368-2  295  end
'Al
Al    4  0  6.0224-2  295  end
'Stainless Steel
c     5  0  1.1928-4  295  end
si    5  0  1.7003-3  295  end
mn    5  0  1.7385-3  295  end
p     5  0  6.9381-5  295  end
s     5  0  4.4673-5  295  end
ni    5  0  8.9506-3  295  end
cr    5  0  1.7450-2  295  end
fe    5  0  5.7202-2  295  end
'ordinary concrete
h     6  0  1.3742-2  295  end
o     6  0  4.5919-2  295  end
c     6  0  1.1532-4  295  end
na    6  0  9.6395-4  295  end
mg    6  0  1.2388-4  295  end
al    6  0  1.7409-3  295  end
si    6  0  1.6617-2  295  end
k     6  0  4.6052-4  295  end
ca    6  0  1.5025-3  295  end
fe    6  0  3.4492-4  295  end
end comp
read celldata
latticecell
squarepitch  pitch=1.956 3  fueld=1.065  1   cladd=1.223  2  end
end celldata
read param gen=520 npg=4000 nsk=20 tba=10.0  end param
read geometry
unit 1
com='concrete, SS,H2O, SS, Al'
cuboid  10  4p.978  13.5   13.0
cuboid  20  4p.978  27.3   13.0
cuboid  30  4p.978  29.5   13.0
cuboid  40  4p.978  30.77  13.0
media   5 1 10
media   3 1 20 -10
media   5 1 30 -20 -10
media   4 1 40 -30 -20 -10
boundary  40
unit  2
com='h2o and end plug'
cylinder  10  0.6115  35.215  30.77
cuboid    20   4p.978   35.215  30.77
media  4 1 10
media  3 1 20 -10
boundary  20
unit 3
com='Lower al grid '
cylinder 10 0.6115  35.816  35.215
cuboid   20 4p.978 35.816  35.215
media  4 1 10
media  4 1 20 -10
boundary  20
unit 4
com='h2o and end plug'
```

```
cylinder  10  0.6115   47.6  35.816
cuboid    20  4p.978  47.6  35.816
media  4 1 10
media  3 1 20 -10
boundary  20
unit  5
com='(Fuel+Clad+H2O)'
cylinder  10  0.5325     109.1  47.6
cylinder  20  0.6115     109.1  47.6
cuboid    30  4p0.978   109.1  47.6
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 6
com='(Fuel+Clad+Void)'
cylinder  10  .5325  118.2   109.1
cylinder  20  .6115  118.2   109.1
cuboid    30   4p.978 118.2  109.1
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary  30
unit 12
com='Cell'
cuboid  10 4p.978 118.2  13.0
array 1 10    place 1 1 1    3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10  4p20.538   118.20 13.0
cuboid  20  4p50.538   148.2 13.0
cuboid  30  4p50.538   148.2 -49.0
array 2 10 place 11 11 1 3*0.0
media  3 1 20 -10
media  6 1 30 -20 -10
boundary  30
end geometry
read array
ara=1 nux=1 nuy=1 nuz=6
fill
1 2 3 4 5 6
end fill
ara=2 nux=21 nuy=21  nuz=1
fill f12 end fill
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.6   zul= 130
xlr= 41.0  ylr= 0.6   zlr= -40
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 50.
xlr= 41.0  ylr= -41.  zlr= 50.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
```

```
end
=csas26        parm=centrm
TCA         *****case 5 *********
238group
read comp
'MOX fuel
u-234   1  0  7.1749-7  295  end
u-235   1  0  9.3926-5  295  end
u-238   1  0  1.2951-2  295  end
pu-238  1  0  2.0003-6  295  end
pu-239  1  0  2.7491-4  295  end
pu-240  1  0  8.8417-5  295  end
'***********  pu-241 varies *****************
pu-241  1  0  2.6670-5  295  end
pu-242  1  0  8.1234-6  295  end
'*****am-241 varies********
am-241  1  0  2.6129-6  295  end
o       1  0  2.7837-2  295  end
b-10    1  0  6.0418-8  295  end
b-11    1  0  2.4319-7  295  end
'clad (ZR-2)
zr      2  0  3.7772-2   295  end
sn      2  0  4.3737-4   295  end
cr      2  0  8.8570-5   295  end
fe      2  0  6.6119-5   295  end
o       2  0  3.5864-5   295  end
'water(Refletor)
h     3  0  6.6735-2  295  end
o     3  0  3.3368-2  295  end
'Al
Al    4  0  6.0224-2  295  end
'Stainless Steel
c     5  0  1.1928-4  295  end
si    5  0  1.7003-3  295  end
mn    5  0  1.7385-3  295  end
p     5  0  6.9381-5  295  end
s     5  0  4.4673-5  295  end
ni    5  0  8.9506-3  295  end
cr    5  0  1.7450-2  295  end
fe    5  0  5.7202-2  295  end
'ordinary concrete
h     6  0  1.3742-2  295  end
o     6  0  4.5919-2  295  end
c     6  0  1.1532-4  295  end
na    6  0  9.6395-4  295  end
mg    6  0  1.2388-4  295  end
al    6  0  1.7409-3  295  end
si    6  0  1.6617-2  295  end
k     6  0  4.6052-4  295  end
ca    6  0  1.5025-3  295  end
fe    6  0  3.4492-4  295  end
end comp
read celldata
latticecell
squarepitch  pitch=1.956 3  fueld=1.065  1   cladd=1.223  2  end
end celldata
read param   gen=520 npg=4000 nsk=20 tba=10.0  end param
read geometry
unit 1
com='concrete, SS,H2O, SS, Al'
cuboid  10  4p.978  13.5   13.0
cuboid  20  4p.978  27.3   13.0
cuboid  30  4p.978  29.5   13.0
cuboid  40  4p.978  30.77  13.0
```

```
media   5 1 10
media   3 1 20 -10
media   5 1 30 -20 -10
media   4 1 40 -30 -20 -10
boundary  40
unit  2
com='h2o and end plug'
cylinder  10  0.6115  35.215  30.77
cuboid    20   4p.978   35.215  30.77
media  4 1 10
media  3 1 20 -10
boundary  20
unit 3
com='Lower al grid '
cylinder 10 0.6115  35.816  35.215
cuboid   20 4p.978 35.816  35.215
media  4 1 10
media  4 1 20 -10
boundary  20
unit 4
com='h2o and end plug'
cylinder  10  0.6115   47.6  35.816
cuboid    20  4p.978  47.6  35.816
media  4 1 10
media  3 1 20 -10
boundary  20
unit  5
com='(Fuel+Clad+H2O)'
cylinder  10  0.5325     112.0  47.6
cylinder  20  0.6115     112.0  47.6
cuboid    30  4p0.978   112.0  47.6
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 6
com='(Fuel+Clad+Void)'
cylinder  10  .5325  118.2   112.0
cylinder  20  .6115  118.2   112.0
cuboid    30   4p.978 118.2  112.0
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary  30
unit 12
com='Cell'
cuboid  10 4p.978 118.2  13.0
array 1 10    place 1 1 1    3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10  4p20.538   118.20 13.0
cuboid  20  4p50.538   148.2 13.0
cuboid  30  4p50.538   148.2 -49.0
array 2 10 place 11 11 1 3*0.0
media  3 1 20 -10
media  6 1 30 -20 -10
boundary  30
end geometry
read array
ara=1 nux=1 nuy=1 nuz=6
fill
1 2 3 4 5 6
end fill
```

```
ara=2 nux=21 nuy=21  nuz=1
fill f12 end fill
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.6   zul= 130
xlr= 41.0  ylr= 0.6   zlr= -40
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 50.
xlr= 41.0  ylr= -41.  zlr= 50.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
=csas26        parm=centrm
TCA          *****case 6 *********
238group
read comp
'MOX fuel
u-234   1  0  7.1749-7  295  end
u-235   1  0  9.3926-5  295  end
u-238   1  0  1.2951-2  295  end
pu-238  1  0  2.0003-6  295  end
pu-239  1  0  2.7491-4  295  end
pu-240  1  0  8.8417-5  295  end
'***********  pu-241 varies *****************
pu-241  1  0  2.4228-5  295  end
pu-242  1  0  8.1234-6  295  end
'*****am-241 varies********
am-241  1  0  5.0543-6  295  end
o       1  0  2.7837-2  295  end
b-10    1  0  6.0418-8  295  end
b-11    1  0  2.4319-7  295  end
'clad (ZR-2)
zr      2  0  3.7772-2   295  end
sn      2  0  4.3737-4   295  end
cr      2  0  8.8570-5   295  end
fe      2  0  6.6119-5   295  end
o       2  0  3.5864-5   295  end
'water(Refletor)
h     3  0  6.6735-2  295  end
o     3  0  3.3368-2  295  end
'Al
Al    4  0  6.0224-2  295  end
'Stainless Steel
c     5  0  1.1928-4  295  end
si    5  0  1.7003-3  295  end
mn    5  0  1.7385-3  295  end
p     5  0  6.9381-5  295  end
s     5  0  4.4673-5  295  end
ni    5  0  8.9506-3  295  end
cr    5  0  1.7450-2  295  end
fe    5  0  5.7202-2  295  end
'ordinary concrete
h     6  0  1.3742-2  295  end
o     6  0  4.5919-2  295  end
```

```
c     6  0  1.1532-4  295  end
na    6  0  9.6395-4  295  end
mg    6  0  1.2388-4  295  end
al    6  0  1.7409-3  295  end
si    6  0  1.6617-2  295  end
k     6  0  4.6052-4  295  end
ca    6  0  1.5025-3  295  end
fe    6  0  3.4492-4  295  end
end comp
read celldata
latticecell
squarepitch  pitch=1.956 3  fueld=1.065  1   cladd=1.223  2  end
end celldata
read param gen=520 npg=4000 nsk=20 tba=10.0  rnd=4D9C9F2D6F55C2F0 end param
read geometry
unit 1
com='concrete, SS,H2O, SS, Al'
cuboid  10  4p.978  13.5   13.0
cuboid  20  4p.978  27.3   13.0
cuboid  30  4p.978  29.5   13.0
cuboid  40  4p.978  30.77  13.0
media   5 1 10
media   3 1 20 -10
media   5 1 30 -20 -10
media   4 1 40 -30 -20 -10
boundary  40
unit  2
com='h2o and end plug'
cylinder  10  0.6115  35.215  30.77
cuboid    20   4p.978   35.215  30.77
media  4 1 10
media  3 1 20 -10
boundary  20
unit 3
com='Lower al grid '
cylinder 10 0.6115  35.816  35.215
cuboid   20 4p.978 35.816  35.215
media  4 1 10
media  4 1 20 -10
boundary  20
unit 4
com='h2o and end plug'
cylinder  10  0.6115   47.6  35.816
cuboid    20  4p.978  47.6  35.816
media  4 1 10
media  3 1 20 -10
boundary  20
unit  5
com='(Fuel+Clad+H2O)'
cylinder  10  0.5325     117.0  47.6
cylinder  20  0.6115     117.0  47.6
cuboid    30  4p0.978   117.0  47.6
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 6
com='(Fuel+Clad+Void)'
cylinder  10  .5325  118.2   117.0
cylinder  20  .6115  118.2   117.0
cuboid    30   4p.978 118.2  117.0
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
```

```
boundary  30
unit 12
com='Cell'
cuboid  10 4p.978 118.2  13.0
array 1 10    place 1 1 1    3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10  4p20.538   118.20 13.0
cuboid  20  4p50.538   148.2 13.0
cuboid  30  4p50.538   148.2 -49.0
array 2 10 place 11 11 1 3*0.0
media  3 1 20 -10
media  6 1 30 -20 -10
boundary  30
end geometry
read array
ara=1 nux=1 nuy=1 nuz=6
fill
1 2 3 4 5 6
end fill
ara=2 nux=21 nuy=21  nuz=1
fill f12 end fill
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.6   zul= 130
xlr= 41.0  ylr= 0.6   zlr= -40
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 50.
xlr= 41.0  ylr= -41.  zlr= 50.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
=csas26       parm=centrm
TCA          *****case 7 *********
238group
read comp
'MOX fuel
u-234   1  0  7.1749-7  295  end
u-235   1  0  9.3926-5  295  end
u-238   1  0  1.2951-2  295  end
pu-238  1  0  2.0003-6  295  end
pu-239  1  0  2.7491-4  295  end
pu-240  1  0  8.8417-5  295  end
'***********  pu-241 varies ******************
pu-241  1  0  2.8133-5  295  end
pu-242  1  0  8.1234-6  295  end
'*****am-241 varies********
am-241  1  0  1.1498-6  295  end
o       1  0  2.7837-2  295  end
b-10    1  0  6.0418-8  295  end
b-11    1  0  2.4319-7  295  end
'clad (ZR-2)
zr      2  0  3.7772-2   295  end
```

