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Criticality Benchmark Guide for Light-Water-Reactor Fuel in Transportation and Storage Packages

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Prepared by
J. J. Lichtenwalter, S. M. Bowman, M. D. DeHart, C. M. Hopper

Oak Ridge National Laboratory

Prepared for
U.S. Nuclear Regulatory Commission

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ABSTRACT

This report is designed as a guide for performing criticality benchmark calculations for light-water-reactor (LWR) fuel applications. The guide provides documentation of 180 criticality experiments with geometries, materials, and neutron interaction characteristics representative of transportation packages containing LWR fuel or uranium oxide pellets or powder. These experiments should benefit the U.S. Nuclear Regulatory Commission (NRC) staff and licensees in validation of computational methods used in LWR fuel storage and transportation concerns. The experiments are classified by key parameters such as enrichment, water/fuel volume, hydrogen-to-fissile ratio (H/X), and lattice pitch. Groups of experiments with common features such as separator plates, shielding walls, and soluble boron are also identified. In addition, a sample validation using these experiments and a statistical analysis of the results are provided. Recommendations for selecting suitable experiments and determination of calculational bias and uncertainty are presented as part of this benchmark guide.

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1 Introduction

This report is designed as a guide for performing criticality benchmark calculations for light-water-reactor (LWR) fuel applications. The guide provides documentation of 180 criticality experiments with geometries, materials, and neutron interaction characteristics representative of transportation packages containing LWR fuel or uranium oxide pellets or powder. These experiments should benefit the U.S. Nuclear Regulatory Commission (NRC) staff and licensees in validation of computational methods used in LWR fuel storage and transportation concerns. The experiments are classified by key parameters such as enrichment, water-to-fuel volume ratio, hydrogen-to-fissile ratio (H/X), and lattice pitch. Groups of experiments with common features such as separator plates, reflecting walls, and soluble boron are also identified. In addition, a sample validation using these experiments and a statistical analysis of the results are provided. Recommendations for selecting suitable experiments and determination of calculational bias and uncertainty are presented as part of this benchmark guide.

A literature survey was performed of low-enriched, LWR-type fuel critical experiment reports to select the experiments documented here. Table 1.1 presents a brief summary of the reports surveyed and the types and number of available experiments found. The table also indicates the number of experiments selected for inclusion in this report. This information may be useful to an analyst who wishes to perform a more extensive validation for a particular category of LWR fuel experiments.

Descriptions of the selected critical experiments are presented in Sect. 2 in sufficient detail for independent analysis by any computational tool that is appropriate for performing criticality safety analyses.

Section 3 documents benchmark calculations of these experiments performed with the SCALE code system[1] using the 44-group ENDF/B-V cross-section library.[2] Results include neutron multiplication factors (k_{eff}), presented individually and combined by experiment type. The SCALE input files used to generate the results of Sect. 3 are listed in Appendix A. Individual results based on the 238-group ENDF/B-V library[3] are also presented for comparison in Appendix B.

Determinations of calculational biases and subcritical limits are discussed in Sect. 4. Statistical analyses of the SCALE calculational results are performed to parameterize trends. The purpose of these analyses is to determine the correlation of bias in calculated k_{eff} values to key parameters. The statistical results are then applied in the demonstration of two methods for establishing an upper subcritical limit (USL): (1) a 95% confidence band for a single future calculation with an administrative subcritical margin and (2) a lower tolerance band based on a 95% confidence band on 99.5% of all future calculations using the *uslstats* program documented in Appendix C.

Section 5 discusses the issue of areas of applicability in the validation of computational methods and presents guidance on how to select criticality experiments that are applicable to validate the computational method for the system of concern. Parameters that should be studied to demonstrate areas of applicability are discussed.

A summary of this benchmark guide is presented in Sect. 6.

Table 1.1 Summary of available LWR critical experiments

Report	No. of available experiments	No. of selected experiments	Description of criticality experiments
ANS Transactions, Vol. 33, p.362 (Ref. 5)	25	9	4.74 wt % ^{235}U UO_2 fuel rods in square lattices of 1.35-cm pitch; fuel clusters separated by air, polystyrene, polyethylene, or water; fuel clusters submersed in aqueous $NaNO_3$ solution
BAW-1484 (Ref. 6)	37	10	2.46 wt % ^{235}U UO_2 fuel rods in square lattices of 1.636-cm pitch; the spacing between 3 × 3 array of LWR-type fuel assemblies is filled with water and B_4C pins, stainless steel sheets, or borated stainless steel sheets; lattices with borated moderator
EPRI-NP-196 (Ref. 7)	6	6	2.35 wt % ^{235}U UO_2 fuel rods in square lattices of 1.562-, 1.905-, and 2.210-cm pitch; lattices with borated moderator
NS&E, Vol. 71, p. 154 (Ref. 8)	26	6	4.74 wt % ^{235}U UO_2 fuel rods in square lattices of 1.26-, 1.60-, 2.10-, and 2.52-cm pitch; triangular and triangular with pseudo-cylindrical shape lattices of 1.35-, 1.72-, and 2.26-cm pitch; irregular hexagonal lattices of 1.35-cm pitch; lattices with water holes
PNL-2438 (Ref. 9)	48	6	2.35 wt % ^{235}U UO_2 fuel rods in square lattices of 2.032-cm pitch; Cd, Al, Cu, stainless steel, borated stainless steel, Boral, and Zircaloy separator plates between assemblies
PNL-2827 (Ref. 10)	23	9	2.35 and 4.31 wt % ^{235}U UO_2 fuel rods in square lattices of 2.032- and 2.540-cm pitch; reflecting walls of Pb or depleted uranium
PNL-3314 (Ref. 11)	142	27	2.35 and 4.31 wt % ^{235}U UO_2 fuel rods in square lattices of 1.684- and 1.892-cm pitch; stainless steel, borated stainless steel, Cd, Al, Cu, Boral, Boroflex, and Zircaloy separator plates between assemblies; lattices with water holes and voids
PNL-3926 (Ref. 12)	22	14	2.35 and 4.31 wt % ^{235}U UO_2 fuel rods in square lattices of 1.684- and 1.892-cm pitch; reflecting walls of Pb or depleted uranium
PNL-4267 (Ref. 13)	9	7	4.31 wt % ^{235}U UO_2 fuel rods in square lattices of 1.890- and 1.715-cm pitch; lattices with borated moderator
PNL-4976 (Ref. 14)	17	1	4.31 wt % (2.35 wt %) ^{235}U UO_2 fuel rods in hexagonal lattices of 2.398-, 1.801-, and 1.598-cm pitch; moderator contains Gadolinium
WCAP-3269 (Ref. 15)	157	9	2.7, 3.7, and 5.7 wt % ^{235}U UO_2 fuel rods in square lattices of 1.029-, 1.105-, and 1.422-cm pitch; lattices with Ag-In-Cd absorber rods, water holes, void tubes
WCAP-3385 (Ref. 16)	3	2	5.74 wt % ^{235}U UO_2 fuel rods in square lattices of 1.321-, 1.422-, and 2.012-cm pitch

Table 1.1 (continued)

Report	No. of available experiments	No. of selected experiments	Description of criticality experiments
BAW-1645 (Ref. 17)	21	8	2.46 wt % ^{235}U UO_2 fuel rods in close-packed triangular lattices of 1.209-cm pitch, close-packed square lattices of 1.209-cm pitch, and square lattices of 1.410-cm pitch
DSN 399/80 (Ref. 18)	4	4	4.74 wt % ^{235}U UO_2 fuel rods in square lattices of 1.6-cm pitch; hafnium separator plates between assemblies
PNL-2615 (Ref. 19)	32	7	4.31 wt % ^{235}U UO_2 fuel rods in square lattices of 2.540-cm pitch; stainless steel, borated stainless steel, Cd, Al, Cu, Boral, and Zircaloy separator plates between assemblies
PNL-6205 (Ref. 20)	19	1	4.31 wt % ^{235}U UO_2 fuel rods in square lattices of 1.891-cm pitch; Boral flux traps
PNL-7167 (Ref. 21)	9	4	4.31 wt % ^{235}U UO_2 fuel rods in square lattices of 1.891-cm pitch; Boral flux traps containing voids filled with Al plates, Al rods, or UO_2 fuel rods
PNL-3602 (Ref. 22)	49	26	2.35 and 4.31 wt % ^{235}U UO_2 fuel rods in square lattices of 2.032- and 2.540-cm pitch; reflecting walls of stainless steel; separator plates of stainless steel, borated stainless steel, Boral, Cu, Cd, and Boroflex between assemblies
Haon et al., PATRAM '80 (Ref. 23)	12	4	4.74 wt % $^{235}UO_2$ fuel rods in square lattices of 1.6-cm pitch; Boral separator plates; lead, steel, or water reflecting walls
BAW-1810 (Ref. 24)	23	10	2.46, 4.02, and 2.46 and 4.02 wt % ^{235}U UO_2 fuel rods in square lattices of 1.636-cm pitch; lattices with 1.94 wt % ^{235}U UO_2-Gd_2O_3 fuel rods, Ag-In-Cd and B_4C absorber rods, void rods
BAW-1231 (Ref. 25)	10	2	4.02 wt % ^{235}U UO_2 fuel rods in square lattices of 1.511-cm pitch; lattice with borated moderator
BAW-1273 (Ref. 26)	10	1	2.46 and 4.02 wt % ^{235}U UO_2 fuel rods in square lattices of 1.702, 1.511, and 1.450-cm pitch; lattice with borated moderator
Y-DR-14 (Ref. 27)	32	4	Paraffin reflected or unreflected rectangular parallelepipeds of paraffin and homogeneous $U(2)F_4$ or $U(3)F_4$
NUREG/CR-0674 (Ref. 28) NUREG/CR-1071 (Ref. 29) NUREG/CR-1653 (Ref. 30) NUREG/CR-2500 (Ref. 31)	20	3	Plastic reflected or concrete reflected fuel cans with 4.46 % enriched U_3O_8
Total	**756**	**180**	

2 Physical Description of Selected Low-Enriched Critical Experiments

This section provides descriptions of the materials and physical layouts of 180 low-enriched critical experiments[5-28] suitable for benchmarking LWR fuel analyses. The experiments were selected based on structural, material, poison, geometry, and spectral similarities to NRC-certified radioactive materials packages.[4] The 180 experiments can be categorized as 173 LWR-type fuel pin lattice experiments and 7 homogeneous uranium experiments. Brief descriptions of the 180 experiments are presented in Table 2.1. More detailed descriptions and modeling assumptions are found in Sects. 2.1 and 2.2. All experimental data reported are nominal values. The reader may refer to the references for these experiments to obtain data regarding experimental uncertainties. Items that are noted as "not modeled" or "ignored" were generally located near the top or bottom of the experiment where neutron leakage was high. The volume occupied by these items in the experiment were modeled as the surrounding medium, either water or void. General modeling and calculational techniques used in the SCALE-4.3 calculations are discussed in Sect. 3.

2.1 LWR-Type Fuel Pin Lattice Experiments

The following sections present descriptions of experiments utilizing UO_2 LWR-type fuel in square and hexagonal lattices moderated by light water. The experiments are categorized as simple lattices (2.1.1), separator plates (2.1.2), reflecting walls (2.1.3), reflecting walls and separator plates (2.1.4), burnable absorber fuel rods (2.1.5), water holes (2.1.6), poison rods (2.1.7), and borated moderator (2.1.8).

2.1.1 Simple Lattice Experiments

This set of experiments consists of large single lattices (cores) and arrays of assemblies void of poisons, significant reflecting materials, water holes, etc. The experiments represent simple transportation packages with primary criticality control by means of controlling assembly interaction. Modeling of the experiments demonstrates the ability of the calculational techniques to predict the neutron multiplication factor of essentially infinite arrays of rods (cores) or neutronically interacting separated assemblies. The experiments provide baselines for comparisons to more complex problems.

2.1.1.1 Simple Lattice Experiments from ANS Transactions, Vol. 33 (Ref. 5)

ANS33SLG consists of a 2 × 2 array of fuel assemblies separated by 5.0 cm of water. The 4.742 wt % UO_2 fuel rod specifications are given in Table 2.2 and Fig. 2.1. The planar and end views of the experiment are shown in Fig. 2.2; the 0.3-cm-thick aluminum wall box was replaced by water in this experiment. Critical data for the experiment are located in Table 2.3.

Assumptions: The holes in the lower lattice grid plate for accommodating the fuel rods were taken to be 1.0 cm in diameter from Ref. 23. The aluminum box density, 2.651 g/cm^3, was assumed from Ref. 23.

Model-experiment comparison: The spring of the fuel rods was modeled as void. The end plugs were modeled as 0.94-cm-diam aluminum cylinders. The fuel rods above the moderator were modeled by the method explained in Sect. 3.2.1.

2.1.1.2 Simple Lattice Experiments from BAW-1484 (Ref. 6)

BW1484SL consists of a 3 × 3 array of fuel assemblies separated by 6.544 cm of water. Details of the 2.459 wt % UO_2 fuel rod design are outlined in Table 2.4 and Fig. 2.3. The vertical dimensions for the experiment are found in Fig. 2.4. Absent from Fig. 2.4: the 1 in. (2.54 cm) between the base plate and core tank is mostly water and the core tank is 0.5 in. (1.27 cm) thick. Difficult to distinguish in Fig. 2.4 is that the fuel rod end plugs are located in 0.125 in.

(0.3175 cm) of water between the bottom grid plate and the base plate. The critical data for this experiment are located in Table 2.5.

Assumptions: The aluminum corner rods are believed to be of fuel rod length. The separation distance between assemblies is believed to have been measured from the cell boundaries of the assemblies. To accommodate fuel rods, square holes with 0.615-cm sides were assumed in the bottom grid plate.

Model-experiment comparison: The 22.9-cm × 22.9-cm × 2.54-cm aluminum top grid plate was not modeled. The fuel rods and separator plate above the moderator region were not modeled.

2.1.1.3 Simple Lattice Experiments from EPRI NP-196 (Ref. 7)

These experiments consist of large singular arrays of fuel rods. Specifications for the 2.35 wt % UO_2 fuel rods are presented in Fig. 2.5. Figure 2.6 is the axial arrangement of experiments **EPRU65** and **EPRU87**. Figure 2.7 is the axial arrangement of experiment **EPRU75**. The grid plate holes for EPRU75 are 0.586 in. (1.488 cm) in diameter. The specifications for the aluminum "eggcrate" grids seen in Fig. 2.6 are given in Fig. 2.8. The core layouts are shown in Figs. 2.9–2.11. The critical data are located in Table 2.6.

Model-experiment comparison: The soluble boron in the moderator was not modeled because of the low concentration. A 182.88-cm-diam, 274.32-cm-tall tank constitutes full-water reflection of the cores. The experiments were modeled with 6 in. (15.24 cm) of water above the lead shield and 30 cm of water below the aluminum solid plate.

2.1.1.4 Simple Lattice Experiments from NS&E, Vol. 71 (Ref. 8)

These experiments consist of large singular arrays of fuel rods in square or hexagonal lattices. Specifications for the 4.742 wt % UO_2 fuel rods are given in Table 2.2 and Fig. 2.1. The principal dimensions of the experiments are also given in Fig. 2.1. The layouts of the three hexagonal lattice cores are presented in Fig. 2.12. The critical data for the experiments are located in Table 2.7.

Assumptions: The holes in the lower grid plate to accommodate the fuel rods were taken to be 1.0 cm in diameter from Ref. 23.

Model-experiment comparison: The reported upper grid, missing from Fig 2.1, was ignored in the model due to insufficient data. The two grid plates were reportedly attached to the support plate by four fuel rods distanced more than 20 cm from the fuel. These rods were not modeled. The fuel rods above the moderator were modeled by the method explained in Sect. 3.2.1. The stainless steel support plate was modeled as 71.40 wt % Fe, 19.16 wt % Cr, and 9.44 wt % Ni. For **NSE71H1**, **NSE71H2**, and **NSE71H3**, 0.25 cm of the bottom end plug was homogenized with the surrounding lower grid plate and water. The remaining 1.55 cm of the bottom end plug was homogenized with the surrounding water.

2.1.1.5 Simple Lattice Experiments from PNL-2438 (Ref. 9)

P2438SLG consists of a 3 × 1 array of fuel assemblies separated by 8.39 cm of water. Details of the 2.35 wt % UO_2 fuel rods are outlined in Fig. 2.5. Planar and axial views of the experiment can be found in Fig. 2.13; the experiment was minus the poison plates and biological shielding walls shown in Fig 2.13. Critical data for the experiments are located in Table 2.8.

Model-experiment comparison: The 1.27-cm-thick acrylic grid plates were modeled as water because acrylic plastic has about the same density and neutron moderating characteristics as water. The carbon steel core tank was not modeled because the amount of water on the boundary of the array ensures a maximum increase in k_{eff}.

2.1.1.6 Simple Lattice Experiments from PNL-2827 (Ref. 10)[10]

P2827SLG consists of a 3 × 1 array of fuel assemblies separated by 8.31 cm of water. Details of the 2.35 wt % UO_2 fuel rods are outlined in Fig. 2.5. Planar and axial views of the experiment can be found in Fig. 2.13; the experiment was minus the poison plates and biological shielding walls shown in Fig. 2.13. Critical data for the experiments are located in Table 2.9.

Model-experiment comparison: The 1.27-cm-thick acrylic grid plates were modeled as water because acrylic plastic has about the same density and neutron moderating characteristics as water. The carbon steel core tank was not modeled because the amount of water on the boundary of the array ensures a maximum increase in k_{eff}.

2.1.1.7 Simple Lattice Experiments from PNL-3314 (Ref. 11)

P3314SLG consists of a 2 × 2 array of fuel assemblies separated by 2.83 cm and 10.86 cm of water. Descriptions of the 4.31 wt % UO_2 fuel rods are provided in Fig. 2.14. Planar and axial views of the experiment are shown in Fig. 2.15. Figure 2.16a (c) illustrates the 2 × 2 assembly configuration. Critical data on the experiment are given in Table 2.10.

Model-experiment comparison: The minimum fuel rod pellet column length, 91.44 cm, was modeled. The two polypropylene (neutronic properties similar to water) grid plates were modeled as water. The carbon steel tank was not modeled because the amount of water on the boundary of the array ensures a maximum increase in k_{eff}.

2.1.1.8 Simple Lattice Experiments from PNL-3926 (Ref. 12)

The experiments consist of 3 × 1 arrays of fuel assemblies separated by 6.59 and 12.79 cm of water. Details of the 2.35 and 4.31 wt % UO_2 fuel rods are outlined in Figs. 2.5 and 2.14. Planar and axial views of the experiment can be found in Fig. 2.15. Absent in the experiments are the poison plates and biological shielding walls of Fig. 2.15. Critical data for the experiments are located in Table 2.11.

Model-experiment comparison: The minimum fuel rod pellet column length, 91.44 cm, was modeled for the 4.31 wt % UO_2 fuel rods. The 1.27-cm-thick polypropylene (0.904 g/cm^3) grid plates were modeled as water because polypropylene has about the same density and neutron moderating characteristics as water. The carbon steel core tank was not modeled because the amount of water on the boundary of the array ensures a maximum increase in k_{eff}.

2.1.1.9 PNL-4267 Simple Lattice Experiments from PNL-4267 (Ref. 13)

The experiments consist of single arrays of fuel rods. Specifications for the 4.31 wt % fuel rod are located in Fig. 2.14. The planar and elevation views of the experiments are illustrated in Fig. 2.17. The Plexiglas box is fully reflected on all four sides by **unborated** water Critical data for the experiments are given in Table 2.12.

Model-experiment comparison: The minimum fuel rod pellet column length, 91.44 cm, was modeled.

The PNL-4267 experiments are subcritical configurations. The number of rods required to achieve critical are predicted by the approach-to-critical method. For **P4267SL1** and **P4267SL2**, the nearest whole number of rods required for criticality was modeled. The partial rod can be modeled if using CSAS2X. **P4267SL1** was modeled with 9 columns of 40 fuel rods, and 1 far left column of 37 fuel rods arbitrarily placed against the lower Plexiglas box side of Fig. 2.17 (planar view). The array was positioned along its length against the right side of the Plexiglas box with the array boundary next to the Plexiglas box surface. The array was centered along its width in the Plexiglas box. **P4267SL2** was modeled with 11 columns of 44 fuel rods, and 1 far left column of 25 fuel rods arbitrarily placed against the lower Plexiglas box side of Fig. 2.17 (planar view). The array was positioned along its length against the right side of the Plexiglas box with the array boundary next to the Plexiglas box surface. The array was centered along its width in the Plexiglas box.

A discrepancy in Fig. 2.17 was noticed. As displayed in the figure, the cell boundaries along the array width are 75.88 cm apart. Forty and 44 fuel rods placed in lattices of 1.890- and 1.715-cm pitch give rise to cell boundaries 75.6 and 75.46 cm apart, not 75.88 cm.

2.1.1.10 Simple Lattice Experiments from PNL-4976 (Ref. 14)

The experiment **P49-194** used a large singular array of fuel rods in a hexagonal lattice. Specifications for the 4.31 wt % UO_2 fuel rods are located in Fig. 2.14. The core assembly and experimental assembly elevations are illustrated in Figs 2.18 and 2.19. Missing from Fig. 2.19: The acrylic (1.185 g/cm^3) is composed of 60 wt % C, 32 wt % O, and 8 wt % H; the polypropylene (0.905 g/cm^3) lattice plates are 91.44 cm in diameter . The critical data for **P49-194** are given in Table 2.13.

Assumptions: With a core tank diameter of 152 cm, the core can be considered fully reflected by water laterally. The acrylic base plate is believed to have the same diameter as the polypropylene lattice plates.

Model-experiment comparison: The minimum fuel pellet column length, 91.44 cm, was used. The aluminum spacers, fiberglass tank bottom, carbon steel tank, and concrete floor were excluded from the model. The polypropylene lattice plates were modeled as polyethylene using hydrogen in a water thermal kernel.

2.1.1.11 Simple Lattice Experiments from WCAP-3269 (Ref. 15)

W3269SL1 and **W3269SL2** use large singular arrays of fuel rods. Descriptions of the 2.72 and 5.7 wt % UO_2 fuel rods are located in Table 2.14. The vertical dimensions of experiments **W3269SL1** and **W3269SL2** are shown in Figs. 2.20 and 2.21; the guide plates are aluminum. The absorber section of Fig. 2.20 was not part of experiment **W3269SL1**. Critical data for the experiments are located in Table 2.15.

Assumptions: The moderator height was believed to have been measured from the bottom of the fuel. The guide plate holes to accommodate fuel rods were assumed to be of fuel rod diameter. In Fig. 2.21, all plates were taken to be of assembly width and depth; full-water reflection was assumed on the sides of the experimental assembly; the 2.54-cm-thick plate below the bottom guide plate was assumed to be of aluminum. In Fig. 2.20, full-water reflector was assumed at the boundary of the assembly defined by the 60.96-cm-square guide plates.

Model-experiment comparison: The fuel rods above the moderator were modeled by the method explained in Sect. 3.2.1. In Fig. 2.21 (**W3269SL2**) the 6.35 cm above the aluminum base plate was modeled as water only. In Fig. 2.20 (**W3269SL1**) the top and center guide plates, in air for this experiment, were not modeled; the bottom end plugs in the bottom guide plate were modeled as aluminum; the bottom end plugs in the 0.188-in. (0.428-cm)-thick water slot and the top end plugs were not modeled.

2.1.1.12 Simple Lattice Experiments from WCAP-3385 (Ref. 16)

W3385SL1 and **W3385SL2** consist of large singular arrays of fuel rods. The 5.74 wt % UO_2 rods are described in Table 2.16. Vertical dimensions of the experiments are given in Fig. 2.22. Missing from, or hard to distinguish in, Fig. 2.22 is that: (1) all structures are made of aluminum, (2) the bottom grid plate rests on a 1-in. (2.54-cm)-thick aluminum slab above 2.5 in. (6.35 cm) of water and a 2-in. (5.08-cm)-thick aluminum slab, (3) the fuel pellet column ends are 0.5 in. (1.27 cm) above the bottom grid plate and 0.4 in. (1.016 cm) below the top grid plate, and (4) the stainless steel support rods are 0.4375 in. (1.1113 cm) in diameter with 0.625-in. (0.476-cm)-thick aluminum cladding. Figure 2.23 shows the location and size of the fuel rod holes and circulation holes of the grid plates of Fig. 2.22. Critical data for the experiments are located in Table 2.17.

Assumptions: The core tank is 121.92 cm in diameter constituting full-water reflection. The end plugs are believed to be of cladding material (i.e., 304 stainless steel).

Model-experiment comparison: The support rods were ignored. Homogenized water and aluminum were used to represent the center grid plate and circulation holes. The fuel rods above the moderator were modeled by the method explained in Sect. 3.2.1.

2.1.2 Separator Plate Experiments

These experiments have been selected to demonstrate the ability of the calculational techniques to predict the neutron multiplication factor of experiments with neutron absorbing or scattering materials (i.e., separator plates) between fuel assemblies. Separator plates are commonly used in transportation packages to limit neutron interaction and increased reactivity associated with the bringing into close proximity of fuel assemblies.

2.1.2.1 Separator Plate Experiments from ANS Transactions, Vol. 33 (Ref. 5)

The experiments consist of 2 × 2 arrays of fuel assemblies separated by aluminum boxes (four sides and a bottom) filled with water, polyethylene powder and balls, and expanded polystyrene. These experiments further test the ability of the calculation method to predict k_{eff} for assemblies with various hydrogenous compound moderators. Specifications of the 4.742 wt % fuel rods are given in Table 2.2 and Fig. 2.1. The planar and end views of the experiment are shown in Fig. 2.2. Critical data for the experiments are located in Table 2.18.

Assumptions: Holes to accommodate the fuel rods in the lower grid plate were taken to be 1.0 cm in diameter from Ref. 23. The aluminum box density, 2.651 g/cm^3, was assumed from Ref. 23.

Model-experiment comparison: The spring of the fuel rods was modeled as void. The end plugs were modeled as 0.94-cm-diam aluminum cylinders. The fuel rods above the moderator were modeled by the method explained in Sect. 3.2.1.

2.1.2.2 Separator Plate Experiments from BAW-1484 (Ref. 6)

The experiments consist of 3 × 3 arrays of fuel assemblies separated by borated aluminum plates and water or 304-L stainless steel plates and water. Details of the 2.459 wt % UO_2 fuel rods are outlined in Table 2.4 and Fig. 2.3. The elevations of the experiments can be found in Fig. 2.24. The top grid was not used in the experiments. Missing from, or difficult to distinguish in, Fig. 2.24 is that (1) the fuel pellet column and fuel rod bottom end plugs extend 0.635 and 0.9525 cm into the aluminum bottom grid, respectively, (2) the aluminum bottom grid and aluminum bottom grid plate are 2.54 cm thick, (3) and 0.3175 cm of water exists between the aluminum bottom grid plate and the 5.08-cm-thick aluminum base plate. Critical data for the experiments are located in Table 2.19.

Assumptions: The aluminum corner rods are assumed to be of fuel rod length. The separation distance between assemblies is believed to have been measured from the cell boundaries of the assemblies. Holes, 0.615 cm on a side, were assumed in the bottom grid plate to accommodate the fuel rods.

Model-experiment comparison: The 22.9-cm × 22.9-cm × 0.3175-cm aluminum center grid plate was not modeled. The fuel rods and separator plate above the moderator region were not modeled. In the model, the separator plates rest in a channel cut 0.635-cm deep into the bottom grid with the channel thickness equaling the separation distance of assemblies and channel length running the length of the assembly.

2.1.2.3 Separator Plate Experiments from BAW-1645 (Ref. 17)

The experiments consist of 5 × 5 arrays of fuel assemblies separated by (presumed) aluminum plates. Details of the 2.459 wt % UO_2 fuel rods are outlined in Table 2.4 and Fig. 2.3. Figure 2.25 is a planar view of the experiments showing the assemblies with mounted aluminum side sheets, or separator plates. Vertical dimensions of the experiments can be found in Fig. 2.26. Missing from, or difficult to distinguish in, Fig. 2.26 is that (1) the end plugs of the fuel rods extend 0.3175 cm into the 3.2-cm-thick aluminum bottom grid plate, (2) the aluminum base plate has dimensions of 122 cm × 122 cm × 8.9 cm, (3) the aluminum base plate is separated from the core tank by 2.86 cm of water, and (4) the separator plates extend vertically from the base of the bottom grid plate to the top of the top grid plate. Critical data for the experiments are located in Table 2.20.

Assumptions: The aluminum corner rods are assumed to be of fuel rod length. The separation distance between assemblies is believed to have been measured from the cell boundaries of the assemblies. The core tank is assumed to be 1.0-cm thick and constructed from carbon steel. With a 274-cm inside core tank diameter, the core is assumed to be fully reflected laterally by water.

Model-experiment comparison: The aluminum top and center grid plates were of unknown thickness and were not modeled. The fuel rods and separator plates above the moderator region and the core tank sides were ignored in the model. For experiments **BW1645T1**, **BW1645T1**, **BW1645T3**, **BW1645T4**, **BW1645S1**, and **BW1645S2**, the 3.2-cm-thick aluminum bottom grid plate has grooves for coolant flow. The top 0.3175 cm of the bottom grid plate around the end plugs was modeled as water only, the middle 1.067 cm of the plate was modeled as a mixture of 25% aluminum and 75% water by volume, and the bottom 1.815 cm was modeled as 100% aluminum by volume. For **B1645SO1** and **B1645SO2**, the 3.2-cm-thick aluminum bottom grid plate was modeled as water around the 0.3175-cm-long bottom end plugs and 2.882 cm of aluminum below the bottom end plugs.

2.1.2.4 Separator Plate Experiments from DSN No. 399/80 (Ref. 18)

The experiments consist of 2 × 2 arrays of fuel assemblies separated by water and hafnium plates, or single assemblies surrounded by hafnium plates. Specifications for the 4.742 wt % UO_2 fuel rods are outlined in Table 2.2 and Fig. 2.1. The elevations of the experiments are also given in Fig. 2.1. For **DSN399-1** and **DSN399-2**, a 0.4-cm-thick stainless steel assembly support plate (not shown in Fig. 2.1) is situated between the bottom plugs of the fuel rods and the 0.8-cm-thick stainless steel support plate. Cross-sectional views of the experiments are provided in Fig. 2.28. Critical data on the experiments are given in Table 2.21.

Assumptions: The assembly separation distances and plate-to-assembly distances are believed to have been measured from the cell boundaries of the assemblies. The holes in the lower lattice grid plate for accommodating the fuel rods were taken to be 1.0 cm in diameter from Ref. 23.

Model-experiment comparison: The fuel rods above the moderator were modeled by the method explained in Sect. 3.2.1. The separator plates were modeled as resting on top of the assembly support plate (**DSN399-1** and **DSN399-2**) or support plate (**DSN399-3** and **DSN399-4**). The spring of the fuel rods was modeled as void. The upper grid plate of stainless steel, left out of Fig. 2.1, was reported as having an insignificant influence on k_{eff}; therefore, it was not modeled. The stainless steel support plates were modeled as 71.40 wt % Fe, 19.16 wt % Cr, and 9.44 wt % Ni. The steel angle irons, shown in Fig. 2.29 (corner A is positioned at the center of the setup of Fig 2.28a), of **DSN399-1** and **DSN399-2** were not modeled.

2.1.2.5 Separator Plate Experiments from PNL-2438 (Ref. 9)

The experiments consist of 3 × 1 arrays of fuel assemblies separated by aluminum, Boral-A, copper, stainless steel, or Zircaloy-4 plates and water. Table 2.22 describes the separator plates. Details of the 2.35 wt % UO_2 fuel rods are outlined in Fig. 2.5. Planar and axial views of the experiment can be found in Fig. 2.13; the experiments were minus the biological shielding walls shown in Fig. 2.13. Critical data for the experiments are located in Table 2.23.

Model-experiment comparison: The top and middle 1.27-cm-thick acrylic grid plates were modeled as water because acrylic plastic has about the same density and neutron moderating characteristics as water. The carbon steel core tank was not modeled. The separator plates were modeled as resting on top of the bottom 2.54-cm-thick acrylic grid plate.

2.1.2.6 Separator Plate Experiments from PNL-2615 (Ref. 19)

The experiments consist of 3 × 1 arrays of fuel assemblies separated by aluminum, Boral-B, cadmium, copper, stainless steel, and Zircaloy-4 plates and water. Table 2.22 describes the separator plates. Details of the 4.31 wt % UO_2 fuel rods are outlined in Fig. 2.14. Planar and axial views of the experiment can be found in Fig. 2.13; the experiments were minus the biological shielding walls shown in Figs. 2.30 and 2.15. Critical data for the experiments are located in Table 2.24.

Model-experiment comparison: The minimum fuel rod pellet column length, 91.44 cm, was modeled. The top and middle 1.27-cm-thick acrylic grid plates were modeled as water because acrylic plastic has about the same density and neutron moderating characteristics as water. The carbon steel core tank was not modeled because the amount of water on the boundary of the array ensures a maximum increase in k_{eff}. The separator plates were modeled as resting on top of the bottom 2.54-cm-thick acrylic grid plate.

2.1.2.7 Separator Plate Experiments from PNL-3314 (Ref. 11)

The experiments consist of 2 × 2 or 3 × 1 arrays of fuel assemblies separated by aluminum, Boral-A, Boral-C, Boroflex, cadmium, copper, copper-cadmium, borated stainless steel, stainless steel, and Zircaloy-4 plates and water. Descriptions of the 2.35 and 4.31 wt % UO_2 fuel rods are provided in Figs. 2.5 and 2.14. Planar and axial views of the 3 × 1 and 2 × 2 assembly experiments are shown in Figs. 2.30 (G = 0) and 2.15; the experiments were minus the biological shielding walls shown in Figs. 2.30 and 2.15. Figures 2.16(a) and 2.16(b) illustrate the assembly and fuel rod array configurations of the experiments. Separator plate data are given in Table 2.22. Critical data on the experiments are given in Table 2.25.

Model-experiment comparison: The minimum fuel rod pellet column length, 91.44 cm, was modeled for the 4.31 wt % UO_2 fuel rods. The two polypropylene (neutronic properties similar to water) grid plates were modeled as water. The carbon steel tank was not modeled because the amount of water on the boundary of the array ensures a maximum increase in k_{eff}. The separator plates were modeled as resting on top of the acrylic plate.

2.1.2.8 Separator Plate Experiments from PNL-6205 (Ref. 20) and PNL-7176 (Ref. 21)

The experiments consist of 2 × 2 arrays of fuel assemblies separated by Boral plates and water. The Boral plates, detailed in Table 2.26, create a flux trap where epithermal neutrons passing through the Boral become thermalized in the water between the Boral plates. Aluminum plates, aluminum rods, and fuel rods were added to the water region of the flux trap in order to investigate the reactivity effect of voiding. The modeling of these experiments tests the ability of the calculation method to predict k_{eff} for assemblies with separator plates acting as flux traps and voiding materials. The 4.31 wt % UO_2 fuel rods are detailed in Fig. 2.14; the experimental elevations are provided in Fig. 2.31; and the critical data are located in Table 2.27. The assemblies for experiments **P62FT231**, **P71F14F3**, **P71F14V3**, **P71F14V5**, and **P71F214R** are displayed in Figs. 2.32-2.36.