```
sn      2  0  4.3737-4   295  end
cr      2  0  8.8570-5   295  end
fe      2  0  6.6119-5   295  end
o       2  0  3.5864-5   295  end
'water(Refletor)
h     3  0  6.6735-2  295  end
o     3  0  3.3368-2  295  end
'Al
Al    4  0  6.0224-2  295  end
'Stainless Steel
c     5  0  1.1928-4  295  end
si    5  0  1.7003-3  295  end
mn    5  0  1.7385-3  295  end
p     5  0  6.9381-5  295  end
s     5  0  4.4673-5  295  end
ni    5  0  8.9506-3  295  end
cr    5  0  1.7450-2  295  end
fe    5  0  5.7202-2  295  end
'ordinary concrete
h     6  0  1.3742-2  295  end
o     6  0  4.5919-2  295  end
c     6  0  1.1532-4  295  end
na    6  0  9.6395-4  295  end
mg    6  0  1.2388-4  295  end
al    6  0  1.7409-3  295  end
si    6  0  1.6617-2  295  end
k     6  0  4.6052-4  295  end
ca    6  0  1.5025-3  295  end
fe    6  0  3.4492-4  295  end
end comp
read celldata
latticecell
squarepitch  pitch=2.225 3  fueld=1.065  1   cladd=1.223  2  end
end celldata
read param  gen=520 npg=4000 nsk=20 tba=10.0  rnd=4D9C9F2D6F55C2F0  end param
read geometry
unit 1
com='concrete, SS,H2O, SS, Al'
cuboid  10  4p1.1125  13.5   13.0
cuboid  20  4p1.1125  27.3   13.0
cuboid  30  4p1.1125  29.5   13.0
cuboid  40  4p1.1125  30.77  13.0
media   5 1 10
media   3 1 20 -10
media   5 1 30 -20 -10
media   4 1 40 -30 -20 -10
boundary  40
unit  2
com='h2o and end plug'
cylinder  10  0.6115  35.215  30.77
cuboid    20   4p1.1125   35.215  30.77
media  4 1 10
media  3 1 20 -10
boundary  20
unit 3
com='Lower al grid '
cylinder 10 0.6115  35.816  35.215
cuboid   20 4p1.1125 35.816  35.215
media  4 1 10
media  4 1 20 -10
boundary  20
unit 4
com='h2o and end plug'
cylinder  10  0.6115   47.6  35.816
```

```
cuboid    20  4p1.1125  47.6  35.816
media  4 1 10
media  3 1 20 -10
boundary  20
unit  5
com='(Fuel+Clad+H2O)'
cylinder  10  0.5325     107.92  47.6
cylinder  20  0.6115     107.92  47.6
cuboid    30  4p01.1125   107.92  47.6
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 6
com='(Fuel+Clad+Void)'
cylinder  10  .5325  118.2   107.92
cylinder  20  .6115  118.2   107.92
cuboid    30   4p1.1125 118.2  107.92
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary  30
unit 12
com='Cell'
cuboid  10 4p1.1125 118.2  13.0
array 1 10    place 1 1 1    3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10  43.3875 -1.1125  43.3875 -1.1125   118.2  13.0
cuboid  20  73.3875 -31.1125 73.3875 -31.1125  148.2  13.0
cuboid  30  73.3875 -31.1125 73.3875 -31.1125  148.2 -49.0
array 2 10 place 1 1 1 3*0.0
media  3 1 20 -10
media  6 1 30 -20 -10
boundary  30
end geometry
read array
ara=1 nux=1 nuy=1 nuz=6
fill
1 2 3 4 5 6
end fill
ara=2 nux=20 nuy=20  nuz=1
fill f12 end fill
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -75.0  yul= 0.6   zul= 130
xlr= 75.0  ylr= 0.6   zlr= -40
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -75.0  yul= 75.   zul= 50.
xlr= 75.0  ylr= -75.  zlr= 50.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
```

```
=csas26        parm=centrm
TCA         *****case 8 *********
238group
read comp
'MOX fuel
u-234   1  0  7.1749-7  295  end
u-235   1  0  9.3926-5  295  end
u-238   1  0  1.2951-2  295  end
pu-238  1  0  2.0003-6  295  end
pu-239  1  0  2.7491-4  295  end
pu-240  1  0  8.8417-5  295  end
'***********  pu-241 varies *****************
pu-241  1  0  2.6649-5  295  end
pu-242  1  0  8.1234-6  295  end
'*****am-241 varies********
am-241  1  0  2.6340-6  295  end
o       1  0  2.7837-2  295  end
b-10    1  0  6.0418-8  295  end
b-11    1  0  2.4319-7  295  end
'clad (ZR-2)
zr      2  0  3.7772-2   295  end
sn      2  0  4.3737-4   295  end
cr      2  0  8.8570-5   295  end
fe      2  0  6.6119-5   295  end
o       2  0  3.5864-5   295  end
'water(Refletor)
h     3  0  6.6735-2  295  end
o     3  0  3.3368-2  295  end
'Al
Al    4  0  6.0224-2  295  end
'Stainless Steel
c     5  0  1.1928-4  295  end
si    5  0  1.7003-3  295  end
mn    5  0  1.7385-3  295  end
p     5  0  6.9381-5  295  end
s     5  0  4.4673-5  295  end
ni    5  0  8.9506-3  295  end
cr    5  0  1.7450-2  295  end
fe    5  0  5.7202-2  295  end
'ordinary concrete
h     6  0  1.3742-2  295  end
o     6  0  4.5919-2  295  end
c     6  0  1.1532-4  295  end
na    6  0  9.6395-4  295  end
mg    6  0  1.2388-4  295  end
al    6  0  1.7409-3  295  end
si    6  0  1.6617-2  295  end
k     6  0  4.6052-4  295  end
ca    6  0  1.5025-3  295  end
fe    6  0  3.4492-4  295  end
end comp
read celldata
latticecell
squarepitch  pitch=2.225 3  fueld=1.065  1   cladd=1.223  2  end
end celldata
read param  gen=520 npg=4000 nsk=20 tba=10.0  end param
read geometry
unit 1
com='concrete, SS,H2O, SS, Al'
cuboid  10  4p1.1125  13.5   13.0
cuboid  20  4p1.1125  27.3   13.0
cuboid  30  4p1.1125  29.5   13.0
cuboid  40  4p1.1125  30.77  13.0
media   5 1 10
```

```
media   3 1 20 -10
media   5 1 30 -20 -10
media   4 1 40 -30 -20 -10
boundary  40
unit  2
com='h2o and end plug'
cylinder  10  0.6115  35.215  30.77
cuboid    20   4p1.1125   35.215  30.77
media  4 1 10
media  3 1 20 -10
boundary  20
unit 3
com='Lower al grid '
cylinder 10 0.6115  35.816  35.215
cuboid   20 4p1.1125 35.816  35.215
media  4 1 10
media  4 1 20 -10
boundary  20
unit 4
com='h2o and end plug'
cylinder  10  0.6115   47.6  35.816
cuboid    20  4p1.1125  47.6  35.816
media  4 1 10
media  3 1 20 -10
boundary  20
unit  5
com='(Fuel+Clad+H2O)'
cylinder  10  0.5325     110.59  47.6
cylinder  20  0.6115     110.59  47.6
cuboid    30  4p01.1125   110.59  47.6
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 6
com='(Fuel+Clad+Void)'
cylinder  10  .5325  118.2   110.59
cylinder  20  .6115  118.2   110.59
cuboid    30   4p1.1125 118.2  110.59
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary  30
unit 12
com='Cell'
cuboid  10 4p1.1125 118.2  13.0
array 1 10    place 1 1 1    3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10  43.3875 -1.1125  43.3875 -1.1125   118.2  13.0
cuboid  20  73.3875 -31.1125 73.3875 -31.1125  148.2  13.0
cuboid  30  73.3875 -31.1125 73.3875 -31.1125  148.2 -49.0
array 2 10 place 1 1 1 3*0.0
media  3 1 20 -10
media  6 1 30 -20 -10
boundary  30
end geometry
read array
ara=1 nux=1 nuy=1 nuz=6
fill
1 2 3 4 5 6
end fill
ara=2 nux=20 nuy=20  nuz=1
```

```
fill f12 end fill
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -75.0  yul= 0.6   zul= 130
xlr= 75.0  ylr= 0.6   zlr= -40
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -75.0  yul= 75.   zul= 50.
xlr= 75.0  ylr= -75.  zlr= 50.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
=csas26       parm=centrm
TCA          *****case 9 *********
238group
read comp
'MOX fuel
u-234   1  0  7.1749-7  295  end
u-235   1  0  9.3926-5  295  end
u-238   1  0  1.2951-2  295  end
pu-238  1  0  2.0003-6  295  end
pu-239  1  0  2.7491-4  295  end
pu-240  1  0  8.8417-5  295  end
'***********  pu-241 varies *****************
pu-241  1  0  2.5373-5  295  end
pu-242  1  0  8.1234-6  295  end
'*****am-241 varies********
am-241  1  0  3.9098-6  295  end
o       1  0  2.7837-2  295  end
b-10    1  0  6.0418-8  295  end
b-11    1  0  2.4319-7  295  end
'clad (ZR-2)
zr      2  0  3.7772-2   295  end
sn      2  0  4.3737-4   295  end
cr      2  0  8.8570-5   295  end
fe      2  0  6.6119-5   295  end
o       2  0  3.5864-5   295  end
'water(Refletor)
h     3  0  6.6735-2  295  end
o     3  0  3.3368-2  295  end
'Al
Al    4  0  6.0224-2  295  end
'Stainless Steel
c     5  0  1.1928-4  295  end
si    5  0  1.7003-3  295  end
mn    5  0  1.7385-3  295  end
p     5  0  6.9381-5  295  end
s     5  0  4.4673-5  295  end
ni    5  0  8.9506-3  295  end
cr    5  0  1.7450-2  295  end
fe    5  0  5.7202-2  295  end
'ordinary concrete
h     6  0  1.3742-2  295  end
o     6  0  4.5919-2  295  end
c     6  0  1.1532-4  295  end
```

```
na    6  0  9.6395-4  295  end
mg    6  0  1.2388-4  295  end
al    6  0  1.7409-3  295  end
si    6  0  1.6617-2  295  end
k     6  0  4.6052-4  295  end
ca    6  0  1.5025-3  295  end
fe    6  0  3.4492-4  295  end
end comp
read celldata
latticecell
squarepitch  pitch=2.225 3  fueld=1.065  1   cladd=1.223  2  end
end celldata
read param gen=520 npg=4000 nsk=20 tba=10.0  end param
read geometry
unit 1
com='concrete, SS,H2O, SS, Al'
cuboid  10  4p1.1125  13.5   13.0
cuboid  20  4p1.1125  27.3   13.0
cuboid  30  4p1.1125  29.5   13.0
cuboid  40  4p1.1125  30.77  13.0
media   5 1 10
media   3 1 20 -10
media   5 1 30 -20 -10
media   4 1 40 -30 -20 -10
boundary  40
unit  2
com='h2o and end plug'
cylinder  10  0.6115  35.215  30.77
cuboid    20   4p1.1125   35.215  30.77
media  4 1 10
media  3 1 20 -10
boundary  20
unit 3
com='Lower al grid '
cylinder 10 0.6115  35.816  35.215
cuboid   20 4p1.1125 35.816  35.215
media  4 1 10
media  4 1 20 -10
boundary  20
unit 4
com='h2o and end plug'
cylinder  10  0.6115   47.6  35.816
cuboid    20  4p1.1125  47.6  35.816
media  4 1 10
media  3 1 20 -10
boundary  20
unit  5
com='(Fuel+Clad+H2O)'
cylinder  10  0.5325     113.23  47.6
cylinder  20  0.6115     113.23  47.6
cuboid    30  4p01.1125   113.23  47.6
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 6
com='(Fuel+Clad+Void)'
cylinder  10  .5325  118.2   113.23
cylinder  20  .6115  118.2   113.23
cuboid    30   4p1.1125 118.2  113.23
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary  30
```

```
unit 12
com='Cell'
cuboid  10 4p1.1125 118.2  13.0
array 1 10    place 1 1 1    3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10  43.3875 -1.1125  43.3875 -1.1125   118.2  13.0
cuboid  20  73.3875 -31.1125 73.3875 -31.1125  148.2  13.0
cuboid  30  73.3875 -31.1125 73.3875 -31.1125  148.2 -49.0
array 2 10 place 1 1 1 3*0.0
media  3 1 20 -10
media  6 1 30 -20 -10
boundary  30
end geometry
read array
ara=1 nux=1 nuy=1 nuz=6
fill
1 2 3 4 5 6
end fill
ara=2 nux=20 nuy=20  nuz=1
fill f12 end fill
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.6   zul= 115
xlr= 41.0  ylr= 0.6   zlr= -10
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 25.
xlr= 41.0  ylr= -41.  zlr= 25.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
=csas26        parm=centrm
TCA         *****case 10 *********
238group
read comp
'MOX fuel
u-234   1  0  7.1749-7  295  end
u-235   1  0  9.3926-5  295  end
u-238   1  0  1.2951-2  295  end
pu-238  1  0  2.0003-6  295  end
pu-239  1  0  2.7491-4  295  end
pu-240  1  0  8.8417-5  295  end
'***********  pu-241 varies ******************
pu-241  1  0  2.8077-5  295  end
pu-242  1  0  8.1234-6  295  end
'*****am-241 varies********
am-241  1  0  1.2053-6  295  end
o       1  0  2.7837-2  295  end
b-10    1  0  6.0418-8  295  end
b-11    1  0  2.4319-7  295  end
'clad (ZR-2)
zr      2  0  3.7772-2   295  end
sn      2  0  4.3737-4   295  end
```

```
cr      2  0  8.8570-5   295  end
fe      2  0  6.6119-5   295  end
o       2  0  3.5864-5   295  end
'water(Refletor)
h     3  0  6.6735-2  295  end
o     3  0  3.3368-2  295  end
'Al
Al    4  0  6.0224-2  295  end
'Stainless Steel
c     5  0  1.1928-4  295  end
si    5  0  1.7003-3  295  end
mn    5  0  1.7385-3  295  end
p     5  0  6.9381-5  295  end
s     5  0  4.4673-5  295  end
ni    5  0  8.9506-3  295  end
cr    5  0  1.7450-2  295  end
fe    5  0  5.7202-2  295  end
'ordinary concrete
h     6  0  1.3742-2  295  end
o     6  0  4.5919-2  295  end
c     6  0  1.1532-4  295  end
na    6  0  9.6395-4  295  end
mg    6  0  1.2388-4  295  end
al    6  0  1.7409-3  295  end
si    6  0  1.6617-2  295  end
k     6  0  4.6052-4  295  end
ca    6  0  1.5025-3  295  end
fe    6  0  3.4492-4  295  end
end comp
read celldata
latticecell
squarepitch  pitch=2.474 3  fueld=1.065  1   cladd=1.223  2  end
end celldata
read param gen=520 npg=4000 nsk=20 tba=10.0  end param
read geometry
unit 1
com='concrete, SS,H2O, SS, Al'
cuboid  10  4p1.237  13.5   13.0
cuboid  20  4p1.237  27.3   13.0
cuboid  30  4p1.237  29.5   13.0
cuboid  40  4p1.237  30.77  13.0
media   5 1 10
media   3 1 20 -10
media   5 1 30 -20 -10
media   4 1 40 -30 -20 -10
boundary  40
unit  2
com='h2o and end plug'
cylinder  10  0.6115  35.215  30.77
cuboid    20   4p1.237   35.215  30.77
media  4 1 10
media  3 1 20 -10
boundary  20
unit 3
com='Lower al grid '
cylinder 10 0.6115  35.816  35.215
cuboid   20 4p1.237 35.816  35.215
media  4 1 10
media  4 1 20 -10
boundary  20
unit 4
com='h2o and end plug'
cylinder  10  0.6115   47.6  35.816
cuboid    20  4p1.237  47.6  35.816
```

```
media  4 1 10
media  3 1 20 -10
boundary  20
unit  5
com='(Fuel+Clad+H2O)'
cylinder  10  0.5325     109.11  47.6
cylinder  20  0.6115     109.11  47.6
cuboid    30  4p01.237   109.11  47.6
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 6
com='(Fuel+Clad+Void)'
cylinder  10  .5325  118.2   109.11
cylinder  20  .6115  118.2   109.11
cuboid    30   4p1.237 118.2  109.11
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary  30
unit 12
com='Cell'
cuboid  10 4p1.237 118.2  13.0
array 1 10    place 1 1 1    3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10  4p25.977   118.2  13.0
cuboid  20  4p55.97  148.2  13.0
cuboid  30 4p55.97  148.2 -49.0
array 2 10 place 11 11 1 3*0.0
media  3 1 20 -10
media  6 1 30 -20 -10
boundary  30
end geometry
read array
ara=1 nux=1 nuy=1 nuz=6
fill
1 2 3 4 5 6
end fill
ara=2 nux=21 nuy=21  nuz=1
fill f12 end fill
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.6   zul= 115
xlr= 41.0  ylr= 0.6   zlr= -10
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 25.
xlr= 41.0  ylr= -41.  zlr= 25.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end
=csas26        parm=centrm
```

```
TCA         *****case 11 *********
238group
read comp
'MOX fuel
u-234   1  0  7.1749-7  295  end
u-235   1  0  9.3926-5  295  end
u-238   1  0  1.2951-2  295  end
pu-238  1  0  2.0003-6  295  end
pu-239  1  0  2.7491-4  295  end
pu-240  1  0  8.8417-5  295  end
'***********  pu-241 varies *****************
pu-241  1  0  2.6617-5  295  end
pu-242  1  0  8.1234-6  295  end
'*****am-241 varies********
am-241  1  0  2.6656-6  295  end
o       1  0  2.7837-2  295  end
b-10    1  0  6.0418-8  295  end
b-11    1  0  2.4319-7  295  end
'clad (ZR-2)
zr      2  0  3.7772-2   295  end
sn      2  0  4.3737-4   295  end
cr      2  0  8.8570-5   295  end
fe      2  0  6.6119-5   295  end
o       2  0  3.5864-5   295  end
'water(Refletor)
h     3  0  6.6735-2  295  end
o     3  0  3.3368-2  295  end
'Al
Al    4  0  6.0224-2  295  end
'Stainless Steel
c     5  0  1.1928-4  295  end
si    5  0  1.7003-3  295  end
mn    5  0  1.7385-3  295  end
p     5  0  6.9381-5  295  end
s     5  0  4.4673-5  295  end
ni    5  0  8.9506-3  295  end
cr    5  0  1.7450-2  295  end
fe    5  0  5.7202-2  295  end
'ordinary concrete
h     6  0  1.3742-2  295  end
o     6  0  4.5919-2  295  end
c     6  0  1.1532-4  295  end
na    6  0  9.6395-4  295  end
mg    6  0  1.2388-4  295  end
al    6  0  1.7409-3  295  end
si    6  0  1.6617-2  295  end
k     6  0  4.6052-4  295  end
ca    6  0  1.5025-3  295  end
fe    6  0  3.4492-4  295  end
end comp
read celldata
latticecell
squarepitch  pitch=2.474 3  fueld=1.065  1   cladd=1.223  2  end
end celldata
read param  gen=520 npg=4000 nsk=20 tba=10.0  end param
read geometry
unit 1
com='concrete, SS,H2O, SS, Al'
cuboid  10  4p1.237  13.5   13.0
cuboid  20  4p1.237  27.3   13.0
cuboid  30  4p1.237  29.5   13.0
cuboid  40  4p1.237  30.77  13.0
media   5 1 10
media   3 1 20 -10
```

```
media   5 1 30 -20 -10
media   4 1 40 -30 -20 -10
boundary  40
unit  2
com='h2o and end plug'
cylinder  10  0.6115  35.215  30.77
cuboid    20   4p1.237   35.215  30.77
media  4 1 10
media  3 1 20 -10
boundary  20
unit 3
com='Lower al grid '
cylinder 10 0.6115  35.816  35.215
cuboid   20 4p1.237 35.816  35.215
media  4 1 10
media  4 1 20 -10
boundary  20
unit 4
com='h2o and end plug'
cylinder  10  0.6115   47.6  35.816
cuboid    20  4p1.237  47.6  35.816
media  4 1 10
media  3 1 20 -10
boundary  20
unit  5
com='(Fuel+Clad+H2O)'
cylinder  10  0.5325     112.13  47.6
cylinder  20  0.6115     112.13  47.6
cuboid    30  4p01.237   112.13  47.6
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
unit 6
com='(Fuel+Clad+Void)'
cylinder  10  .5325  118.2   112.13
cylinder  20  .6115  118.2   112.13
cuboid    30   4p1.237 118.2  112.13
media  1 1 10
media  2 1 20 -10
media  0 1 30 -20 -10
boundary  30
unit 12
com='Cell'
cuboid  10 4p1.237 118.2  13.0
array 1 10    place 1 1 1    3*0.0
boundary 10
global unit 13
com='Cells in assembly'
cuboid  10  4p25.977   118.2  13.0
cuboid  20  4p55.97  148.2  13.0
cuboid  30 4p55.97  148.2 -49.0
array 2 10 place 11 11 1 3*0.0
media  3 1 20 -10
media  6 1 30 -20 -10
boundary  30
end geometry
read array
ara=1 nux=1 nuy=1 nuz=6
fill
1 2 3 4 5 6
end fill
ara=2 nux=21 nuy=21  nuz=1
fill f12 end fill
```

```
end fill
end array
read plot
ttl='simple plot 1'
pic=mix
xul= -41.0  yul= 0.6   zul= 115
xlr= 41.0  ylr= 0.6   zlr= -10
uax=1.0 wdn=-1.0
nax=400
lpi=10
scr=yes end
ttl='simple plot 2'
pic=mix
xul= -41.0  yul= 41.   zul= 25.
xlr= 41.0  ylr= -41.  zlr= 25.
uax=1.0 vdn=-1.0
nax=400 end
end plot
end data
end

=csas26     parm=centrm
pnl-4976 exp196 4.31 w/o uo2 rods in infinite lattice, actual pitch
238group
read comp
'4.31 w/o uo2 ***MIXTURE 1
uo2   1 den=10.4 1.0 293 92234 0.022 92235 4.306 92236 0.022 92238 95.65 end
al    2 end
h2o   3 end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4 16000 1.7
                          8016 22.1 14000 0.3 4 end
poly(h2o)   5  den=.904 end
plexiglass  6  1.0 end

'MOX fuel MIXTURE 7
uo2     7 den=9.54 0.98 293 end
puo2    7 den=9.54 0.02 293  94238 0.009 94239 91.836 94240 7.760
                             94241 0.367 94242 0.028  end
am-241  7 den=9.54 0.0000646 293 end
uo2     8 den=9.54 1.0 end
zirc2   9 end
h2o    10 end

'4.31 w/o uo2 ***MIXTURE 11
uo2 11 den=10.4 .864 293 92234 0.022 92235 4.306 92236 0.022 92238 95.65 end
'aluminum clad
al     11 .6876 end
'moderator
h2o    11 .6238 end

end comp
read celldata
'uo2 fuel
latticecell triangpitch  pitch=1.598 3  fueld=1.265 1  cladd=1.415  2
                         gapd= 1.283 0  end
'mox fuel
multiregion cylindrical  right=white  end
7 .6415    9  .7075  10 .8098  11 1.4532  end zone
end celldata
read param  gen=520 npg=4000 nsk=20 tba=10.0  end param
read geom
unit 1
cylinder 10 .6325      45.72 -45.72
cylinder 20 .6415      45.72 -45.72
```

```
cylinder 30 .6415      48.26 -48.26
cylinder 40 .7075      48.26 -48.26
hexprism 50 .799       48.26 -48.26
media 1 1 10
media 0 1 20 -10
media 4 1 30 -20 -10
media 2 1 40 -30 -20 -10
media 3 1 50 -40 -30 -20 -10
boundary 50
unit 2
cylinder 10  .6415  45.72  -45.52
cylinder 20  .6415  45.72  -45.72
cylinder 30  .7175  46.545 -46.418
hexprism 40  .799   48.26 -48.26
media 7 1 10
media 8 1 20 -10
media 9 1 30 -20 -10
media 3 1 40 -30 -20 -10
boundary 40
unit 3
hexprism 10  .799   48.26 -48.26
media  3 1 10
boundary 10
global unit 4
cuboid  10  36.6 -36.6   36. -36.  2p48.26
cuboid  20  36.6 -36.6   36. -36.  48.26 -50.8
cuboid  30  66.6 -66.56  66. -66.  78.26 -80.8
array 1 10 place    25 27 1  3*0.0
media 6 1 20 -10
media 3 1 30 -20 -10
boundary 30
end geom
read array
ara=1 typ=shexagonal nux=49  nuy=53  nuz=1
fill
 49r3
 20r3 2r1 2 2r1 2 2r1 21r3
 18r3 2 2r1 2 2r1 2 2r1 2 2r1 2 1 17r3
 15r3 1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 1 16r3
 13r3 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 13r3
 12r3 1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 1 13r3
 11r3  1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 1 11r3
 9r3  1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 11r3
 9r3  2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 9r3
 8r3  2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 9r3
 7r3  2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1
7r3
 6r3  1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 1
7r3
 6r3  2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1
2 6r3
 5r3  2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1  6r3
 5r3  1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 1 5r3
 4r3  2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1
2 2r1 2 4r3
 5r3  2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 2r1 3r3
 4r3  1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 2r1 2 1 3r3
 5r3  2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 2r1 3r3
 4r3  1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
```

```
2r1 2 2r1 2 1 3r3
 4r3  2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1
2 2r1 2 2r1 2 2r3
 4r3  1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 2r1 2 1  3r3
 4r3  2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1
2 2r1 2 2r1 2 2r3
 3r3  2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 2r1 2 1 1 2r3
 4r3  2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1
2 2r1 2 2r1 2 2r3
 3r3  2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 2r1 2 2r1 3r3

 2r3 1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1
2 2r1 2 2r1 2 1 2r3

 2r3 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 2r1 2 2r1 3r3
 3r3 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 2r1 2 3r3
 2r3 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 2r1 2 1 1 3r3
 3r3 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 2r1 2 3r3
 2r3 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 2r1 2 1  4r3
 3r3  2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1
2 2r1 2 2r1 2 3r3
 3r3  1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 2r1 2 1 3r3
 5r3  2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 2r1 3r3
 4r3  1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 2r1 2 1 4r3
 4r3  2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 2r1 4r3
 4r3  2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1
2 2r1 2 4r3
 6r3  1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1 2 1 4r3
 6r3  2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2
2r1  5r3
 7r3  2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1
2 5r3
 7r3  1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 1
6r3
 8r3  2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1
6r3
 9r3  2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 8r3
 10r3  2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 8r3
 11r3   2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 1 9r3
 12r3  1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 1 10r3
 13r3 1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 1 12r3
 14r3 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 12r3
 16r3 1 2 2r1 2 2r1 2 2r1 2 2r1 2 2r1 2 1 15r3
 19r3 2 2r1 2 2r1 2 2r1 2 2r1 2  17r3
 21r3 2r1 2 2r1 2 2r1 21r3
 49r3
 end fill
end array
read plot   scr=yes
ttl='xy slice '
xul=-70  yul=70  zul=0
```

```
xlr=70 ylr=-70  zlr=0
uax=1  vdn=-1 nax=640  nch='0123'end
end plot
end data
end
```

APPENDIX E

Pu BENCHMARK CASES

APPENDIX E
Pu BENCHMARK CASES