Assumptions: The aluminum rods are assumed to be of fuel rod length. The aluminum voiding plates are assumed to be of Boral plate width and height.

Model-experiment comparison: The minimum fuel rod pellet column length, 91.44 cm, was modeled. The polypropylene lattice plates (0.90 g/cm^3) were modeled as water because of their neutron moderating similarities to water. The separator plates were modeled as resting on top of the base plate.

The PNL-6205 and PNL-7167 experiments are subcritical configurations. The number of rods required to achieve delayed critical is predicted by the approach- to-critical method. Table 2.28 shows the number of rods of the experiment (column 2), shown in Figs. 2.32–2.36, the predicted number of rods needed for delayed critical (column 3), and the number of rods modeled with CSAS25 (column 4). Note the partial rod of column 3 can be modeled if using CSAS2X instead of CSAS25. The extra rods modeled were arbitrary placed in one of the four assemblies. The modeled assembly sizes are listed in Table 2.28.

2.1.3 Reflecting Wall Experiments

Large transportation packages have reflectors in the form of biological shielding materials that are part of the packaging. The materials facilitate the return of neutrons leaking from the outer fissile material boundary. Modeling of these experiments demonstrates the ability of the calculational techniques to predict the neutron multiplication factor of water and lead-, steel-, or uranium-reflected assemblies.

2.1.3.1 Reflecting Wall Experiments from PNL-2827 (Ref. 10)

The experiments consist of 3 × 1 arrays of fuel assemblies separated by water and reflected by water and two lead or depleted uranium reflecting walls. Details of the 2.35 and 4.31 wt % UO_2 fuel rods are outlined in Figs. 2.5 and 2.14. Planar and axial views of the experiments can be found in Fig. 2.13. Absent in the experiments are the poison plates of Fig. 2.13. Details of the lead and uranium reflecting walls are provided in Figs. 2.37 and 2.38. Critical data for the experiments are located in Table 2.29.

Model-experiment comparison: The minimum fuel rod pellet column length, 91.44 cm, was modeled for the 4.31 wt % UO_2 fuel rods. The 1.27-cm-thick acrylic grid plates were modeled as water because acrylic plastic has about the same density and neutron moderating characteristics as water. The carbon steel core tank was not modeled because the amount of water on the boundary of the array ensures a maximum increase in k_{eff}.

2.1.3.2 Reflecting Wall Experiments from PNL-3602 (Ref. 22)

The experiments consist of 3 × 1 arrays of fuel assemblies separated by water and reflected by water and two steel reflecting walls. Details of the 2.35 and 4.31 wt % UO_2 fuel rods are outlined in Figs. 2.5 and 2.14. Planar and axial views of the experiments can be found in Fig. 2.30. Absent in the experiments are the poison plates of Fig. 2.30. Details of the steel reflecting walls are provided in Fig. 2.39. Critical data for the experiments are located in Table 2.30.

Model-experiment comparison: The minimum fuel rod pellet column length, 91.44 cm, was modeled for the 4.31 wt % UO_2 fuel rods. The 1.27-cm-thick acrylic and polypropylene grid plates were modeled as water because these materials have similar densities and neutron moderating characteristics as water. The carbon steel core tank was not modeled because the amount of water on the boundary of the array ensures a maximum increase in k_{eff}.

2.1.3.3 Reflecting Wall Experiments from PNL-3926 (Ref. 12)

The experiments consist of 3 × 1 arrays of fuel assemblies separated by water and reflected by water and two lead or depleted uranium reflecting walls. Details of the 2.35% and 4.31 wt % UO_2 fuel rods are outlined in Figs. 2.5 and 2.14. Planar and axial views of the experiments can be found in Fig. 2.15. However, these experiments do not contain poison plates as shown in the figure. Details of the lead and uranium reflecting walls are provided in Figs. 2.37 and 2.38. Critical data for the experiments are located in Table 2.31.

Model-experiment comparison: The minimum fuel rod pellet column length, 91.44 cm, was modeled for the 4.31 wt % UO_2 fuel rods. The 1.27-cm-thick polypropylene (0.904 g/cm^3) grid plates were modeled as water because polypropylene has about the same density and neutron moderating characteristics as water. The carbon steel core tank was not modeled because the amount of water on the boundary of the array is equivalent to an infinite water reflector.

2.1.4 Reflecting Wall-Separator Plate Experiments

These experiments have been selected to demonstrate the ability of the calculational techniques to predict the neutron multiplication factor of experiments with neutron absorbing or scattering materials (i.e., separator plates) between fuel assemblies reflected by water and steel. Separator plates are commonly used in transportation packages to limit neutron interaction and increased reactivity associated with the bringing into close proximity of fuel assemblies. In addition, large transportation packages may also have reflectors in the form of biological shielding materials that facilitates the return of neutrons leaking from the outer fissile material boundary.

2.1.4.1 Reflecting Wall-Separator Plate Experiments from PNL-3602 (Ref. 22)

The experiments consist of 3 × 1 arrays of fuel assemblies separated by water and Boral, cadmium, copper, borated and unborated stainless steel separator plates and reflected by water and two steel reflecting walls. Details of the 2.35 and 4.31 wt % UO_2 fuel rods are outlined in Figs. 2.5 and 2.14. Planar and axial views of the experiments can be found in Fig 2.30 (G = 0). Descriptions of the separator plates are provided in Table 2.22. Details of the steel reflecting walls are provided in Fig 2.39. Critical data for the experiments are located in Table 2.32.

Model-experiment comparison: The minimum fuel rod pellet column length, 91.44 cm, was modeled for the 4.31 wt % UO_2 fuel rods. The polypropylene grid plates were modeled as water because polypropylene has similar densities and neutron moderating characteristics as water. The carbon steel core tank was not modeled because the amount of water on the boundary of the array ensures a maximum increase in k_{eff}. The separator plates were modeled resting on top of the bottom 2.54-cm-thick acrylic plate.

2.1.4.2 Reflecting Wall-Separator Plate Experiments from PATRAM'80 (Ref. 23)

The experiments consist of 2 × 2 arrays of fuel assemblies separated by water and Boral plates and reflected by water and lead or steel reflecting walls. Details of the 4.742 wt % fuel rods are outlined in Figs. 2.1 and Table 2.2. The principal dimensions for the experiments are found in Fig. 2.1. A 0.4-cm-thick steel (composition specified on Fig. 2.1) assembly support plate, not shown in Fig. 2.1, is situated between the bottom plugs of the fuel rods and the 0.8-cm-thick support plate. The lower grid plate holes for accommodating the fuel rods are 1.0 cm in diameter. The planarview of a quarter of an experimental assembly is displayed in Fig. 2.40. Critical data for the experiments are located in Table 2.33.

Assumptions: The four stainless steel corner rods were assumed to be of fuel rod length.

Model-experiment comparison: The upper grid plate was ignored due to lack of information. The spring of the fuel rods was modeled as void. The lower grid plate around the corner rods was ignored. The fuel rods above the moderator were modeled by the method explained in Sect. 3.2.1.

2.1.5 Burnable Absorber Fuel Rod Experiments[24]

Modeling these experiments demonstrates the ability of the calculational techniques to predict the neutron multiplication factors of experiments that have UO_2 fuel rods fabricated with gadolinia for extended burnup purposes. A set of five experiments were performed with various 2.459 or 2.459 and 4.020 wt % UO_2 and 1.944 wt % UO_2-Gd_2O_3 fuel rod configurations. The 2.459 wt % UO_2 rods are detailed in Table 2.4 and Fig. 2.3, the 4.020 wt % UO_2 rods are detailed in Table 2.34, and the 1.944 wt % UO_2-Gd_2O_3 rods are detailed in Table 2.35. The vertical dimensions are believed to be those presented in Fig. 2.4. In Fig. 2.4 the aluminum core tank is 1.27 cm thick and 152.4 cm in diameter. The core configurations for the experiments are located in Figs. 2.41-2.45. Critical data are located in Table 2.36. Note, these experiments contained borated water and water holes.

Assumptions: The vertical dimensions are believed to be those of Fig. 2.4. The 152.4-cm-diam core tank filled with water constitutes full-water reflection of the cores.

Model-experiment comparison: The fuel rods above the moderator were not modeled. The top and bottom grid plates were ignored.

2.1.6 Water Hole Experiments

LWR fuel elements have lattice positions, usually in a 5 × 5 matrix, filled by control rod and instrumentation clusters. The clusters are sometimes removed when the LWR fuel assemblies are shipped, leaving behind water holes that are richer in thermalized neutrons than the surrounding cells. The modeling of the experiments in this section tests the ability of the calculation techniques to handle cells with different degrees of moderation.

2.1.6.1 Water Hole Experiments from BAW-1810 (Ref. 24)

The experiments consist of 2.459 or 2.459 and 4.020 wt % UO_2 fuel rod configurations with water holes. The 2.459 wt % UO_2 rods are detailed in Table 2.4 and Fig. 2.3 and the 4.020 wt % UO_2 rods are detailed in Table 2.34. The vertical dimensions are believed to be those presented in Fig. 2.4. In Fig. 2.4 the aluminum core tank is 1.27 cm thick and 152.4 cm in diameter. The core configurations for the experiments are located in Figs. 2.46–2.48. Critical data are located in Table 2.37. Note, these experiments contained borated water.

Assumptions: The vertical dimensions are believed to be those of Fig. 2.4. The 152.4-cm-diam core tank filled with water constitutes full-water reflection of the cores.

Model-experiment comparison: The fuel rods above the moderator were not modeled. The top and bottom grid plates were ignored.

2.1.6.2 Water Hole Experiments from NS&E, Vol. 71 (Ref. 8)

The experiments consist of large singular arrays of 4.742 wt % UO_2 fuel rods with 5 × 5 and 8 × 8 matrices of water holes. Fuel rod specifications are given in Table 2.2 and Fig. 2.1. The principal dimensions of the experiments are also given in Fig. 2.1. The critical data for the experiments are located in Table 2.38.

Assumptions: The holes in the lower grid plate to accommodate the fuel rods were taken to be 1.0 cm in diameter from Ref. 23.

Model-experiment comparison: The reported upper grid, missing from Fig. 2.1, was ignored in the model due to insufficient data. The two grid plates were reportedly attached to the support plate by four fuel rods distanced more than 20 cm from the fuel. These rods were not modeled. The stainless steel support plate was modeled as 71.40 wt % Fe, 19.16 wt % Cr, and 9.44 wt % Ni. Figure 2.49 represents the cross-sectional view of the modeled assemblies.

2.1.6.3 Water Hole Experiments from PNL-3314 (Ref. 11)

The experiments consist of single lattices with 5 × 5 matrices of water holes. Descriptions of the 2.35 wt % and 4.31 wt % UO_2 fuel rods are provided in Figs. 2.5 and 2.14. Planar and axial views of the experiment setup are shown in Fig. 2.15. The cross-sectional view of the experimental setup showing water hole positions is presented in Fig. 2.50. Critical data on the experiment are given in Table 2.39.

Model-experiment comparison: **P3314W1** and **P3314W2** are subcritical configurations. The number of predicted rods to achieve criticality were obtained by the approach-to-critical method. The number of fuel rods modeled was rounded from the predicted number to the nearest whole number. Note: The partial predicted rod can be modeled if using CSAS2X. The geometric models for **P3314W1** and **P3314W2** are seen in Fig. 2.51. The partial row of fuel rods was arbitrarily located against the assembly left cell boundary. The two polypropylene (neutronic properties similar to water) grid plates were modeled as water. The carbon steel tank was not modeled because the amount of water on the boundary of the array ensures a maximum increase in k_{eff}.

2.1.6.4 Water Hole Experiments from WCAP-3269 (Ref. 15)

The experiments consist of large single arrays of fuel rods and water holes. Descriptions of the 2.72 and 5.7 wt % UO_2 fuel rods can be found in Table 2.14. The vertical dimensions of experiments **W3269W1** and **W3269W2** are shown in Figs. 2.20 and 2.21; the guide plates are aluminum. The absorber section of Fig. 2.20 was not part of the experiments. Core layouts showing water hole locations are given in Fig. 2.52. Critical data for the experiments are located in Table 2.40.

Assumptions: The moderator height was believed to have been measured from the bottom of the fuel. The guide plate holes to accommodate fuel rods were assumed to be of fuel rod diameter. In Fig. 2.21, all plates were taken to be of assembly width and depth; full-water reflection was assumed on the sides of the experimental assembly; the 2.54-cm-thick plate below the bottom guide plate was assumed to be of aluminum. In Fig. 2.20, full-water reflector was assumed at the boundary of the assembly defined by the 60.96-cm-square guide plates.

Model-experiment comparison: The fuel rods above the moderator were modeled by the method explained in Sect. 3.2.1. For **W3269W2** the 6.35-cm gap above the aluminum base plate was modeled as water only. For **W3269W1**, the top and center guide plates, in air for this experiment, were not modeled; the bottom end plugs in the bottom guide plate were modeled as aluminum; the bottom end plugs in the 0.188-in. (0.478-cm)-thick water slot and the top end plugs were not modeled.

2.1.7 Absorber Rod Experiments

Modeling of these experiments tests the ability of the calculational techniques to predict neutron multiplication factors of experiments simulating shipping packages of LWR assemblies with control rod clusters intact.

2.1.7.1 Absorber Rod Experiments from BAW-1484 (Ref. 6)

The experiments consist of a 3 × 3 array of fuel assemblies separated by a water gap containing B_4C absorber rods. Details of the 2.459 wt % UO_2 fuel rod design are outlined in Table 2.4 and Fig. 2.3. Details of the B_4C rods are outlined in Table 2.41. The vertical dimensions for the experiment are found in Fig. 2.4. Absent from Fig. 2.4: the 1 in. (2.54 cm) between the base plate and core tank is mostly water and the core tank is 0.5 in. (1.27 cm) thick. Difficult to distinguish in Fig. 2.4 is that the fuel rod end plugs are located in 0.125 in. (0.3175 cm) of water between the bottom grid plate and the base plate. Cross-sectional views of experiments **BW1484C1** and **BW1484C2** are located in Figs. 2.53 and 2.54. The critical data are located in Table 2.42.

Assumptions: The aluminum corner rods are taken to be of fuel rod length. The separation distance between assemblies is believed to have been measured from the cell boundaries of the assemblies. To accommodate the fuel rods, square holes with 0.615-cm sides were assumed in the bottom grid plate.

Model-experiment comparison: The 22.9-cm-wide × 22.9-cm-long × 2.54-cm-thick aluminum top grid plate was not modeled. The fuel rods and separator plate above the moderator region were not modeled.

2.1.7.2 Absorber Rod Experiments from BAW-1810 (Ref. 24)

The experiments consist of 2.459 or 2.459 and 4.020 wt % UO_2 fuel rod configurations with Ag-In-Cd and B_4C absorber rods. The 2.459 wt % UO_2 rods are detailed in Table 2.4 and Fig. 2.3. The 4.020 wt % UO_2 rods are detailed in Table 2.34. Properties of the Ag-In-Cd and B_4C rods are given in Tables 2.43 and 2.41. The vertical dimensions are believed to be those presented in Fig. 2.4. In Fig. 2.4 the aluminum core tank is 1.27 cm thick and 152.4 cm in diameter. The core configurations for the experiments are located in Figs. 2.55 and 2.56. Critical data are located in Table 2.44. Note, these experiments have borated water and water holes.

Assumptions: The vertical dimensions are those of Fig. 2.4. The 152.4-cm-diam core tank filled with water constitutes full-water reflection of the cores.

Model-experiment comparison: The fuel and absorber rods above the moderator were not modeled. The top and bottom grid plates were ignored.

2.1.7.3 Absorber Rod Experiments from WCAP-3269 (Ref. 15)

Experiments **W3269A** and **W3269C** used large single arrays of 5.7 and 2.72 wt % UO_2 fuel rods and Ag-In-Cd absorber rods. **W3269B1**, **W3269B2**, and **W3269B3** used large single arrays of 3.7 wt % UO_2 fuel rods and Ag-In-Cd absorber rods. Descriptions of the 2.72, 3.7, and 5.7 wt % UO_2 fuel rods can be found in Table 2.14. The vertical dimensions of experiments **W3269A** and **W3269C** are shown in Figs. 2.21 and 2.20. Figure 2.57 displays the vertical dimensions for **W3269B1**, **W3269B2**, and **W3269B3**. All experiments used aluminum guide plates. The core layouts of **W3269A** and **W3269C**, with water holes replaced by Ag-In-Cd rods, are given in Fig. 2.52. The core layouts of **W3269B1**, **W3269B2**, and **W3269B3** are given in Figs. 2.58-2.60. The cruciform in Figs. 2.58-2.60 are control rod fuel followers. Each cruciform has a center fuel rod and four vanes with nine fuel rods on a 0.418-in. (1.062-cm) pitch. Critical data for the experiments are located in Table 2.45.

Assumptions: The Ag-In-Cd rods are assumed to be of fuel rod length. The moderator height was believed to have been measured from the bottom of the fuel. The guide plate holes to accommodate fuel rods were assumed to be of fuel rod diameter. For **W3269A**, **W3269B1**, **W3269B2**, and **W3269B3** full water reflection was assumed laterally beyond the assembly boundary. For **W3269C**, full water reflection was assumed outside the assembly boundary defined by the 60.96-cm-square guide plates. In Fig. 2.21, the 2.54-cm-thick plate below the bottom guide plate was assumed to be of aluminum.

Model-experiment comparison: The fuel rods above the moderator were modeled by the method explained in Sect. 3.2.1. For **W3269A**, the 6.35 cm above the base plate was modeled as water only. For **W3269B1**, **W3269B2**, and **W3269B3**, no data were available on the fuel rod end plugs so the plugs were modeled as water; the center guide plate, 70.17 cm above the bottom of the fuel, was not modeled because it was above the moderator level; the eccentricity of the fuel follower was treated as described in Sect. 3.2.1. For **W3269C**, the top and center guide plates, in air for this experiment, were not modeled; the bottom end plugs in the bottom guide plate were modeled as aluminum; the bottom end plugs in the 0.188-in. (0.478-cm)-thick water slot and top end plugs were not modeled.

2.1.8 Soluble Boron Experiments

Boric acid is often used in shipping casks as an additional measure for preventing accidental criticality; boric acid is a strong absorber that can significantly affect the neutronics of a system. The experiments described in this section are used to test the ability of the calculational techniques to predict the neutron multiplication factors of systems with a borated water moderator.

2.1.8.1 Soluble Boron Experiments from BAW-1231 (Ref. 25)

The experiments consist of large arrays of fuel rods moderated by borated water. Properties of the 4.020 wt % fuel rods are given in Table 2.34. The core layouts and vertical dimensions of the experiments are given in Figs. 2.61 and 2.62. The top and bottom grid plates of Fig. 2.62 are aluminum. Critical data for the experiments are in Table 2.46.

Assumptions: Holes of fuel rod diameter were assumed in the grid plates. The core tank is 274.32 cm in diameter constituting full-water reflection. The end plugs are believed to be made of aluminum.

Model-experiment comparison: The fuel rods above the moderator were modeled by the method explained in Sect. 3.2.1. The top grid plate, top end plugs, and top end plugs above the top grid plate were modeled as a solid aluminum slab.

2.1.8.2 Soluble Boron Experiments from BAW-1273 (Ref. 26)

BW1273M consists of a large cylindrical array of fuel rods moderated by borated water. Properties of the 2.459 wt % UO_2 fuel rods are given in Table 2.4 and Fig. 2.3. The vertical dimensions of the experiment are given in Fig. 2.63. Missing from Fig. 2.63 are two 0.0625-in. (0.1588-cm)-thick aluminum midplane grid plates with bases 49 and 82 cm above the reference plane. Critical data for the experiments are in Table 2.47.

Assumptions: The 274.32-cm-diam core tank filled with water constitutes full-water reflection of the core. Square holes, 1.27 cm on a side, were assumed in each grid plate to accommodate the fuel rods.

Model-experiment comparison: The fuel rods above the moderator were modeled by the method explained in Sect 3.2.1. The top grid plate was not modeled. Figure 2.64 shows a cross-sectional view of the modeled core for reference.

2.1.8.3 Soluble Boron Experiments from BAW-1484 (Ref. 6)

The experiments consisted of 3 × 3 arrays of fuel assemblies separated by water gaps and moderated with borated water. Details of the 2.459 wt % UO_2 fuel rods are outlined in Table 2.4 and Fig. 2.3. The elevations of experiments **BW1484B1** and **BW1484B2** can be found in Fig. 2.4. Absent from Fig 2.4: the 1 in. (2.54 cm) below the base plate is mostly water and the core tank is 0.5 in. (1.27 cm) thick. Difficult to distinguish in Fig. 2.4 is that the fuel rod end plugs are located in 0.125 in. (0.3175 cm) of water between the bottom grid plate and the base plate. The elevations of experiment **BW1484B3** are given in Fig. 2.24. The top grid of Fig. 2.24 was not used in the experiments. Missing from, or difficult to distinguish in, Fig. 2.24 is that: (1) the fuel pellet column and fuel rod bottom end plugs extend 0.635 and 0.9525 cm into the aluminum bottom grid, respectively, (2) the aluminum bottom grid and aluminum bottom grid plate are 2.54 cm thick, (3) and 0.3175 cm of water exists between the aluminum bottom grid plate and the 5.08-cm-thick aluminum base plate. Critical data for the experiments are located in Table 2.48.

Assumptions: The aluminum corner rods are taken to be of fuel rods length. The separation distance between assemblies is believed to have been measured from the cell boundaries of the assemblies. Holes, 0.615 cm on a side, were assumed in the bottom grid plate to accommodate the fuel rods.

Model-experiment comparison: The fuel rods above the moderator region were not modeled. The 22.9-cm-wide × 22.9-cm-long × 2.54-cm-thick aluminum top grid plate were not modeled.

2.1.8.4 Soluble Boron Experiments from EPRI NP-196 (Ref. 7)

These experiments consist of large singular arrays of fuel rods moderated by borated water. Specifications of the 2.35 wt % UO_2 fuel rods are presented in Fig. 2.5. Figure 2.6 shows the axial dimensions of experiments **EPRU65B** and **EPRU87B**. Figure 2.7 shows the axial dimensions of experiment **EPRU75B**. The grid plate holes for **EPRU75B** are 0.586 in. (1.488 cm) in diameter. The specifications for the aluminum "eggcrate" grids seen in Fig. 2.6 are given in Fig. 2.8. The core layouts are shown in Figs. 2.65–2.67. The critical data are located in Table 2.49.

Model-experiment comparison: A 182.88-cm-diam, 274.32-cm-tall tank contributes full-water reflection of the cores. The experiments were modeled with 6 in. (15.24 cm) of water above the lead shield and 30 cm of water below the aluminum solid plate.

2.1.8.5 Soluble Boron Experiments from PNL-4267 (Ref. 13)

The experiments consist of a single array of fuel rods moderated by borated water. Specifications of the 4.31 wt % UO_2 fuel rods are located in Fig. 2.14. The experimental setup is illustrated in Fig. 2.17. The box is full-water reflected on all four sides with **unborated** water. Critical data for the experiments are given in Table 2.50. The reader should be aware of the large uncertainty associated with some measured boron concentration values.

Model-experiment comparison: The minimum fuel rod pellet column length, 91.44 cm, was modeled.

The PNL-4267 experiments are subcritical configurations. The number of rods required to achieve critical are predicted by the approach-to-critical method. For **P4267SL1** and **P4267SL2**, the nearest whole number of rods required for criticality were modeled. The partial rod can be modeled if using CSAS2X. **P4267B1** was modeled with 23 columns of 40 fuel rods, and 1 far-left column of 3 fuel rods. **P4267B2** was modeled with 30 columns of 40 fuel rods and 1 far-left column of 37 fuel rods. **P4267B3** was modeled with 16 columns of 44 fuel rods and 1 far-left column of 33 fuel rods. **P4267B4** was modeled with 20 columns of 44 fuel rods and 1 far-left column of 37 fuel rods. **P4267B5** was modeled with 27 columns of 44 fuel rods and 1 far-left column of 4 fuel rods. The far-left columns of the arrays were arbitrarily placed against the lower Plexiglas box side of Fig. 2.17 (planar view). The arrays were positioned along their length against the right side of the Plexiglas box with the boundary next to the Plexiglas box surface. The arrays were centered along their width in the Plexiglas box.

A discrepancy in Fig. 2.17 was noticed. As marked, the cell boundaries along the array width are 75.88 cm apart. Forty and 44 fuel rods placed in lattices of 1.890- and 1.715-cm pitch give rise to cell boundaries 75.6 and 75.46 cm apart, not 75.88 cm.

2.2 Homogeneous Uranium

Modeling this set of experiments tests the ability of the calculational techniques to predict the neutron multiplication factors of homogeneous uranium systems such as shipping containers with low-enriched uranium oxide pellets or powder.

2.2.1 Homogenized Uranium in Paraffin

These experiments consisted of paraffin-reflected or unreflected parallelepipeds of homogeneous $U(2)F_4$ or $U(3)F_4$ and paraffin. The fuel atom densities for each experiment are listed in Table 2.51. Critical data of the experiments are located in Table 2.52.

2.2.2 Damp Uranium Oxide Experiments[28-31]

The experiments **CR1071AS**, **CR1653AS**, and **CR2500S** consist of 42, 38, and 30 cans of damp uranium oxide moderated and reflected by Plexiglas. The fuel cans and damp uranium oxide for the three experiments are detailed in Table 2.53. Material compositions of the cans, moderator, and reflector are given in Table 2.54. Isometric drawings of the fuel can configurations are found in Fig. 2.68. Table 2.55 contains **CR1071AS** core, reflector, faceplate, frame extender, and filler dimensions corresponding to Fig. 2.69. Table 2.56 contains **CR1653AS** core, reflector, and filler dimensions corresponding to Fig. 2.70. The reflector end panel and frame dimensions of Fig 2.70 are shown in Fig 2.71 for clarification. For **CR2500S**, Table 2.57 lists the cuboid dimensions corresponding to the three nested cuboids of Fig. 2.72.

<u>Assumptions:</u> All voids were assumed to be filled with nonfire-retardant Plexiglas in **CR2500S** except the void to the east of the north and south table cores. For all experiments, nearly 80% of the reflector is reported to be fire-retardant Plexiglas. The experimenter suggests that the north frame, south frame, and south end panel be modeled as fire-retardant Plexiglas and the north end panel, frame extensions, and filler blocks be modeled as nonfire-retardant Plexiglas.

<u>Model-experiment comparison:</u> The fuel can contents (i.e., U_3O8, H_2O, and polyethylene) were homogenized over the can cavity. The fuel can, vinyl tape, and mylar tape were homogenized over the fuel can shell volume.

Table 2.1 Case descriptions of LWR-type UO_2 fuel pin lattice critical benchmark experiments

Case No.	Case designation	Enrich. (wt %)	Pitch (cm)	H_2O/fuel volume	Description	Reference No.
1	ANS33AL1	4.74	1.35	2.302	H_2O filled Al cruciform boxes	5
2	ANS33AL2	4.74	1.35	2.302	H_2O filled Al cruciform boxes	5
3	ANS33AL3	4.74	1.35	2.302	H_2O filled Al cruciform boxes	5
4	ANS33EB1	4.74	1.35	2.302	Polyethylene balls in Al cruciform boxes	5
5	ANS33EB2	4.74	1.35	2.302	Polyethylene balls in Al cruciform boxes	5
6	ANS33EP1	4.74	1.35	2.302	Polyethylene powder in Al cruciform boxes	5
7	ANS33EP2	4.74	1.35	2.302	Polyethylene powder in Al cruciform boxes	5
8	ANS33SLG	4.74	1.35	2.302	Simple square lattice	5
9	ANS33STY	4.74	1.35	2.302	Expanded polystyrene in Al cruciform box	5
10	B1645SO1	2.46	1.410	1.015	Al separator plates, borated H_2O	17
11	B1645SO2	2.46	1.410	1.015	Al separator plates, borated H_2O	17
12	BW1231B1	4.02	1.511	1.139	Borated H_2O	25
13	BW1231B2	4.02	1.511	1.139	Borated H_2O	25
14	BW1273M	2.46	1.511	1.376	Borated H_2O	26
15	BW1484A1	2.46	1.636	1.841	Borated Al absorber plates, borated H_2O	6
16	BW1484A2	2.46	1.636	1.841	Borated Al absorber plates, borated H_2O	6
17	BW1484B1	2.46	1.636	1.841	Borated H_2O	6
18	BW1484B2	2.46	1.636	1.841	Borated H_2O	6
19	BW1484B3	2.46	1.636	1.841	Borated H_2O	6
20	BW1484C1	2.46	1.636	1.841	B_4C rods	6
21	BW1484C2	2.46	1.636	1.841	B_4C rods	6
22	BW1484S1	2.46	1.636	1.841	Stainless steel absorber plates, borated H_2O	6
23	BW1484S2	2.46	1.636	1.841	Stainless steel absorber plates, borated H_2O	6
24	BW1484SL	2.46	1.636	1.841	Simple square lattice	6
25	BW1645S1	2.46	1.209	0.383	Al separator plates, borated H_2O	17
26	BW1645S2	2.46	1.209	0.383	Al separator plates, borated H_2O	17
27	BW1645T1	2.46	1.209	0.148	Hexagonal lattice, Al separator plates, borated H_2O	17
28	BW1645T2	2.46	1.209	0.148	Hexagonal lattice, Al separator plates, borated H_2O	17
29	BW1645T3	2.46	1.209	0.148	Hexagonal lattice, Al separator plates, borated H_2O	17
30	BW1645T4	2.46	1.209	0.148	Hexagonal lattice, Al separator plates, borated H_2O	17
31	BW1810A	2.46	1.636	1.841	UO_2-Gd_2O_3 rods, water holes, borated H_2O	24
32	BW1810B	2.46	1.636	1.841	UO_2-Gd_2O_3 rods, water holes, borated H_2O	24
33	BW1810C	2.46 & 4.02	1.636	1.841 & 1.532	UO_2-Gd_2O_3 rods, water holes, borated H_2O	24

Table 2.1 (continued)

Case No.	Case designation	Enrich. (wt %)	Pitch (cm)	H_2O/fuel volume	Description	Reference No.
34	BW1810D	2.46 & 4.02	1.636	1.841 & 1.532	UO_2-Gd_2O_3 rods, water holes, borated H_2O	24
35	BW1810E	2.46 & 4.02	1.636	1.841 & 1.532	UO_2-Gd_2O_3 rods, water holes, borated H_2O	24
36	BW1810F	2.46	1.636	1.841	Water holes, borated H_2O	24
37	BW1810G	2.46 & 4.02	1.636	1.841 & 1.532	Water holes, borated H_2O	24
38	BW1810H	2.46 & 4.02	1.636	1.841 & 1.532	Water holes, borated H_2O	24
39	BW1810I	2.46	1.636	1.841	Water holes, Ag-In-Cd rods, borated H_2O	24
40	BW1810J	2.46 & 4.02	1.636	1.841 & 1.532	Water holes, B_4C rods, borated H_2O	24
41	CR1071AS	4.46	2.43	0.77	U_3O_8 fuel cans	28
42	CR1653AS	4.48	2.43	1.25	U_3O_8 fuel cans	28
43	CR2500S	4.48	2.43	2.03	U_3O_8 fuel cans	28
44	DSN399-1	4.74	1.6	3.807	Hafnium separator plates	18
45	DSN399-2	4.74	1.6	3.807	Hafnium separator plates	18
46	DSN399-3	4.74	1.6	3.807	Hafnium separator plates	18
47	DSN399-4	4.74	1.6	3.807	Hafnium separator plates	18
48	EPRU65	2.35	1.562	1.196	Simple square lattice	7
49	EPRU65B	2.35	1.562	1.196	Borated H_2O	7
50	EPRU75	2.35	1.905	2.408	Simple square lattice	7
51	EPRU75B	2.35	1.905	2.408	Borated H_2O	7
52	EPRU87	2.35	2.210	3.687	Simple square lattice	7
53	EPRU87B	2.35	2.210	3.687	Borated H_2O	7
54	NSE71H1	4.74	1.35	2.302	Simple hexagonal lattice	8
55	NSE71H2	4.74	1.72	4.619	Simple hexagonal lattice	8
56	NSE71H3	4.74	2.26	9.004	Simple hexagonal lattice	8
57	NSE71SQ	4.74	1.26	1.823	Simple square lattice	8
58	NSE71W1	4.74	1.26	1.823	Water holes	8
59	NSE71W2	4.74	1.26	1.823	Water holes	8
60	P2438AL	2.35	2.032	2.918	Aluminum separator plates	9
61	P2438BA	2.35	2.032	2.918	Boral-A separator plates	9
62	P2438CU	2.35	2.032	2.918	Copper separator plates	9

Table 2.1 (continued)

Case No.	Case designation	Enrich. (wt %)	Pitch (cm)	H_2O/fuel volume	Description	Reference No.
63	P2438SLG	2.35	2.032	2.918	Simple square lattice	9
64	P2438SS	2.35	2.032	2.918	Stainless steel separator plates	9
65	P2438ZR	2.35	2.032	2.918	Zircaloy-4 separator plates	9
66	P2615AL	4.31	2.540	3.883	Aluminum separator plates	19
67	P2615BA	4.31	2.540	3.883	Boral-A separator plates	19
68	P2615CD1	4.31	2.540	3.883	Cadmium separator plates	19
69	P2615CD2	4.31	2.540	3.883	Cadmium separator plates	19
70	P2615CU	4.31	2.540	3.883	Copper separator plates	19
71	P2615SS	4.31	2.540	3.883	Stainless steel separator plates	19
72	P2615ZR	4.31	2.540	3.883	Zircaloy-4 separator plates	19
73	P2827L1	2.35	2.032	2.918	Lead reflecting walls	10
74	P2827L2	2.35	2.032	2.918	Lead reflecting walls	10
75	P2827L3	4.31	2.540	3.883	Lead reflecting walls	10
76	P2827L4	4.31	2.540	3.883	Lead reflecting walls	10
77	P2827SLG	2.35	2.032	2.918	Simple square lattice	10
78	P2827U1	2.35	2.032	2.918	Uranium reflecting walls	10
79	P2827U2	2.35	2.032	2.918	Uranium reflecting walls	10
80	P2827U3	4.31	2.540	3.883	Uranium reflecting walls	10
81	P2827U4	4.31	2.540	3.883	Uranium reflecting walls	10
82	P3314AL	4.31	1.892	1.60	Aluminum separator plates	11
83	P3314BA	4.31	1.892	1.60	Boral-A separator plates	11
84	P3314BC	4.31	1.892	1.60	Boral-C separator plates	11
85	P3314BF1	4.31	1.892	1.60	Boroflex separator plates	11
86	P3314BF2	4.31	1.892	1.60	Boroflex separator plates	11
87	P3314BS1	2.35	1.684	1.60	Borated steel separator plates	11
88	P3314BS2	2.35	1.684	1.60	Borated steel separator plates	11
89	P3314BS3	4.31	1.892	1.60	Borated steel separator plates	11
90	P3314BS4	4.31	1.892	1.60	Borated steel separator plates	11
91	P3314CD1	4.31	1.892	1.60	Cadmium separator plates	11
92	P3314CD2	2.35	1.684	1.60	Cadmium separator plates	11
93	P3314CU1	4.31	1.892	1.60	Copper separator plates	11
94	P3314CU2	4.31	1.892	1.60	Copper separator plates	11