```
=csas26      parm=centrm
Case 1, Ni, Pu/Ta/Al
238groupndf5
read comp
pu-239   1 0.0  0.039960  end
ta       2  den=14.62553 1 293 73181 100      end
al       3 0.0  0.020087  end
ni       4 0.0  0.088859  end
fe       5 0.0  0.084648  end
h        6 0.0  0.066766  end
o        6 0.0  0.033383  end
h        7 0.0  0.078996  end
c        7 0.0  0.039498  end
end comp
read param
gen=520 npg=4000 nsk=20 tba=10.0
end param
read geom
unit 1
 cylinder  10 5.69975 2p0.15748
 cylinder  20 5.715   2p0.17272
 cylinder  30 5.715   0.17272  -0.2413
 cylinder  40 5.715   0.17272  -0.27686
 cuboid    50 4p5.715  0.17272 -0.27686
 media     1 1 10
 media     4 1 20 -10
 media     3 1 30 -20 -10
 media     2 1 40 -30 -20 -10
 media     0 1 50 -40 -30 -20 -10
 boundary  50

unit 2
 cylinder  10 5.69975 2p0.107445
 cylinder  20 5.715   0.107445  -0.122685
 cylinder  30 5.715   0.107445  -0.191265
 cylinder  40 5.715   0.107445  -0.226825
 cuboid    50 4p5.715 0.107445 -0.226825
 media     1 1 10
 media     4 1 20 -10
 media     3 1 30 -20 -10
 media     2 1 40 -30 -20 -10
 media     0 1 50 -40 -30 -20 -10
 boundary  50

 unit 10
 cylinder  10  5.715  13.09523  -0.27686
 cylinder  20  5.7404  13.09523 -0.27686
 cylinder  30  5.8674  13.29843 -0.48006
 cylinder  40  6.0706  15.05103 -2.23266
 cylinder  50  6.1976  15.05103 -2.23266
 cylinder  60  10.0076 35.37103 -9.85266
 cylinder  70  10.0076 35.37103 -11.83386
 cylinder  80  10.0584 43.16614 -11.83386
 cylinder  90  10.3632 43.16614 -11.83386
 cylinder 100  48.26   43.16614 -11.52906
 cylinder 110  48.26   43.16614 -11.83386
 cuboid   120  4p48.26 43.16614 -11.83386

 array  1 10  place  1 1 1      0.0 0.0 0.0
 media  0 1 20 -10
```

```
 media  2 1 30 -20 -10
 media  3 1 40 -30 -20 -10
 media  0 1 50 -40 -30 -20 -10
 media  4 1 60 -50 -40 -30 -20 -10
 media  3 1 70 -60 -50 -40 -30 -20 -10
 media  0 1 80 -70 -60 -50 -40 -30 -20 -10
 media  5 1 90 -80 -70 -60 -50 -40 -30 -20 -10
 media  6 1 100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 media  5 1 110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 media  0 1 120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 boundary 120

 unit 20
 cylinder  10 25.4  30.48 0.0
 cuboid    20 4p48.26  30.48 0.0
 media  7 1 10
 media  0 1 20 -10
 boundary 20

 global unit 30
 cuboid  10 4p48.26 85.48 0.0
 array 2 10 place    1 1 1    0.0 0.0 0.0
 boundary 10


end geom
read array
ara=1 nux=1 nuy=1 nuz=30
fill
29r1 2
end fill

ara=2 nux=1 nuy=1 nuz=2
fill 20 10
end fill
end array

read plot
ttl='simple plot 1'
pic=mix
xul= -50.0  yul= 0.0   zul= 85.0
xlr= 50.0  ylr= 0.0   zlr= -0.0
uax=1.0 wdn=-1.0
nax=900
lpi=10
scr=yes end

ttl='simple plot 2'
pic=mix
xul= -7.0  yul= 7.0   zul= 48.0
xlr= 7.0  ylr= -7.0   zlr= 48.0
uax=1.0 vdn=-1.0
nax=900
lpi=10
scr=yes end

ttl='simple plot 3'
pic=mix
xul= -7.0  yul= 0.0   zul= 56.0
xlr= 7.0  ylr= 0.0   zlr= 38.0
uax=1.0 wdn=-1.0
nax=600
lpi=10
scr=yes end
```

```
end plot

end data
end
=csas26       parm=centrm
Case 2, Ni + Fe, Pu/Ta/Al
238groupndf5
read comp
pu-239   1 0.0  0.039960  end
ta       2  den=14.62553 1 293 73181 100      end
al       3 0.0  0.020087  end
ni       4 0.0  0.088859  end
fe       5 0.0  0.084648  end
h        6 0.0  0.066766  end
o        6 0.0  0.033383  end
h        7 0.0  0.078996  end
c        7 0.0  0.039498  end
end comp
read param
gen=520 npg=4000 nsk=20 tba=10.0
end param
read geom
unit 1
 cylinder  10 5.69975 2p0.15748
 cylinder  20 5.715   2p0.17272
 cylinder  30 5.715   0.17272  -0.2413
 cylinder  40 5.715   0.17272  -0.27686
 cuboid    50 4p5.715  0.17272 -0.27686
 media     1 1 10
 media     4 1 20 -10
 media     3 1 30 -20 -10
 media     2 1 40 -30 -20 -10
 media     0 1 50 -40 -30 -20 -10
 boundary  50

unit 2
 cylinder  10 5.69975 2p0.0997
 cylinder  20 5.715   0.0997  -0.11494
 cylinder  30 5.715   0.0997  -0.18352
 cylinder  40 5.715   0.0997  -0.21908
 cuboid    50 4p5.715 0.0997 -0.21908
 media     1 1 10
 media     4 1 20 -10
 media     3 1 30 -20 -10
 media     2 1 40 -30 -20 -10
 media     0 1 50 -40 -30 -20 -10
 boundary  50

 unit 10
 cylinder  10  5.715  12.63016  -0.27686
 cylinder  20  5.7404  12.63016 -0.27686
 cylinder  30  5.8674  12.83336 -0.48006
 cylinder  40  6.0706  14.58596 -2.23266
 cylinder  50  6.1976  14.58596 -2.23266
 cylinder  60  10.0076 34.90596 -9.85266
 cylinder  70  10.0076 34.90596 -11.83386
 cylinder  80  10.0584 43.16614 -11.83386
 cylinder  90  12.3444 43.16614 -11.83386
 cylinder 100  48.26   43.16614 -11.52906
 cylinder 110  48.26   43.16614 -11.83386
 cuboid   120  4p48.26 43.16614 -11.83386

 array  1 10  place  1 1 1      0.0 0.0 0.0
 media  0 1 20 -10
```

```
 media  2 1 30 -20 -10
 media  3 1 40 -30 -20 -10
 media  0 1 50 -40 -30 -20 -10
 media  4 1 60 -50 -40 -30 -20 -10
 media  3 1 70 -60 -50 -40 -30 -20 -10
 media  0 1 80 -70 -60 -50 -40 -30 -20 -10
 media  5 1 90 -80 -70 -60 -50 -40 -30 -20 -10
 media  6 1 100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 media  5 1 110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 media  0 1 120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 boundary 120

 unit 20
 cylinder  10 25.4  30.48 0.0
 cuboid    20 4p48.26  30.48 0.0
 media  7 1 10
 media  0 1 20 -10
 boundary 20

 global unit 30
 cuboid  10 4p48.26 85.48 0.0
 array 2 10 place    1 1 1    0.0 0.0 0.0
 boundary 10


end geom
read array
ara=1 nux=1 nuy=1 nuz=29
fill
28r1 2
end fill

ara=2 nux=1 nuy=1 nuz=2
fill 20 10
end fill
end array

read plot
ttl='simple plot 1'
pic=mix
xul= -50.0  yul= 0.0   zul= 85.0
xlr= 50.0  ylr= 0.0   zlr= -0.0
uax=1.0 wdn=-1.0
nax=900
lpi=10
scr=yes end

ttl='simple plot 2'
pic=mix
xul= -7.0  yul= 7.0   zul= 48.0
xlr= 7.0  ylr= -7.0   zlr= 48.0
uax=1.0 vdn=-1.0
nax=900
lpi=10
scr=yes end

ttl='simple plot 3'
pic=mix
xul= -7.0  yul= 0.0   zul= 56.0
xlr= 7.0  ylr= 0.0   zlr= 38.0
uax=1.0 wdn=-1.0
nax=600
lpi=10
scr=yes end
```

```
end plot

end data
end
=csas26      parm=centrm
Case 3, Ni + Fe, Pu/Ta
238groupndf5
read comp
pu-239   1 0.0  0.039960 end
ta       2  den=14.62553 1 293 73181 100      end
al       3 0.0  0.020087  end
ni       4 0.0  0.088859  end
fe       5 0.0  0.084648  end
h        6 0.0  0.066766  end
o        6 0.0  0.033383  end
h        7 0.0  0.078996  end
c        7 0.0  0.039498  end
end comp
read param
gen=520 npg=4000 nsk=20 tba=10.0
end param
read geom
unit 1
 cylinder  10 5.69975 2p0.15748
 cylinder  20 5.715   2p0.17272
 cylinder  30 5.715   0.17272  -0.20828
 cuboid    40 4p5.715  0.17272 -0.20828
 media     1 1 10
 media     4 1 20 -10
 media     2 1 30 -20 -10
 media     0 1 40 -30 -20 -10
 boundary  40

unit 2
 cylinder  10 5.69975 2p0.071715
 cylinder  20 5.715   0.071715  -0.086955
 cylinder  30 5.715   0.071715  -0.122515
 cuboid    40 4p5.715 0.071715  -0.122515
 media     1 1 10
 media     4 1 20 -10
 media     2 1 30 -20 -10
 media     0 1 40 -30 -20 -10
 boundary  40

 unit 10
 cylinder  10  5.715  8.36795  -0.20828
 cylinder  20  5.7404  8.36795 -0.20828
 cylinder  30  5.8674  8.57115 -0.41148
 cylinder  40  6.0706  10.32375 -2.16408
 cylinder  50  6.1976  10.32375 -2.16408
 cylinder  60  10.0076 30.64375 -9.78408
 cylinder  70  10.0076 30.64375 -11.76528
 cylinder  80  10.0584 43.23472 -11.76528
 cylinder  90  12.3444 43.23472 -11.76528
 cylinder 100  48.26   43.23472 -11.46048
 cylinder 110  48.26   43.23472 -11.76528
 cuboid   120  4p48.26 43.23472 -11.76528

 array  1 10  place  1 1 1      0.0 0.0 0.0
 media  0 1 20 -10
 media  2 1 30 -20 -10
 media  3 1 40 -30 -20 -10
 media  0 1 50 -40 -30 -20 -10
 media  4 1 60 -50 -40 -30 -20 -10
```

```
 media  3 1 70 -60 -50 -40 -30 -20 -10
 media  0 1 80 -70 -60 -50 -40 -30 -20 -10
 media  5 1 90 -80 -70 -60 -50 -40 -30 -20 -10
 media  6 1 100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 media  5 1 110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 media  0 1 120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 boundary 120

 unit 20
 cylinder  10 25.4  30.48 0.0
 cuboid    20 4p48.26  30.48 0.0
 media  7 1 10
 media  0 1 20 -10
 boundary 20

 global unit 30
 cuboid  10 4p48.26 85.48 0.0
 array 2 10 place    1 1 1    0.0 0.0 0.0
 boundary 10


end geom
read array
ara=1 nux=1 nuy=1 nuz=23
fill
22r1 2
end fill

ara=2 nux=1 nuy=1 nuz=2
fill 20 10
end fill
end array

read plot
ttl='simple plot 1'
pic=mix
xul= -50.0  yul= 0.0   zul= 85.0
xlr= 50.0  ylr= 0.0   zlr= -0.0
uax=1.0 wdn=-1.0
nax=900
lpi=10
scr=yes end

ttl='simple plot 2'
pic=mix
xul= -7.0  yul= 7.0   zul= 48.0
xlr= 7.0  ylr= -7.0   zlr= 48.0
uax=1.0 vdn=-1.0
nax=900
lpi=10
scr=yes end

ttl='simple plot 3'
pic=mix
xul= -7.0  yul= 0.0   zul= 56.0
xlr= 7.0  ylr= 0.0   zlr= 38.0
uax=1.0 wdn=-1.0
nax=600
lpi=10
scr=yes end
end plot

end data
end
```

```
=csas26      parm=centrm
Case 4, Ni, Pu/Ta
238groupndf5
read comp
pu-239   1 0.0  0.039960  end
ta       2  den=14.62553 1 293 73181 100      end
al       3 0.0  0.020087  end
ni       4 0.0  0.088859  end
fe       5 0.0  0.084648  end
h        6 0.0  0.066766  end
o        6 0.0  0.033383  end
h        7 0.0  0.078996  end
c        7 0.0  0.039498  end
end comp
read param
gen=520 npg=4000 nsk=20 tba=10.0
end param
read geom
unit 1
 cylinder  10 5.69975 2p0.15748
 cylinder  20 5.715   2p0.17272
 cylinder  30 5.715   0.17272  -0.20828
 cuboid    40 4p5.715  0.17272 -0.20828
 media     1 1 10
 media     4 1 20 -10
 media     2 1 30 -20 -10
 media     0 1 40 -30 -20 -10
 boundary  40

unit 2
 cylinder  10 5.69975 2p0.04395
 cylinder  20 5.715   0.04395  -0.05919
 cylinder  30 5.715   0.04395  -0.09475
 cuboid    40 4p5.715 0.04395  -0.09475
 media     1 1 10
 media     4 1 20 -10
 media     2 1 30 -20 -10
 media     0 1 40 -30 -20 -10
 boundary  40

 unit 10
 cylinder  10  5.715   8.69342  -0.20828
 cylinder  20  5.7404  8.69342  -0.20828
 cylinder  30  5.8674  8.89662  -0.41148
 cylinder  40  6.0706  10.64922 -2.16408
 cylinder  50  6.1976  10.64922 -2.16408
 cylinder  60  10.0076 30.96922 -9.78408
 cylinder  70  10.0076 30.96922 -11.76528
 cylinder  80  10.0584 43.23472 -11.76528
 cylinder  90  10.3632 43.23472 -11.76528
 cylinder 100  48.26   43.23472 -11.46048
 cylinder 110  48.26   43.23472 -11.76528
 cuboid   120  4p48.26 43.23472 -11.76528

 array  1 10  place  1 1 1      0.0 0.0 0.0
 media  0 1 20 -10
 media  2 1 30 -20 -10
 media  3 1 40 -30 -20 -10
 media  0 1 50 -40 -30 -20 -10
 media  4 1 60 -50 -40 -30 -20 -10
 media  3 1 70 -60 -50 -40 -30 -20 -10
 media  0 1 80 -70 -60 -50 -40 -30 -20 -10
 media  5 1 90 -80 -70 -60 -50 -40 -30 -20 -10
 media  6 1 100 -90 -80 -70 -60 -50 -40 -30 -20 -10
```

```
 media  5 1 110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 media  0 1 120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 boundary 120

 unit 20
 cylinder  10 25.4  30.48 0.0
 cuboid    20 4p48.26  30.48 0.0
 media  7 1 10
 media  0 1 20 -10
 boundary 20

 global unit 30
 cuboid  10 4p48.26 85.48 0.0
 array 2 10 place    1 1 1    0.0 0.0 0.0
 boundary 10


end geom
read array
ara=1 nux=1 nuy=1 nuz=24
fill
23r1 2
end fill

ara=2 nux=1 nuy=1 nuz=2
fill 20 10
end fill
end array

read plot
ttl='simple plot 1'
pic=mix
xul= -50.0  yul= 0.0   zul= 85.0
xlr= 50.0  ylr= 0.0   zlr= -0.0
uax=1.0 wdn=-1.0
nax=900
lpi=10
scr=yes end

ttl='simple plot 2'
pic=mix
xul= -7.0  yul= 7.0   zul= 48.0
xlr= 7.0  ylr= -7.0   zlr= 48.0
uax=1.0 vdn=-1.0
nax=900
lpi=10
scr=yes end

ttl='simple plot 3'
pic=mix
xul= -7.0  yul= 0.0   zul= 56.0
xlr= 7.0  ylr= 0.0   zlr= 38.0
uax=1.0 wdn=-1.0
nax=600
lpi=10
scr=yes end
end plot

end data
end
=csas26       parm=centrm
Case 5, Ni, Pu
238groupndf5
read comp
```

```
pu-239   1 0.0  0.039960  end
ta       2  den=14.62553 1 293 73181 100      end
al       3 0.0  0.020087  end
ni       4 0.0  0.088859  end
fe       5 0.0  0.084648  end
h        6 0.0  0.066766  end
o        6 0.0  0.033383  end
h        7 0.0  0.078996  end
c        7 0.0  0.039498  end
end comp
read param
gen=520 npg=4000 nsk=20 tba=10.0
end param
read geom
unit 1
 cylinder  10 5.69975  2p0.15748
 cylinder  20 5.715    2p0.17272
 cuboid    30 4p5.715  2p0.17272
 media     1 1 10
 media     4 1 20 -10
 media     0 1 30 -20 -10
 boundary  30

unit 2
 cylinder  10 5.69975 2p0.046975
 cylinder  20 5.715   0.046975  -0.062215
 cuboid    30 4p5.715 0.046975   -0.062215
 media     1 1 10
 media     4 1 20 -10
 media     0 1 30 -20 -10
 boundary  30

 unit 10
 cylinder  10  5.715   7.19071  -0.17272
 cylinder  20  5.7404  7.19071  -0.17272
 cylinder  30  5.8674  7.39391  -0.37592
 cylinder  40  6.0706  9.14651  -2.12852
 cylinder  50  6.1976  9.14651  -2.12852
 cylinder  60  10.0076 29.46651 -9.74852
 cylinder  70  10.0076 29.46651 -11.72972
 cylinder  80  10.0584 43.27028 -11.72972
 cylinder  90  10.3632 43.27028 -11.72972
 cylinder 100  48.26   43.27028 -11.42492
 cylinder 110  48.26   43.27028 -11.72972
 cuboid   120  4p48.26 43.27028 -11.72972

 array  1 10  place  1 1 1      0.0 0.0 0.0
 media  0 1 20 -10
 media  2 1 30 -20 -10
 media  3 1 40 -30 -20 -10
 media  0 1 50 -40 -30 -20 -10
 media  4 1 60 -50 -40 -30 -20 -10
 media  3 1 70 -60 -50 -40 -30 -20 -10
 media  0 1 80 -70 -60 -50 -40 -30 -20 -10
 media  5 1 90 -80 -70 -60 -50 -40 -30 -20 -10
 media  6 1 100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 media  5 1 110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 media  0 1 120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 boundary 120

 unit 20
 cylinder  10 25.4  30.48 0.0
 cuboid    20 4p48.26  30.48 0.0
 media  7 1 10
```

```
 media  0 1 20 -10
 boundary 20

 global unit 30
 cuboid  10 4p48.26 85.48 0.0
 array 2 10 place    1 1 1    0.0 0.0 0.0
 boundary 10


end geom
read array
ara=1 nux=1 nuy=1 nuz=22
fill
21r1 2
end fill

ara=2 nux=1 nuy=1 nuz=2
fill 20 10
end fill
end array

read plot
ttl='simple plot 1'
pic=mix
xul= -50.0  yul= 0.0   zul= 85.0
xlr= 50.0  ylr= 0.0   zlr= -0.0
uax=1.0 wdn=-1.0
nax=900
lpi=10
scr=yes end

ttl='simple plot 2'
pic=mix
xul= -7.0  yul= 7.0   zul= 48.0
xlr= 7.0  ylr= -7.0   zlr= 48.0
uax=1.0 vdn=-1.0
nax=900
lpi=10
scr=yes end

ttl='simple plot 3'
pic=mix
xul= -7.0  yul= 0.0   zul= 56.0
xlr= 7.0  ylr= 0.0   zlr= 38.0
uax=1.0 wdn=-1.0
nax=600
lpi=10
scr=yes end
end plot

end data
end
=csas26       parm=centrm
Case 6, Fe, Pu/Ta
238groupndf5
read comp
pu-239   1 0.0  0.039960  end
ta       2  den=14.62553 1 293 73181 100      end
al       3 0.0  0.020087  end
ni       4 0.0  0.088859  end
fe       5 0.0  0.084648  end
h        6 0.0  0.066766  end
o        6 0.0  0.033383  end
h        7 0.0  0.078996  end
```

```
c        7 0.0  0.039498  end
end comp
read param
gen=520 npg=4000 nsk=20 tba=10.0
end param
read geom
unit 1
 cylinder  10 5.69975 2p0.15748
 cylinder  20 5.715   2p0.17272
 cylinder  30 5.715   0.17272  -0.20828
 cuboid    40 4p5.715  0.17272 -0.20828
 media     1 1 10
 media     4 1 20 -10
 media     2 1 30 -20 -10
 media     0 1 40 -30 -20 -10
 boundary  40

unit 2
 cylinder  10 5.69975 2p0.028565
 cylinder  20 5.715   0.028565  -0.043805
 cylinder  30 5.715   0.028565  -0.079365
 cuboid    40 4p5.715 0.028565  -0.079365
 media     1 1 10
 media     4 1 20 -10
 media     2 1 30 -20 -10
 media     0 1 40 -30 -20 -10
 boundary  40

 unit 10
 cylinder  10  5.715   9.42465  -0.20828
 cylinder  20  5.7404  9.42465  -0.20828
 cylinder  30  5.8674  9.62785  -0.41148
 cylinder  40  6.0706  11.38045 -2.16408
 cylinder  50  6.1976  11.38045 -2.16408
 cylinder  60  10.0076 31.70045 -9.78408
 cylinder  70  10.0076 31.70045 -11.76528
 cylinder  80  10.0584 43.23472 -11.76528
 cylinder  90  10.3632 43.23472 -11.76528
 cylinder 100  48.26   43.23472 -11.46048
 cylinder 110  48.26   43.23472 -11.76528
 cuboid   120  4p48.26 43.23472 -11.76528

 array  1 10  place  1 1 1      0.0 0.0 0.0
 media  0 1 20 -10
 media  2 1 30 -20 -10
 media  3 1 40 -30 -20 -10
 media  0 1 50 -40 -30 -20 -10
 media  5 1 60 -50 -40 -30 -20 -10
 media  3 1 70 -60 -50 -40 -30 -20 -10
 media  0 1 80 -70 -60 -50 -40 -30 -20 -10
 media  5 1 90 -80 -70 -60 -50 -40 -30 -20 -10
 media  6 1 100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 media  5 1 110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 media  0 1 120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 boundary 120

 unit 20
 cylinder  10 25.4  30.48 0.0
 cuboid    20 4p48.26  30.48 0.0
 media  7 1 10
 media  0 1 20 -10
 boundary 20

 global unit 30
```

```
 cuboid  10 4p48.26 85.48 0.0
 array 2 10 place    1 1 1    0.0 0.0 0.0
 boundary 10


end geom
read array
ara=1 nux=1 nuy=1 nuz=26
fill
25r1 2
end fill

ara=2 nux=1 nuy=1 nuz=2
fill 20 10
end fill
end array

read plot
ttl='simple plot 1'
pic=mix
xul= -50.0  yul= 0.0   zul= 85.0
xlr= 50.0  ylr= 0.0   zlr= -0.0
uax=1.0 wdn=-1.0
nax=900
lpi=10
scr=yes end

ttl='simple plot 2'
pic=mix
xul= -7.0  yul= 7.0   zul= 48.0
xlr= 7.0  ylr= -7.0   zlr= 48.0
uax=1.0 vdn=-1.0
nax=900
lpi=10
scr=yes end

ttl='simple plot 3'
pic=mix
xul= -7.0  yul= 0.0   zul= 56.0
xlr= 7.0  ylr= 0.0   zlr= 38.0
uax=1.0 wdn=-1.0
nax=600
lpi=10
scr=yes end
end plot

end data
end
=csas26      parm=centrm
Case 7, Fe, Pu/Ta/Al
238groupndf5
read comp
pu-239   1 0.0  0.039960 end
ta           2  den=14.62553 1 293 73181 100      end
al           3 0.0  0.020087  end
ni           4 0.0  0.088859  end
fe           5 0.0  0.084648  end
h            6 0.0  0.066766  end
o            6 0.0  0.033383  end
h            7 0.0  0.078996  end
c            7 0.0  0.039498  end
end comp
read param
gen=520 npg=4000 nsk=20 tba=10.0
```

```
end param
read geom
unit 1
 cylinder  10 5.69975 2p0.15748
 cylinder  20 5.715   2p0.17272
 cylinder  30 5.715   0.17272  -0.2413
 cylinder  40 5.715   0.17272  -0.27686
 cuboid    50 4p5.715  0.17272 -0.27686
 media     1 1 10
 media     4 1 20 -10
 media     3 1 30 -20 -10
 media     2 1 40 -30 -20 -10
 media     0 1 50 -40 -30 -20 -10
 boundary  50

unit 2
 cylinder  10 5.69975 2p0.041165
 cylinder  20 5.715   0.041165  -0.056405
 cylinder  30 5.715   0.041165  -0.124985
 cylinder  40 5.715   0.041165  -0.160545
 cuboid    50 4p5.715 0.041165  -0.160545
 media     1 1 10
 media     4 1 20 -10
 media     3 1 30 -20 -10
 media     2 1 40 -30 -20 -10
 media     0 1 50 -40 -30 -20 -10
 boundary  50

 unit 10
 cylinder  10  5.715   14.76099 -0.27686
 cylinder  20  5.7404  14.76099 -0.27686
 cylinder  30  5.8674  14.96419 -0.48006
 cylinder  40  6.0706  16.71679 -2.23266
 cylinder  50  6.1976  16.71679 -2.23266
 cylinder  60  10.0076 37.03679 -9.85266
 cylinder  70  10.0076 37.03679 -11.83386
 cylinder  80  10.0584 43.25069 -11.83386
 cylinder  90  10.3632 43.25069 -11.83386
 cylinder 100  48.26   43.25069 -11.52906
 cylinder 110  48.26   43.25069 -11.83386
 cuboid   120  4p48.26 43.25069 -11.83386

 array  1 10  place  1 1 1      0.0 0.0 0.0
 media  0 1 20 -10
 media  2 1 30 -20 -10
 media  3 1 40 -30 -20 -10
 media  0 1 50 -40 -30 -20 -10
 media  5 1 60 -50 -40 -30 -20 -10
 media  3 1 70 -60 -50 -40 -30 -20 -10
 media  0 1 80 -70 -60 -50 -40 -30 -20 -10
 media  5 1 90 -80 -70 -60 -50 -40 -30 -20 -10
 media  6 1 100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 media  5 1 110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 media  0 1 120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10
 boundary 120

 unit 20
 cylinder  10 25.4  30.48 0.0
 cuboid    20 4p48.26  30.48 0.0
 media  7 1 10
 media  0 1 20 -10
 boundary 20

 global unit 30
```

```
 cuboid  10 4p48.26 85.48 0.0
 array 2 10 place    1 1 1    0.0 0.0 0.0
 boundary 10


end geom
read array
ara=1 nux=1 nuy=1 nuz=34
fill
33r1 2
end fill

ara=2 nux=1 nuy=1 nuz=2
fill 20 10
end fill
end array

read plot
ttl='simple plot 1'
pic=mix
xul= -50.0  yul= 0.0   zul= 85.0
xlr= 50.0  ylr= 0.0   zlr= -0.0
uax=1.0 wdn=-1.0
nax=900
lpi=10
scr=yes end

ttl='simple plot 2'
pic=mix
xul= -7.0  yul= 7.0   zul= 48.0
xlr= 7.0  ylr= -7.0   zlr= 48.0
uax=1.0 vdn=-1.0
nax=900
lpi=10
scr=yes end

ttl='simple plot 3'
pic=mix
xul= -7.0  yul= 0.0   zul= 56.0
xlr= 7.0  ylr= 0.0   zlr= 38.0
uax=1.0 wdn=-1.0
nax=600
lpi=10
scr=yes end
end plot

end data
end
```

APPENDIX F

^{233}U BENCHMARK CASES

APPENDIX F
^{233}U BENCHMARK CASES

```
=csas26       parm=centrm
Fallstaff; soln No.1; sphere  1 Be only
238groupndf5
read comp
u-232 1 0.0 4.5608-8 end
u-233 1 0.0 2.2379-3 end
u-234 1 0.0 2.4316-5 end
u-235 1 0.0 8.9598-7 end
u-238 1 0.0 7.1284-6 end
h     1 0.0 5.5183-2 end
o     1 0.0 3.2043-2 end
f     1 0.0 4.7182-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
end comp
read parm gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   7.8726
sphere  20   7.9209
sphere  30  15.9209
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.1;  Sphere 2 Be only
238groupndf5
read comp
u-232 1 0.0 4.5608-8 end
u-233 1 0.0 2.2379-3 end
u-234 1 0.0 2.4316-5 end
u-235 1 0.0 8.9598-7 end
u-238 1 0.0 7.1284-6 end
h     1 0.0 5.5183-2 end
o     1 0.0 3.2043-2 end
f     1 0.0 4.7182-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
end comp
read parm gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   8.5152
sphere  20   8.5635
sphere  30  14.3835
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
```