Table 2.1 (continued)

Case No.	Case designation	Enrich. (wt %)	Pitch (cm)	H_2O/fuel volume	Description	Reference number
95	P3314CU3	4.31	1.892	1.60	Copper separator plates	11
96	P3314CU4	4.31	1.892	1.60	Copper-cadmium separator plates	11
97	P3314CU5	2.35	1.684	1.60	Copper separator plates	11
98	P3314CU6	2.35	1.684	1.60	Copper-cadmium separator plates	11
99	P3314SLG	4.31	1.892	1.60	Simple square lattice	11
100	P3314SS1	4.31	1.892	1.60	Steel separator plates	11
101	P3314SS2	4.31	1.892	1.60	Steel separator plates	11
102	P3314SS3	4.31	1.892	1.60	Steel separator plates	11
103	P3314SS4	4.31	1.892	1.60	Steel separator plates	11
104	P3314SS5	2.35	1.684	1.60	Steel separator plates	11
105	P3314SS6	4.31	1.892	1.60	Steel separator plates	11
106	P3314W1	4.31	1.892	1.60	Water holes	11
107	P3314W2	2.35	1.684	1.60	Water holes	11
108	P3314ZR	4.31	1.892	1.60	Zircaloy-4 separator plates	11
109	P3602BA	4.31	1.892	1.60	Boral-B separator plates, steel reflecting walls	22
110	P3602BS1	2.35	1.684	1.60	Borated steel separator plates, steel reflecting walls	22
111	P3602BS2	4.31	1.892	1.60	Borated steel separator plates, steel reflecting walls	22
112	P3602CD1	2.35	1.684	1.60	Cadmium separator plates, steel reflecting walls	22
113	P3602CD2	4.31	1.892	1.60	Cadmium separator plates, steel reflecting walls	22
114	P3602CU1	2.35	1.684	1.60	Copper separator plates, steel reflecting walls	22
115	P3602CU2	2.35	1.684	1.60	Copper-cadmium separator plates, steel reflecting walls	22
116	P3602CU3	4.31	1.892	1.60	Copper separator plates, steel reflecting walls	22
117	P3602CU4	4.31	1.892	1.60	Copper-cadmium separator plates, steel reflecting walls	22
118	P3602N11	2.35	1.684	1.60	Steel reflecting walls	22
119	P3602N12	2.35	1.684	1.60	Steel reflecting walls	22
120	P3602N13	2.35	1.684	1.60	Steel reflecting walls	22
121	P3602N14	2.35	1.684	1.60	Steel reflecting walls	22
122	P3602N21	2.35	2.032	2.918	Steel reflecting walls	22
123	P3602N22	2.35	2.032	2.918	Steel reflecting walls	22
124	P3602N31	4.31	1.892	1.60	Steel reflecting walls	22

Table 2.1 (continued)

Case No.	Case designation	Enrich. (wt %)	Pitch (cm)	H_2O/fuel volume	Description	Reference number
125	P3602N32	4.31	1.892	1.60	Steel reflecting walls	22
126	P3602N33	4.31	1.892	1.60	Steel reflecting walls	22
127	P3602N34	4.31	1.892	1.60	Steel reflecting walls	22
128	P3602N35	4.31	1.892	1.60	Steel reflecting walls	22
129	P3602N36	4.31	1.892	1.60	Steel reflecting walls	22
130	P3602N41	4.31	2.540	3.883	Steel reflecting walls	22
131	P3602N42	4.31	2.540	3.883	Steel reflecting walls	22
132	P3602N43	4.31	2.540	3.883	Steel reflecting walls	22
133	P3602SS1	2.35	1.684	1.60	Steel separator plates, steel reflecting walls	22
134	P3602SS2	4.31	1.892	1.60	Steel separator plates, steel reflecting walls	22
135	P3926L1	2.35	1.684	1.60	Lead reflecting walls	12
136	P3926L2	2.35	1.684	1.60	Lead reflecting walls	12
137	P3926L3	2.35	1.684	1.60	Lead reflecting walls	12
138	P3926L4	4.31	1.892	1.60	Lead reflecting walls	12
139	P3926L5	4.31	1.892	1.60	Lead reflecting walls	12
140	P3926L6	4.31	1.892	1.60	Lead reflecting walls	12
141	P3926SL1	2.35	1.684	1.60	Simple lattice	12
142	P3926SL2	4.31	1.892	1.60	Simple lattice	12
143	P3926U1	2.35	1.684	1.60	Uranium reflecting walls	12
144	P3926U2	2.35	1.684	1.60	Uranium reflecting walls	12
145	P3926U3	2.35	1.684	1.60	Uranium reflecting walls	12
146	P3926U4	4.31	1.892	1.60	Uranium reflecting walls	12
147	P3926U5	4.31	1.892	1.60	Uranium reflecting walls	12
148	P3926U6	4.31	1.892	1.60	Uranium reflecting walls	13
149	P4267B1	4.31	1.8901	1.59	Borated H_2O	13
150	P4267B2	4.31	.890	1.59	Borated H_2O	13
151	P4267B3	4.31	1.715	1.090	Borated H_2O	13
152	P4267B4	4.31	1.715	1.090	Borated H_2O	13
153	P4267B5	4.31	1.715	1.090	Borated H_2O	13

Table 2.1 (continued)

Case No.	Case designation	Enrich. (wt %)	Pitch (cm)	H_2O/fuel volume	Description	Reference number
154	P4267SL1	4.31	1.890	1.59	Borated H_2O	13
155	P4267SL2	4.31	1.715	1.090	Borated H_2O	13
156	P49-194	4.31	1.598	0.509	Simple hexagonal lattice	14
157	P62FT231	4.31	1.891	1.60	Boral flux traps, no void material	20
158	P71F14F3	4.31	1.891	1.60	Boral flux traps, void material fuel rods	21
159	P71F14V3	4.31	1.891	1.60	Boral flux traps, void material Al plates	21
160	P71F14V5	4.31	1.891	1.60	Boral flux traps, void material Al rods	21
161	P71F214R	4.31	1.891	1.60	Boral flux traps, no void material	21
162	PAT80L1	4.74	1.6	3.807	Boral separator plates, lead reflecting walls	23
163	PAT80L2	4.74	1.6	3.807	Boral separator plates, lead reflecting walls	23
164	PAT80SS1	4.74	1.6	3.807	Boral separator plates, steel reflecting walls	23
165	PAT80SS2	4.74	1.6	3.807	Boral separator plates, steel reflecting walls	23
166	W3269A	5.7	1.422	1.93	Ag-In-Cd rods	15
167	W3269B1	3.7	1.105	1.432	Ag-In-Cd rods	15
168	W3269B2	3.7	1.105	1.432	Ag-In-Cd rods	15
169	W3269B3	3.7	1.105	1.432	Ag-In-Cd rods	15
170	W3269C	2.72	1.524	1.494	Ag-In-Cd rods	15
171	W3269SL1	2.72	1.524	1.494	Simple square lattice	15
172	W3269SL2	5.7	1.422	1. 93	Simple square lattice	15
173	W3269W1	2.72	1.524	1.494	Water holes	15
174	W3269W2	5.7	1.422	1. 93	Water holes	15
175	W3385SL1	5.74	1.422	1.932	Simple square lattice	16
176	W3385SL2	5.74	2.012	5.067	Simple square lattice	16
177	YDR14PL2	2.00	-	8.23	Homogenized $U(2)F_4$ in paraffin	27
178	YDR14PL3	3.00	-	4.05	Homogenized $U(3)F_4$ in paraffin	27
179	YDR14UN2	2.00	-	5.95	Homogenized $U(2)F_4$ in paraffin	27
180	YDR14UN3	3.00	-	4.05	Homogenized $U(3)F_4$ in paraffin	27

Table 2.2 Properties of UO_2 fuel rods from ANS Transactions, Vol. 33[a]

Parameter	Value
Outside diameter, cm	0.94
Wall thickness, cm	0.06
Wall material	aluminum[b]
Pellet diameter, cm	0.790
Total fuel length, cm	100.0[c]
Active fuel length, cm	90.0
Enrichment, $^{235}U/U$ wt %	4.742
Fuel density, g/cm^3	10.38

[a] See Ref. 5.
[b] 98.85 wt % Al, 0.47 wt % Mg, 0.43 wt % Si, 0.22 wt % Fe, 0.03 wt % Zn.
[c] Includes 1.8-cm-long bottom end plug, 1.3-cm-long top end plug, and 6.9-cm-long spring above the pellet stack.

Table 2.3 Critical data for simple lattice experiment **ANS33SLG**[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Separation of assemblies[b]	No. of assemblies–assembly size (No. of rods)	Moderator height,[c] H_c (cm)
ANS33SLG	4.742	1.35	5.0 cm	4–18×18	31.47

[a] See Ref. 5.
[b] Perpendicular distance between cell boundaries of assemblies.
[c] Measured from lower end of fuel rod pellet column.

Table 2.4 Properties of UO_2 fuel rods from BAW-1484[a]

Parameter	Value
Outside diameter, cm	1.206
Wall thickness, cm	0.081
Wall material	aluminum
Pellet diameter, cm	1.030
Total length, cm	156.44[b]
Active fuel length, cm	153.34
Enrichment, $^{235}U/U$ wt %	2.459
Fuel density, g/cm^3	10.22

[a] See Ref. 6.

[b] Includes 0.3175-cm-long aluminum top and bottom end plugs and 2.464 cm of Kaowool above the pellet stack.

Table 2.5 Critical data for simple lattice experiment **BW1484SL** from BAW-1484[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Separation of assemblies[b]	No. of assemblies–assembly size (No. of rods)	Moderator height,[c] H_c (cm)
BW1484SL	2.459	1.636	6.544 cm	9–14×14[d]	129.65

[a] See Ref. 6.

[b] Believed to be the perpendicular distance between cell boundaries of assemblies.

[c] Measured from the top of the aluminum base plate.

[d] Four corner rods of assemblies are 0.635-cm-radius aluminum rods.

Table 2.6 Critical data for simple lattice experiments from EPRI NP-196[a]

Experiment	Enrichment (wt %)	Pitch (cm)	No. of rods	Moderator height[b] (cm)	Boron concentration (ppm)
EPRU65	2.35	1.562	708	111.76	0.9
EPRU75	2.35	1.905	383	112.08	0.5
EPRU87	2.35	2.210	342	111.76	0.9

[a] See Ref. 7.
[b] Measured from the top of the aluminum solid plate.

Table 2.7 Critical data for simple lattice experiments from NS&E, Vol. 71[a]

Experiment	Enrichment (wt %)	Pitch (cm)	No. of assemblies–assembly size (No. of rods)	Moderator height,[b] H_c (cm)
NSE71H1	4.742	1.35[c]	1–14 per side (547)	60.93
NSE71H2	4.742	1.72[c]	1–10 per side (271)	68.06
NSE71H3	4.742	2.26[c]	1–9 per side (217)	79.50
NSE71SQ	4.742	1.26	1–22×22	90.69

[a] See Ref. 8.
[b] Measured from lower end of fuel rod pellet column.
[c] Hexagonal lattice.

Table 2.8 Critical data for simple lattice experiment **P2438SLG** from PNL-2438[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Separation of assemblies,[b] X_c (cm)	No. of assemblies–assembly size (No. of rods)
P2438SLG	2.35	2.032	8.39	3–20×16

[a] See Ref. 9.
[b] Perpendicular distance between cell boundaries of assemblies.

Table 2.9 Critical data for simple lattice experiment **P2827SLG** from PNL-2827[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Separation of assemblies,[b] X_c (cm)	No. of assemblies–assembly size (No. of rods)
P2827SLG	2.35	2.032	8.31	3–19×16

[a] See Ref. 10.
[b] Perpendicular distance between cell boundaries of assemblies.

Table 2.10 Critical data for simple lattice experiment **P3314SLG** from PNL-3314[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Separation of assemblies,[b] X_c; Y_c (cm)	No. of assemblies–assembly size (No. of rods)
P3314SLG	4.31	1.892	2.83; 10.86	2–9×12; 2–9×1

[a] See Ref. 11.
[b] Perpendicular distance between cell boundaries of assemblies.

Table 2.11 Critical data for simple lattice experiments from PNL-3926[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Separation of assemblies,[b] X_c (cm)	No. of assemblies–assembly size (No. of rods)
P3926SL1	2.35	1.684	6.59	2–20×18; 1–23×18[c]
P3926SL2	4.31	1.892	12.79	3–12×16

[a] See Ref. 12.
[b] Perpendicular distance from outer rod surface to outer rod surface.
[c] Center assembly.

Table 2.12 Critical data for simple lattice experiments from PNL-4267[a]

				Total No. of rods	
Experiment	Enrichment (wt %)	Pitch (cm)	Array width (No. of rods)	Predicted[b]	Modeled
P4267SL1	4.31	1.890	40	356.8	357
P4267SL2	4.31	1.715	44	509.08	509

[a] See Ref. 13.
[b] Obtained by approach-to-critical method.

Table 2.13 Critical data for simple lattice experiment **P49-194** from PNL-4976[a]

Experiment	Enrichment (wt %)	Pitch[b] (cm)	No. of assemblies–assembly size (No. of rods)
P49-194	4.31	1.598	1–1185

[a] See Ref. 14.
[b] Hexagonal lattice.

Table 2.14 Properties of UO_2 fuel rods from WCAP-3269[a]

	2.72	3.7	5.7
Outer diameter, cm	1.1895	0.8600	0.9931
Wall thickness, cm	0.0799	0.0406	0.0762
Wall material	Zircaloy-4[b]	304-stainless steel[c]	304-stainless steel[c]
Pellet diameter, cm	1.0160	0.7544	0.9068
Total fuel length, cm	139.65[d]	–[e]	97.155[f]
Active fuel length, cm	121.92	121.92	92.964
Enrichment, ^{235}U/U, wt %	2.72	3.7	5.7
Fuel density, g/cm^3	10.412	10.4120	10.1928

[a] See Ref. 15.

[b] 98.20 wt % Zr, 1.4 wt % Sn, 0.21 wt % Fe, 0.10 wt % Cr.

[c] 18.54 wt % Cr, 9.44 wt % Ni, 1.76 wt % Mn, 69.46 wt % Fe.

[d] Includes 3.81-cm-long bottom and at least 13.92-cm-long top 304-stainless steel end plugs.

[e] No data available on end plug lengths.

[f] Includes 1.905-cm-long bottom and at least 2.286-cm-long top Zircaloy-4 end plugs.

Table 2.15 Critical data for simple lattice experiments from WCAP-3269[a]

Experiment	Enrichment (wt %)	Pitch (cm)	No. of assemblies–assembly size (No. of rods)	Moderator height[b] (cm)
W3269SL1	2.72	1.524	1–31×31	38.58
W3269SL2	5.7	1.422	1–27×17	52.97

[a] See Ref. 15.

[b] Believed to have been measured from the bottom of fuel, see Figs. 20 and 21.

Table 2.16 Properties of UO_2 fuel rods from WCAP-3385[a]

Parameter	Value
Outside diameter, cm	0.993
Wall thickness, cm	0.038
Wall material	304-stainless steel
Pellet diameter, cm	0.907
Total fuel length, cm	97.155[b]
Active fuel length, cm	92.96
Enrichment, $^{235}U/U$ wt %	5.74
Fuel density, g/cm^3	10.19

[a] See Ref. 16.
[b] Includes 1.905-cm-long bottom and 2.286-cm-long top end plugs believed to be of 304-stainless steel.

Table 2.17 Critical data for simple lattice experiments from WCAP-3385[a]

Experiment	Enrichment (wt %)	Pitch (cm)	No. of assemblies–assembly size[b] (No. of rods)	Moderator height[c] (cm)
W3385SL1	5.74	1.42	1–19×19	83.71
W3385SL2	5.74	2.012	1–13×14	90.60

[a] See Ref. 16.
[b] Obtained by approach-to-critical method.
[c] Reference from bottom of fuel rod pellet column.

Table 2.18 Critical data for separator plate experiments from ANS Transactions, Vol. 33[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Plate material	Plate thickness (cm)	Separation of assemblies[b] (cm)	No. of assemblies–assembly size (No. of rods)	Moderator height,[c] H_c (cm)	Interstitial compound	Interstitial Compound density (g/cm^3)
ANS33AL1	4.742	1.35	aluminum	0.3	2.5	4-18×18	25.66	H_2O	1.0
ANS33AL2	4.742	1.35	aluminum	0.3	5.0	4-18×18	32.78	H_2O	1.0
ANS33AL3	4.742	1.35	aluminum	0.3	10.0	4-18×18	64.12	H_2O	1.0
ANS33EB1	4.742	1.35	aluminum	0.3	2.5	4-18×18	25.54	$(CH_2)_n$	0.5540
ANS33EB2	4.742	1.35	aluminum	0.3	5.0	4-18×18	30.73	$(CH_2)_n$	0.5796
ANS33EP1	4.742	1.35	aluminum	0.3	2.5	4-18×18	26.98	$(CH_2)_n$	0.2879
ANS33EP2	4.742	1.35	aluminum	0.3	5.0	4-18×18	30.16	$(C_8H_8)_n$	0.3335
ANS33STG	4.742	1.35	aluminum	0.3	2.5	4-18×18	28.61	$(C_8H_8)_n$	0.0323

[a]See Ref. 5.
[b]Perpendicular distance between cell boundaries of assemblies.
[c]Measured from lower end of fuel rod pellet column.

Table 2.19 Critical data for separator plate experiments from BAW-1484[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Plate material	Plate dimensions (cm)	Separation of assemblies[b] (cm)	Plate-to-center assembly distance[c] (cm)	No. of assemblies–assembly size[d] (No. of rods)	Moderator height,[e] H (cm)	Boron concentration (ppm)
BW1484A1	2.459	1.636	1.614 wt % B aluminum[f]	91.6×155.6×0.645	1.636	0.3725	9-14×14	150.27	15
BW1484A2	2.459	1.636	0.100 wt % B aluminum[f]	91.6×155.6×0.645	4.908	0.3725	9-14×14	151.69	72
BW1484S1	2.459	1.636	304-L stainless steel	91.6×155.6×0.462	1.636	0.4525	9-14×14	149.90	514
							9-14×14	100.89	432
BW1484S2	2.459	1.636	304-L stainless steel	91.6×155.6×0.462	1.636	0.4525			

[a]See Ref. 6.
[b]Believed to be the perpendicular distance between cell boundaries of assemblies.
[c]Perpendicular distance between cell boundary of assembly and near surface of plate.
[d]Four corner rods of assemblies are 0.635-cm-radius aluminum rods.
[e]Measured from the top of the aluminum base plate.
[f]Density of 2.7 g/cm^3.

Table 2.20 Critical data for separator plate experiments from BAW-1645[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Plate[b] material	Plate dimensions (cm)	Separation of assemblies (cm)	Plate-to-assembly distance (cm)	No. of assemblies–assemby size (No. of rods)	Moderator height,[c] H_c (cm)	Boron concentration (ppm)
BW1645S1	2.459	1.2090	aluminum	15.24 × 159.32[e] × 0.0762	1.778 × 1.778[f]	0.0	9–15 × 15	100.24	746
BW1645S2	2.459	1.2090	aluminum	15.24 × 159.32[e] × 0.0762	1.778 × 1.778[f]	0.0	9–15 × 15	145.00	886
B1645SO1	2.459	1.4097	aluminum	15.24 × 159.32[e] × 0.0762	1.792 × 1.792[f]	0.0	9–15 × 15	101.81	1068
B1645SO2	2.459	1.4097	aluminum	15.24 × 159.32[e] × 0.0762	1.792 × 1.792[f]	0.0	9–15 × 15	144.85	1156
BW1645T1	2.459	1.2093[d]	aluminum	15.24 × 159.32[e] × 0.0762	1.778 × 1.945[g]	0.0	25–247[h]	104.82	335
BW1645T2	2.459	1.2093[d]	aluminum	15.24 × 159.32[e] × 0.0762	1.778 × 1.945[g]	0.0	25–247[h]	143.96	435
BW1645T3	2.459	1.2093[d]	aluminum	15.24 × 159.32[e] × 0.0762	2.539 × 2.709[g]	0.0	25–247[h]	142.54	361
BW1645T4	2.459	1.2093[d]	aluminum	15.24 × 159.32[e] × 0.0762	3.807 × 3.976[g]	0.0	25–247[h]	145.64	121

[a]See Ref. 17.
[b]Assumed to be aluminum.
[c]Measured from lower end of pellet column of fuel rods.
[d]Hexagonal lattice.
[e]Minimum height.
[f]Believed to be the perpendicular distance between outermost fuel rods of assemblies.
[g]Perpendicular distance between outermost fuel rods of assemblies, see Fig. 2.27.
[h]Nine rows of 15, 8 rows of 14, 4 corner rods are aluminum, see Fig. 2.27.

Table 2.21 Critical data for separator plate experiments from DSN No. 399/80[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Plate material[b]	Plate dimensions (cm)	Separation of assemblies[c] (cm)	Plate-to-assembly distance (cm)	No. of assemblies–assembly size (No. of rods)	Moderator height,[d] H_c (cm)
DSN399-1	4.742	1.35	hafnium	100×100×0.1046	1.8	0.9[e]	4-18×18	37.66
DSN399-2	4.742	1.35	hafnium	100×100×0.1046	5.8	2.9[e]	4-18×18	53.40
DSN399-3	4.742	1.60	hafnium	50×100×0.1046	–	0.8[f]	1-21×21	49.99
DSN399-4	4.742	1.60	hafnium	50×100×0.1046	–	2.4[f]	1-20×20	52.83

[a]See Ref. 18.
[b]Density of 13.29 g/cm^3.
[c]Believed to be the perpendicular distance between cell boundaries of assemblies.
[d]Measured from lower end of fuel rod pellet column.
[e]Believed to be the perpendicular distance between cell boundaries of assemblies and center of plate.
[f]Perpendicular distance between cell boundary of assembly and near surface of plate.

Table 2.22 Description of separator plates from PNL-2438[a,b]

Element	Separator plate, wt %						
	Boral-A, Boral-B, Boral-C	Cu-Cd, Cu	Al	Zr-4	Steel: 0.0 wt % B, 1.1 wt % B, 1.6 wt % B	Cd	Boroflex
Al	62.39, 61.21, 59.26,		97.15				
B	28.70, 30.36, 31.88	0.005, 0.0			0.0, 1.05, 1.62		32.74
C	7.97, 8.43, 8.86	0.002, 0.340					21.13
H							2.65
Cd		0.989, 0.0				99.7	
Cr	0.05, 0.0, 0.0		0.21	0.13	18.56, 19.03, 19.60		0.03
Cu	0.09, 0.0, 0.0	98.685, 99.60	0.12		0.27, 0.28, 0.26		
Fe	0.33, 0.02, 0.05	0.020, 0.004	0.82	0.21	68.24, 68.04, 66.40		0.05
Mg	0.05, 0.01, 0.01	0.0, 0.002					
Mn	0.05, 0.0, 0.0	0.009, 0.0	0.21		1.58, 1.58, 1.69		
Mo					0.26, 0.49, 0.31		
Na	0.02, 0.02, 0.02	0.0, 0.002					
Ni	0.02, 0.0, 0.0	0.01, 0.0			11.09, 9.53, 10.12		
O		0.019, 0.03					21.01
Si	0.2, 0.0, 0.06	0.004, 0.02	0.82				22.39
Sn		0.25, 0.0		1.5			
S	0.03, 0.0, 0.0	0.0, 0.002	0.06				
Ti			0.61				
Zn	0.10, 0.0, 0.0	0.007, 0.0				0.3	
Zr				98.16			
Density, g/cm	2.49, 2.50, 2.47	8.910, 8.913	2.692	6.32	7.930, 7.900, 7.770	8.650	1.731
Thickness, cm	0.713[c], 0.292[d], 0.231[e]	0.357, 0.646 or 0.337[f]	0.625	0.652	0.485 or 0.302, 0.298, 0.298	0.061	0.546,[g] 0.772[g]

[a]See Ref. 9.
[b]Separator plates are 91.5 cm long by 35.6 cm wide.
[c]Includes 0.102-cm-thick aluminum on sides of Boral-A.
[d]Includes 0.038-cm-thick aluminum on sides of Boral-B.
[e]Includes 0.025-cm-thick aluminum on sides of Boral-C.
[f]Separator plate is 30.6 cm wide.
[g]Includes 0.160-cm-thick Plexiglas on sides of Boroflex.

Table 2.23 Critical data for separator plate experiments from PNL-2438[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Plate material	Plate thickness (cm)	Separation of assemblies,[b] X_c (cm)	Plate-to-assembly distance,[c] G (cm)	No. of assemblies–assembly size (No. of rods)
P2438AL	2.35	2.032	aluminum	0.625	8.67	0.645	3-20×16
P2438BA	2.35	2.032	Boral-A	0.713	5.05	0.645	2-22×16;1-20×16[d]
P2438CU	2.35	2.032	copper	0.646	6.62	0.645	3-20×16
P2438SS	2.35	2.032	stainless steel	0.485	6.88	0.645	3-20×16
P2438ZR	2.35	2.032	Zircaloy-4	0.652	8.79	0.645	3-20×16

[a]See Ref. 9.
[b]Perpendicular distance between cell boundaries of assemblies.
[c]Perpendicular distance between cell boundary of center assembly and near surface of plate.
[d]Center assembly.

Table 2.24 Critical data for separator plate experiments from PNL-2615[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Plate material	Plate thickness (cm)	Separation of assemblies,[b] X_c (cm)	Plate-to-assembly distance,[c] G (cm)	No. of assemblies–assembly size (No. of rods)
P2615AL	4.31	2.540	aluminum	0.625	10.72	0.105	3-15×8
P2615BA	4.31	2.540	Boral-A	0.713	6.72	3.277	3-15×8
P2615CD1	4.31	2.540	cadmium	0.2006	7.28	3.277	3-15×8
P2615CD2	4.31	2.540	cadmium	0.2006	5.68	0.529	3-15×8
P2615CU	4.31	2.540	copper	0.646	8.15	0.084	3-15×8
P2615SS	4.31	2.540	stainless steel	0.485	8.58	0.245	3-15×8
P2615ZR	4.31	2.540	Zircaloy-4	0.652	10.92	0.078	3-15×8

[a]See Ref. 19.

[b]Perpendicular distance between cell boundaries of assemblies.

[c]Perpendicular distance between cell boundary of center assembly and near surface of plate.

Table 2.25 Criticality data for separator plate experiments from PNL-3314[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Plate material	Plate thickness (cm)	Separation of assemblies,[b] X_c; Y_c (cm)	No. of assemblies–assembly size (no. of rods)
P3314CU5	2.35	1.684	Copper	0.337	5.24	2-20×18;1-25×18[c]
P3314CU6	2.35	1.684	Copper-Cd	0.357	2.60	2-20×18;1-25×18[c]
P3314CD2	2.35	1.684	Cadmium	0.061	3.04	2-17×20;1-25×20[c]
P3314SS5	2.35	1.684	Steel, 0.0 wt % B	0.302	7.80	2-17×20;1-25×20[c]
P3314BS1	2.35	1.684	Steel, 1.1 wt % B	0.298	3.86	2-17×20;1-25×20[c]
P3314BS2	2.35	1.684	Steel, 1.6 wt % B	0.298	3.46	2-17×20;1-25×20[c]
P3314CU3	4.31	1.892	Copper	0.337	10.36	3-12×16
P3314CU4	4.31	1.892	Copper-Cd	0.357	7.61	3-12×16
P3314SS6	4.31	1.892	Steel, 0.0 wt % B	0.302	10.52	3-12×16
P3314BS3	4.31	1.892	Steel, 1.1 wt % B	0.298	7.23	3-12×16
P3314BS4	4.31	1.892	Steel, 1.6 wt % B	0.298	6.63	3-12×16
P3314CU1	4.31	1.892	Copper	0.337	2.83, 5.94	2-9×12; 2-9×7
P3314CU2	4.31	1.892	Copper	0.646	2.83, 2.67	2-9×12; 2-9×5
P3314CD1	4.31	1.892	Cadmium	0.061	2.83, 5.30	2-11×14; 2-11×13
P3315SS1	4.31	1.892	Steel, 0.0 wt % B	0.302	2.83, 3.38	2-9×12; 2-9×2
P3314SS2	4.31	1.892	Steel, 0.0 wt % B	0.302	2.83, 11.55	2-9×12; 2-9×13
P3314SS3	4.31	1.892	Steel, 0.0 wt % B	0.485	2.83, 4.47	2-9×12; 2-9×5
P3314SS4	4.31	1.892	Steel, 0.0 wt % B	0.485	2.83, 8.36	2-9×12; 2-9×12
P3314AL	4.31	1.892	Aluminum	0.625	2.83, 9.04	2-9×12; 2-9×1
P3314ZR	4.31	1.892	Zircaloy-4	0.652	2.83, 11.04	2-9×12; 2-9×1
P3314BF1	4.31	1.892	Boroflex	0.546	2.83, 3.60	2-11×14; 2-11×14
P3314BF2	4.31	1.892	Boroflex	0.772	2.83, 4.94	2-11×14; 2-11×16
P3314BC	4.31	1.892	Boral-C	0.231	2.83, 3.53	2-11×14; 2-11×14
P3314BA	4.31	1.892	Boral-A	0.713	2.83, 4.80	2-11×14; 2×11×16

[a]See Ref. 11.

[b]Perpendicular distance between cell boundaries of assemblies.

[c]Center assembly.

Table 2.26 Description of Boral separator plates in experiments from PNL-6205 and PNL-7167[a]

Element	Separator plate, wt %	
	PNL-6205	PNL-7167
Al	54.33	62.54
B	35.63	29.22
C	9.95	8.16
O	0.07	0.06
Fe	0.02	0.02
Core density, g/cm^3	2.64	2.64
Core thickness, cm	0.683[b]	0.673[b]
Length, cm	96	96
Width, cm	45	45

[a]See Refs. 21 and 22.

[b]Includes two 0.1015-cm-thick aluminum side plates.

Table 2.27 Critical data for separator plate experiments from PNL-6205 and PNL-7167[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Plate material	Plate thickness[b] (cm)	Separation of assemblies[c] (cm)	Plate-to-assembly distance[d] (cm)	No. of assemblies–assembly size (No. of rods)	Void material in flux trap
P62FT231	4.31	1.891	Boral	0.683	5.19	0.057	4-16×15	None
P71F14F3	4.31	1.891	Boral	0.673	5.19	0.057	3-14×15; 1-15×15	14 fuel rods on 1.891-cm pitch
P71F14V3	4.31	1.891	Boral	0.673	5.19	0.057	3-14×15; 1-15×15	3-0.63-cm-thick equally spaced aluminum plates
P71F14V5	4.31	1.891	Boral	0.673	5.19	0.057	3-15×15; 1-15×16	14-1.27-cm-diam aluminum rods on 1.891-cm pitch
P71F214R	4.31	1.891	Boral	0.673	5.19	0.057	3-16×15; 1-15×15	None

[a]See Refs. 20 and 21

[b]Includes two 0.1015-cm-thick aluminum side plates.

[c]Perpendicular distance between cell boundaries of assemblies.

[d]Perpendicular distance between cell boundaries of assemblies and near surface of plate.

Table 2.28 Modeled assemblies of PNL-6205 and PNL-7167 separator plate experiments

				Modeled assemblies (No. rows × fuel rods per row)			
Experiment	No. of rods, experiment	No. of rods, delayed critical (predicted)	No. of rods modeled	Top left	Top right	Bottom left	Bottom right
P62FT231	960	963	963	15×16	15×16	15×16	12×16, 3×17[a]
P71F14F3	855	858.5	858	12×14, 3×15[a]	15×14	15×15	15×14
P71F14V3	855	862.1	862	15×14	15×15	15×14	8×14, 7×15[a]
P71F14V5	915	924.9	925	1×10[b], 15×15[a]	16×15	15×15	15×15
P71F214R	945	952	952	15×16	15×16	15×16	7×16, 8×15[a]

[a]Bottom rows.

[b]Aligned against right assembly boundary.

Table 2.29 Critical data for reflecting wall experiments from PNL-2827[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Reflector material	Separation of assemblies,[b] X_c (cm)	Wall-to-assembly distance,[c] Y (cm)	No. of assemblies–assembly size (No. of rods)
P2827L1	2.35	2.032	lead	13.27	0.66	3–19×16
P2827L2	2.35	2.032	lead	11.25	2.616	3–19×16
P2827L3	4.31	2.540	lead	20.78	0.66	3–13×8
P2827L4	4.31	2.540	lead	19.04	1.321	3–13×8
P2827U1	2.35	2.032	depleted uranium	11.83	0.0	3–19×16
P2827U2	2.35	2.032	depleted uranium	14.11	1.956	3–19×16
P2827U3	4.31	2.540	depleted uranium	15.38	0.0	3–13×8
P2827U4	4.31	2.540	depleted uranium	15.32	1.956	3–13×8

[a] See Ref. 10.
[b] Perpendicular distance from outer rod surface to outer rod surface of assemblies.
[c] Perpendicular distance between cell boundaries of assemblies and near surface of reflecting walls.

Table 2.30 Critical data for reflecting wall experiments from PNL-3602[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Reflector material	Separator of assemblies,[b] X_c (cm)	Wall-to-assembly distance,[c] Y(cm)	No. of assemblies–assembly size (No. of rods)	Grid plates material
P3602N11	2.35	1.684	steel	8.98	0.0	2–20×18; 1–25×18[d]	polypropylene
P3602N12	2.35	1.684	steel	9.58	0.66	2–20×18; 1–25×18[d]	polypropylene
P3602N13	2.35	1.684	steel	9.66	1.684	2–20×18; 1–25×18[d]	polypropylene
P3602N14	2.35	1.684	steel	8.54	3.912	2–20×18; 1–25×18[d]	polypropylene
P3602N21	2.35	2.032	steel	11.20	0.66	2–20×18; 1–25×18[d]	polypropylene
P3602n22	2.35	2.032	steel	10.36	2.616	3–19×16	acrylic
P3602N31	4.31	1.892	steel	14.87	0.0	3–19×16	acrylic
P3602N32	4.31	1.892	steel	15.74	0.66	3–12×16	acrylic
P3602N33	4.31	1.892	steel	15.87	1.321	3–12×16	polypropylene
P3602N34	4.31	1.892	steel	15.84	1.956	3–12×16	polypropylene
P3602N35	4.31	1.892	steel	15.15	2.616	3–12×16	polypropylene
P3602N36	4.31	1.892	steel	13.82	5.405	3–13×8	polypropylene
P3602N41	4.31	2.540	steel	12.89	0.0	3–13×8	acrylic
P3602N42	4.31	2.540	steel	14.12	1.321	3–13×8	acrylic
P3602N43	4.31	2.540	steel	12.44	2.616	3–13×8	acrylic

[a] See Ref. 22.

[b] Perpendicular distance from outer rod surface to outer rod surface of assemblies.

[c] Perpendicular distance between cell boundary of assembly and near surface of reflecting wall.

[d] Center assembly.