```
=csas26       parm=centrm
Fallstaff; soln No.1; sphere 3  Be only
238groupndf5
read comp
u-232 1 0.0 4.5608-8 end
u-233 1 0.0 2.2379-3 end
u-234 1 0.0 2.4316-5 end
u-235 1 0.0 8.9598-7 end
u-238 1 0.0 7.1284-6 end
h     1 0.0 5.5183-2 end
o     1 0.0 3.2043-2 end
f     1 0.0 4.7182-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
end comp
read parm gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   9.0079
sphere  20   9.0562
sphere  30  13.7262
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.1; sphere 3  Be and CH2
238groupndf5
read comp
u-232 1 0.0 4.5608-8 end
u-233 1 0.0 2.2379-3 end
u-234 1 0.0 2.4316-5 end
u-235 1 0.0 8.9598-7 end
u-238 1 0.0 7.1284-6 end
h     1 0.0 5.5183-2 end
o     1 0.0 3.2043-2 end
f     1 0.0 4.7182-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parm gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   9.0079
sphere  20   9.0562
sphere  30  10.1962
sphere  40  14.3062
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
end geom
end data
end
```

```
=csas26       parm=centrm
Fallstaff; soln No.1 sphere 4  Be
238groupndf5
read comp
u-232 1 0.0 4.5608-8 end
u-233 1 0.0 2.2379-3 end
u-234 1 0.0 2.4316-5 end
u-235 1 0.0 8.9598-7 end
u-238 1 0.0 7.1284-6 end
h     1 0.0 5.5183-2 end
o     1 0.0 3.2043-2 end
f     1 0.0 4.7182-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
end comp
read parm gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   9.6633
sphere  20   9.7116
sphere  30 13.2116
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.1; sphere 4 Be and CH2
238groupndf5
read comp
u-232 1 0.0 4.5608-8 end
u-233 1 0.0 2.2379-3 end
u-234 1 0.0 2.4316-5 end
u-235 1 0.0 8.9598-7 end
u-238 1 0.0 7.1284-6 end
h     1 0.0 5.5183-2 end
o     1 0.0 3.2043-2 end
f     1 0.0 4.7182-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parm gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   9.6633
sphere  20   9.7116
sphere  30  10.2216
sphere  40  13.5316
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
end geom
end data
end
```

```
=csas26       parm=centrm
Fallstaff; soln No.1; sphere  5  Be only
238groupndf5
read comp
u-232 1 0.0 4.5608-8 end
u-233 1 0.0 2.2379-3 end
u-234 1 0.0 2.4316-5 end
u-235 1 0.0 8.9598-7 end
u-238 1 0.0 7.1284-6 end
h     1 0.0 5.5183-2 end
o     1 0.0 3.2043-2 end
f     1 0.0 4.7182-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
end comp
read parm gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   10.1625
sphere  20   10.2107
sphere  30  12.9007
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26      parm=centrm
Fallstaff; soln No.1; sphere  5 CH2 only
238groupndf5
read comp
u-232 1 0.0 4.5608-8 end
u-233 1 0.0 2.2379-3 end
u-234 1 0.0 2.4316-5 end
u-235 1 0.0 8.9598-7 end
u-238 1 0.0 7.1284-6 end
h     1 0.0 5.5183-2 end
o     1 0.0 3.2043-2 end
f     1 0.0 4.7182-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parm gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   10.1625
sphere  20   10.2107
sphere  40  13.2607
media  1 1 10
media  2 1 20 -10
media  4 1 40 -20 -10
boundary  40
end geom
end data
end
=csas26      parm=centrm
Fallstaff; soln No.1; sphere  5 CH2 and Be
```

```
238groupndf5
read comp
u-232 1 0.0 4.5608-8 end
u-233 1 0.0 2.2379-3 end
u-234 1 0.0 2.4316-5 end
u-235 1 0.0 8.9598-7 end
u-238 1 0.0 7.1284-6 end
h     1 0.0 5.5183-2 end
o     1 0.0 3.2043-2 end
f     1 0.0 4.7182-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parm gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   10.1625
sphere  20   10.2107
sphere  30  11.4807
sphere  40   12.9507
media   1 1 10
media   2 1 20 -10
media   3 1 30 -20 -10
media   4 1 40 -30 -20 -10
boundary  40
end geom
end data
end
=csas26      parm=centrm
Fallstaff; soln No.1; sphere 6 Be only
238groupndf5
read comp
u-232 1 0.0 4.5608-8 end
u-233 1 0.0 2.2379-3 end
u-234 1 0.0 2.4316-5 end
u-235 1 0.0 8.9598-7 end
u-238 1 0.0 7.1284-6 end
h     1 0.0 5.5183-2 end
o     1 0.0 3.2043-2 end
f     1 0.0 4.7182-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
end comp
read parm gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   10.7992
sphere  20   10.8475
sphere  30  12.6775
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.1; sphere  6  Be and CH2
```

```
238groupndf5
read comp
u-232 1 0.0 4.5608-8 end
u-233 1 0.0 2.2379-3 end
u-234 1 0.0 2.4316-5 end
u-235 1 0.0 8.9598-7 end
u-238 1 0.0 7.1284-6 end
h     1 0.0 5.5183-2 end
o     1 0.0 3.2043-2 end
f     1 0.0 4.7182-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parm gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   10.7992
sphere  20   10.8475
sphere  30   11.4875
sphere  40   12.8375
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.2; sphere  1 Be only
238groupndf5
read comp
u-232 1 0.0 3.9445-8 end
u-233 1 0.0 1.9355-3 end
u-234 1 0.0 2.1030-5 end
u-235 1 0.0 7.7491-7 end
u-238 1 0.0 6.1652-6 end
h     1 0.0 5.6654-2 end
o     1 0.0 3.2171-2 end
f     1 0.0 4.0930-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   7.8726
sphere  20   7.9209
sphere  30  15.9209
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.2;  Sphere 2 Be only
```

```
238groupndf5
read comp
u-232 1 0.0 3.9445-8 end
u-233 1 0.0 1.9355-3 end
u-234 1 0.0 2.1030-5 end
u-235 1 0.0 7.7491-7 end
u-238 1 0.0 6.1652-6 end
h     1 0.0 5.6654-2 end
o     1 0.0 3.2171-2 end
f     1 0.0 4.0930-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   8.5152
sphere  20   8.5635
sphere  30  14.5035
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.2;  Sphere 2 Be  and CH2
238groupndf5
read comp
u-232 1 0.0 3.9445-8 end
u-233 1 0.0 1.9355-3 end
u-234 1 0.0 2.1030-5 end
u-235 1 0.0 7.7491-7 end
u-238 1 0.0 6.1652-6 end
h     1 0.0 5.6654-2 end
o     1 0.0 3.2171-2 end
f     1 0.0 4.0930-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   8.5152
sphere  20   8.5635
sphere  30   10.2135
sphere  40   15.3935
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
end geom
end data
end
=csas26      parm=centrm
Fallstaff; soln No.2;  Sphere 3 Be only
```

```
238groupndf5
read comp
u-232 1 0.0 3.9445-8 end
u-233 1 0.0 1.9355-3 end
u-234 1 0.0 2.1030-5 end
u-235 1 0.0 7.7491-7 end
u-238 1 0.0 6.1652-6 end
h     1 0.0 5.6654-2 end
o     1 0.0 3.2171-2 end
f     1 0.0 4.0930-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   9.0079
sphere  20   9.0562
sphere  30  13.7562
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26      parm=centrm
Fallstaff; soln No.2;  Sphere 3  CH2 only
238groupndf5
read comp
u-232 1 0.0 3.9445-8 end
u-233 1 0.0 1.9355-3 end
u-234 1 0.0 2.1030-5 end
u-235 1 0.0 7.7491-7 end
u-238 1 0.0 6.1652-6 end
h     1 0.0 5.6654-2 end
o     1 0.0 3.2171-2 end
f     1 0.0 4.0930-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   9.0079
sphere  20   9.0562
sphere  30   20.7362
media  1 1 10
media  2 1 20 -10
media  4 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26      parm=centrm
Fallstaff; soln No.2;  Sphere 3  BE and CH2
238groupndf5
read comp
```

```
u-232 1 0.0 3.9445-8 end
u-233 1 0.0 1.9355-3 end
u-234 1 0.0 2.1030-5 end
u-235 1 0.0 7.7491-7 end
u-238 1 0.0 6.1652-6 end
h     1 0.0 5.6654-2 end
o     1 0.0 3.2171-2 end
f     1 0.0 4.0930-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   9.0079
sphere  20   9.0562
sphere  30   10.1962
sphere  40   14.2562
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
end geom
end data
end
=csas26      parm=centrm
Fallstaff; soln No.2;  Sphere 4 Be only
238groupndf5
read comp
u-232 1 0.0 3.9445-8 end
u-233 1 0.0 1.9355-3 end
u-234 1 0.0 2.1030-5 end
u-235 1 0.0 7.7491-7 end
u-238 1 0.0 6.1652-6 end
h     1 0.0 5.6654-2 end
o     1 0.0 3.2171-2 end
f     1 0.0 4.0930-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   9.6633
sphere  20   9.7116
sphere  30  13.1416
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.2;  Sphere 5 Be only
238groupndf5
read comp
```

```
u-232 1 0.0 3.9445-8 end
u-233 1 0.0 1.9355-3 end
u-234 1 0.0 2.1030-5 end
u-235 1 0.0 7.7491-7 end
u-238 1 0.0 6.1652-6 end
h     1 0.0 5.6654-2 end
o     1 0.0 3.2171-2 end
f     1 0.0 4.0930-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   10.1625
sphere  20   10.2107
sphere  30   12.8307
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.2;  Sphere 5  CH2 only
238groupndf5
read comp
u-232 1 0.0 3.9445-8 end
u-233 1 0.0 1.9355-3 end
u-234 1 0.0 2.1030-5 end
u-235 1 0.0 7.7491-7 end
u-238 1 0.0 6.1652-6 end
h     1 0.0 5.6654-2 end
o     1 0.0 3.2171-2 end
f     1 0.0 4.0930-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   10.1625
sphere  20   10.2107
sphere  30   13.2807
media  1 1 10
media  2 1 20 -10
media  4 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.2;  Sphere 6 Be only
238groupndf5
read comp
u-232 1 0.0 3.9445-8 end
u-233 1 0.0 1.9355-3 end
```

```
u-234 1 0.0 2.1030-5 end
u-235 1 0.0 7.7491-7 end
u-238 1 0.0 6.1652-6 end
h     1 0.0 5.6654-2 end
o     1 0.0 3.2171-2 end
f     1 0.0 4.0930-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   10.7992
sphere  20   10.8475
sphere  30   12.6275
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.2;  Sphere 7 Be only
238groupndf5
read comp
u-232 1 0.0 3.9445-8 end
u-233 1 0.0 1.9355-3 end
u-234 1 0.0 2.1030-5 end
u-235 1 0.0 7.7491-7 end
u-238 1 0.0 6.1652-6 end
h     1 0.0 5.6654-2 end
o     1 0.0 3.2171-2 end
f     1 0.0 4.0930-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   11.4152
sphere  20   11.4635
sphere  30   12.6435
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.2;  Sphere 7  CH2 only
238groupndf5
read comp
u-232 1 0.0 3.9445-8 end
u-233 1 0.0 1.9355-3 end
u-234 1 0.0 2.1030-5 end
u-235 1 0.0 7.7491-7 end
u-238 1 0.0 6.1652-6 end
h     1 0.0 5.6654-2 end
```