Table 2.31 Critical data for reflecting wall experiments from PNL-3926[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Reflector material	Separation of assemblies,[b] X_c (cm)	Wall-to-assembly distance,[c] Y(cm)	No. of assemblies–assembly size (No. of rods)
P3926L1	2.35	1.684	lead	10.06	0.0	2–20×18; 1–23×18[d]
P3926L2	2.35	1.684	lead	10.11	0.66	2–20×18; 1–23×18[d]
P3926L3	2.35	1.684	lead	8.50	3.276	2–20×18; 1–23×18[d]
P3926L4	4.31	1.892	lead	17.74	0.0	3–12×16
P3926L5	4.31	1.892	lead	18.18	0.66	3–12×16
P3926L6	4.31	1.892	lead	17.43	1.956	3–12×16
P3926U1	2.35	1.684	depleted uranium	8.06	0.0	2–20×18; 1–23×18[d]
P3926U2	2.35	1.684	depleted uranium	9.50	1.321	2–20×18; 1–23×18[d]
P3926U3	2.35	1.684	depleted uranium	9.19	3.912	2–20×18; 1–23×18[d]
P3926U4	4.31	1.892	depleted uranium	15.33	0.0	3–12×16
P3926U5	4.31	1.892	depleted uranium	19.24	1.956	3–12×16
P3926U6	4.31	1.892	depleted uranium	18.78	3.276	3–12×16

[a] See Ref. 12.

[b] Perpendicular distance from outer rod surface to outer rod surface of assemblies.

[c] Perpendicular distance between cell boundary of assemblies and near surface of reflecting walls.

[d] Center assembly.

Table 2.32 Critical data for reflecting wall-separator plate experiments from PNL-3602[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Plate material	Plate thickness (cm)	Reflecting wall material	Separation of assemblies,[b] X_c (cm)	Wall-to-assembly distance,[c] Y (cm)	No. of assemblies–assembly size (No. of rods)
P3602BB	4.31	1.892	Boral-B	0.292	steel	8.30	1.956	3–12×16
P3602BS1	2.35	1.684	1.1 wt % B steel	0.298	steel	4.80	1.321	2–20×18; 1–25×18[d]
P3602BS2	4.31	1.892	1.1 wt % B steel	0.298	steel	9.83	1.956	3–12×16
P3602CD1	2.35	1.684	cadmium	0.061	steel	3.86	1.321	2–20×18; 1–25×18[d]
P3602CD2	4.31	1.892	cadmium	0.061	steel	8.94	1.956	3–12×16
P3602CU1	2.35	1.684	copper	0.337	steel	7.79	1.321	2–20×18; 1–25×18[d]
P3602CU2	2.35	1.684	99 wt % copper–1 wt % cadmium	0.357	steel	5.43	1.321	2–20×18; 1–25×18[d]
P3602CU3	4.31	1.892	copper	0.337	steel	13.47	1.956	3–12×16
P3602CU4	4.31	1.892	99 wt % copper–1 wt % cadmium	0.357	steel	10.57	1.956	3–12×16
P3602SS1	2.35	1.684	steel	0.302	steel	8.28	1.321	2–20×18; 1–25×18[d]
P3602SS2	4.31	1.892	steel	0.302	steel	13.75	1.956	3–12×16

[a] See Ref. 22.
[b] Perpendicular distance from outer rod surface to outer rod surface of assemblies.
[c] Perpendicular distance between cell boundary of assemblies and near surface of reflecting walls.
[d] Center assembly.

Table 2.33 Critical data for reflecting wall-separator plate experiments[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Plate material[b]	Plate thickness[c] (cm)	Reflector material	Reflector thickness, E (cm)	Separation of assemblies[d] (cm)	Plate-to-assembly distance[e] (cm)	Wall-to-assembly distance[f] (cm)	No. of assemblies–assembly size[g] (No. of rods)	Moderator height,[h] H_c (cm)
PAT80L1	4.742	1.6	Boral	0.65	lead[i]	10.0	4.9	0.8	1.68	4–18×18	53.98
PAT80L2	4.742	1.6	Boral	0.65	lead[i]	10.0	4.9	0.8	3.95	4–18×18	63.85
PAT80SS1	4.742	1.6	Boral	0.65	steel[j]	15.0	4.9	0.8	1.68	4–18×18	51.55
PAT80SS2	4.742	1.6	Boral	0.65	steel[j]	15.0	4.9	0.8	3.95	4–18×18	61.84

[a] See Ref. 23.
[b] Boral (2.6189 g/cm³): 71.63 wt % Al, 22.20 wt % B, and 6.17 wt % C.
[c] Includes 0.11-cm-thick aluminum (2.651 g/cm³) sides.
[d] Perpendicular distance between the center of outer rods of assemblies.
[e] Perpendicular distance between the center of outer rods of assemblies and near surface of plates.
[f] Perpendicular distance between the center of outer rods of assemblies and near surface of reflecting walls.
[g] Includes four 1.0-cm-diam stainless steel corner rods.
[h] Measured from lower end of fuel rod pellet column.
[i] Lead (11.34 g/cm³).
[j] Steel (7.8 g/cm³): 99.66 wt % Fe, 0.20 wt % Si, and 0.14 wt % C.

Table 2.34 Physical properties of UO_2 fuel rods from BAW-1810[a]

Parameter	Value
Outside diameter, cm	1.2078
Wall thickness, cm	0.0406
Wall material	304 stainless steel
Fuel diameter, cm	1.128
Total length, cm	181.6[b]
Active fuel length, cm	169.4
Enrichment, $^{235}U/U$, wt %	4.020
Fuel density, g/cm^3	9.46

[a]See Ref. 24.

[b]Includes approximately 5.967-cm-long stainless steel end plugs.

Table 2.35 Physical properties of UO_2-Gd_2O_3 fuel rods from BAW-1810[a]

Parameter	Value
Outside diameter, cm	1.207
Wall thickness, cm	0.081
Wall material	aluminum
Fuel pellet diameter, cm	1.030
Total length, cm	160.02[b]
Active fuel length, cm	153.42
Enrichment, $^{235}U/U$, wt %	1.944
Gadolinia, wt %	4.00
UO_2 density, g/cm^3	10.24
Gd_2O_3 density, g/cm^3	0.410
Gd density, g/cm^3	0.356
O density, g/cm^3	0.054

[a]See Ref. 24.

[b]Includes 0.3175-cm-long aluminum end plugs and 5.97 cm of void above the 153.42-cm-long pellet stack (active fuel).

Table 2.36 Critical data for UO_2-Gd_2O_3 rod experiments from BAW-1810[a]

Experiment	Enrichment (wt %)	Pitch (cm)	No. of 2.459 wt % ^{235}U rods	No. of 4.020 wt % ^{235}U rods	No. of UO_2-Gd_2O_3 rods	No. of water holes	Moderator height,[b] H (cm)	Boron concentration (ppm)
BW1810A	2.459	1.636	4788	0	20	153	145.0	1239.3
BW1810B	2.459	1.636	4772	0	36	153	145.0	1170.7
BW1810C	2.459 and 4.020	1.636	3676	912[c]	32	180	145.0	1499.0
BW1810D	2.459 and 4.020	1.636	3920	860[d]	28	153	145.0	1653.8
BW1810E	2.459 and 4.020	1.636	3920	852[e]	36	153	145.0	1579.4

[a]See Ref. 24.
[b]Measured from the top of the 5.08-cm-thick aluminum base plate.
[c]Inner 32 × 32 lattice positions including 80 water holes and 32 Gd_2O_3 rods.
[d]Inner 31 × 31 lattice positions including 73 water holes and 28 Gd_2O_3 rods.
[e]Inner 31 × 31 lattice positions including 73 water holes and 36 Gd_2O_3 rods.

Table 2.37 Critical data for water hole experiments from BAW-1810[a]

Experiment	Enrichment (wt %)	Pitch (cm)	No. of 2.459 wt % ^{235}U rods	No. of 4.020 wt % ^{235}U rods	No. of water holes	Moderator height,[b] H (cm)	Boron concentration (ppm)
BW1810F	2.459	1.636	4808	0	153	145.0	1337.9
BW1810G	2.459 and 4.020	1.636	3676	944[c]	180	145.0	1776.8
BW1810H	2.459 and 4.020	1.636	3920	888[d]	153	145.0	1899.3

[a] See Ref. 24.

[b] Measured from the top of the 5.08-cm-thick aluminum base plate.

[c] Inner 32 × 32 lattice positions including 80 water holes.

[d] Inner 31 × 31 lattice positions including 73 water holes.

Table 2.38 Critical data for **NSE71W1** and **NSE71W2** water hole experiments[a]

Experiment	Enrichment (wt %)	Pitch (cm)	No. of assemblies–assembly size (No. of positions)	No. of fuel rods	No. of water holes	Frequency of water holes	Moderator height,[b] H_c
NSE71W1	4.742	1.26	1–22×22	459	25	1 in 5 positions	81.36
NSE71W2[c]	4.742	1.26	1–22×22	420	64	1 in 3 positions	73.05

[a]See Ref. 8.
[b]Measured from lower end of fuel rod pellet column.
[c]Given as an example in Ref. 8.

Table 2.39 Critical data for water hole experiments from PNL-3314[a]

Experiment	Enrichment (wt %)	Pitch (cm)	No. of assemblies–assembly size (No. of positions)	No. of fuel rods		No. of water holes
				Predicted[b]	Modeled	
P3314W1	4.31	1.892	1–14×14	167.6	168	25
P3314W2	2.35	1.684	1–23×23	485.8	486	25

[a]See Ref. 11.

[b]Obtained by approach-to-critical method.

Table 2.40 Critical data for water hole experiments from WCAP-3269[a]

Experiment	Enrichment (wt %)	Pitch (cm)	No. of assemblies–assembly size (No. of positions)	No. of fuel rods	No. of water holes	Moderator height,[b] H_c
W3269W1	2.72	1.524	1–31×31	945	16	37.21
W3269W2	5.7	1.422	1–27×17	453	6	51.93

[a]See Ref. 15.

[b]Believed to have been measured from the bottom of fuel, see Figs. 2.20 and 2.21.

Table 2.41 Properties of B_4C absorber rods from BAW-1484[a]

Parameter	Value
Outside diameter, cm	1.113
Wall thickness, cm	0.089
Wall material	aluminum
Total length, cm	177.5[b]
Active length, cm	177.18
B_4C powder density, g/cm^3	1.28

[a]See Ref. 6.

[b]Includes 0.3175-cm-long aluminum bottom end plug.

Table 2.42 Critical data for B_4C absorber rod experiments from BAW-1484[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Separation of assemblies[b] (cm)	No. of assemblies–assembly size[c] (No. of rods)	No. of absorber rods	Moderator height,[d] H (cm)
BW1484C1	2.459	1.636	1.636	9–14×14	84	145.68
BW1484C2	2.459	1.636	4.908	9–14×14	34	111.49

[a]See Ref. 6.

[b]Believed to be the perpendicular distance between cell boundaries of assemblies.

[c]Four corner rods of assemblies are 0.635-cm-radius aluminum rods.

[d]Measured from the top of the aluminum base plate.

Table 2.43 Properties of Ag-In-Cd absorber rods from BAW-1810[a]

Parameter	Value
Outside diameter, cm	1.207
Wall thickness, cm	0.081
Wall material	aluminum
Length, cm	157.56[b]
Wt % Ag	79.68
Wt % In	15.09
Wt % Cd	5.2
Wt % Cu	0.05
Wt % Zr	0.02
Density, g/cm^3	10.15

[a]See Ref. 25.

[b]Minus the 0.3175-cm-long aluminum bottom end plug.

Table 2.44 Critical data for absorber rod experiments from BAW-1810[a]

Experiment	Enrichment (wt %)	Pitch (cm)	No. of 2.459 wt % ^{235}U rods	No. of 4.020 wt % ^{235}U rods	Absorber rod	No. of absorber rods	No. of water holes	Moderator height,[b] H (cm)	Boron concentration (ppm)
BW1810I	2.459	1.636	4808	0	Ag-In-Cd	16	137	145.0	1250.0
BW1810J	2.459 and 4.020	1.636	3920	888[c]	B_4C	16	137	145.0	1635.4

[a] See Ref. 24.

[b] Measured from the top of the 5.08-cm-thick aluminum base plate.

[c] Inner 31 × 31 positions include 57 water holes and 16 B_4C rods.

Table 2.45 Critical data for Ag-In-Cd absorber rod experiments from WCAP-3269[a]

Experiment	Enrichment (wt %)	Pitch (cm)	No. of assemblies–assembly size (No. of rods)	No. of fuel rods	No. of Ag-In-Cd rods[b]	Ag-In-Cd rod diameter (cm)	Moderator height[c] (cm)
W3269A	5.7	1.422	1–27×17	453	6	1.024	88.27
W3269B1	3.7	1.105	1–47×47[d]	2221	12	0.838	55.41
W3269B2	3.7	1.105	1–47×47[d]	2209	24	0.838	64.56
W3269B3	3.7	1.105	1–47×47[d]	2185	48	0.838	57.00
W3269C	2.72	1.524	1–31×31	945	16	1.024	89.75

[a]See Ref. 15.
[b]Rods taken to be 79.6 wt % Ag, 15.17 wt % In, 5.08 wt % Cd with a density of 9.91 g/cm³.
[c]Believed to have been measured from the bottom of the fuel, see Figs. 2.20 and 2.21.
[d]Includes 24 fuel follower rods positioned outside the array (see Figs. 2.58, 2.59, and 2.60).

Table 2.46 Critical data for soluble boron experiments from BAW-1231[a]

Experiment	Enrichment (wt %)	Pitch (cm)	No. of fuel rods	Moderator height[b] (cm)	Boron concentration (ppm)
BW1231B1	4.020	1.511	936	167.5	1152
BW1231B2	4.020	1.511	4904	146.65	3389

[a]See Ref. 25.
[b]Measured from the bottom of the active fuel or reference plane of Fig. 2.62.

Table 2.47 Critical data for soluble boron experiment **BW1273M**[a]

Experiment	Enrichment (wt %)	Pitch (cm)	No. of fuel rods	Moderator height,[b] H (cm)	Boron concentration (ppm)
BW1273M	2.459	1.511	5137	93.2	1675

[a]See Ref. 26.
[b]Measured from the bottom of the active fuel or reference plane in Fig. 2.63.

Table 2.48 Critical data for soluble boron experiments from BAW-1484[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Separation of assemblies[b] (cm)	No. of assemblies–assembly size[c] (No. of rods)	Moderator height[d] (cm)	Boron concentration (ppm)
BW1484B1	2.459	1.636	0.0	9–14×14	144.29	1037
BW1484B2	2.459	1.636	1.636	9–14×14	100.32	702
BW1484B3	2.459	1.636	4.908	9–14×14	149.12	143

[a]See Ref. 6.
[b]Believed to be the perpendicular distance between cell boundaries of assemblies.
[c]Four corner rods of assemblies are 0.635-cm-radius aluminum rods.
[d]Measured from the top of the aluminum base plate.

Table 2.49 Critical data for soluble boron experiments from EPRI NP-196[a]

Experiment	Enrichment (wt %)	Pitch (cm)	No. of rods	Moderator height[b] (cm)	Boron concentration (ppm)
EPRU65B	2.35	1.562	1201	111.76	463.8
EPRU75B	2.35	1.905	1201	112.08	568
EPRU87B	2.35	2.210	885	111.76	285.8

[a]See Ref. 7.
[b]Measured from the base of the aluminum solid plate.

Table 2.50 Critical data for soluble boron experiments PNL-4267[a]

Experiment	Enrichment (wt %)	Pitch (cm)	Array width (No. of rods)	Total No. of rods: Predicted[b]	Total No. of rods: Modeled	Boron concentration (g/l)
P4267B1	4.31	1.890	40	922.8	923	2.15±0.35
P4267B2	4.31	1.890	40	1236.8	1237	2.55±0.07
P4267B3	4.31	1.715	44	737.0	737	1.03±0.05
P4267B4	4.31	1.715	44	916.96	917	1.82±0.30
P4267B5	4.31	1.715	44	1191.96	1192	2.55±0.21

[a]See Ref. 13.
[b]Obtained by approach-to-critical method.

Table 2.51 Atom densities (atoms/b-cm) of fuel in critical experiments from Y-DR-14[a]

Experiment	^{235}U	^{238}U	H	C	F
YDR14UN2	1.330E-4	6.437E-3	3.910E-2	1.880E-2	2.628E-2
YDR14PL2	1.119E-4	5.415E-3	4.547E-2	2.186E-2	2.211E-2
YDR14PL3	2.349E-4	7.500E-3	3.134E-2	1.507E-2	3.094E-2
YDR14UN3	2.349E-4	7.500E-3	3.134E-2	1.507E-2	3.094E-2

[a]See Ref. 27.

Table 2.52 Criticality data for homogenized uranium experiments from Y-DR-14[a]

Experiments	Enrichment (wt %)	Fuel form	Fuel dimensions (cm)	Reflector
YDR14PL2	2.00	$U(2)F_4$	53.67×53.67×54.29	15.2-cm paraffin on top and sides 15.2-cm Plexiglas[b] on bottom
YDR14PL3	3.00	$U(3)F_4$	43.47×43.47×86.39	15.2-cm paraffin on top and sides 15.2-cm Plexiglas[b] on bottom
YDR14UN2	2.00	$U(2)F_4$	56.22×56.22×122.47	none
YDR14UN3	3.00	$U(3)F_4$	56.47×56.47×86.64	none

[a]See Ref. 27.
[b]Volume fraction: 0.918 Plexiglas, 0.062 aluminum, 0.01 void.

Table 2.53 Cuboid fuel can descriptions for **CR1071AS, CR1653AS, CR2500S**[a]

Parameter	CR1071AS	CR1653AS	CR2500S
Can			
Material[b]	aluminum	aluminum	aluminum
Can volume, cm^3	$(15.28)^3$	$(15.24)^3$	$(15.24)^3$
Wall thickness,[c] cm	0.15	0.16	0.16
Cavity volume, cm^3	$(14.98)^3$	$(14.92)^3$	$(14.92)^3$
Vinyl tape mass, g	3	3.0	3.4
Mylar tape mass, g	4	4.0	5.9
Cavity contents			
U_3O_8 mass, g	15088	15084	15081
H_2O mass, g	314	533.4	905.3
C_2H_4 mass, g	53	53.0	53.0
U_3O_8 enrichment			
^{234}U, wt %	0.03	0.030	0.03
^{235}U, wt %	4.46	4.481	4.48
^{236}U, wt %	0.08	0.089	0.09
^{238}U, wt %	95.43	95.399	95.40

[a]See Refs. 28-31.

[b]Density of 2.713 g/cm^3.

[c]Walls have water injection holes (56 total) of 0.64 cm diameter.

Table 2.54 Materials for damp uranium oxide experiments[a]

Element, wt %	Fire-retardant Plexiglas	Glue[b]	Vinyl tape	Mylar tape	Nonfire-retardant Plexiglas	Paper[b]	Polyethylene
Al			0.5				
Br	7.10						
C	52.03	86.29	45.91	65.50	59.52	42.17	84.90
Ca			6.9				
Cl	1.81		25.73				
H	7.16	11.67	5.92	6.83	7.84	6.48	14.01
N	0.16		0.16				
O	29.82	1.20	10.82	27.02	32.23	49.50	1.20
P	1.02						
Pb			1.1				
Si			0.6				
Ti			1.6				
Zn			0.1				
Density, g/cm^3	1.284	0.728	1.310	1.11	1.185	0.766	0.824

[a]See Ref. 29.

[b]Plates of both Plexiglas types covered with paper (0.49 wt %) and glue (0.16 wt %).

Table 2.55 Cuboid dimensions[a] (cm) of Fig. 2.69 for **CR1071AS**[b]

Core				Reflector interior				Reflector exterior				Faceplate thickness		Frame extender thickness		Gap		Filler thickness						
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
68.0	34.4	34.4	50.6	68.0	34.7	34.7	50.6	128.4	65.3	74.5	133.6	1.23	1.23	7.4	–	–	–	8.5	8.5	4.9	12.2	7.3	7.3	26.1

[a]Calculated from photograph.
[b]See Ref. 29.
[c]Dimensions for plastic reflector of shape seen in Figure 2.72.

Table 2.56 Cuboid dimensions (cm) of Fig. 2.70 for **CR1653AS**[a]

Core					Reflector interior					Reflector exterior					
L	M	N	O	P[b]	G	H	I	J	K	A[c]	B[c]	C	D	E	F
33.3	33.3	68.9	50.9	1.26	33.5	33.6	69.0	69.2	69.2	60.0	73.5	128.3	134.4	–	0.5

[a]See Ref. 30.
[b]Void.
[c]Includes 1.23-cm-thick nonfire-retardant Plexiglas on mating face.

Table 2.57 Cuboid dimensions for **CR2500S**[a]

	Cuboid		Dimension (cm)
Core[b]	North table	East/west	50.8
		North/south	33.3
		Vertical	51.1
	South table	East/west	51.1
		North/south	33.4
		Vertical	51.1
Reflector interior[c]	North table	East/west	77.6
		North/south	33.5
		Vertical	51.1
	South table	East/west	77.4
		North/south	33.9
		Vertical	51.1
Reflector exterior[c]	North table	East/west	128.3
		North/south	59.7[d,e]
		Vertical	132.5
	South table	East/west	128.4
		North/south	74.4[d]
		Vertical	134.6
Core location[f]	North table	West	25.3
		Bottom	55.1
	South table	West	25.8
		Bottom	55.4

[a]See Ref. 31.
[b]Planar and elevation views of core seen in Fig. 2.70.
[c]Dimensions for plastic reflector of shape seen in Fig. 2.72.
[d]Includes 1.215-cm-thick faceplate.
[e]Includes thickness of plastic inserted between frame and end panel.
[f]Locates the lower west corner of the core relative to the reflector exterior.

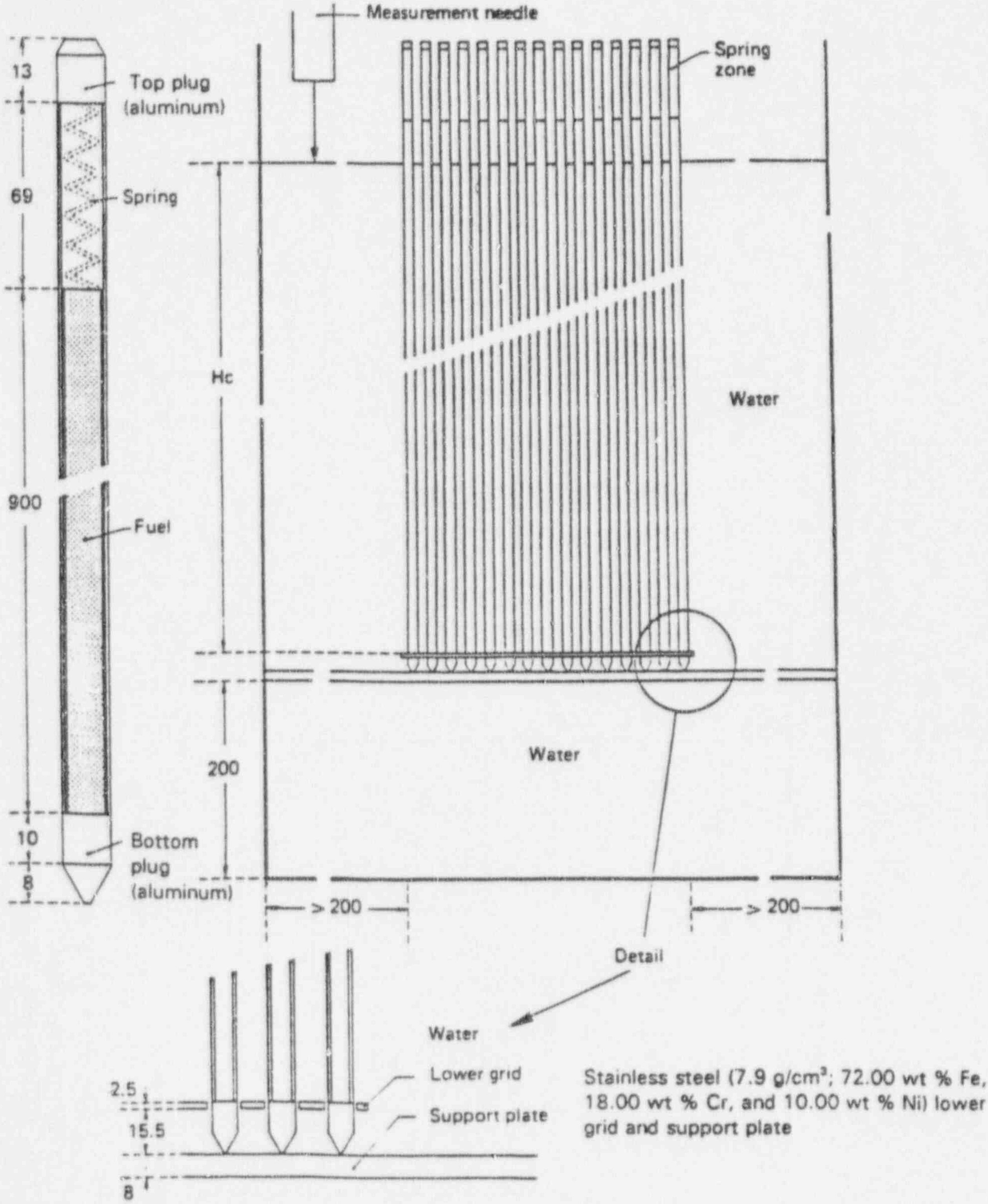


Figure 2.1 Principal dimensions (in centimeters) of 4.742 wt % UO_2 fuel rods for ANS Transactions, Vol. 33, and NS&E, Vol. 71, and assembly for NS&E, Vol. 71. Source: Refs. 5 and 8 (Reprinted with permission by author)

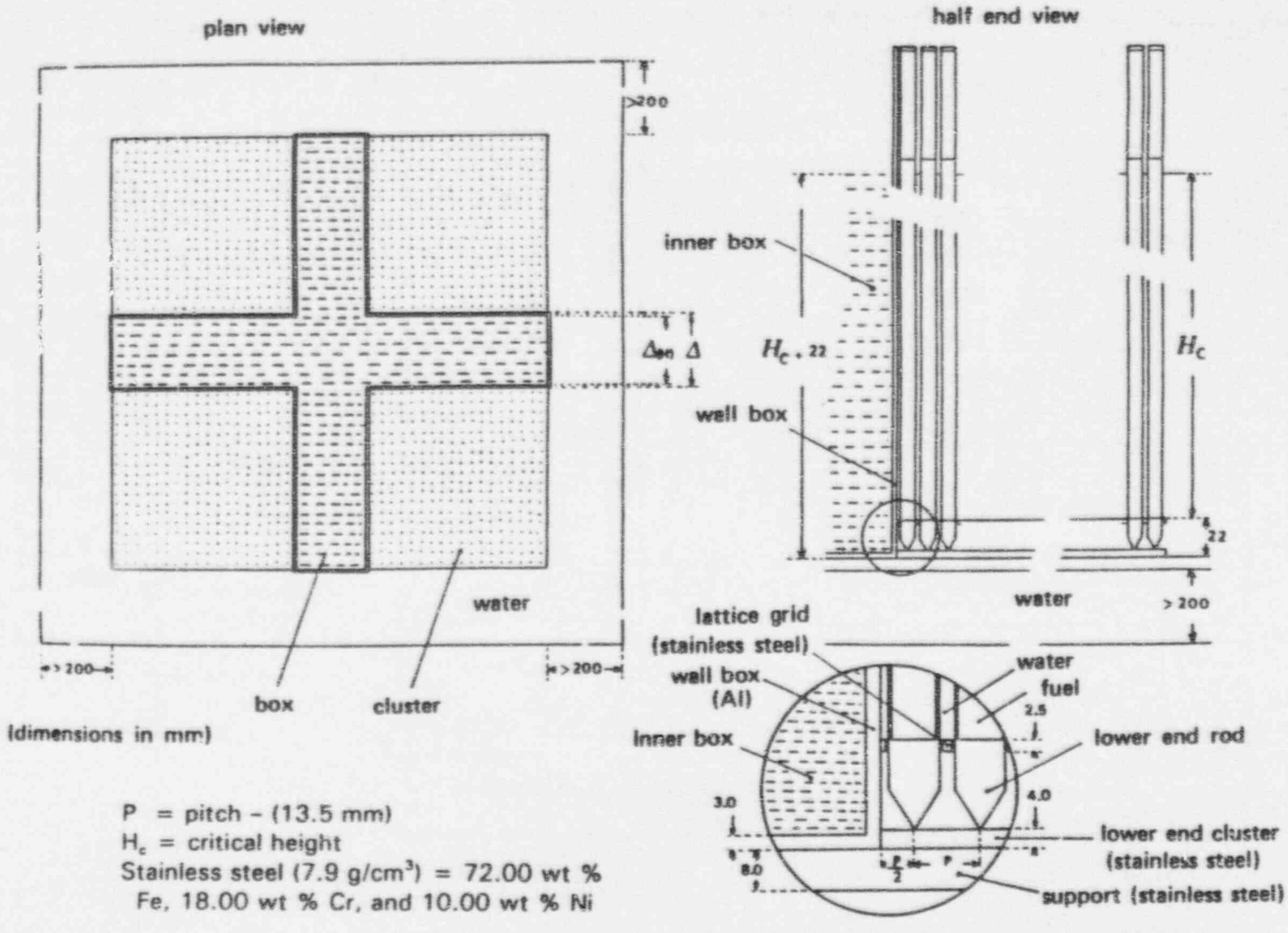


Figure 2.2 Planar and half-end view of experiments from ANS Transactions, Vol. 33 (dimensions in millimeters). Source: Ref. 5

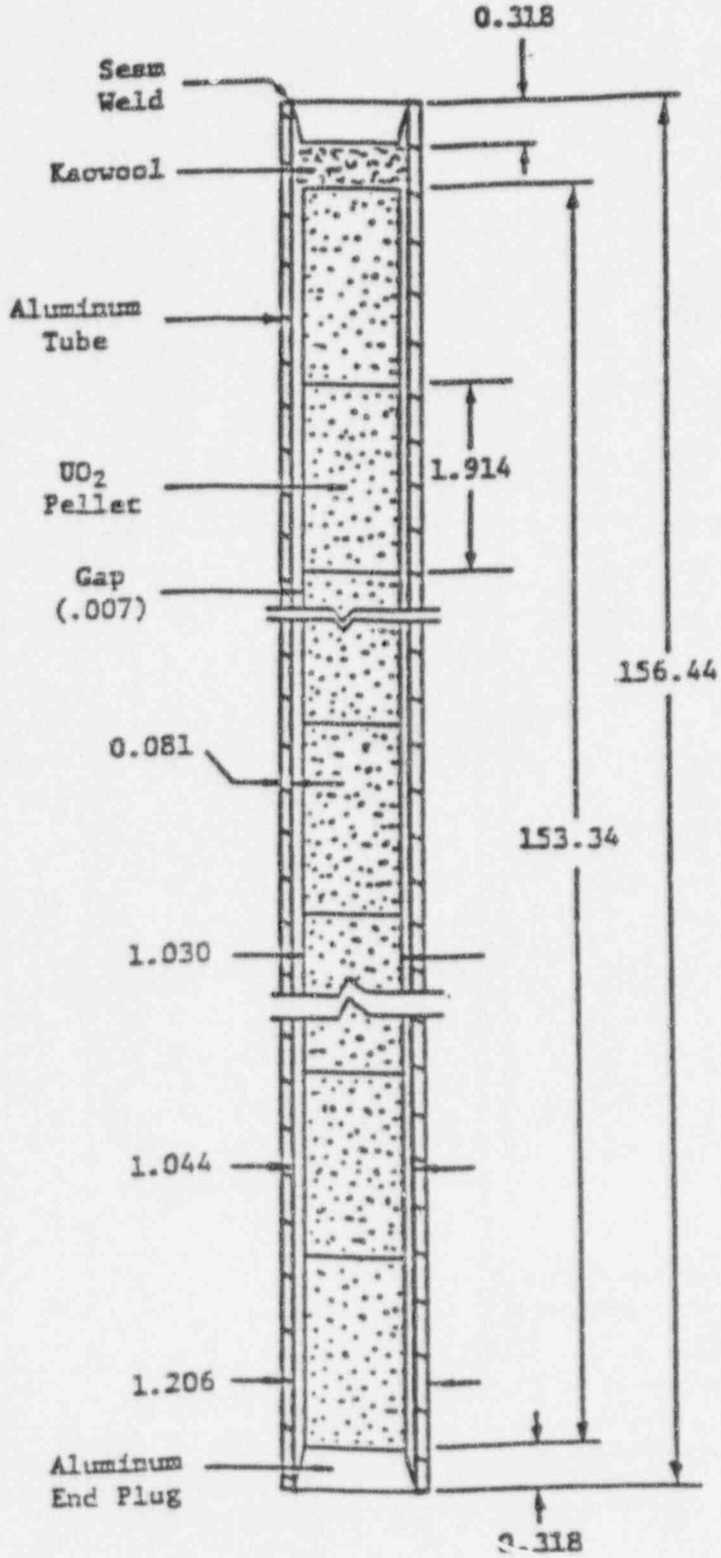


Figure 2.3 Dimensions (in centimeters) of 2.459 wt % UO_2 fuel rods for BAW-1484 experiments. Source: Ref. 6