```
o     1 0.0 3.2171-2 end
f     1 0.0 4.0930-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   11.4152
sphere  20   11.4635
sphere  30   12.9835
media  1 1 10
media  2 1 20 -10
media  4 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.3; sphere  1 Be only
238groupndf5
read comp
u-232 1 0.0 2.9871-8 end
u-233 1 0.0 1.4657-3 end
u-234 1 0.0 1.5925-5 end
u-235 1 0.0 5.8682-7 end
u-238 1 0.0 4.6687-6 end
h     1 0.0 5.9146-2 end
o     1 0.0 3.2474-2 end
f     1 0.0 3.1214-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   7.8726
sphere  20   7.9209
sphere  30  16.6109
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.3; sphere  2 Be only
238groupndf5
read comp
u-232 1 0.0 2.9871-8 end
u-233 1 0.0 1.4657-3 end
u-234 1 0.0 1.5925-5 end
u-235 1 0.0 5.8682-7 end
u-238 1 0.0 4.6687-6 end
h     1 0.0 5.9146-2 end
```

```
o     1 0.0 3.2474-2 end
f     1 0.0 3.1214-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   8.5152
sphere  20   8.5635
sphere  30  14.7635
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.3; sphere  3 Be only
238groupndf5
read comp
u-232 1 0.0 2.9871-8 end
u-233 1 0.0 1.4657-3 end
u-234 1 0.0 1.5925-5 end
u-235 1 0.0 5.8682-7 end
u-238 1 0.0 4.6687-6 end
h     1 0.0 5.9146-2 end
o     1 0.0 3.2474-2 end
f     1 0.0 3.1214-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   9.0079
sphere  20   9.0562
sphere  30  14.0862
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.3; sphere  3 Be and CH2
238groupndf5
read comp
u-232 1 0.0 2.9871-8 end
u-233 1 0.0 1.4657-3 end
u-234 1 0.0 1.5925-5 end
u-235 1 0.0 5.8682-7 end
u-238 1 0.0 4.6687-6 end
h     1 0.0 5.9146-2 end
```

```
o     1 0.0 3.2474-2 end
f     1 0.0 3.1214-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   9.0079
sphere  20   9.0562
sphere  30  10.1962
sphere  40  14.5362
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
media  4 1 40 -30 -20 -10
boundary  40
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.3; sphere  4 Be only
238groupndf5
read comp
u-232 1 0.0 2.9871-8 end
u-233 1 0.0 1.4657-3 end
u-234 1 0.0 1.5925-5 end
u-235 1 0.0 5.8682-7 end
u-238 1 0.0 4.6687-6 end
h     1 0.0 5.9146-2 end
o     1 0.0 3.2474-2 end
f     1 0.0 3.1214-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   9.6633
sphere  20   9.7116
sphere  30  13.3216
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.3; sphere  5 Be only
238groupndf5
read comp
u-232 1 0.0 2.9871-8 end
u-233 1 0.0 1.4657-3 end
u-234 1 0.0 1.5925-5 end
u-235 1 0.0 5.8682-7 end
```

```
u-238 1 0.0 4.6687-6 end
h     1 0.0 5.9146-2 end
o     1 0.0 3.2474-2 end
f     1 0.0 3.1214-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   10.1625
sphere  20   10.2107
sphere  30  12.9307
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.3; sphere  5 Ch2 only
238groupndf5
read comp
u-232 1 0.0 2.9871-8 end
u-233 1 0.0 1.4657-3 end
u-234 1 0.0 1.5925-5 end
u-235 1 0.0 5.8682-7 end
u-238 1 0.0 4.6687-6 end
h     1 0.0 5.9146-2 end
o     1 0.0 3.2474-2 end
f     1 0.0 3.1214-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   10.1625
sphere  20   10.2107
sphere  30  13.3107
media  1 1 10
media  2 1 20 -10
media  4 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.3; sphere  6 Be only
238groupndf5
read comp
u-232 1 0.0 2.9871-8 end
u-233 1 0.0 1.4657-3 end
u-234 1 0.0 1.5925-5 end
u-235 1 0.0 5.8682-7 end
```

```
u-238 1 0.0 4.6687-6 end
h     1 0.0 5.9146-2 end
o     1 0.0 3.2474-2 end
f     1 0.0 3.1214-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   10.7992
sphere  20   10.8475
sphere  30  12.9275
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26      parm=centrm
Fallstaff; soln No.3; sphere  7 Be only
238groupndf5
read comp
u-232 1 0.0 2.9871-8 end
u-233 1 0.0 1.4657-3 end
u-234 1 0.0 1.5925-5 end
u-235 1 0.0 5.8682-7 end
u-238 1 0.0 4.6687-6 end
h     1 0.0 5.9146-2 end
o     1 0.0 3.2474-2 end
f     1 0.0 3.1214-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10  11.4152
sphere  20  11.4635
sphere  30  12.6535
media  1 1 10
media  2 1 20 -10
media  3 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26       parm=centrm
Fallstaff; soln No.3; sphere  7 CH2 only
238groupndf5
read comp
u-232 1 0.0 2.9871-8 end
u-233 1 0.0 1.4657-3 end
u-234 1 0.0 1.5925-5 end
u-235 1 0.0 5.8682-7 end
```

```
u-238 1 0.0 4.6687-6 end
h     1 0.0 5.9146-2 end
o     1 0.0 3.2474-2 end
f     1 0.0 3.1214-3 end
fe    2 0.0 6.1248-2 end
cr    2 0.0 1.6678-2 end
ni    2 0.0 9.0264-3 end
be    3 0.0 1.2161-1 end
c     4 0.0 3.9497-2 end
h     4 0.0 7.8994-2 end
end comp
read parms gen=520 npg=4000 nsk=20 tba=10.0 end parms
read geom
global unit 1
sphere  10   11.4152
sphere  20   11.4635
sphere  30   13.0635
media  1 1 10
media  2 1 20 -10
media  4 1 30 -20 -10
boundary  30
end geom
end data
end
=csas26      parm=centrm
exp. 40 simplified model
238gr
read comp
u-233 1 0 8.5797-4 293 end
u-234 1 0 4.0002-6 293 end
u-238 1 0 7.6526-6 293 end
al    1 0 1.2392-5 293 end
cr    1 0 1.2860-7 293 end
fe    1 0 5.9871-7 293 end
na    1 0 2.3633-5 293 end
h     1 0 6.3302-2 293 end
o     1 0 3.3390-2 293 end
f     1 0 1.8016-3 293 end

al    2 0 5.9881-2 293 end
si    2 0 5.8108-4 293 end

c     3 0 3.8419-2 293 end
h-poly 3 0 7.9911-2 293 end

end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
global unit 1
cylinder 10 6.3230 56.3528 0.0
cylinder 20 6.3230 91.2928 0.0
cylinder 30 6.4521 91.4219 -0.1291
cylinder 40 21.6921 91.4219 -15.3691
media  1 1 10
media  0 1 20 -10
media  2 1 30 -20 -10
media  3 1 40 -30 -20 -10
boundary  40
end geom
end data
end
=csas26       parm=centrm
exp. 41 simplified model
238gr
```

```
read comp
u-233 1 0 8.5797-4 293 end
u-234 1 0 4.0002-6 293 end
u-238 1 0 7.6526-6 293 end
h     1 0 6.3280-2 293 end
o     1 0 3.3379-2 293 end
f     1 0 1.8082-3 293 end
al    1 0 1.4338-5 293 end
cr    1 0 1.6076-7 293 end
fe    1 0 9.0301-7 293 end
mg    1 0 1.5632-8 293 end
mo    1 0 1.4401-8 293 end
na    1 0 2.3467-5 293 end
ni    1 0 2.9424-8 293 end
sn    1 0 1.3093-8 293 end

al    2 0 5.9881-2 293 end
si    2 0 5.8108-4 293 end

c      3 0 3.8419-2 293 end
h-poly 3 0 7.9911-2 293 end

h     4 0 5.2843-2 293 end
c     4 0 3.3195-2 293 end
o     4 0 3.9521-3 293 end
cl    4 0 5.5079-3 293 end

end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
global unit 1
cylinder 10 6.8265 48.5411 0.0
cylinder 20 6.8265 91.2811 0.0
cylinder 30 7.0045 91.4591 -0.178
cylinder 40 7.1336 91.5882 -.3071
cylinder 50 22.3736 91.5882 -15.5471
media  1 1 10
media  0 1 20 -10
media  4 1 30 -20 -10
media  2 1 40 -30 -20 -10
media  3 1 50 -40 -30 -20 -10
boundary  50
end geom
end data
end
=csas26       parm=centrm
exp. 42 simplified model
238gr
read comp
u-233 1 0 8.5797-4 293 end
u-234 1 0 4.0002-6 293 end
u-238 1 0 7.6526-6 293 end
h     1 0 6.3258-2 293 end
o     1 0 3.3368-2 293 end
f     1 0 1.8147-3 293 end
al    1 0 1.6283-5 293 end
cr    1 0 1.9291-7 293 end
fe    1 0 1.2073-6 293 end
mg    1 0 3.1264-8 293 end
mo    1 0 2.8801-8 293 end
na    1 0 2.3302-5 293 end
ni    1 0 5.8849-8 293 end
sn    1 0 2.6186-8 293 end
```

```
al    2 0 5.9881-2 293 end
si    2 0 5.8108-4 293 end

c      3 0 3.8419-2 293 end
h-poly 3 0 7.9911-2 293 end

h     4 0 5.2843-2 293 end
c     4 0 3.3195-2 293 end
o     4 0 3.9521-3 293 end
cl    4 0 5.5079-3 293 end

end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
global unit 1
cylinder 10 7.5589 23.8240 0.0
cylinder 20 7.5589 91.2640 0.0
cylinder 30 7.6880 91.3931 -.1291
cylinder 40 22.3736 91.3931 -15.3691
media  1 1 10
media  0 1 20 -10
media  2 1 30 -20  -10
media  3 1 40 -30 -20 -10
boundary  40
end geom
end data
end
=csas26        parm=centrm
exp. 45 simplified model
238gr
read comp
u-233 1 0 1.3406-3 293 end
u-234 1 0 6.2507-6 293 end
u-238 1 0 1.1958-5 293 end
h     1 0 6.1043-2 293 end
o     1 0 3.3239-2 293 end
f     1 0 2.8502-3 293 end
al    1 0 3.2309-5 293 end
cr    1 0 4.4585-7 293 end
fe    1 0 3.5051-6 293 end
mg    1 0 1.4452-7 293 end
mo    1 0 1.3313-7 293 end
na    1 0 2.5782-5 293 end
ni    1 0 2.7203-7 293 end
sn    1 0 1.2105-7 293 end

al    2 0 5.9881-2 293 end
si    2 0 5.8108-4 293 end

c      3 0 3.8419-2 293 end
h-poly 3 0 7.9911-2 293 end

h     4 0 5.2843-2 293 end
c     4 0 3.3195-2 293 end
o     4 0 3.9521-3 293 end
cl    4 0 5.5079-3 293 end

end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
global unit 1
cylinder 10 8.3302 16.7061 0.0
cylinder 20 8.5082 16.8841 -0.178
cylinder 30 8.6373 17.0132 -.3071
```

```
cylinder 40 23.8773 32.2532 -15.5471
media  1 1 10
media  4 1 20 -10
media  2 1 30 -20 -10
media  3 1 40 -30 -20 -10
boundary  40
end geom
end data
end
=csas26      parm=centrm
exp. 55 simplified model
238gr
read comp
u-233 1 0 1.5525-3 293 end
u-234 1 0 7.2384-6 293 end
u-238 1 0 1.3847-5 293 end
h     1 0 6.0513-2 293 end
o     1 0 3.3404-2 293 end
f     1 0 3.3364-3 293 end
al    1 0 4.8742-5 293 end
cr    1 0 7.1173-7 293 end
fe    1 0 5.9756-6 293 end
mg    1 0 2.6915-7 293 end
mo    1 0 2.4794-7 293 end
na    1 0 2.6219-5 293 end
ni    1 0 5.0661-7 293 end
sn    1 0 2.2543-7 293 end

al    2 0 5.9881-2 293 end
si    2 0 5.8108-4 293 end

c      3 0 3.8419-2 293 end
h-poly 3 0 7.9911-2 293 end

h     4 0 5.2843-2 293 end
c     4 0 3.3195-2 293 end
o     4 0 3.9521-3 293 end
cl    4 0 5.5079-3 293 end

end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
global unit 1
cylinder 10 8.3302 16.5061 0.0
cylinder 20 8.3302 16.7061 0.0
cylinder 30 8.5082 16.8841 -0.178
cylinder 40 8.6373 17.0132 -.3071
cylinder 50 23.8773 31.2532 -15.5471
media  1 1 10
media  0 1 20  -10
media  4 1 30 -20 -10
media  2 1 40 -30 -20 -10
media  3 1 50 -40 -30 -20 -10
boundary  50
end geom
end data
end
=csas26       parm=centrm
exp. 57 simplified model
238gr
read comp
u-233 1 0 4.2568-4 293 end
u-234 1 0 1.9847-6 293 end
u-238 1 0 3.7969-6 293 end
```