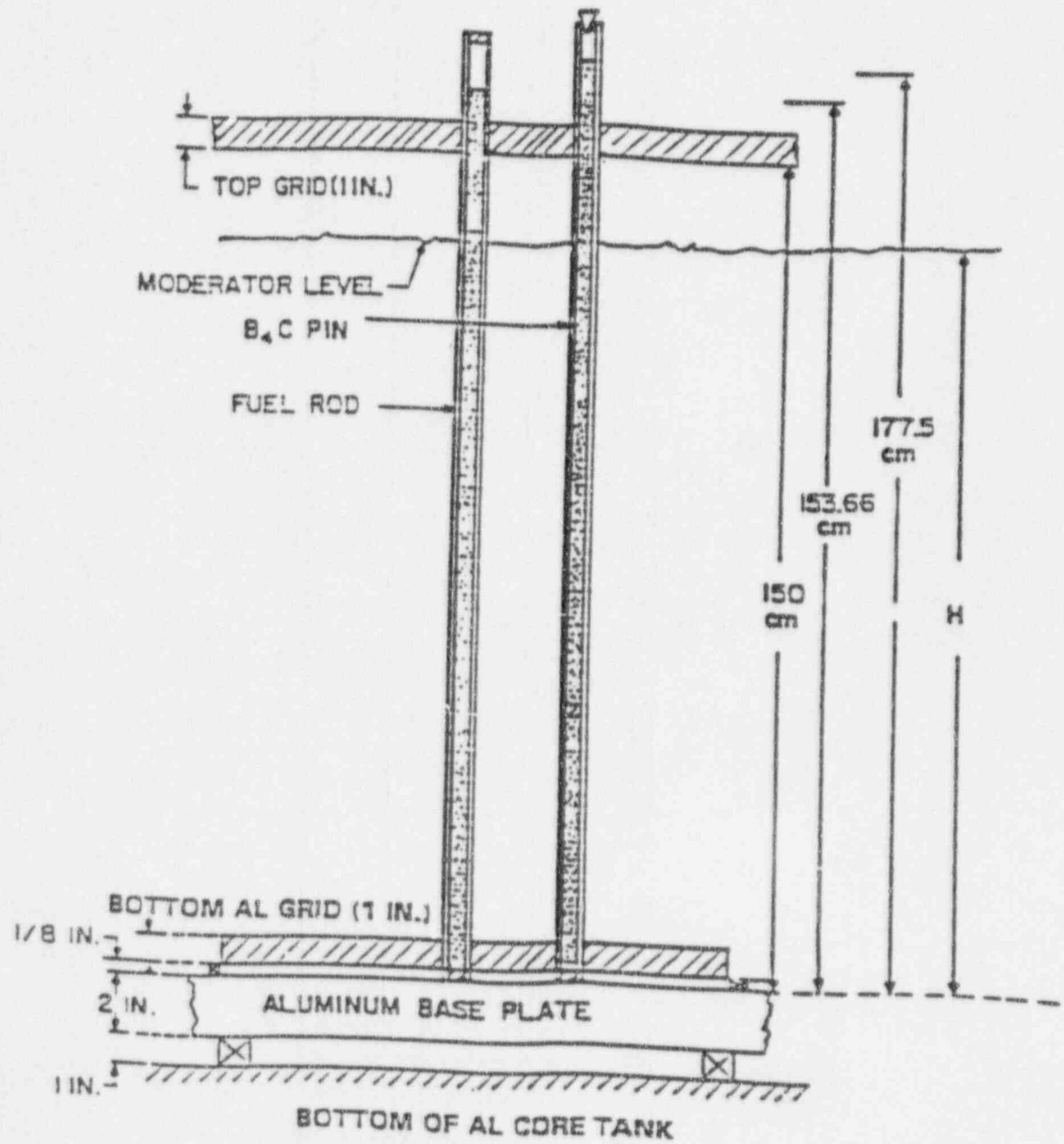
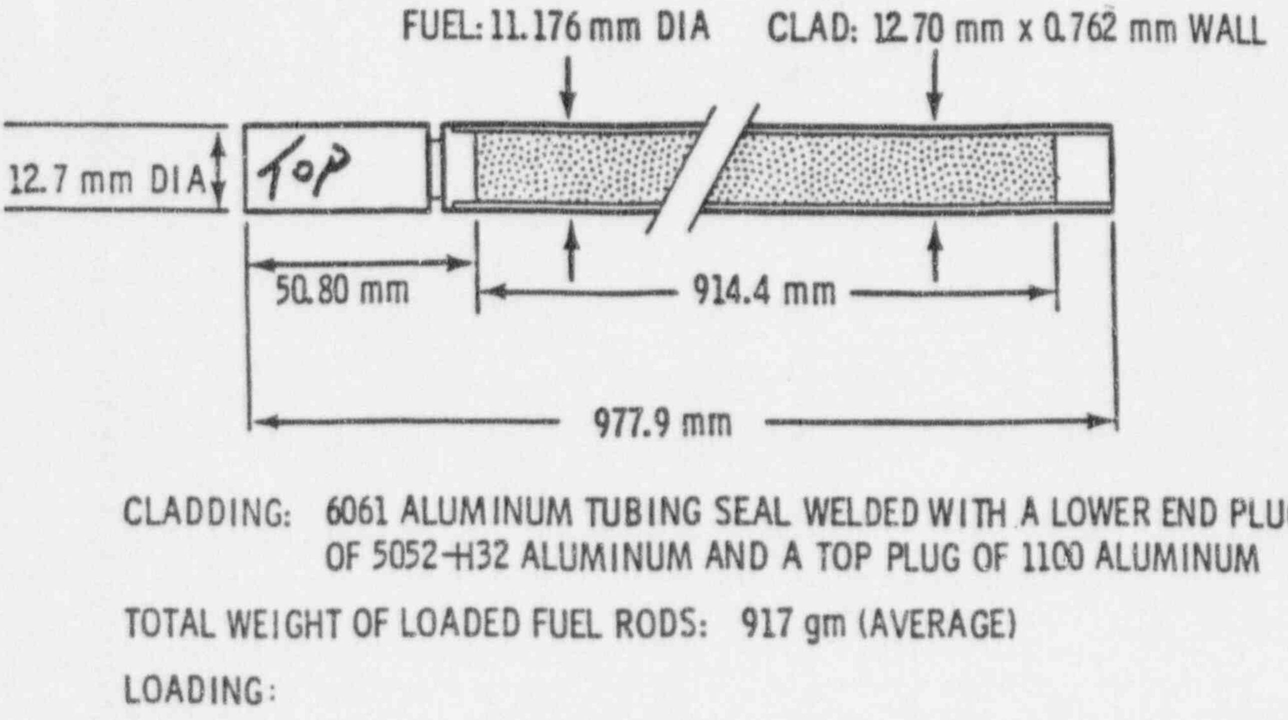


Figure 2.4 Experiment **BW1484SL** vertical dimensions. *Source*: Ref. 6

DESCRIPTION OF 2.35 wt% ^{235}U ENRICHED UO_2 RODS



CLADDING: 6061 ALUMINUM TUBING SEAL WELDED WITH A LOWER END PLUG OF 5052-H32 ALUMINUM AND A TOP PLUG OF 1100 ALUMINUM

TOTAL WEIGHT OF LOADED FUEL RODS: 917 gm (AVERAGE)

LOADING:

825 gm OF UO_2 POWDER/ROD, 726 gm OF U/ROD, 17.08 gm OF U-235/ROD
ENRICHMENT - 2.35 ± 0.05 w/o U-235
FUEL DENSITY - 9.20 mg/mm^3 (84% THEORETICAL DENSITY)

Figure 2.5 Description of 2.35 wt % UO_2 fuel rods used in experiments from EPRI NP-196. Source: Ref. 7. (Copyright © 1976. Electric Power Research Institute. EPRI NP-196. *Clean Critical Experiment Benchmarks for Plutonium Recycle in LWRs.* Reprinted with Permission.)

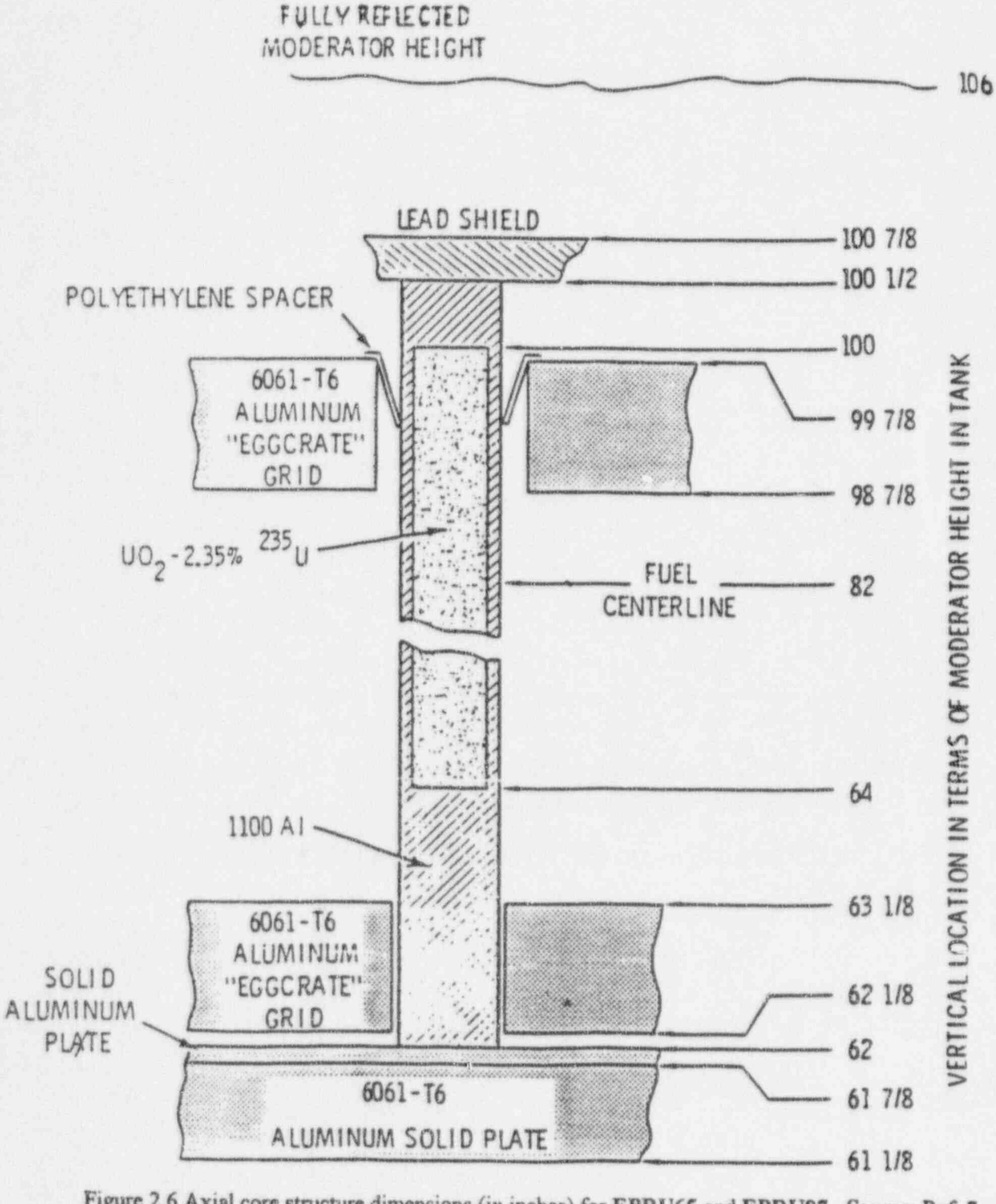


Figure 2.6 Axial core structure dimensions (in inches) for **EPRU65** and **EPRU87**. Source: Ref. 7 (Copyright © 1976. Electric Power Research Institute. EPRI NP-196. *Clean Critical Experiment Benchmarks for Plutonium Recycle in LWRs*. Reprinted with Permission.)

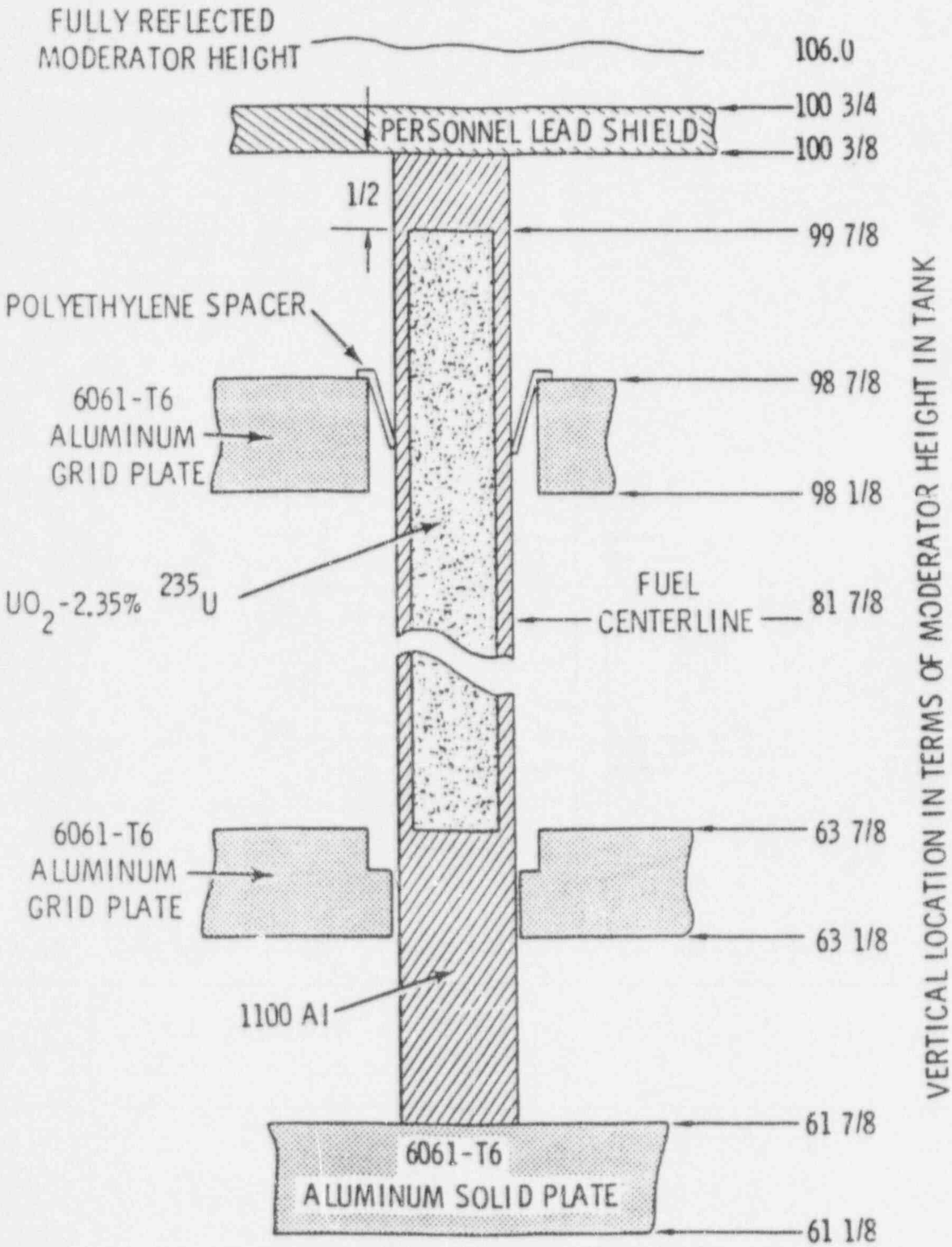
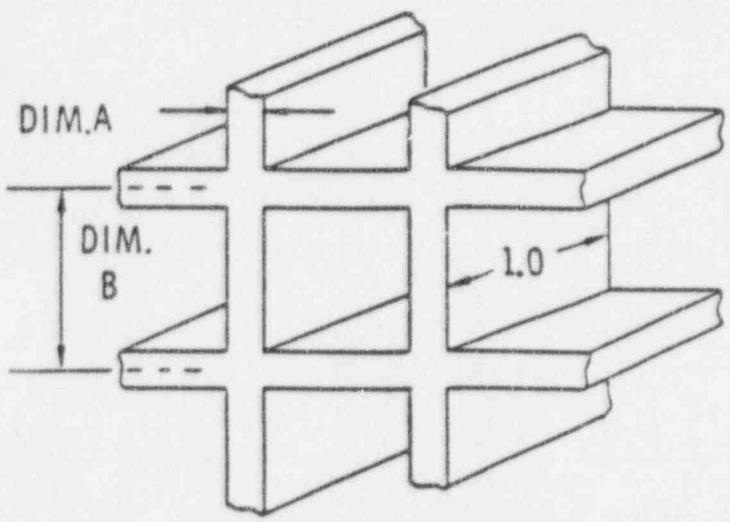


Figure 2.7 Axial core structure dimensions (in inches) for **EPRU75**. Source: Ref. 7 (Copyright © 1976. Electric Power Research Institute. EPRI NP-196. *Clean Critical Experiment Benchmarks for Plutonium Recycle in LWRs*. Reprinted with Permission.)



FUEL TYPE	PITCH	GRID	DIM.A	DIM B
UO_2-2.35% ^{235}U	0.615 0.87	UPPER LOWER	0.032 0.090	0.615

Figure 2.8 Dimensions (in inches) of "eggcrate" grids for **EPRU65** and **EPRU87**. Source: Ref. 7 (Copyright © 1976. Electric Power Research Institute. EPRI NP-196. *Clean Critical Experiment Benchmarks for Plutonium Recycle in LWRs*. Reprinted with Permission.)

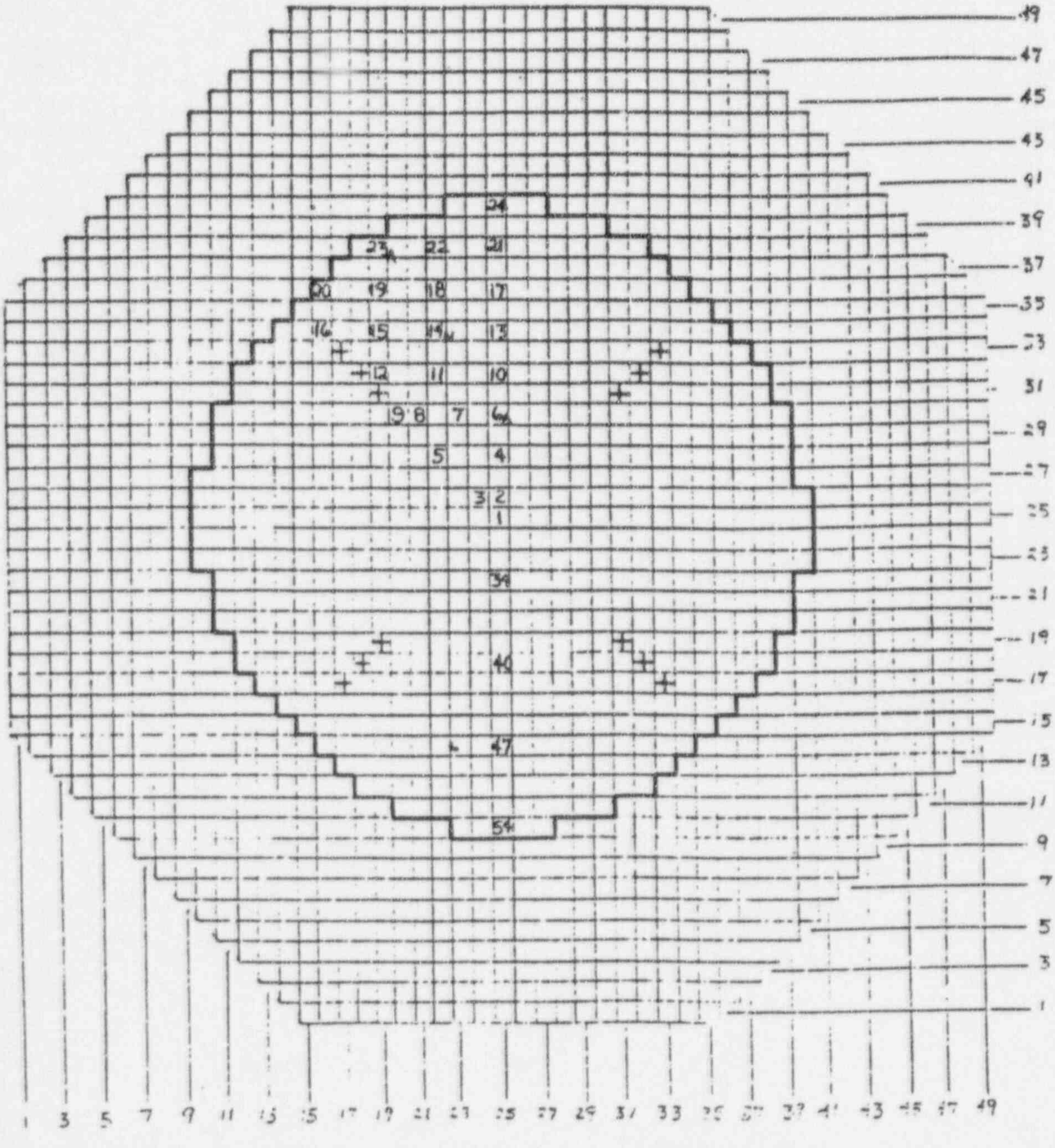


Figure 2.9 Core layout for **EPRU65**. Source: Ref. 7 (Copyright © 1976. Electric Power Research Institute. EPRI NP-196. *Clean Critical Experiment Benchmarks for Plutonium Recycle in LWRs*. Reprinted with Permission.)

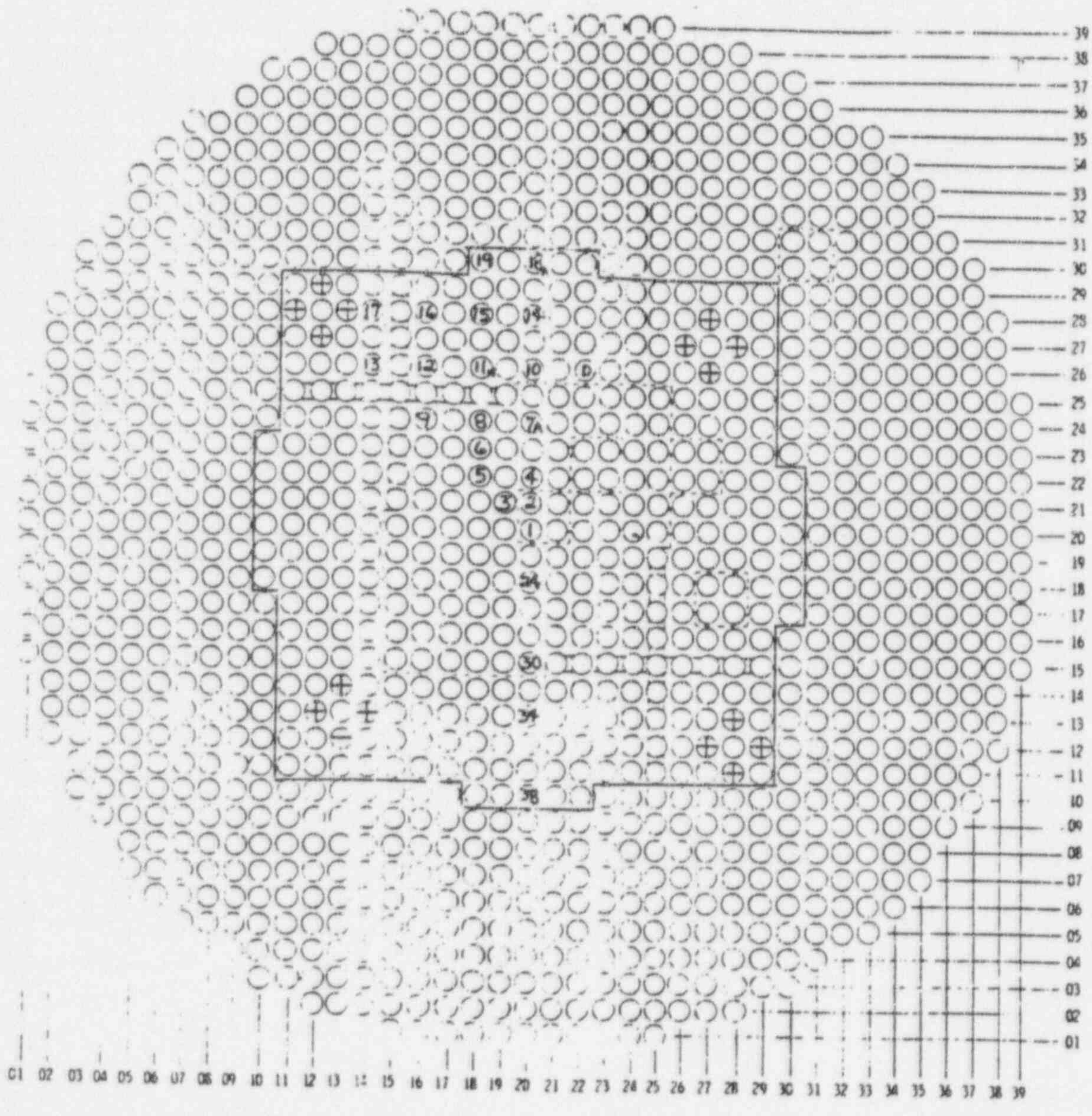
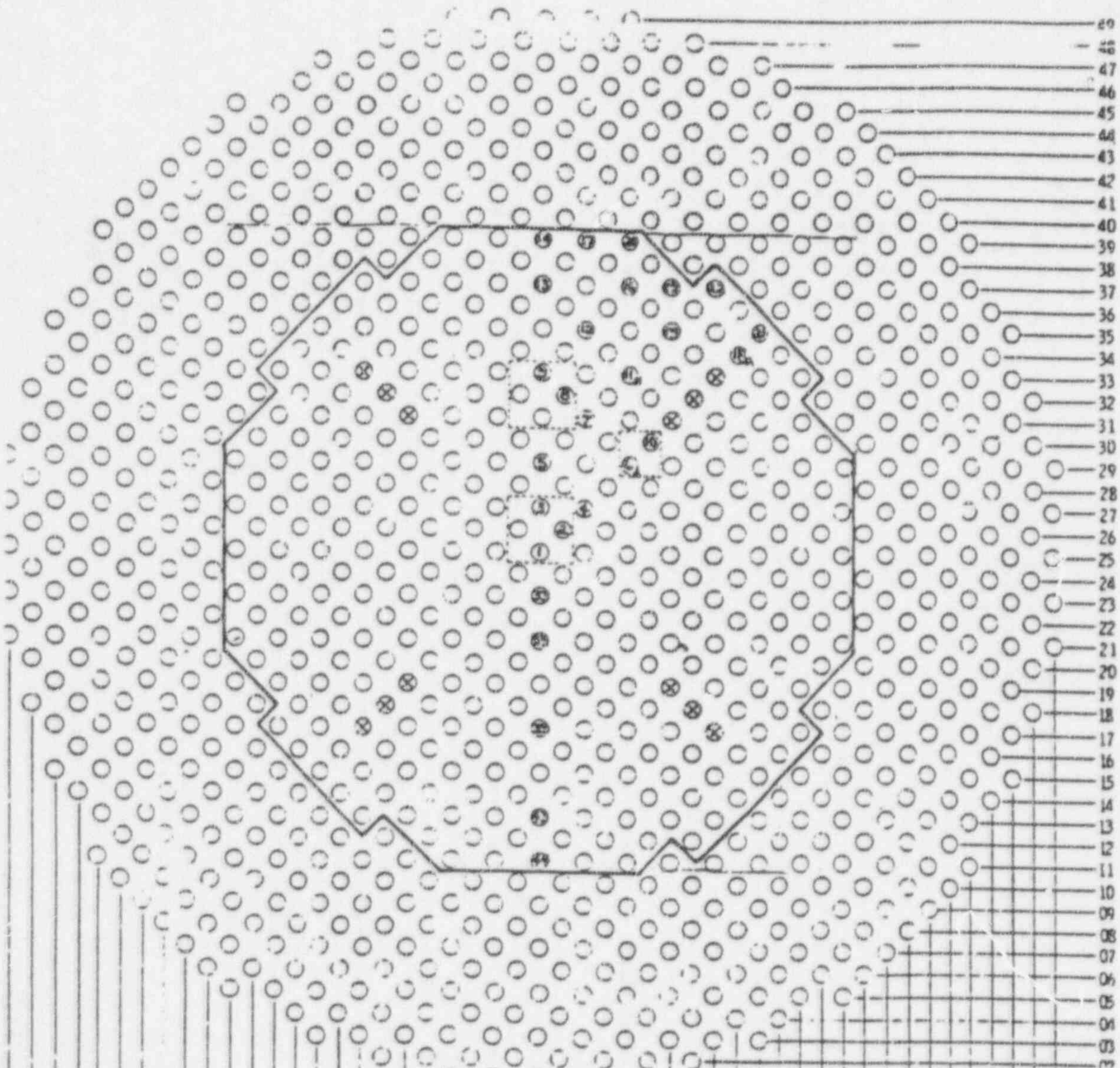


Figure 2.10 Core layout for **EPRU75**. Source: Ref. 7 (Copyright © 1976. Electric Power Research Institute. EPRI NP-196. *Clean Critical Experiment Benchmarks for Plutonium Recycle in LWRs.* Reprinted with Permission.)



0.87-INCH UO_2 CORE, UNBORATED, GAMMA SCAN IRRADIATION

Figure 2.11 Core layout for EPRU87. Source: Ref. 7 (Copyright © 1976. Electric Power Research Institute. EPRI NP-196. *Clean Critical Experiment Benchmarks for Plutonium Recycle in LWRs.* Reprinted with Permission.)

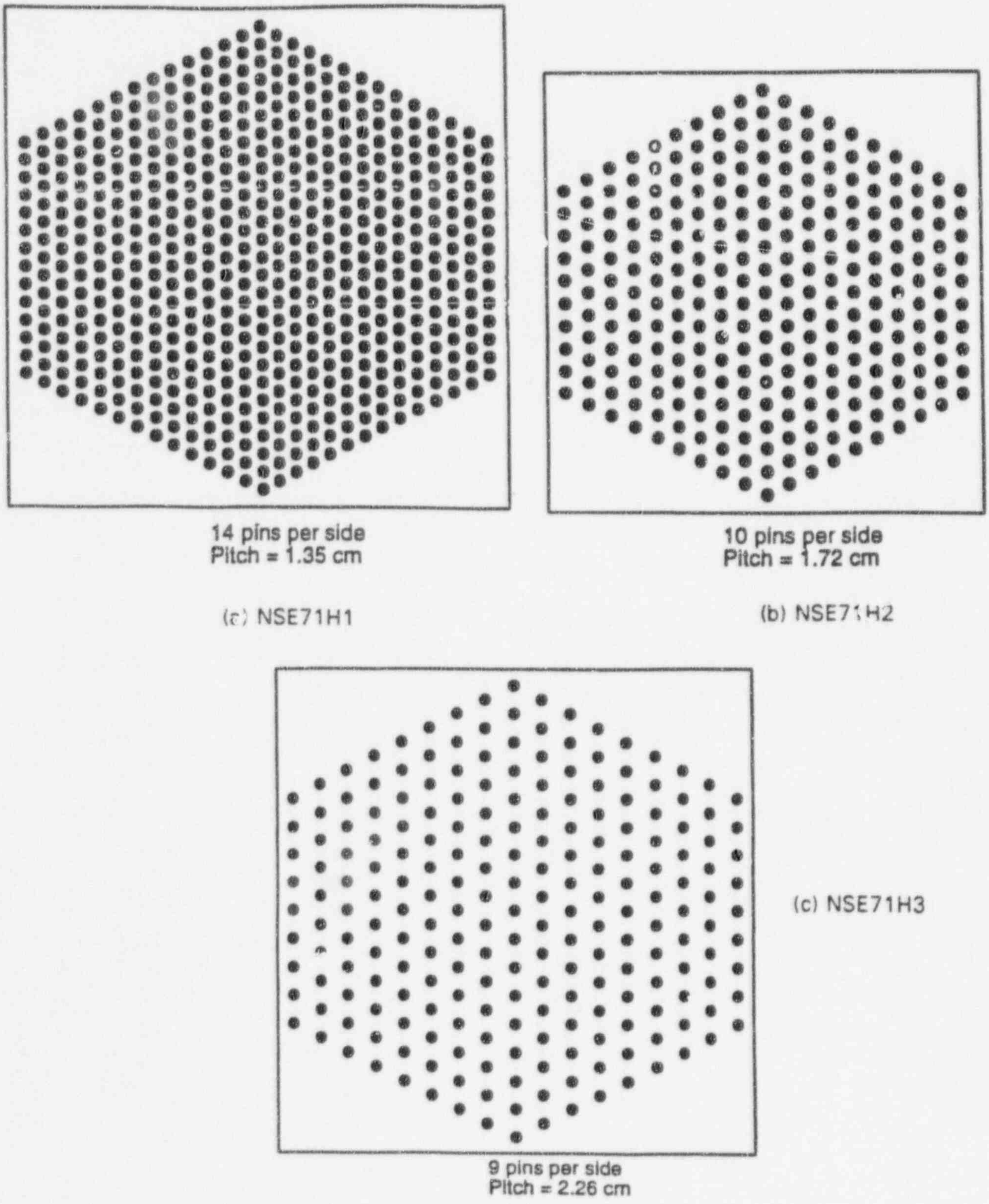


Figure 2.12 Core configurations for three hexagonal lattice experiments of NS&E, Vol. 71. *Source*: Ref. 8 (Reprinted with permission by author)

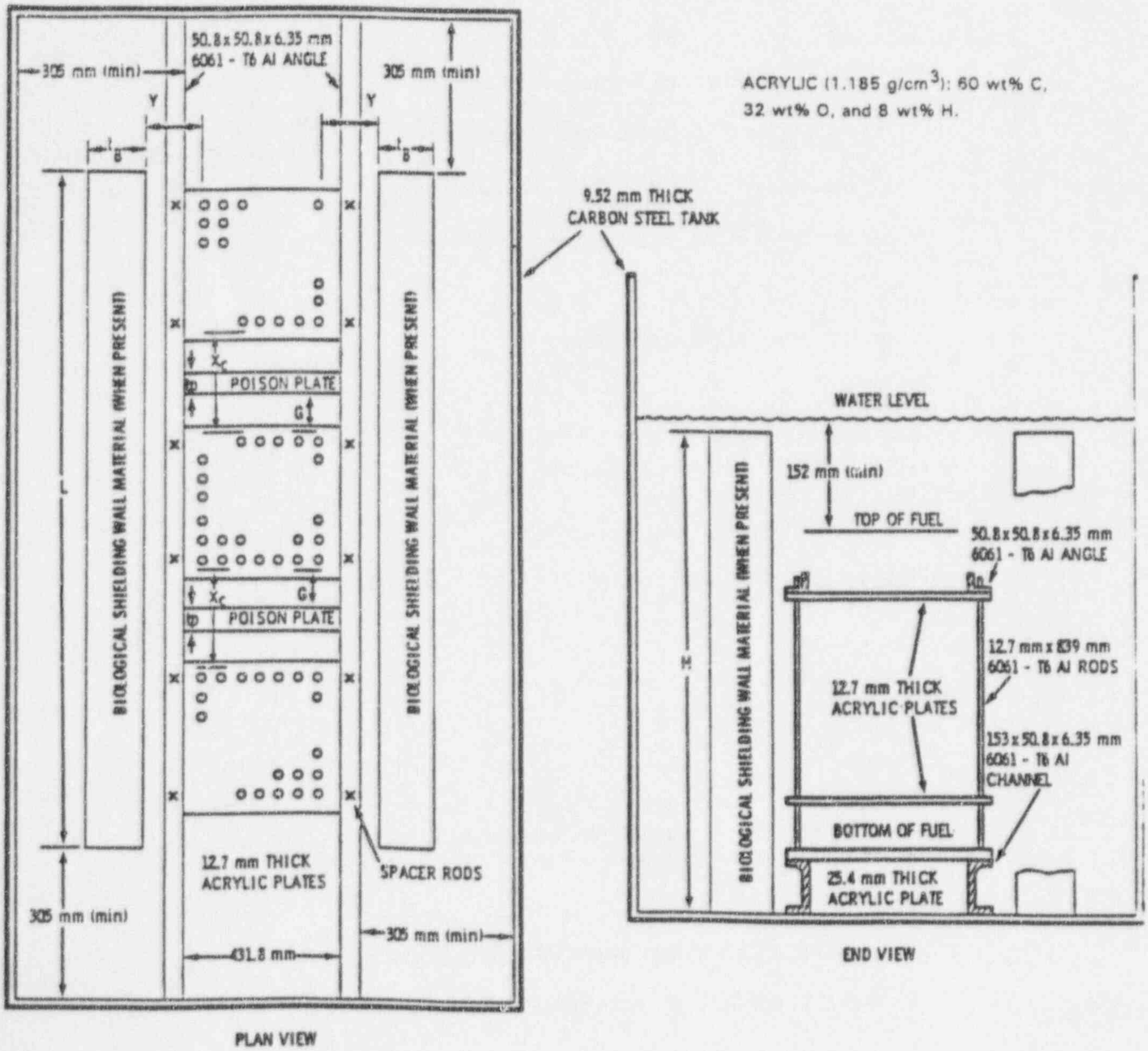
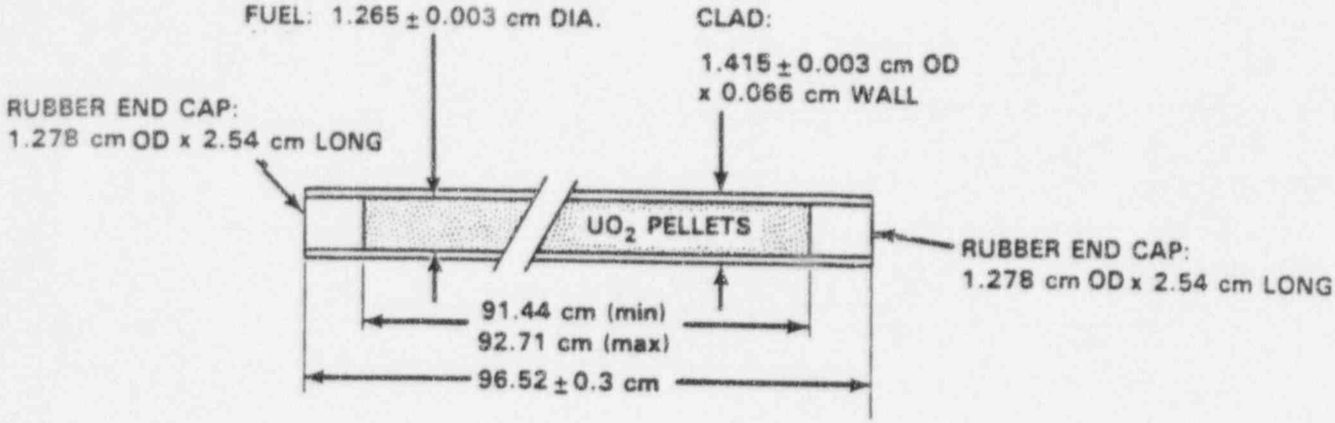