```
h     1 0 6.5072-2 293 end
o     1 0 3.3399-2 293 end
f     1 0 1.0071-3 293 end
al    1 0 3.7567-5 293 end
cr    1 0 5.5500-7 293 end
fe    1 0 4.7191-6 293 end
mg    1 0 2.1588-7 293 end
mo    1 0 1.9877-7 293 end
na    1 0 1.8115-5 293 end
ni    1 0 4.0634-7 293 end
sn    1 0 1.8082-7 293 end

al    2 0 5.9881-2 293 end
si    2 0 5.8108-4 293 end

c      3 0 3.8419-2 293 end
h-poly 3 0 7.9911-2 293 end

h     4 0 5.2843-2 293 end
c     4 0 3.3195-2 293 end
o     4 0 3.9521-3 293 end
cl    4 0 5.5079-3 293 end

end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
global unit 1
cylinder 10 9.5246 18.1783 0.0
cylinder 20 9.5246 18.8283 0.0
cylinder 30 9.6537 18.9574 -.1291
cylinder 40 24.8937 34.1974 -15.3691
media  1 1 10
media  0 1 20 -10
media  2 1 30 -20  -10
media  3 1 40 -30 -20 -10
boundary  40
end geom
end data
end
=csas26      parm=centrm
exp. 58 simplified model
238gr
read comp
u-233 1 0 2.6374-4 293 end
u-234 1 0 1.2297-6 293 end
u-238 1 0 2.3524-6 293 end
h     1 0 6.5462-2 293 end
o     1 0 3.3266-2 293 end
f     1 0 6.7478-4 293 end
al    1 0 3.6724-5 293 end
cr    1 0 5.4530-7 293 end
fe    1 0 4.6615-6 293 end
mg    1 0 2.1463-7 293 end
mo    1 0 1.9772-7 293 end
na    1 0 1.6818-5 293 end
ni    1 0 4.0399-7 293 end
sn    1 0 1.7977-7 293 end

al    2 0 5.9881-2 293 end
si    2 0 5.8108-4 293 end

c      3 0 3.8419-2 293 end
h-poly 3 0 7.9911-2 293 end
```

```
h     4 0 5.2843-2 293 end
c     4 0 3.3195-2 293 end
o     4 0 3.9521-3 293 end
cl    4 0 5.5079-3 293 end

end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
global unit 1
cylinder 10 10.2645 19.9610 0.0
cylinder 20 10.2645 20.2900 0.0
cylinder 30 10.3936 20.4191 -.1291
cylinder 40 25.6336 35.6591 -15.3691
media  1 1 10
media  0 1 20 -10
media  2 1 30 -20  -10
media  3 1 40 -30 -20 -10
boundary  40
end geom
end data
end
=csas26       parm=centrm
exp. 61 simplified model
238gr
read comp
u-233 1 0 2.0088-4 293 end
u-234 1 0 9.3659-7 293 end
u-238 1 0 1.7917-6 293 end
h     1 0 6.5461-2 293 end
o     1 0 3.3138-2 293 end
f     1 0 5.6914-4 293 end
al    1 0 4.3348-5 293 end
cr    1 0 6.5646-7 293 end
fe    1 0 5.7275-6 293 end
mg    1 0 2.7007-7 293 end
mo    1 0 2.4879-7 293 end
na    1 0 1.5704-5 293 end
ni    1 0 5.0835-7 293 end
sn    1 0 2.2621-7 293 end

al    2 0 5.9881-2 293 end
si    2 0 5.8108-4 293 end

c      3 0 3.8419-2 293 end
h-poly 3 0 7.9911-2 293 end

h     4 0 5.2843-2 293 end
c     4 0 3.3195-2 293 end
o     4 0 3.9521-3 293 end
cl    4 0 5.5079-3 293 end

end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
global unit 1
cylinder 10 10.7641 21.9494 0.0
cylinder 20 10.7641 21.9494 0.0
cylinder 30 10.8932 22.0785 -.1291
cylinder 40 26.1332 37.3185 -15.3691
media  1 1 10
media  0 1 20 -10
media  2 1 30 -20  -10
media  3 1 40 -30 -20 -10
boundary  40
```

```
end geom
end data
end
=csas26       parm=centrm
exp. 62 simplified model
238gr
read comp
u-233 1 0 1.6737-4 293 end
u-234 1 0 7.8036-7 293 end
u-238 1 0 1.4929-6 293 end
h     1 0 6.5609-2 293 end
o     1 0 3.3144-2 293 end
f     1 0 4.9899-4 293 end
al    1 0 4.2752-5 293 end
cr    1 0 6.4743-7 293 end
fe    1 0 5.6486-6 293 end
mg    1 0 2.6635-7 293 end
mo    1 0 2.4537-7 293 end
na    1 0 1.5487-5 293 end
ni    1 0 5.0136-7 293 end
sn    1 0 2.2309-7 293 end

al    2 0 5.9881-2 293 end
si    2 0 5.8108-4 293 end

c      3 0 3.8419-2 293 end
h-poly 3 0 7.9911-2 293 end

h     4 0 5.2843-2 293 end
c     4 0 3.3195-2 293 end
o     4 0 3.9521-3 293 end
cl    4 0 5.5079-3 293 end

end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
global unit 1
cylinder 10 11.4351 22.8338 0.0
cylinder 20 11.4351 22.8338 0.0
cylinder 30 11.5642 22.9629 -.1291
cylinder 40 26.8042 38.2029 -15.3691
media  1 1 10
media  0 1 20 -10
media  2 1 30 -20  -10
media  3 1 40 -30 -20 -10
boundary  40
end geom
end data
end
=csas26      parm=centrm
exp. 65 simplified model
238gr
read comp
u-233 1 0 8.5557-5 293 end
u-234 1 0 3.9891-7 293 end
u-238 1 0 7.6313-7 293 end
h     1 0 6.5697-2 293 end
o     1 0 3.3022-2 293 end
f     1 0 3.4182-4 293 end
al    1 0 4.5514-5 293 end
cr    1 0 6.9526-7 293 end
fe    1 0 6.1192-6 293 end
mg    1 0 2.9141-7 293 end
mo    1 0 2.6846-7 293 end
```

```
na    1 0 1.4541-5 293 end
ni    1 0 5.4853-7 293 end
sn    1 0 2.4408-7 293 end

al    2 0 5.9881-2 293 end
si    2 0 5.8108-4 293 end

c      3 0 3.8419-2 293 end
h-poly 3 0 7.9911-2 293 end

h     4 0 5.2843-2 293 end
c     4 0 3.3195-2 293 end
o     4 0 3.9521-3 293 end
cl    4 0 5.5079-3 293 end

end comp
read param gen=520 npg=4000 nsk=20 tba=10.0 end param
read geom
global unit 1
cylinder 10 15.2571 30.1448 0.0
cylinder 20 15.2571 30.1590 0.0
cylinder 30 15.3862 30.2881 -.1291
cylinder 40 30.1448 45.5281 -15.3691
media  1 1 10
media  0 1 20 -10
media  2 1 30 -20  -10
media  3 1 40 -30 -20 -10
boundary  40
end geom
end data
end
```

APPENDIX G

OECD CALCULATIONAL BENCHMARK CASES

APPENDIX G
OECD CALCULATIONAL BENCHMARK CASES

```
=csas1x      parm=centrm
oecd problem case1a
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
h2o    2  1.0       293.0  end
boron  2  1.3810-3  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.0297  2  fueld=0.96  1  end
more data
isn=16
end more
centrm data
n2d=1  tole=0.001  isn=16
end centrm
end celldata
end
=csas1x      parm=centrm
oecd problem case1b
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
h2o    2  1.0       293.0  end
boron  2  5.9188-4  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.0297  2  fueld=0.96  1  end
more data
isn=16
end more
centrm data
n2d=1  tole=0.001  isn=16
end centrm
end celldata
end
=csas1x      parm=centrm
oecd problem case1c
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.273     293.0  92235  2.5  92238  97.5  end
h2o    2  0.727     293.0  end
boron  2  1.0040-3  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.0297  2  fueld=0.872  1  end
more data
isn=16
end more
centrm data
n2d=1  tole=0.001 isn=16
end centrm
end celldata
end
=csas1x      parm=centrm
oecd problem case1d
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
```

```
uo2    2  0.273     293.0  92235  2.5  92238  97.5  end
h2o    2  0.727     293.0  end
boron  2  4.3030-4  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.0297  2  fueld=0.872  1  end
more data
isn=16
end more
centrm data
n2d=1  tole=0.001 isn=16
end centrm
end celldata
end
=csas1x      parm=centrm
oecd problem case1e
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.429     293.0  92235  2.5  92238  97.5  end
h2o    2  0.571     293.0  end
boron  2  7.8855-4  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.0297  2  fueld=0.762  1  end
more data
isn=16
end more
centrm data
n2d=1  tole=0.001 isn=16
end centrm
end celldata
end
=csas1x      parm=centrm
oecd problem case1e
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.429     293.0  92235  2.5  92238  97.5  end
h2o    2  0.571     293.0  end
boron  2  3.3796-4  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.0297  2  fueld=0.762  1  end
more data
isn=16
end more
centrm data
n2d=1  tole=0.001  isn=16
end centrm
end celldata
end
=csas1x      parm=centrm
oecd problem case2a
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
h2o    2  1.0       293.0  end
boron  2  1.3810-3  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.0943  2  fueld=0.96  1  end
end celldata
end
```

```
=csas1x      parm=centrm
oecd problem case2b
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
h2o    2  1.0       293.0  end
boron  2  5.9188-4  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.0943  2  fueld=0.96  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case2c
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.20      293.0  92235  2.5  92238  97.5  end
h2o    2  0.80      293.0  end
boron  2  1.1048-3  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.0943  2  fueld=0.872  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case2d
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.20      293.0  92235  2.5  92238  97.5  end
h2o    2  0.80      293.0  end
boron  2  4.7350-4  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.0943  2  fueld=0.872  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case2e
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.333     293.0  92235  2.5  92238  97.5  end
h2o    2  0.667     293.0  end
boron  2  9.2113-4  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.0943  2  fueld=0.762  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case2f
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.333     293.0  92235  2.5  92238  97.5  end
h2o    2  0.667     293.0  end
boron  2  3.9478-4  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.0943  2  fueld=0.762  1  end
end celldata
end
```

```
=csas1x      parm=centrm
oecd problem case3a
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
h2o    2  1.0       293.0  end
boron  2  1.3810-3  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.1788  2  fueld=0.96  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case3b
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
h2o    2  1.0       293.0  end
boron  2  5.9188-4  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.1788  2  fueld=0.96  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case3c
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.143     293.0  92235  2.5  92238  97.5  end
h2o    2  0.857     293.0  end
boron  2  1.1835-3  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.1788  2   fueld=0.872  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case3d
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.143     293.0  92235  2.5  92238  97.5  end
h2o    2  0.857     293.0  end
boron  2  5.0724-4  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.1788  2  fueld=0.872  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case3e
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.25      293.0  92235  2.5  92238  97.5  end
h2o    2  0.75      293.0  end
boron  2  1.0356-3  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.1788  2  fueld=0.762  1  end
end celldata
end
=csas1x      parm=centrm
```

```
oecd problem case3e
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.25      293.0  92235  2.5  92238  97.5  end
h2o    2  0.75      293.0  end
boron  2  4.4391-4  293.0  end
end comp
read celldata
latticecell sphtriangp  pitch=1.1788  2  fueld=0.762  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case4a
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
h2o    2  1.0       293.0  end
boron  2  1.3810-3  293.0  end
end comp
read celldata
latticecell sphsquarep  pitch=0.9749  2  fueld=0.96  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case4b
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
h2o    2  1.0       293.0  end
boron  2  5.9188-4  293.0  end
end comp
read celldata
latticecell sphsquarep  pitch=0.9749  2  fueld=0.96  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case4c
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.2       293.0  92235  2.5  92238  97.5  end
h2o    2  0.8       293.0  end
boron  2  1.1048-3  293.0  end
end comp
read celldata
latticecell sphsquarep  pitch=0.9749  2  fueld=0.872  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case4d
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.2       293.0  92235  2.5  92238  97.5  end
h2o    2  0.8       293.0  end
boron  2  4.7350-4  293.0  end
end comp
read celldata
latticecell sphsquarep  pitch=0.9749  2  fueld=0.872  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case4e
```

```
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.333     293.0  92235  2.5  92238  97.5  end
h2o    2  0.667     293.0  end
boron  2  9.2113-4  293.0  end
end comp
read celldata
latticecell sphsquarep  pitch=0.9749  2  fueld=0.762  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case4f
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.333     293.0  92235  2.5  92238  97.5  end
h2o    2  0.667     293.0  end
boron  2  3.9478-4  293.0  end
end comp
read celldata
latticecell sphsquarep  pitch=0.9749  2  fueld=0.762  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case5a
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
h2o    2  1.0       293.0  end
boron  2  1.3810-3  293.0  end
end comp
read celldata
latticecell sphsquarep  pitch=1.0501  2  fueld=0.96  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case5b
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
h2o    2  1.0       293.0  end
boron  2  5.9188-4  293.0  end
end comp
read celldata
latticecell sphsquarep  pitch=1.0501  2  fueld=0.96  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case5c
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.143     293.0  92235  2.5  92238  97.5  end
h2o    2  0.857     293.0  end
boron  2  1.1835-3  293.0  end
end comp
read celldata
latticecell sphsquarep  pitch=1.0501  2  fueld=0.762  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case5d
238group
```

```
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.143     293.0  92235  2.5  92238  97.5  end
h2o    2  0.857     293.0  end
boron  2  5.0724-4  293.0  end
end comp
read celldata
latticecell sphsquarep  pitch=1.0501  2  fueld=0.762  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case5e
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.25      293.0  92235  2.5  92238  97.5  end
h2o    2  0.75      293.0  end
boron  2  1.0358-3  293.0  end
end comp
read celldata
latticecell sphsquarep  pitch=1.0501  2  fueld=0.762  1  end
end celldata
end
=csas1x      parm=centrm
oecd problem case5f
238group
read comp
uo2    1  1.0       293.0  92235  2.5  92238  97.5  end
uo2    2  0.25      293.0  92235  2.5  92238  97.5  end
h2o    2  0.75      293.0  end
boron  2  4.4391-4  293.0  end
end comp
read celldata
latticecell sphsquarep  pitch=1.0501 2  fueld=0.762  1  end
end celldata
end
```

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