Figure 2.13 Planar and end views of experiments from PNL-2438. *Source*: Ref. 9 (Reprinted with permission from authors)



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%

NOTES:

1. ERROR LIMITS ARE ONE STANDARD DEVIATION
2. END CAP DENSITY IS 1.321 g/cm^3

Figure 2.14 Description of 4.31 wt % UO_2 fuel rods used in experiments from PNL-3314. *Source*: Refs. 11 and 14 (Reprinted with permission from authors)

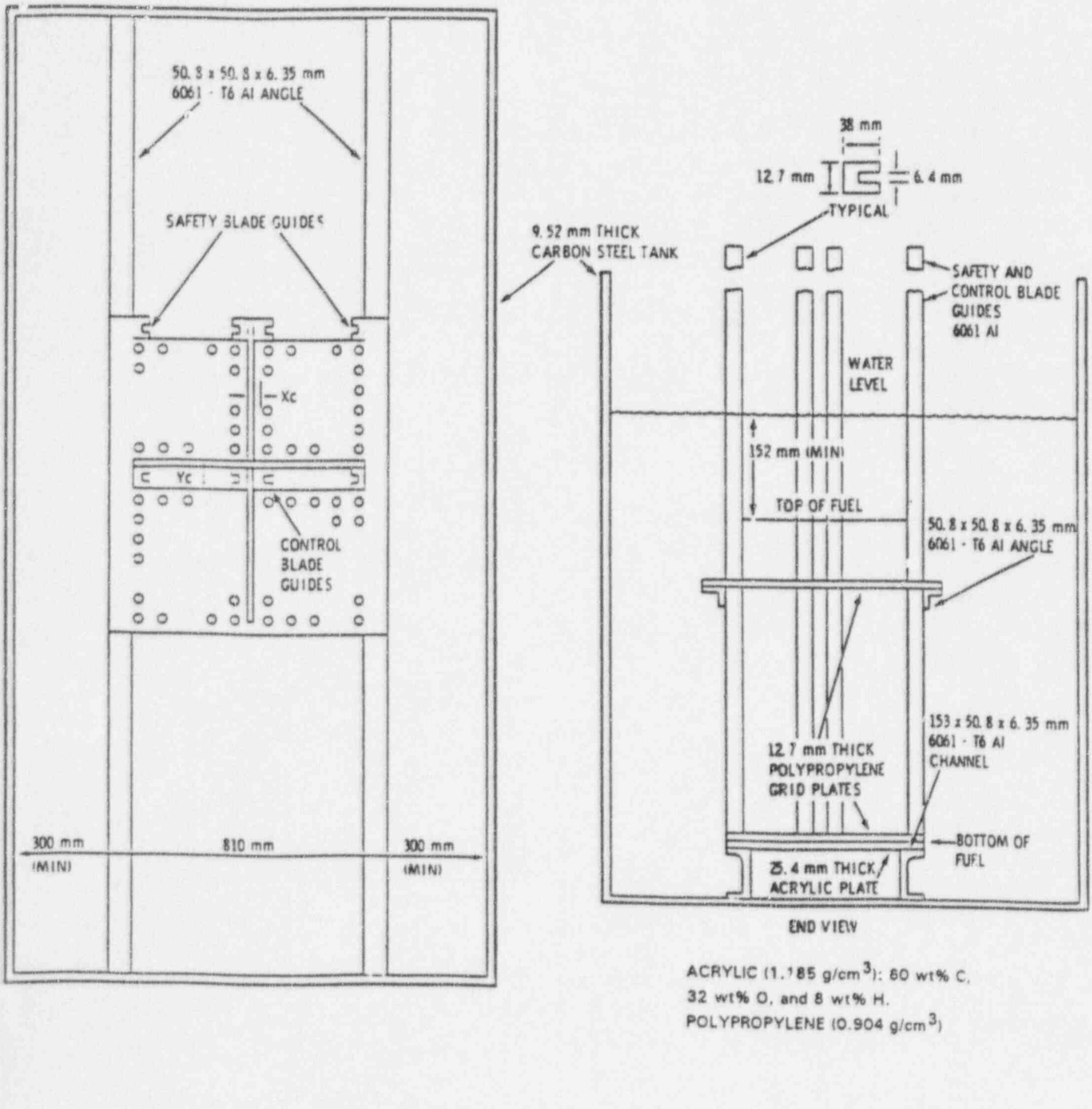


Figure 2.15 Planar and end view of experiments with four-assembly geometry from PNL-3314. Source: Ref. 11 (Reprinted with permission from author)

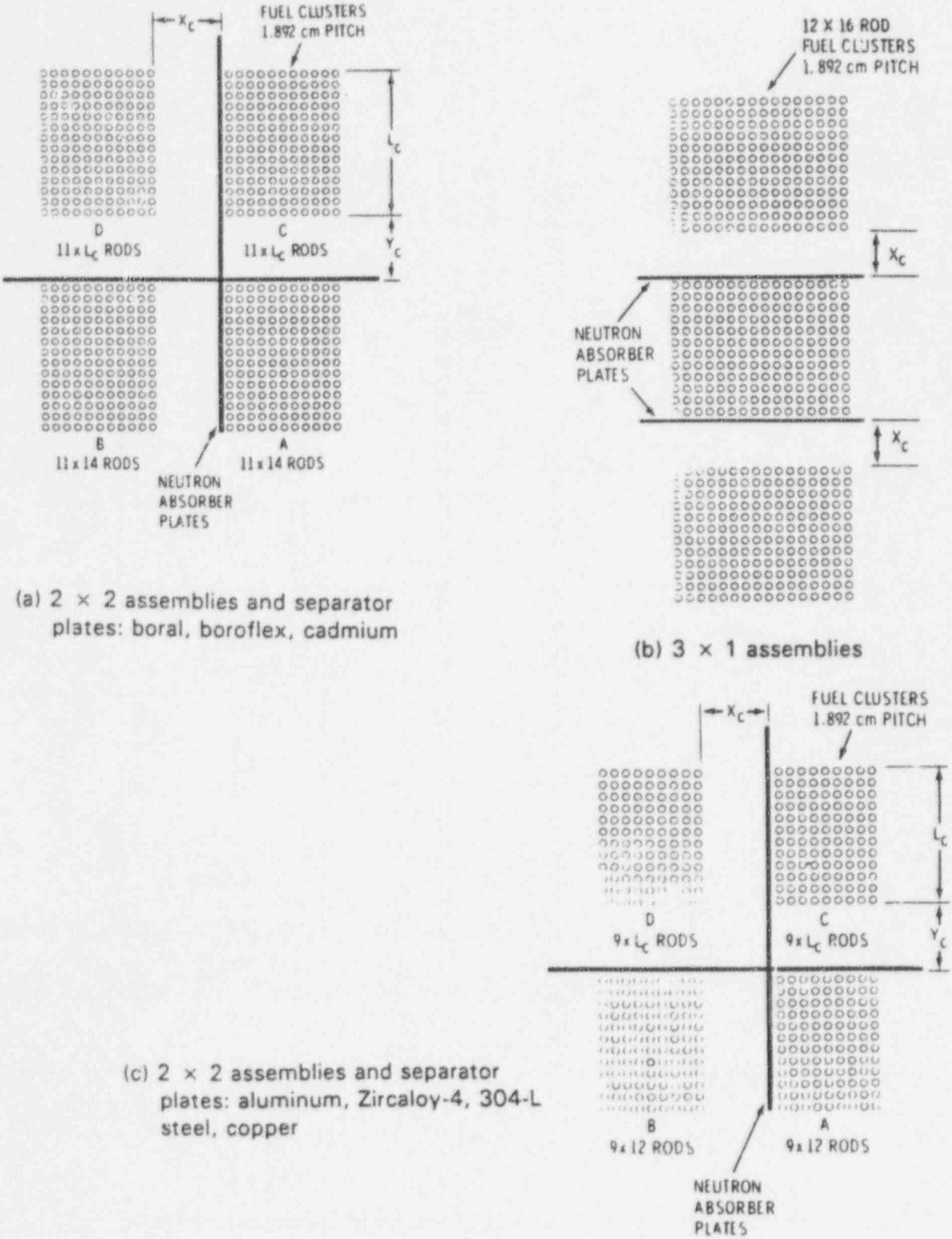


Figure 2.16a Fuel assemblies and absorber plate configurations for experiments with 4.31 wt % UO_2 fuel rods from PNL-3314. Source: Ref. 11 (Reprinted with permission from author)

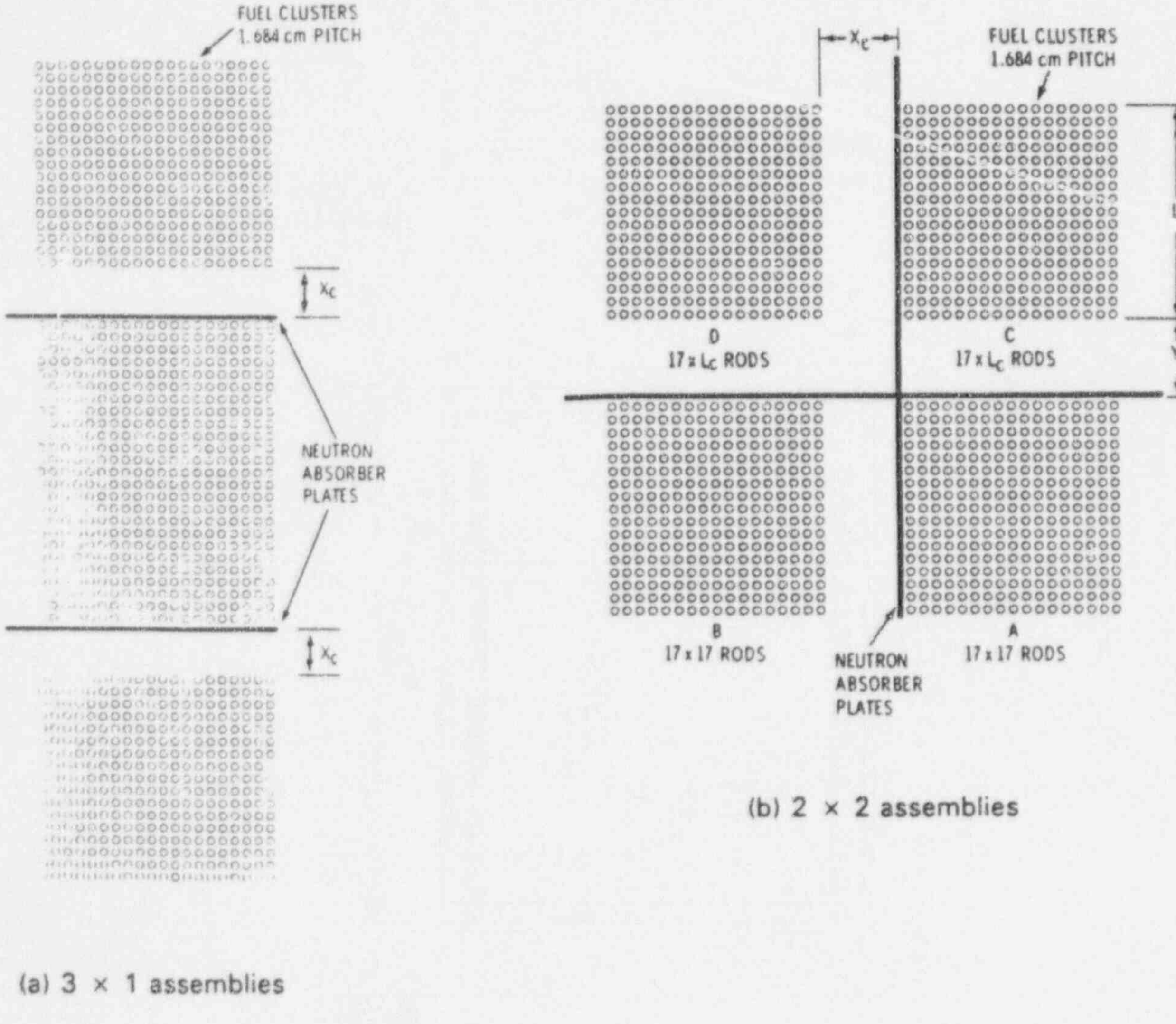


Figure 2.16b Fuel assemblies and absorber plate configurations for experiments with 2.35 wt % UO_2 fuel rods from PNL-3314. *Source*: Ref. 11 (Reprinted with permission from author)

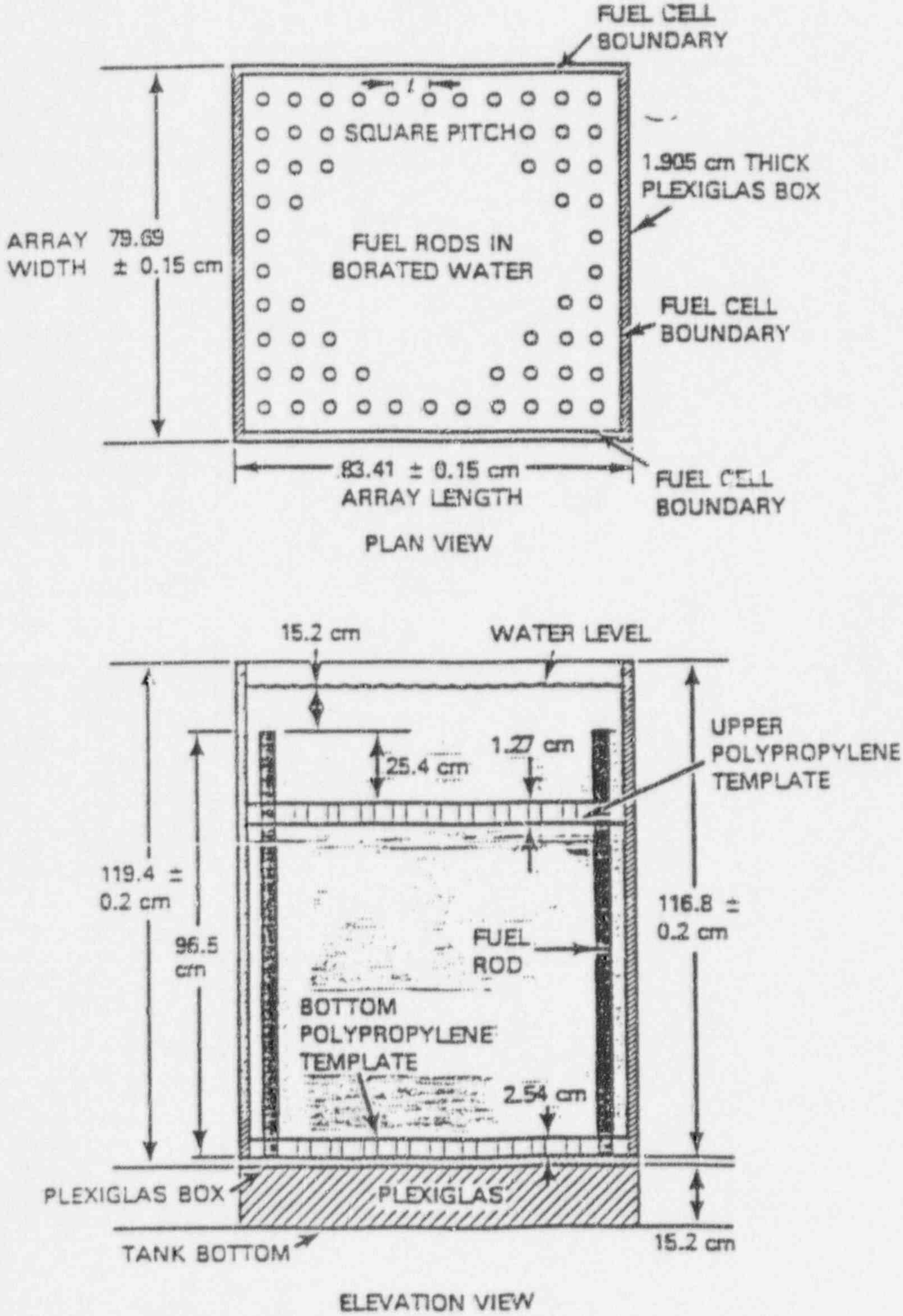


Figure 2.17 Experimental setup for experiments from PNL-4267. Source: Ref. 13 (Reprinted with permission from author)

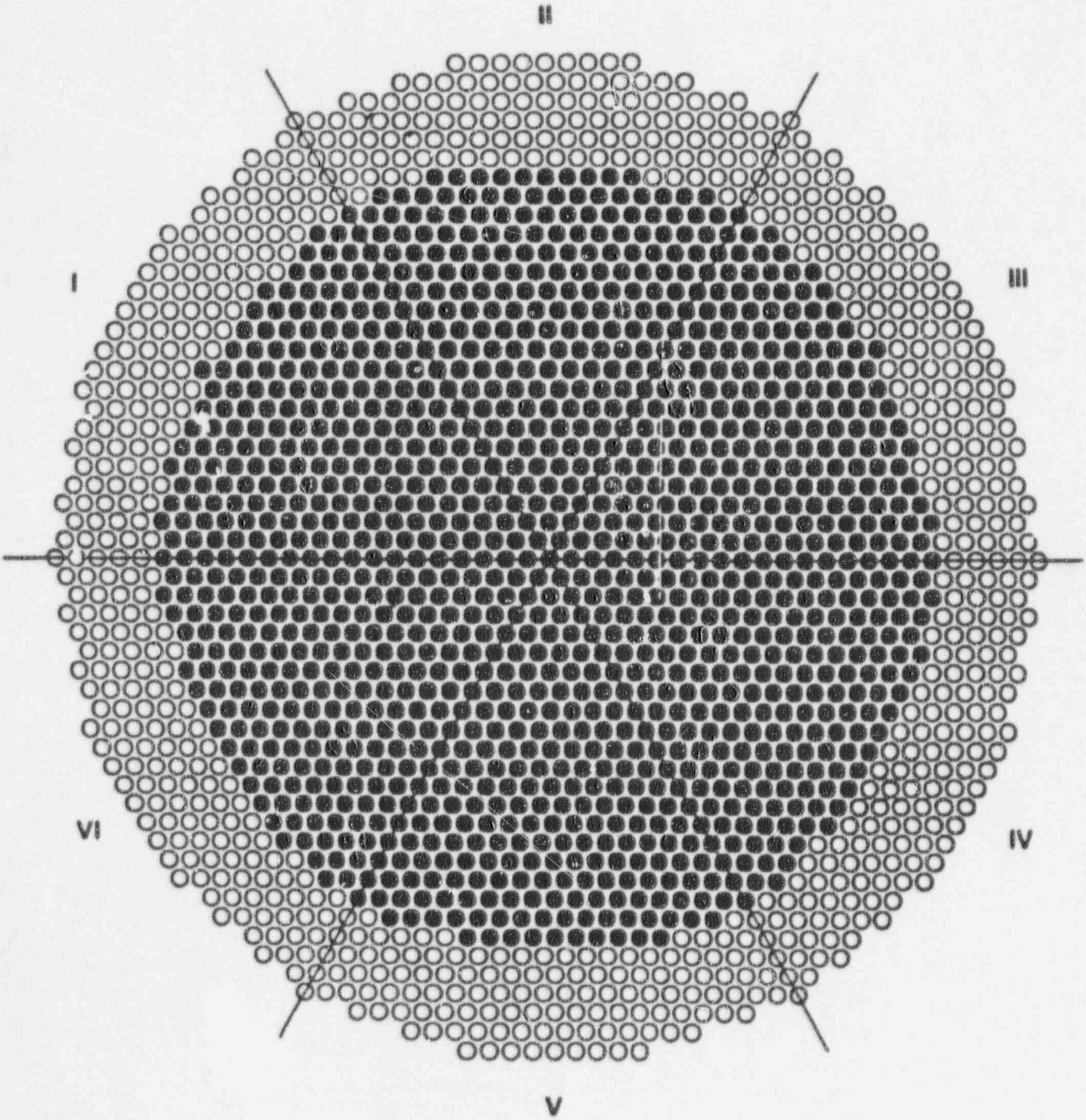


Figure 2.18 Core assembly for P49-194. *Source*: Ref. 14 (Reprinted with permission from author)

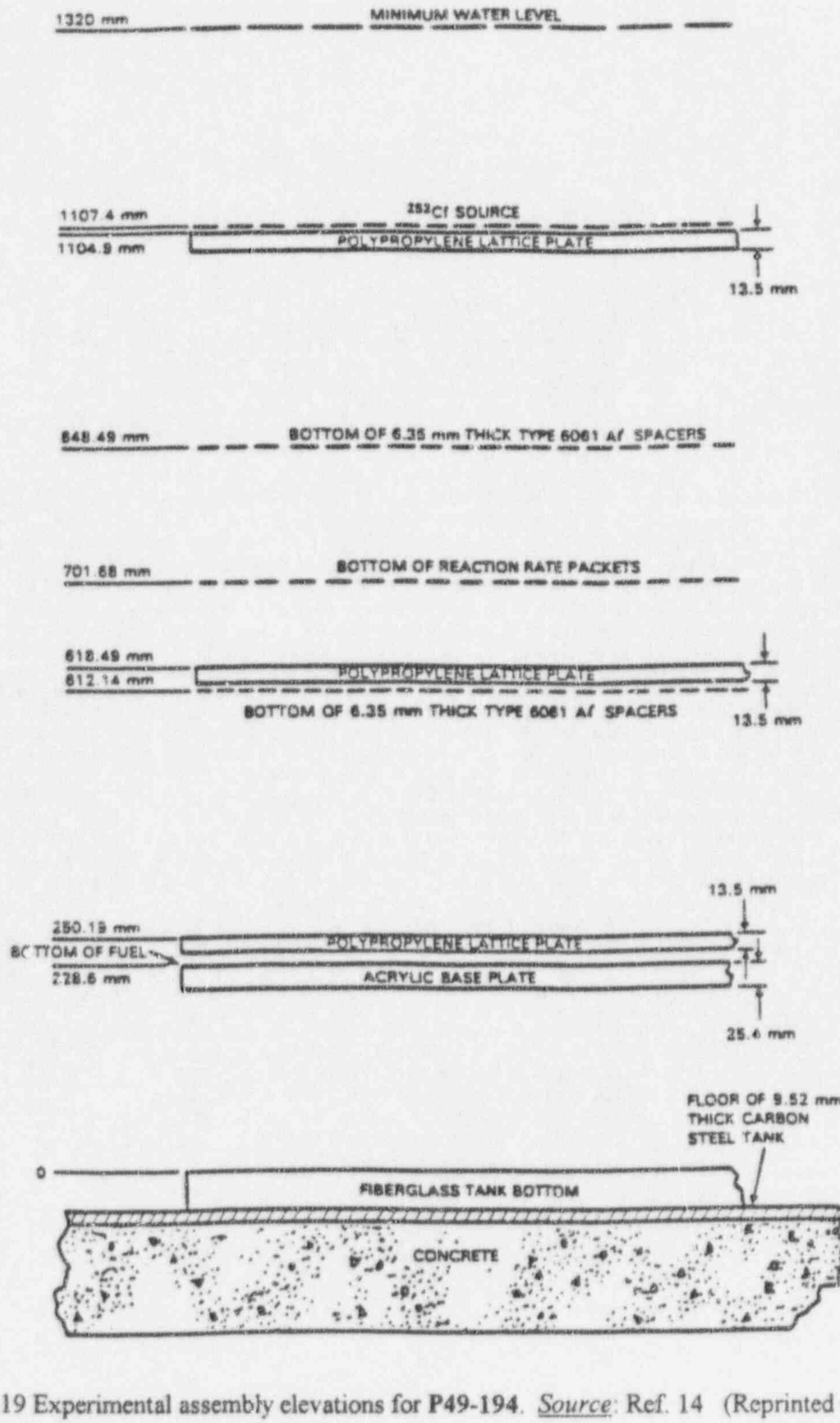


Figure 2.19 Experimental assembly elevations for **P49-194**. *Source*: Ref. 14 (Reprinted with permission from author)

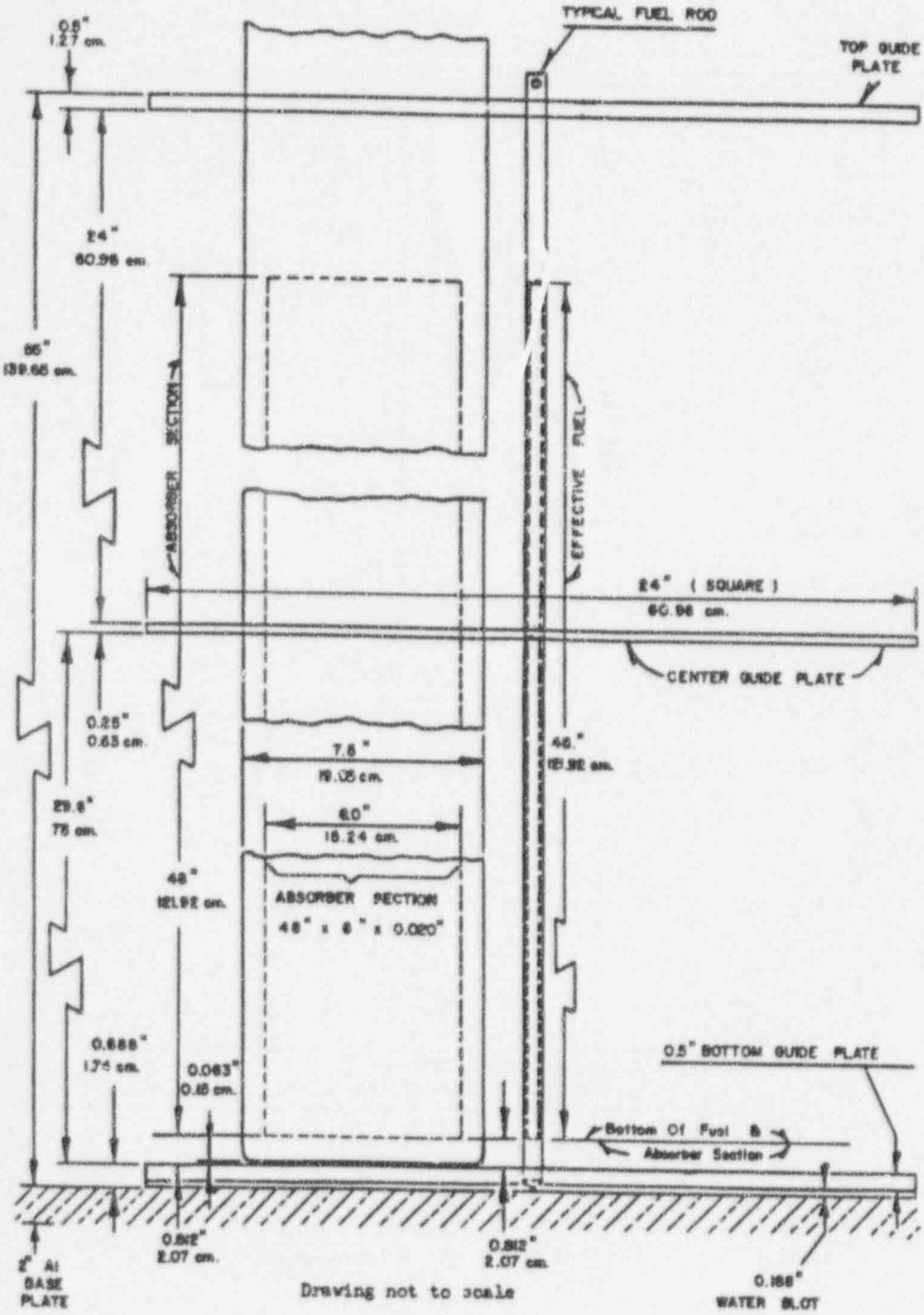


Figure 2.20 Vertical dimensions of experimental assembly for W3269SL1. _Source_: Ref. 15

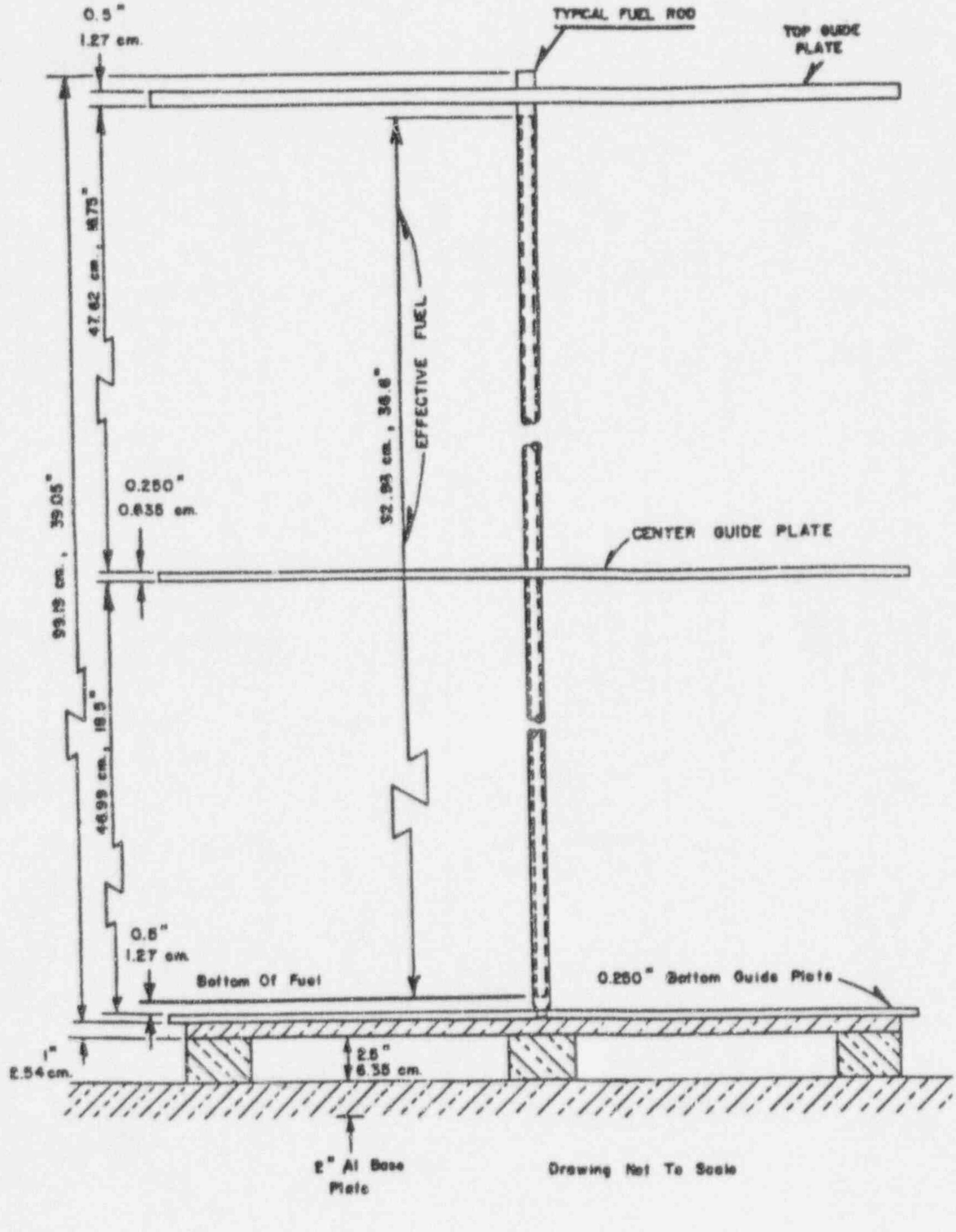


Figure 2.21 Vertical dimensions of experimental assembly for W3269SL2. *Source*: Ref. 15

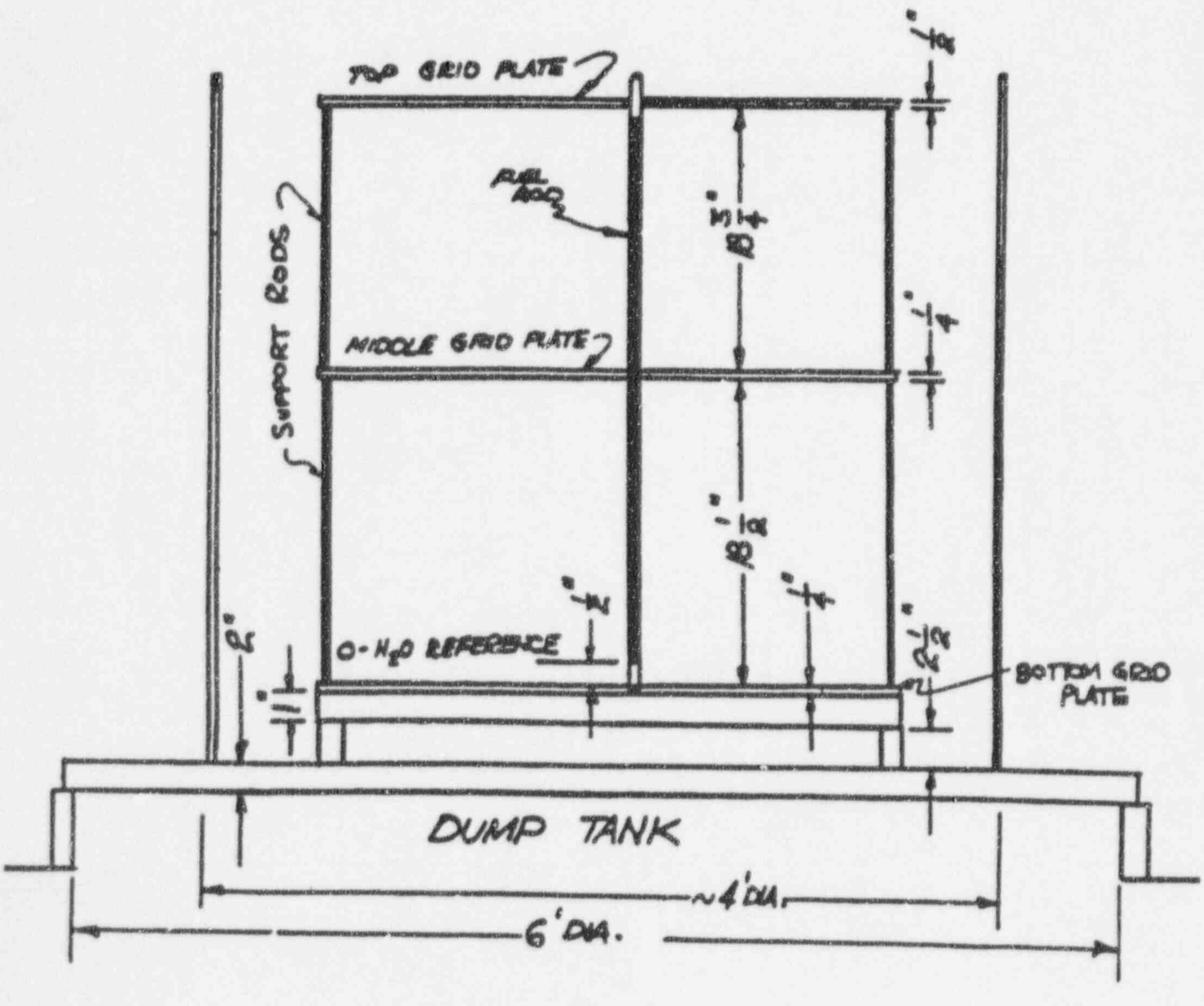


Figure 2.22 Vertical dimensions of experiments from WCAP-3385. <u>Source</u>: Ref. 16

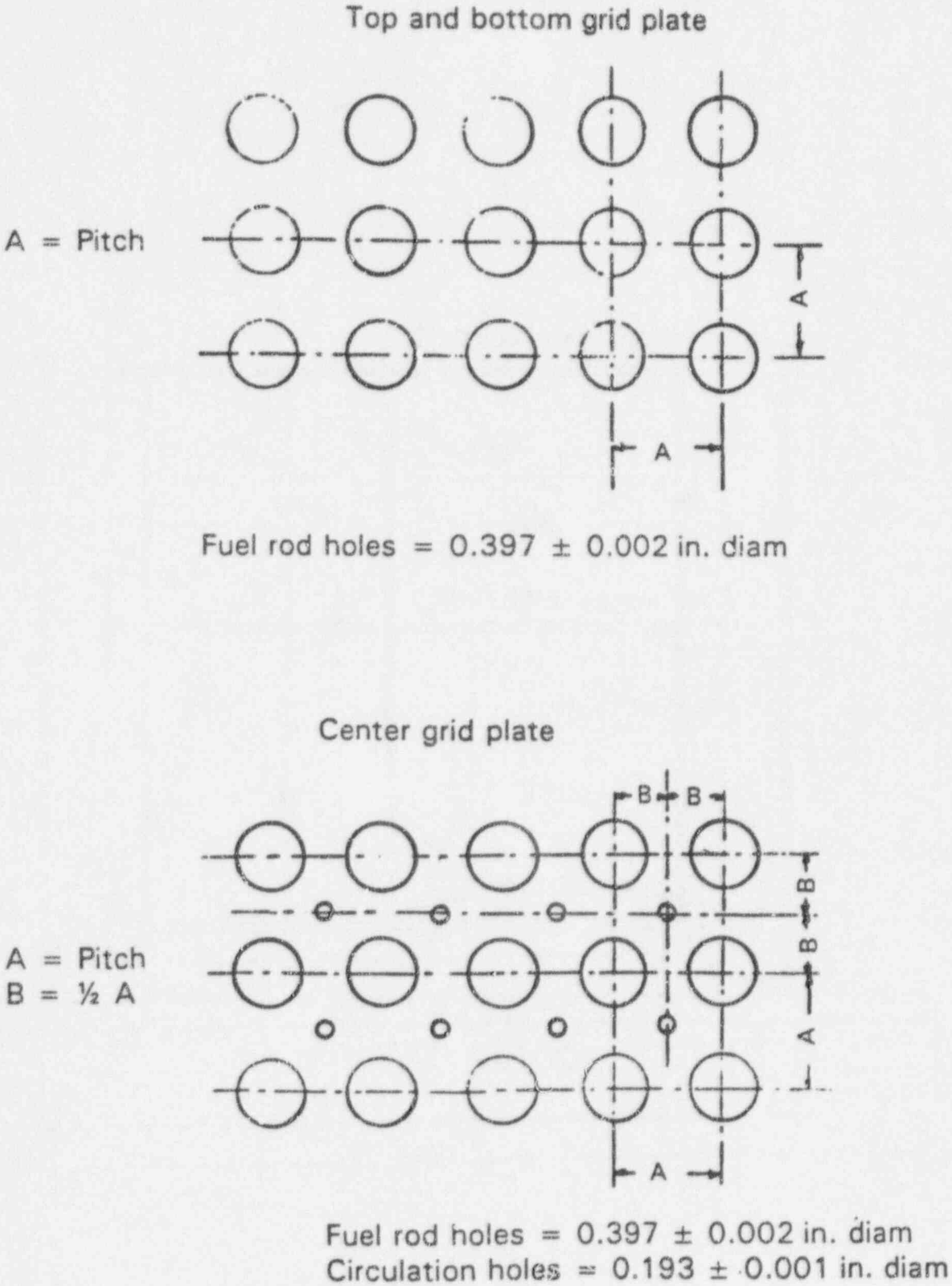
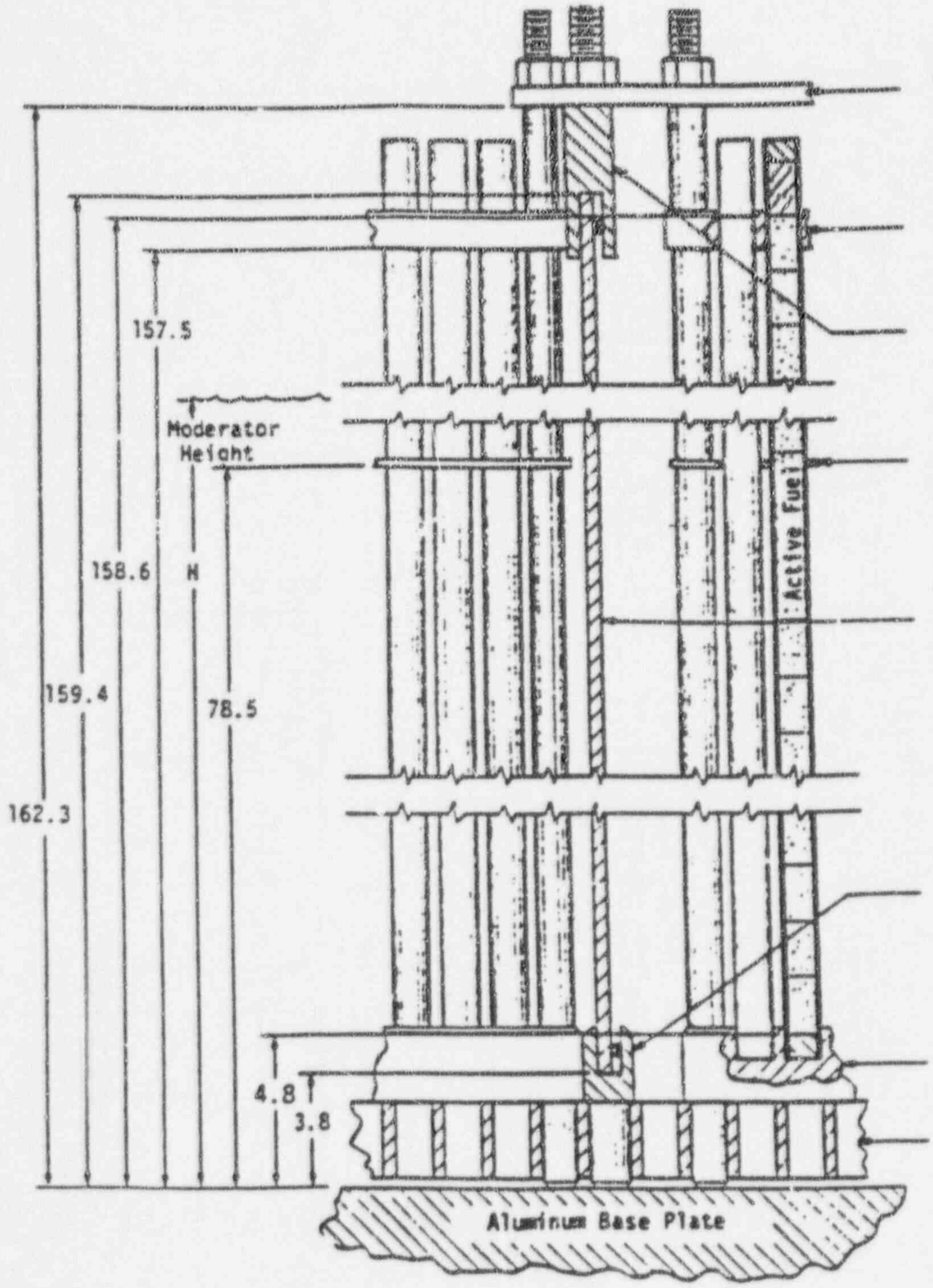


Figure 2.23 Grid plate layouts for experiments from WCAP-3385. <u>Source</u>: Ref. 16



Note: Dimensions given in centimeters.

Figure 2.24 Vertical dimensions for separator plate experiments from BAW-1484. *Source*: Ref. 6

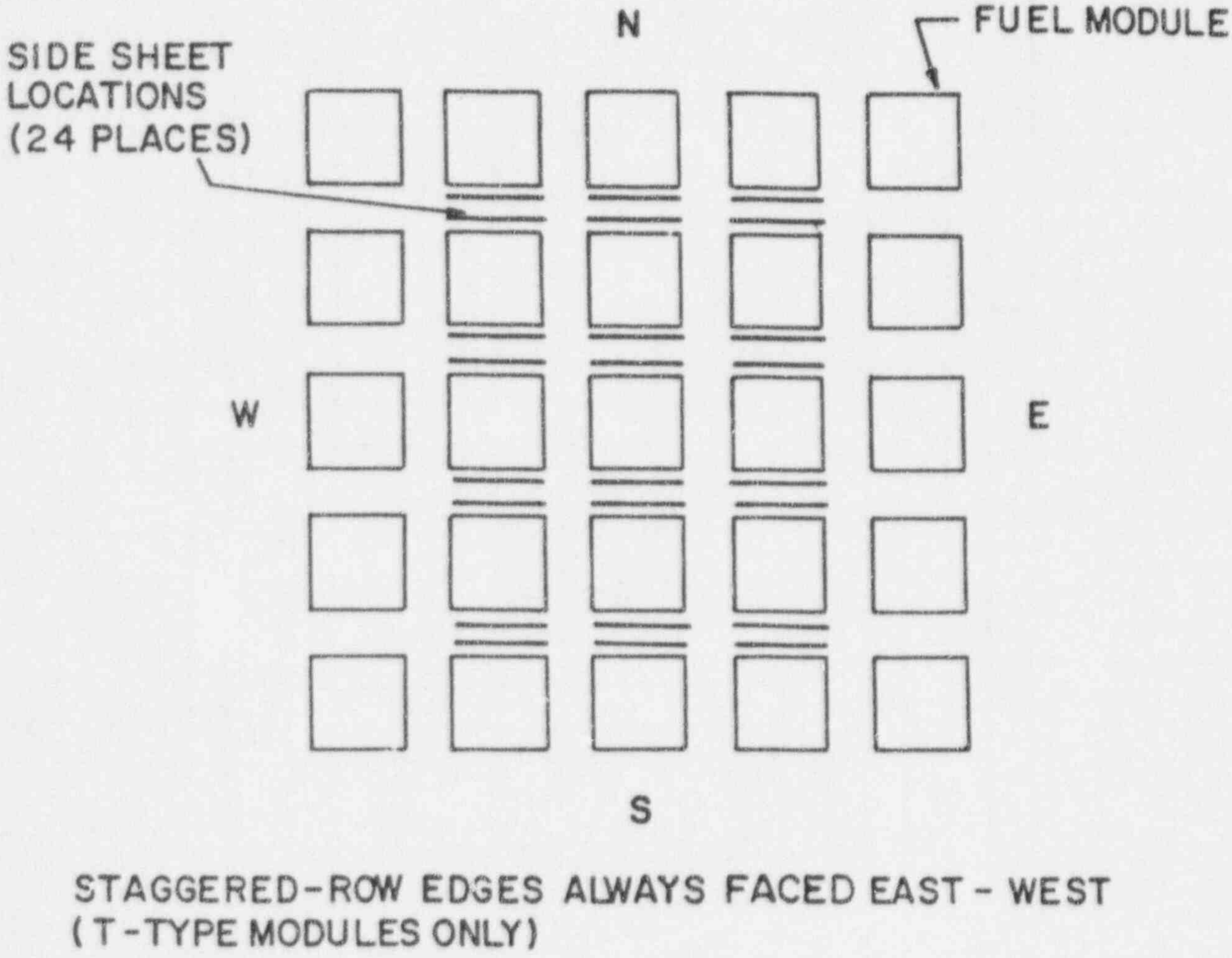


Figure 2.25 Side sheet locations for separator plate experiments from BAW-1645. *Source*: Ref. 17

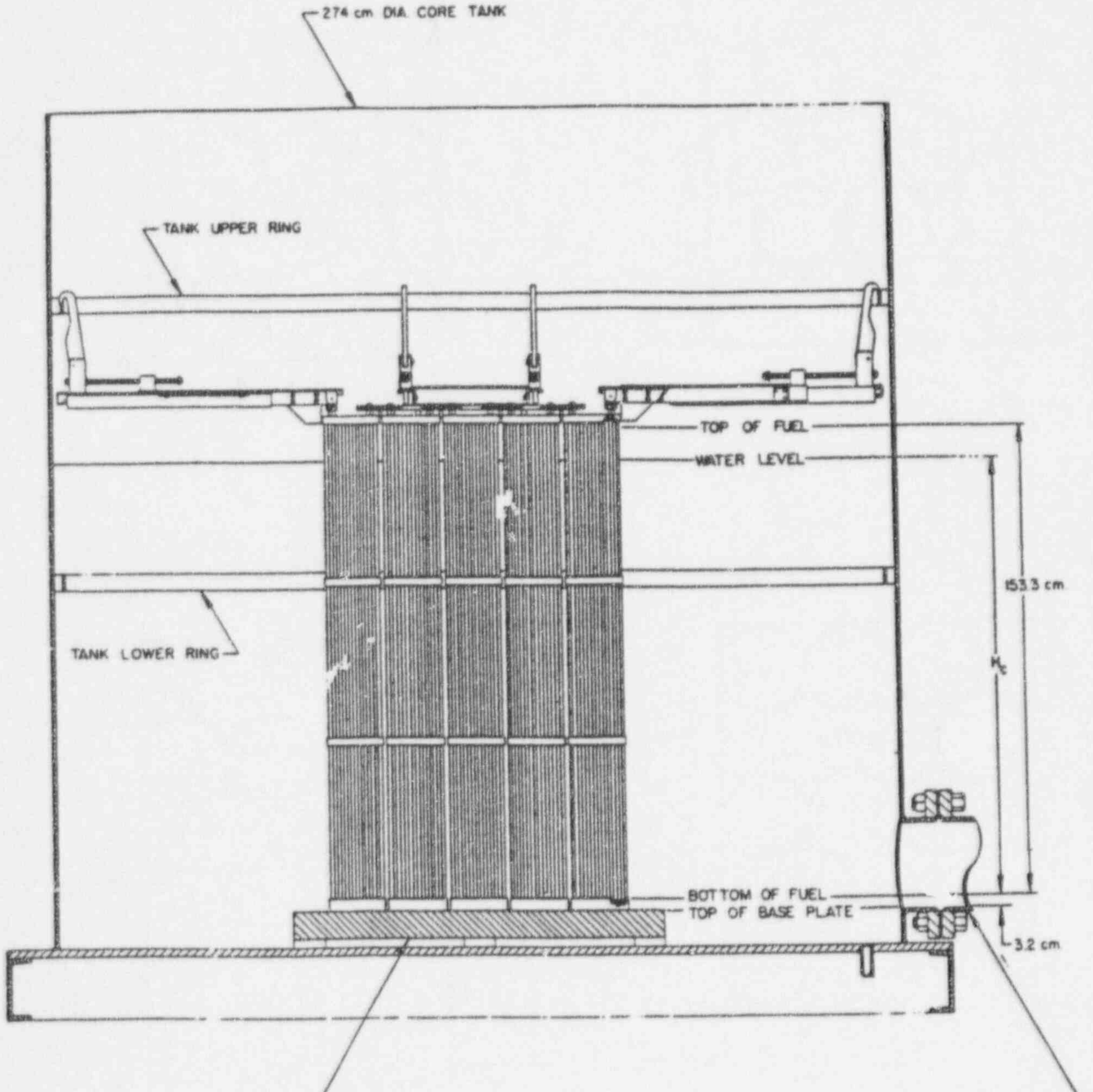


Figure 2.26 Vertical dimensions of experiments from BAW-1645. *Source*: Ref. 17

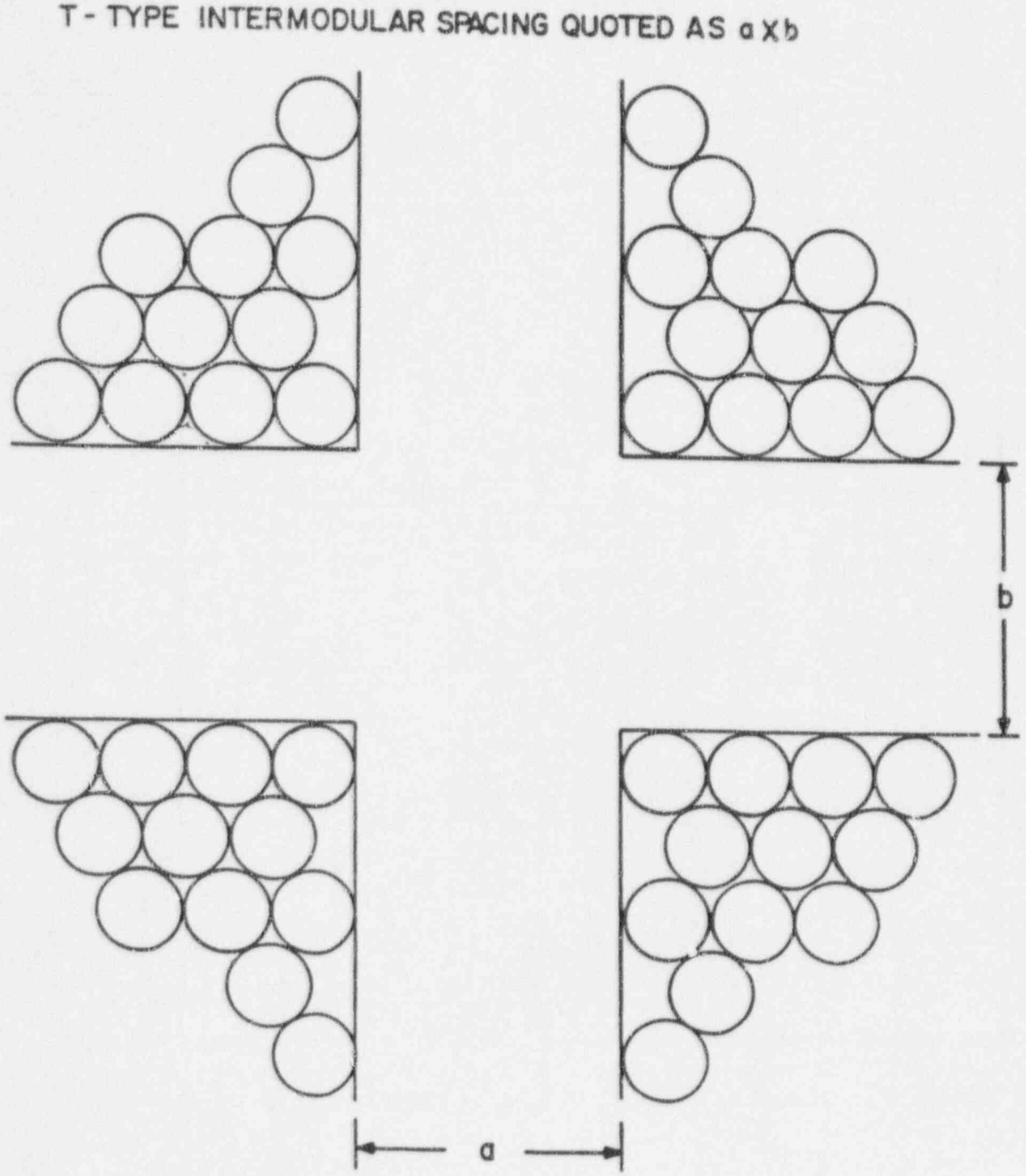
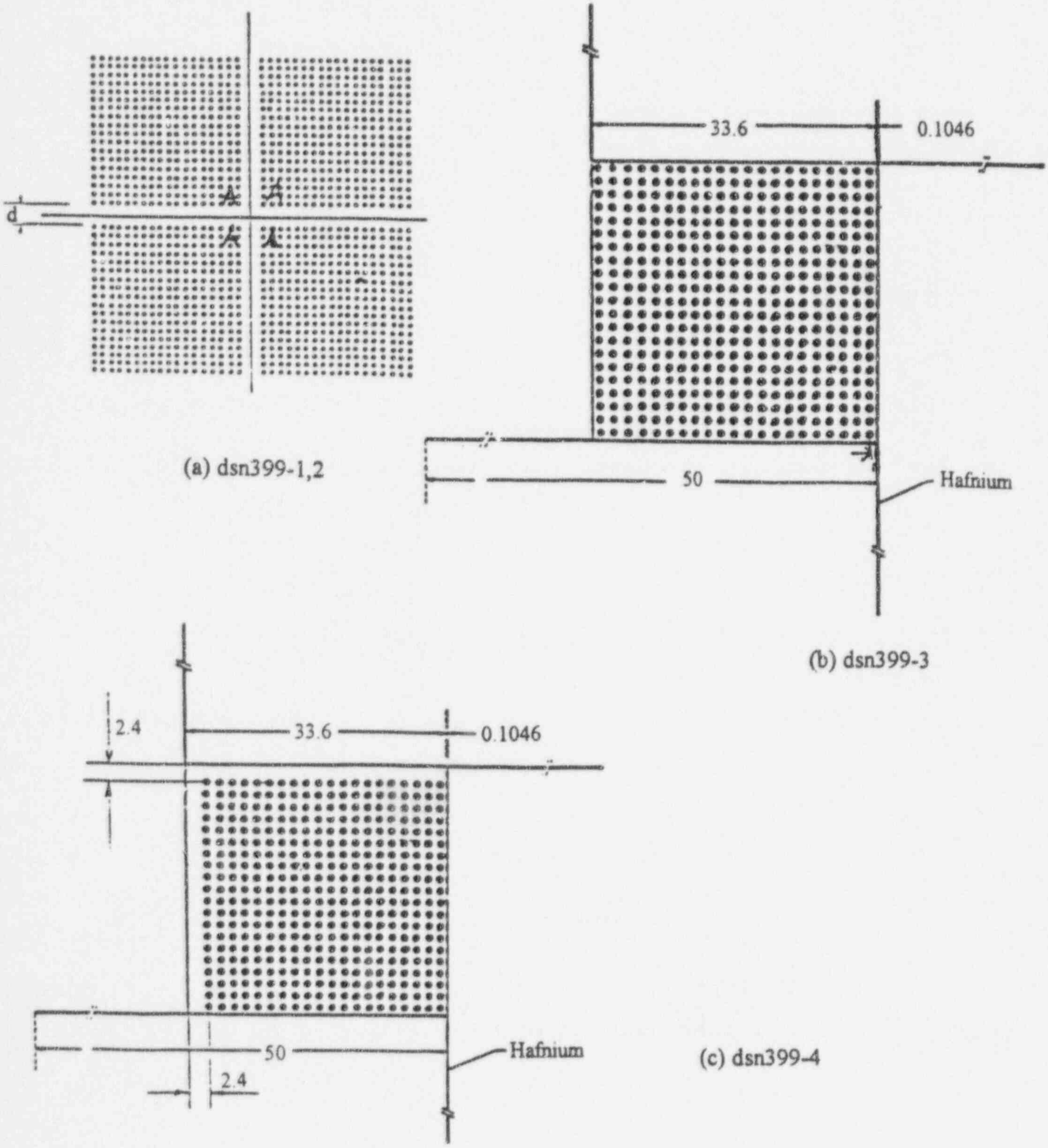


Figure 2.27 Intermediate spacing for **BW1645T1**, **BW1645T2**, **BW1645T3**, and **BW1645T4**. Source: Ref. 17



(a) dsn399-1,2

(b) dsn399-3

(c) dsn399-4

Figure 2.28 Cross-sectional view of separator plate experiments from DSN No. 399/80 (dimensions in cm).
Source: Ref. 18

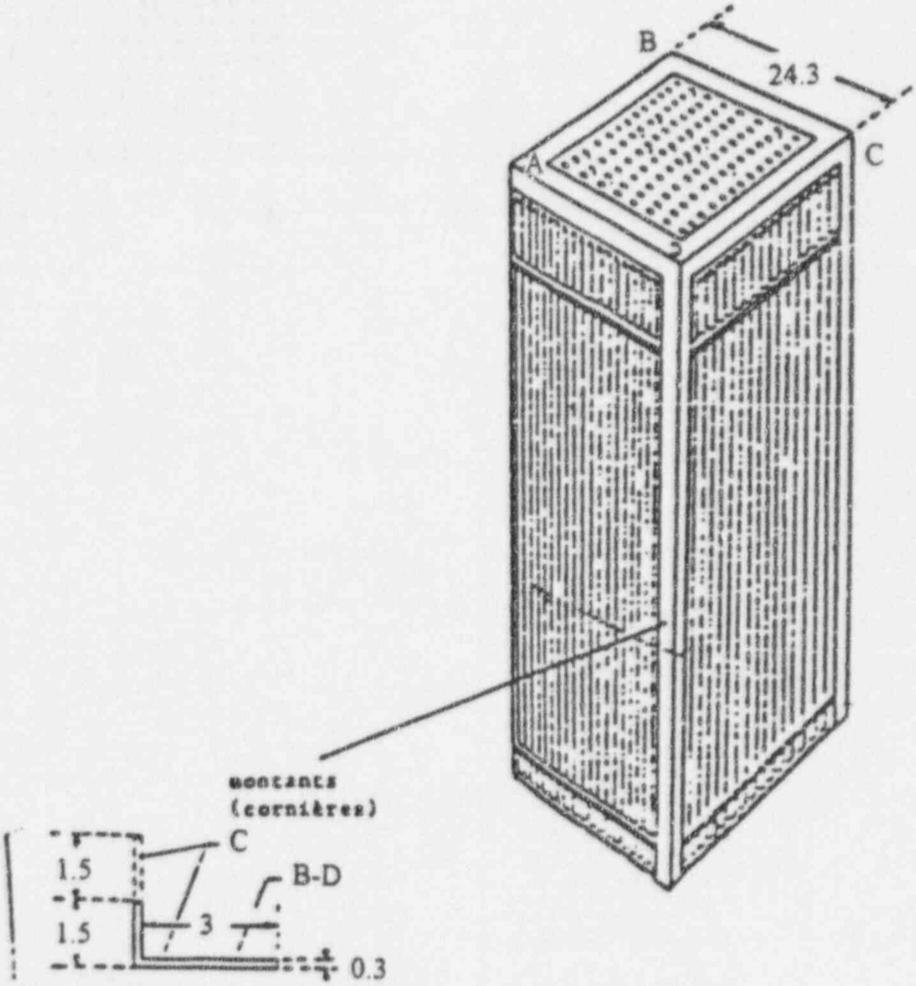


Figure 2.29 Fuel cluster and steel angle iron for DSN399-1 and DSN399-2 (dimensions in cm). *Source*: Ref. 18

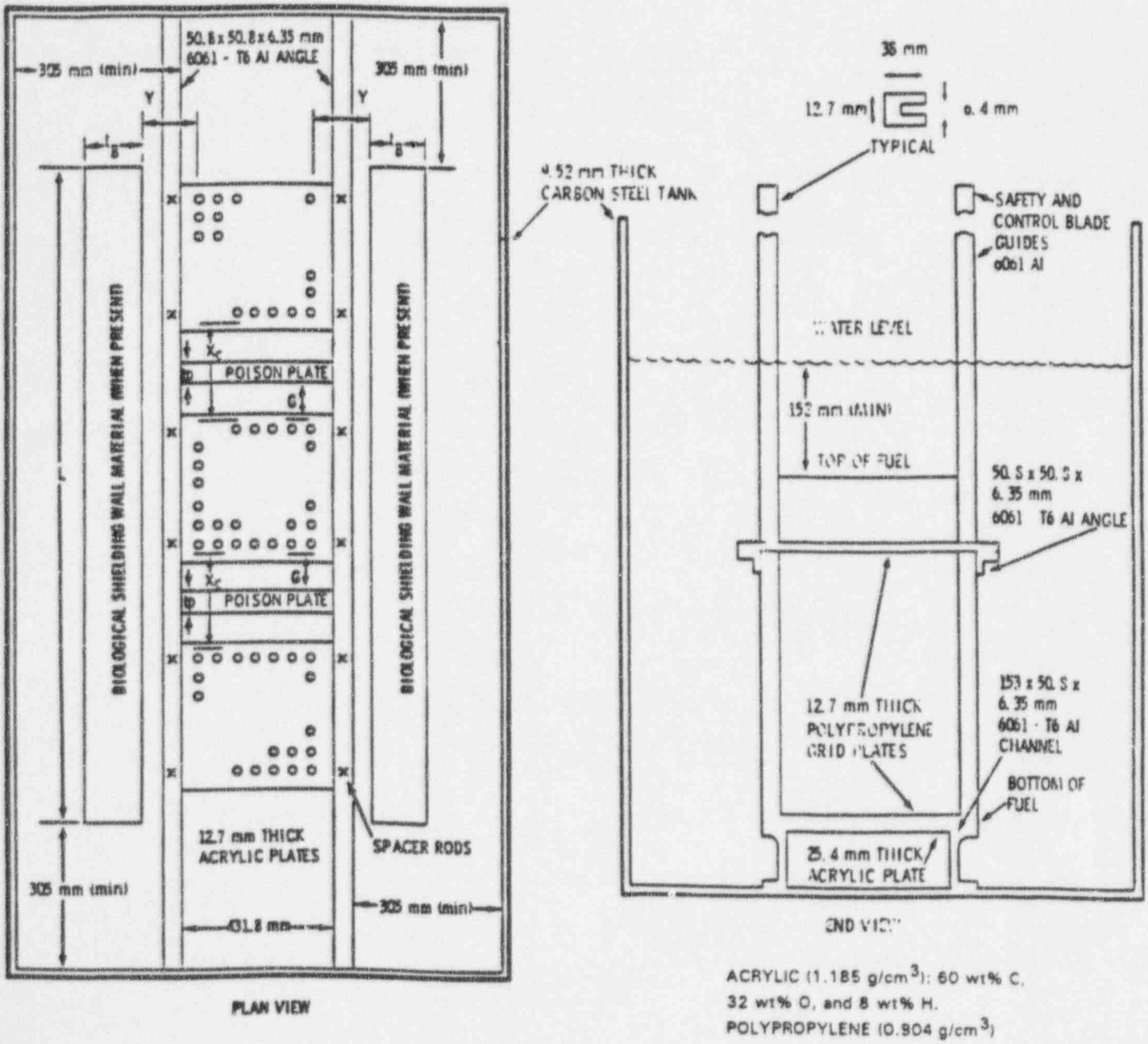


Figure 2.30 Planar and end view of experiments with three-assembly geometry from PNL-3314.
Source: Ref. 11

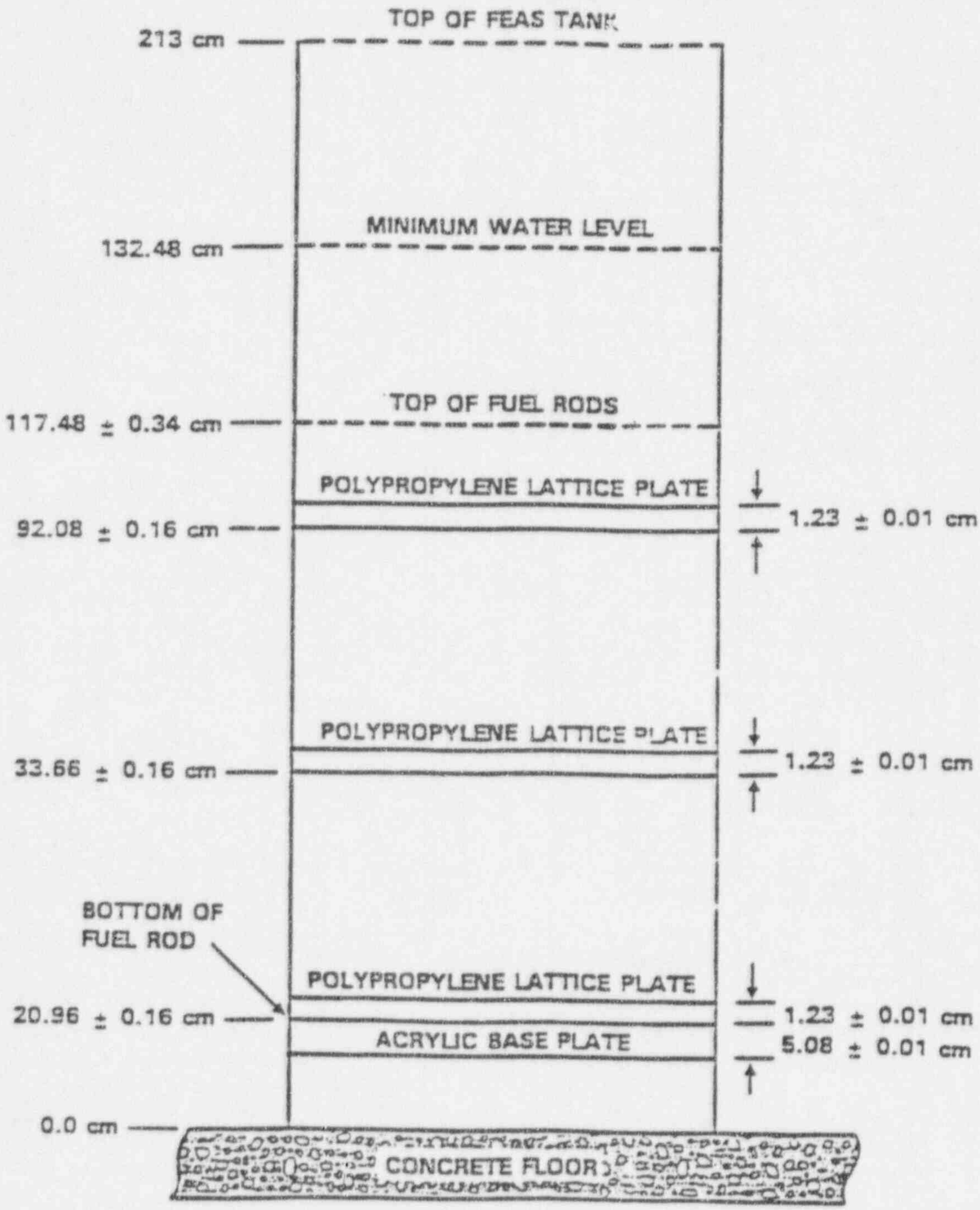
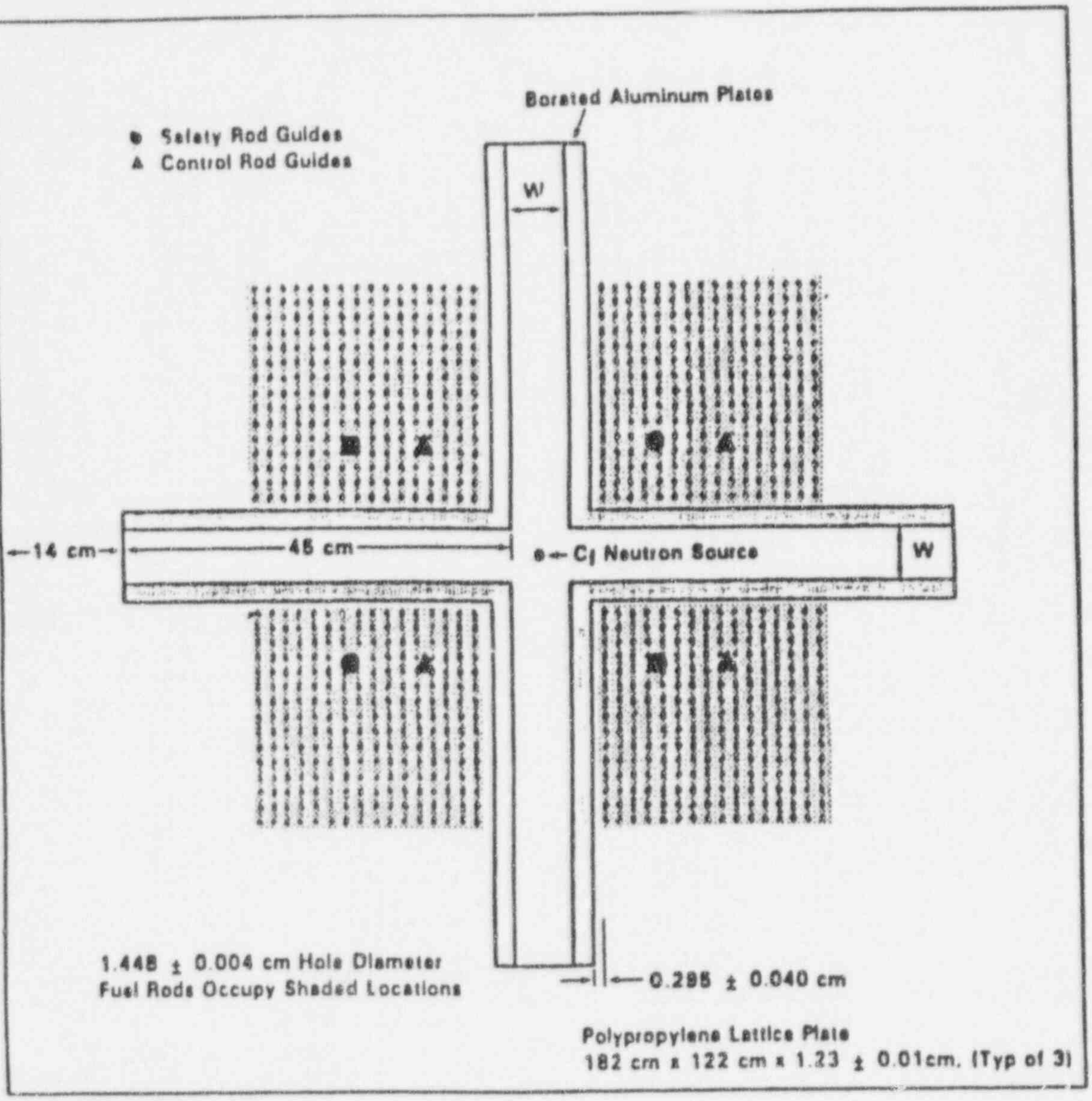


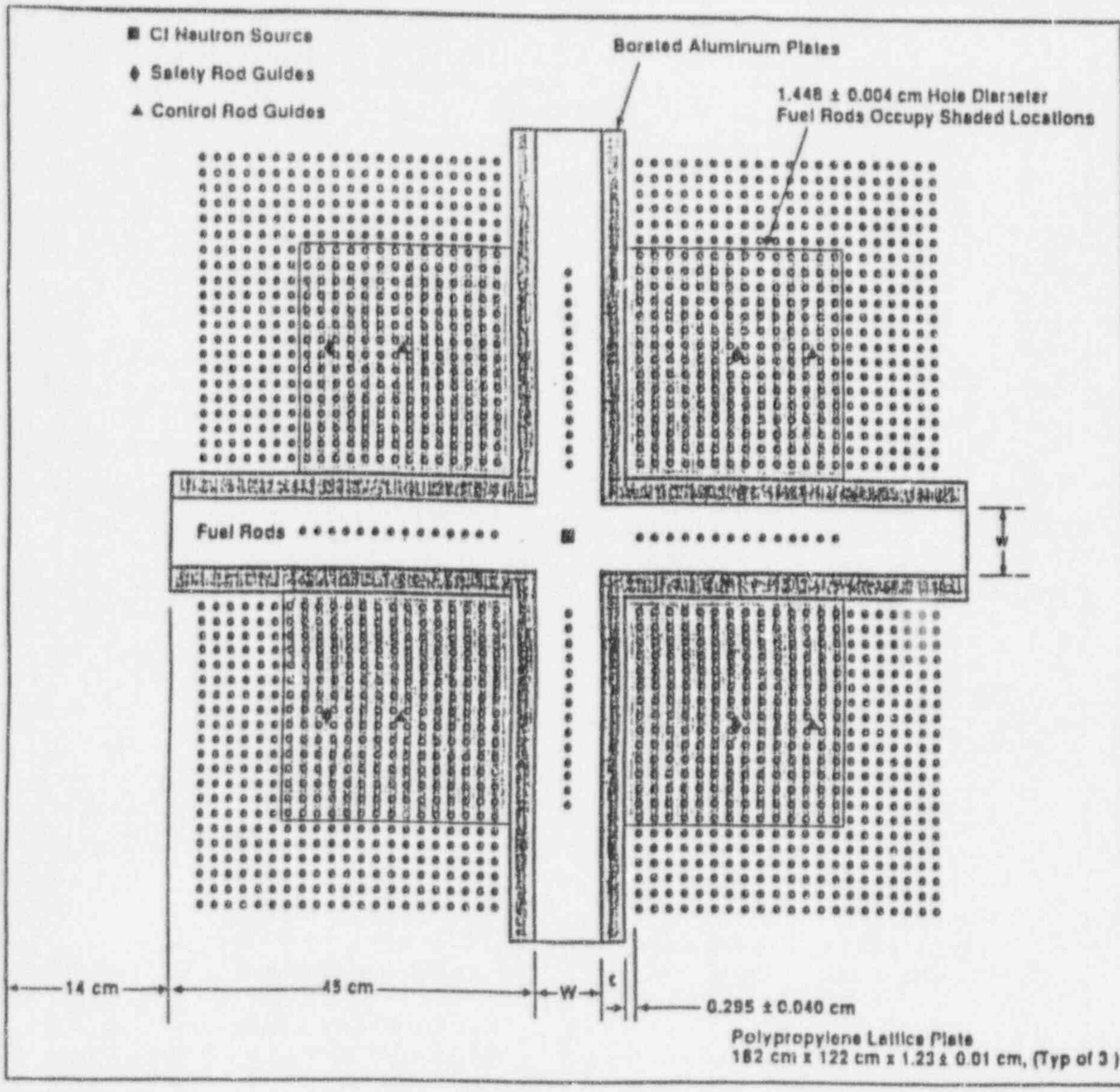
Figure 2.31 Experimental assembly evaluations for experiments from PNL-6205 and PNL-7176. *Source*: Refs. 20 and 21 (Reprinted with permission from authors)



Assembly Number	: 231
Lattice Pitch	: 1.891 ± 0.001 cm
Safety Rods	: Out of System
Control Rods	: Out of System

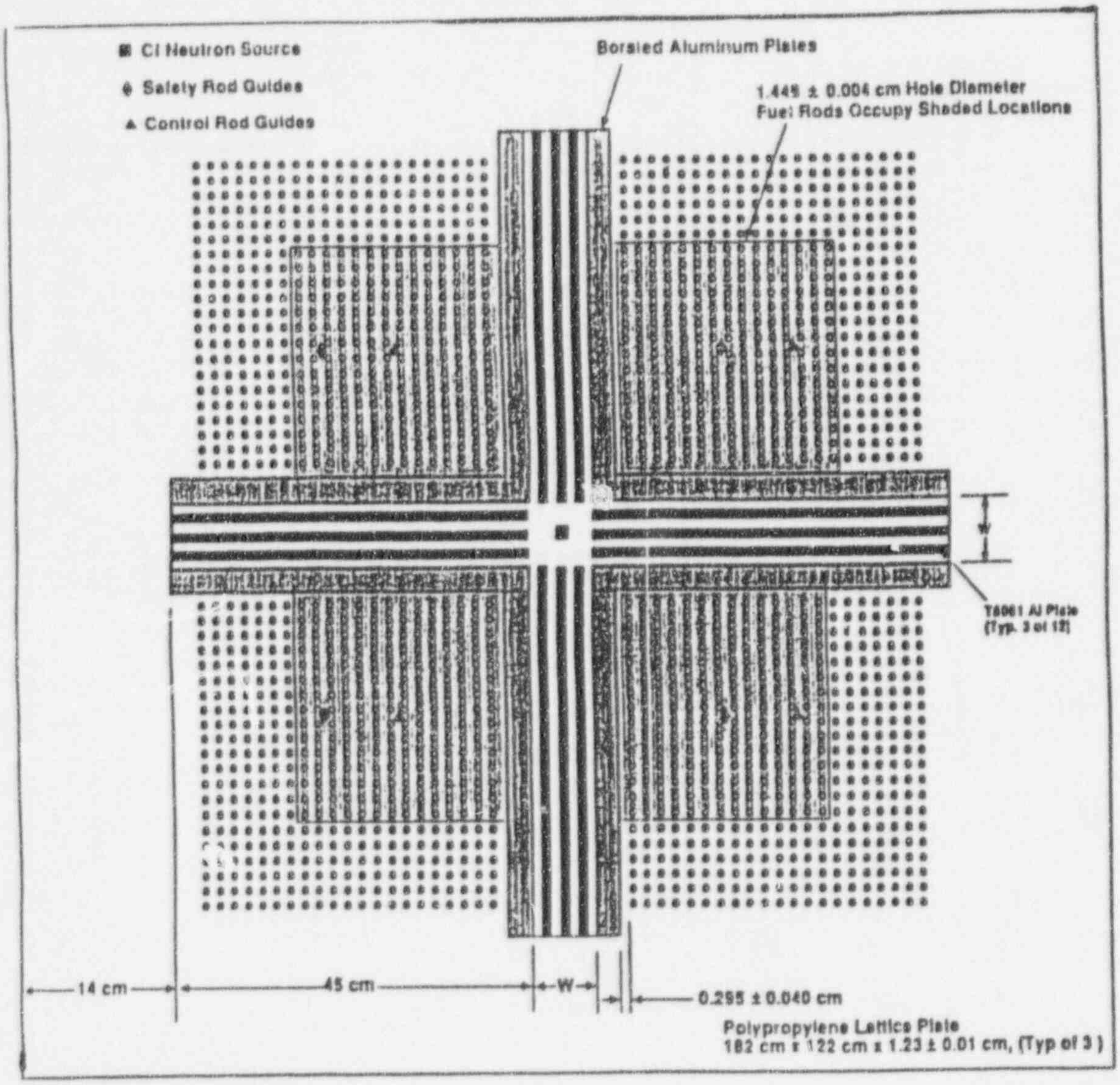
Fuel Rods	: 960
Fuel	: 4.31 wt % ^{235}U Enriched UO_2
Flux Trap Width, W	: 3.71 ± 0.020
Plates	: 0.45 ± 0.01 g/cm^2
Boron	: Boral
k_{eff}	: See Comments
Comments	: 963 Rods Predicted for Delayed Criticality

Figure 2.32 Experimental assembly for P62FT231. *Source*: Ref. 20 (Reprinted with permission from author)



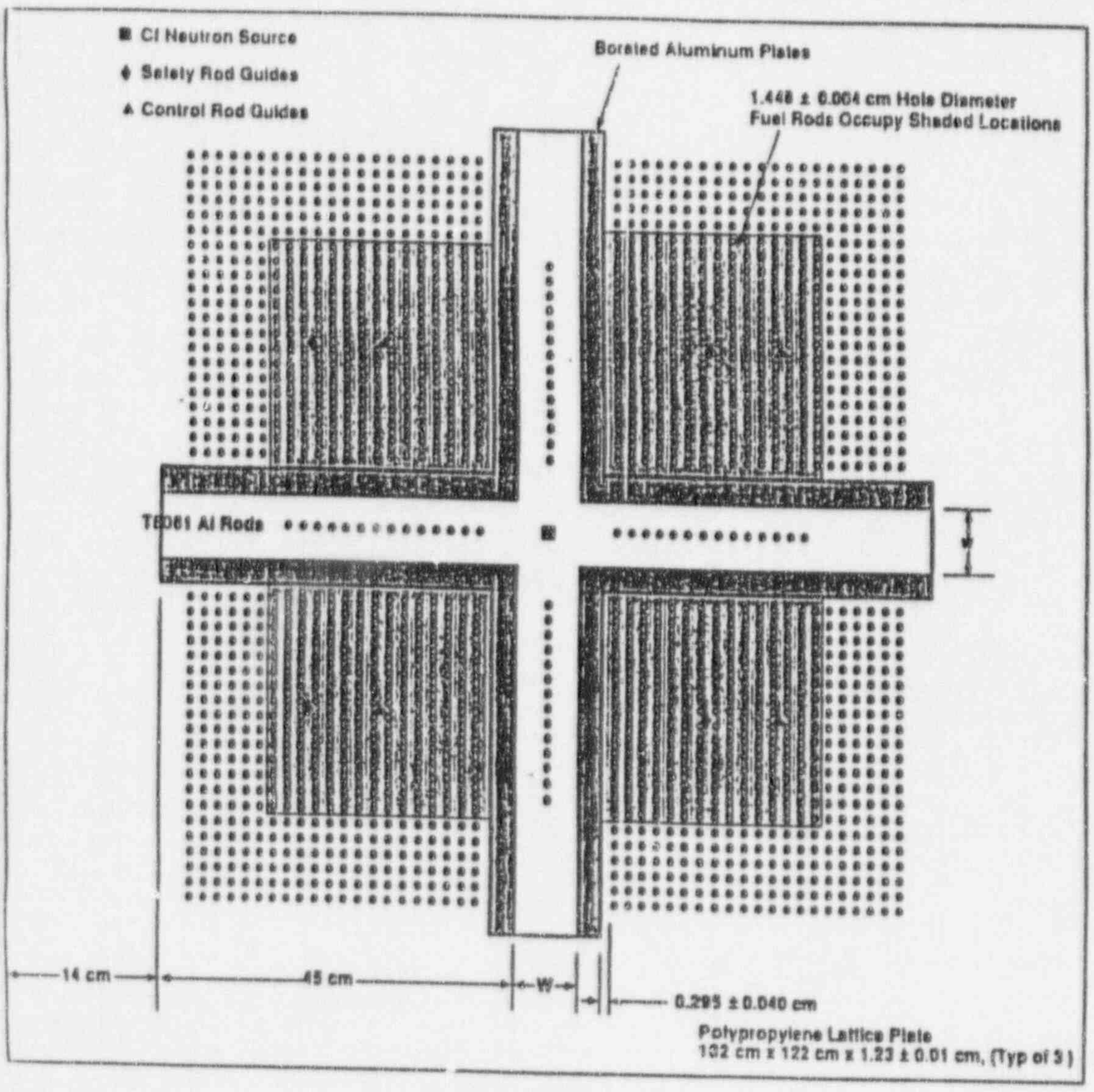
Assembly Number	: 214F3
Lattice Pitch	: 1.891 ± 0.001 cm
Safety Rods	: Out of System
Control Rods	: Out of System
Fuel Rods	: 855 (see comments)
Fuel	: 4.31 wt% ^{235}U Enriched UO_2
Flux Trap Width, W	: 3.73 ± 0.02 cm
Plates	: Boral
Boron	: 0.36 ± 0.02 gB/cm^2
Voiding Material	: Fuel Rods
Comments	: 858.5 ± 0.1 Rods Predicted for Delayed Criticality (does not include fuel in flux trap regions)

Figure 2.33 Experimental assembly for P71F14F3. Source: Ref. 21 (Reprinted with permission from authors)



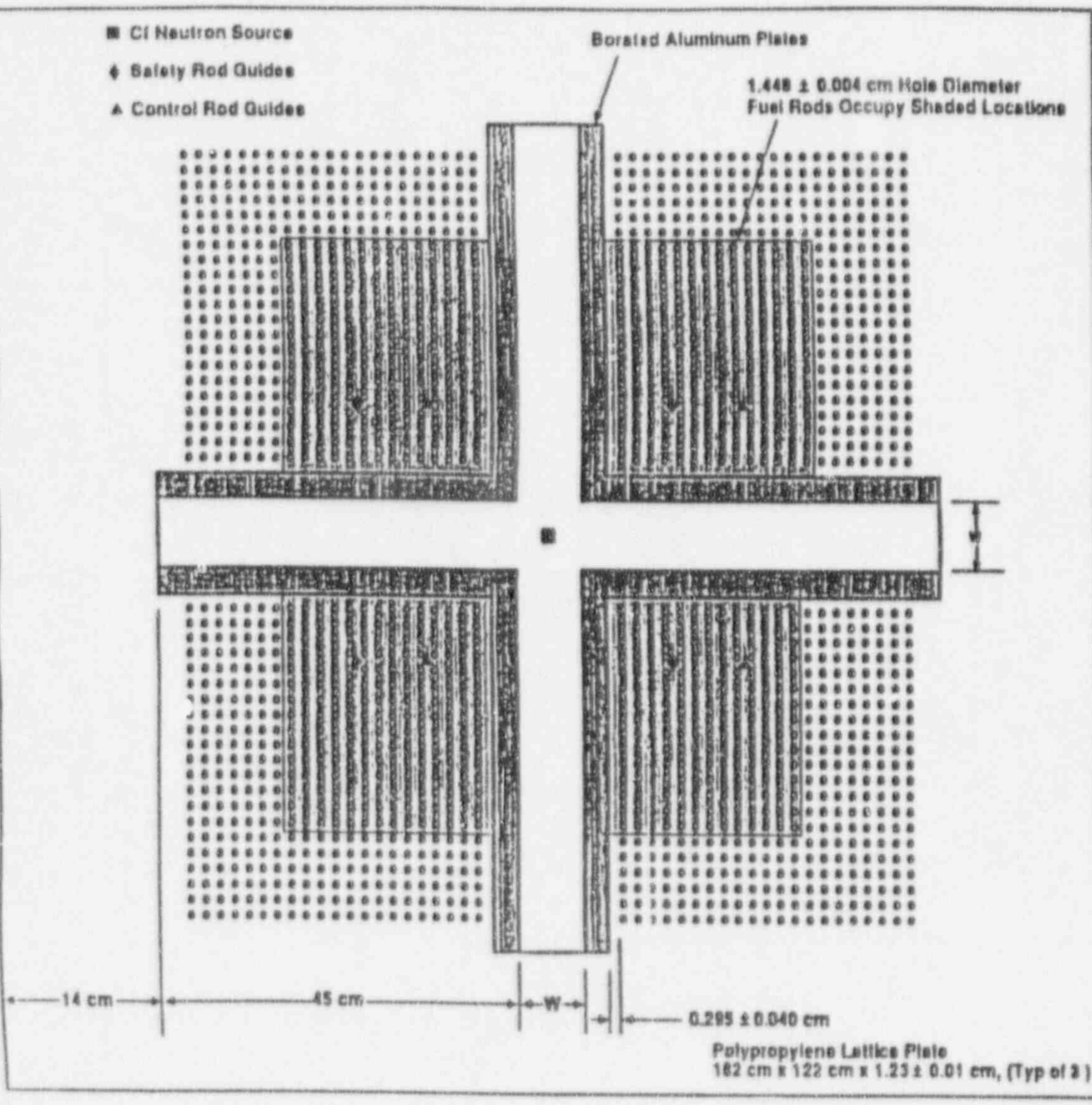
Assembly Number	: 214V3
Lattice Pitch	: 1.891 ± 0.001 cm
Safety Rods	: Out of System
Control Rods	: Out of System
Fuel Rods	: 855 (see comments)
Fuel	: 4.31 wt% ^{235}U Enriched UO_2
Flux Trap Width, W	: 3.73 ± 0.02 cm
Plates	: Boral
Boron	: 0.36 ± 0.02 gB/cm^2
Voiding Material	: 0.63 ± 0.001 cm th Al Plate
Comments	: 862.1± 1.2 Rods Predicted for Delayed Criticality

Figure 2.34 Experimental assembly for P71F14V3. *Source*: Ref. 21 (Reprinted with permission from authors)



Assembly Number	: 214V5
Lattice Pitch	: 1.891 ± 0.001 cm
Safety Rods	: Out of System
Control Rods	: Out of System
Fuel Rods	: 815 (see comments)
Fuel	: 4.31 wt% ^{235}U Enriched UO_2
Flux Trap Width, W	: 3.73 ± 0.02 cm
Plates	: Boral
Boron	: 0.36 ± 0.02 gB/cm^2
Voiding Material	: 1.27 ± 0.005 cm dia. Al Rods
Comments	: 824.8 ± 1.6 Rods Predicted for Delayed Criticality

Figure 2.35 Experimental assembly for P71F14V5



Assembly Number	: 214R
Lattice Pitch	: 1.891 ± 0.001 cm
Safety Rods	: Out of System
Control Rods	: Out of System
Fuel Rods	: 948 (see comments)
Fuel	: 4.31 wt% ^{235}U Enriched UO_2
Flux Trap Width, W	: 3.73 ± 0.02 cm
Plates	: Boral
Boron	: 0.38 ± 0.02 gB/cm^2
Voiding Material	: None
Comments	: 952 Rods Predicted for Delayed Criticality

Figure 2.36 Experimental assembly for P71F214R

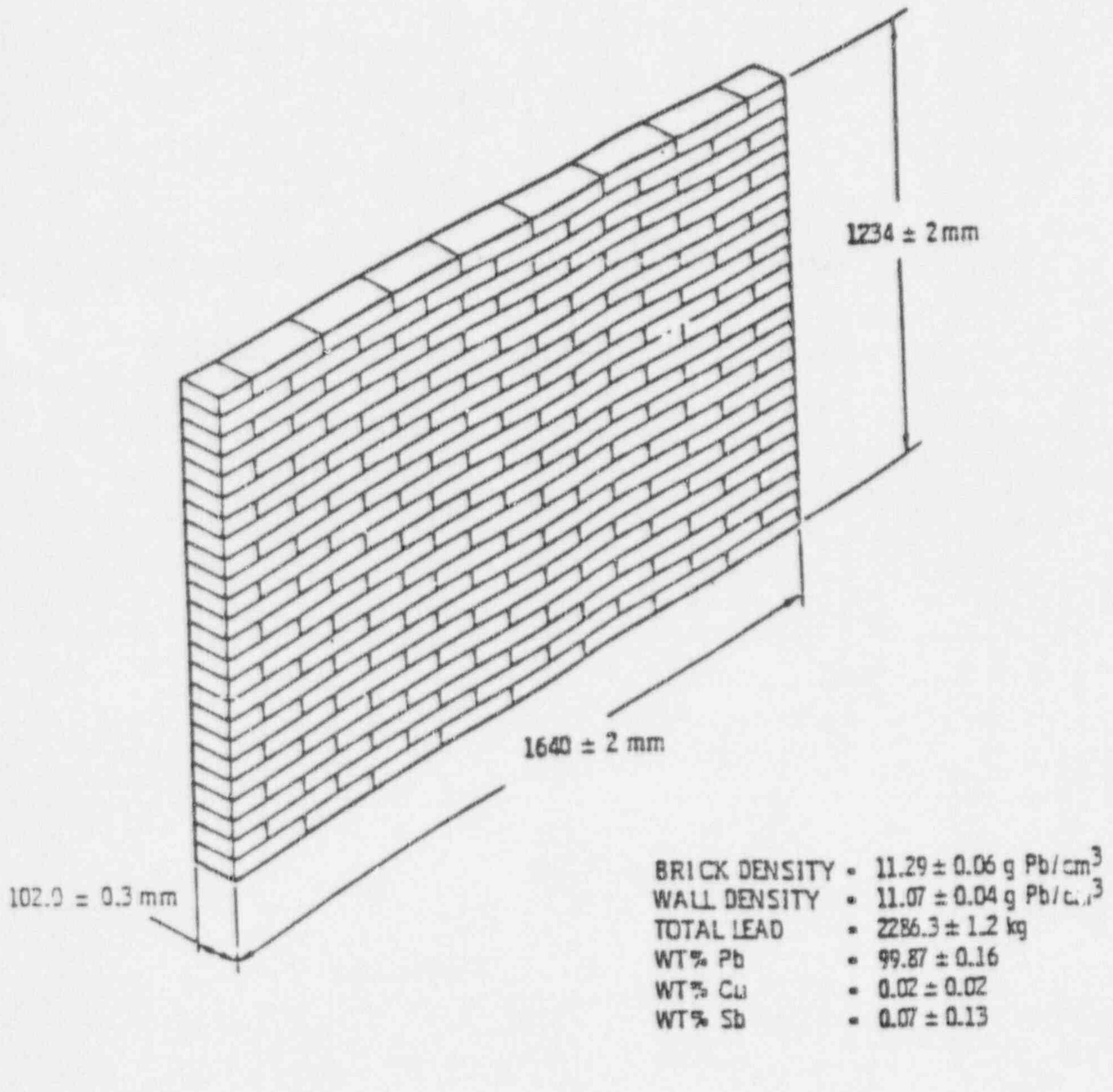


Figure 2.37 Assembled lead wall for experiments from PNL-2827. *Source*: Ref. 10 (Reprinted with permission from authors)

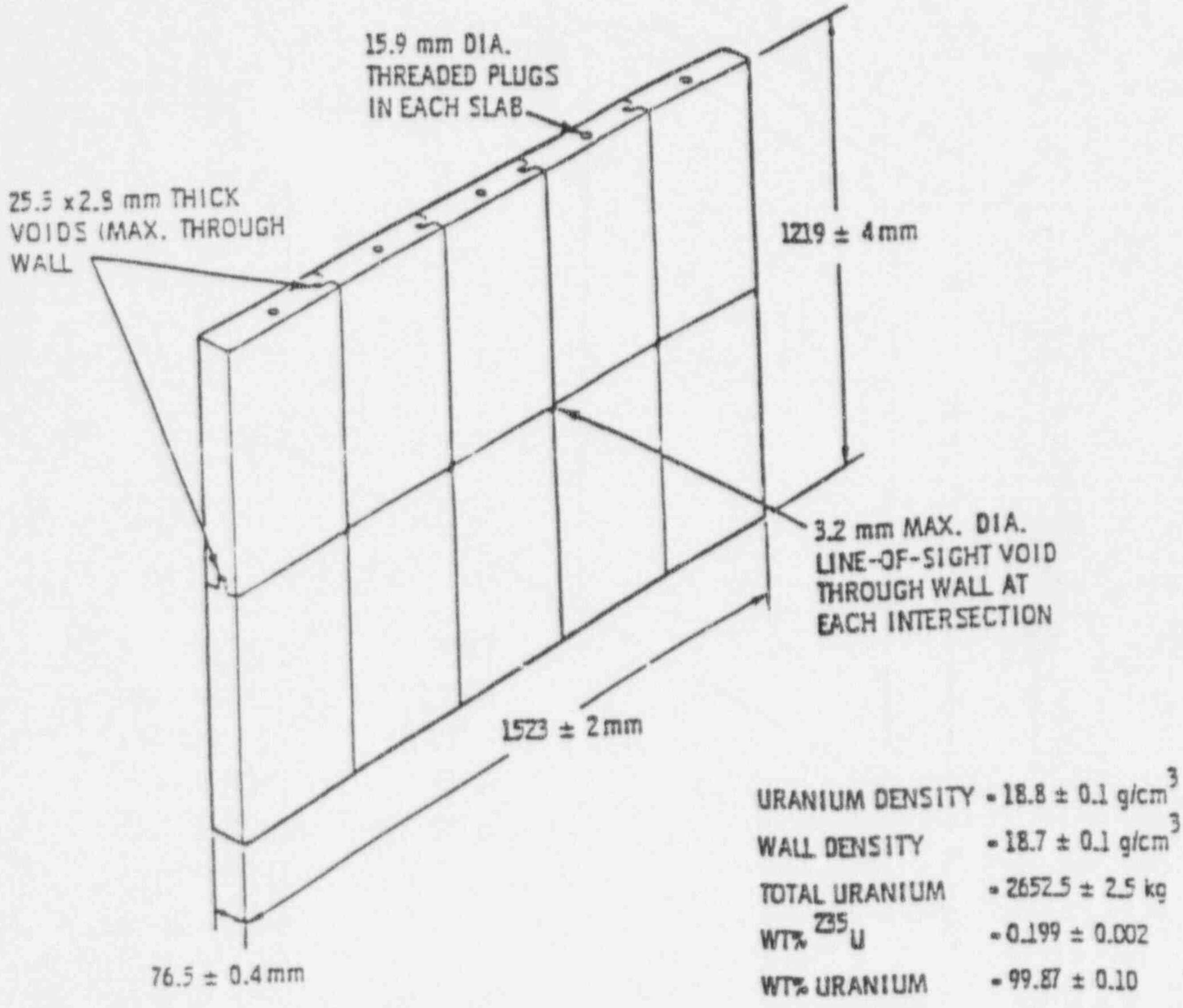


Figure 2.38 Assembled depleted uranium wall for experiments from PNL-2827. Source: Ref. 10 (Reprinted with permission from authors)

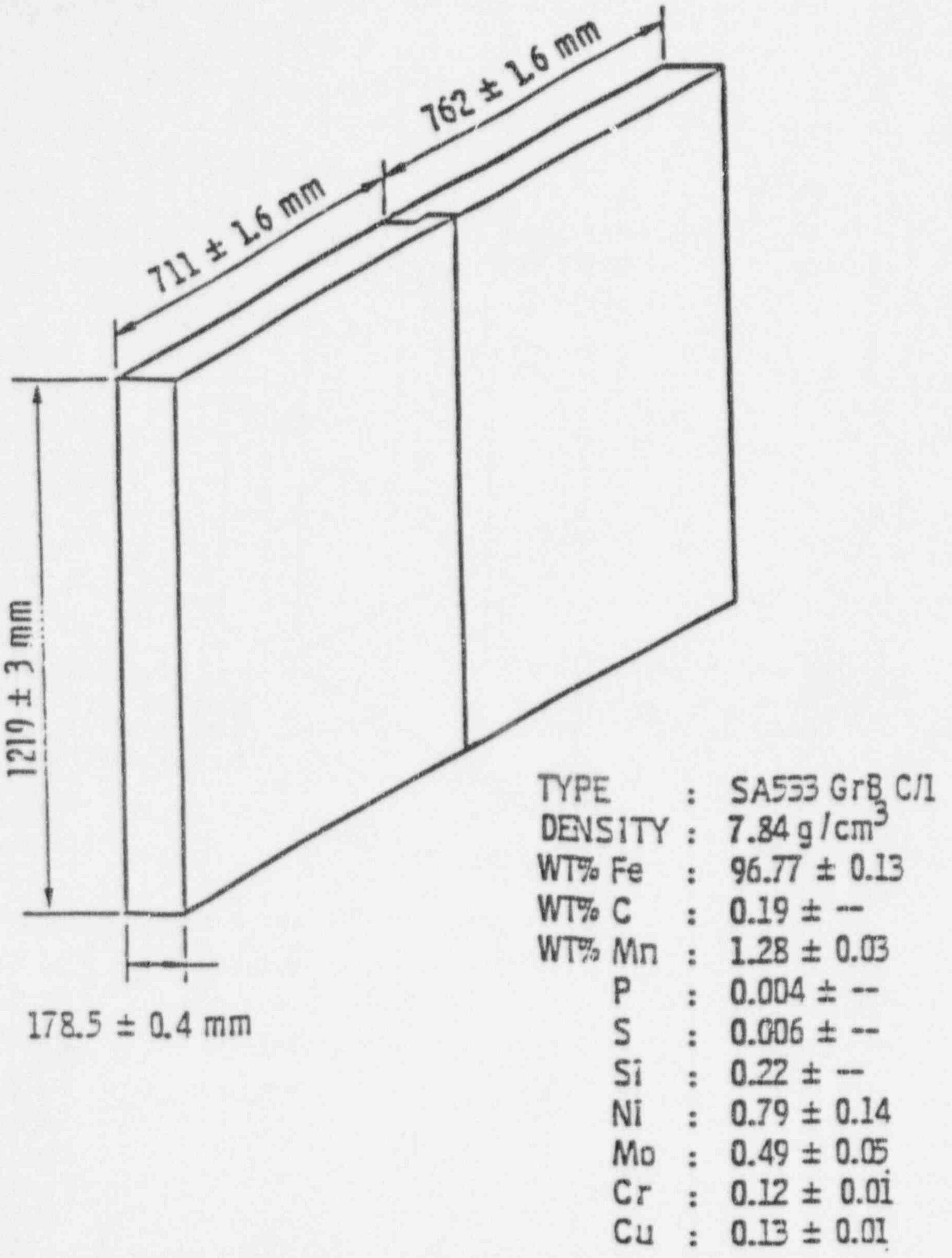


Figure 2.39 Assembled steel wall for experiments from PNL-3602. Source: Ref. 22 (Reprinted with permission from authors)

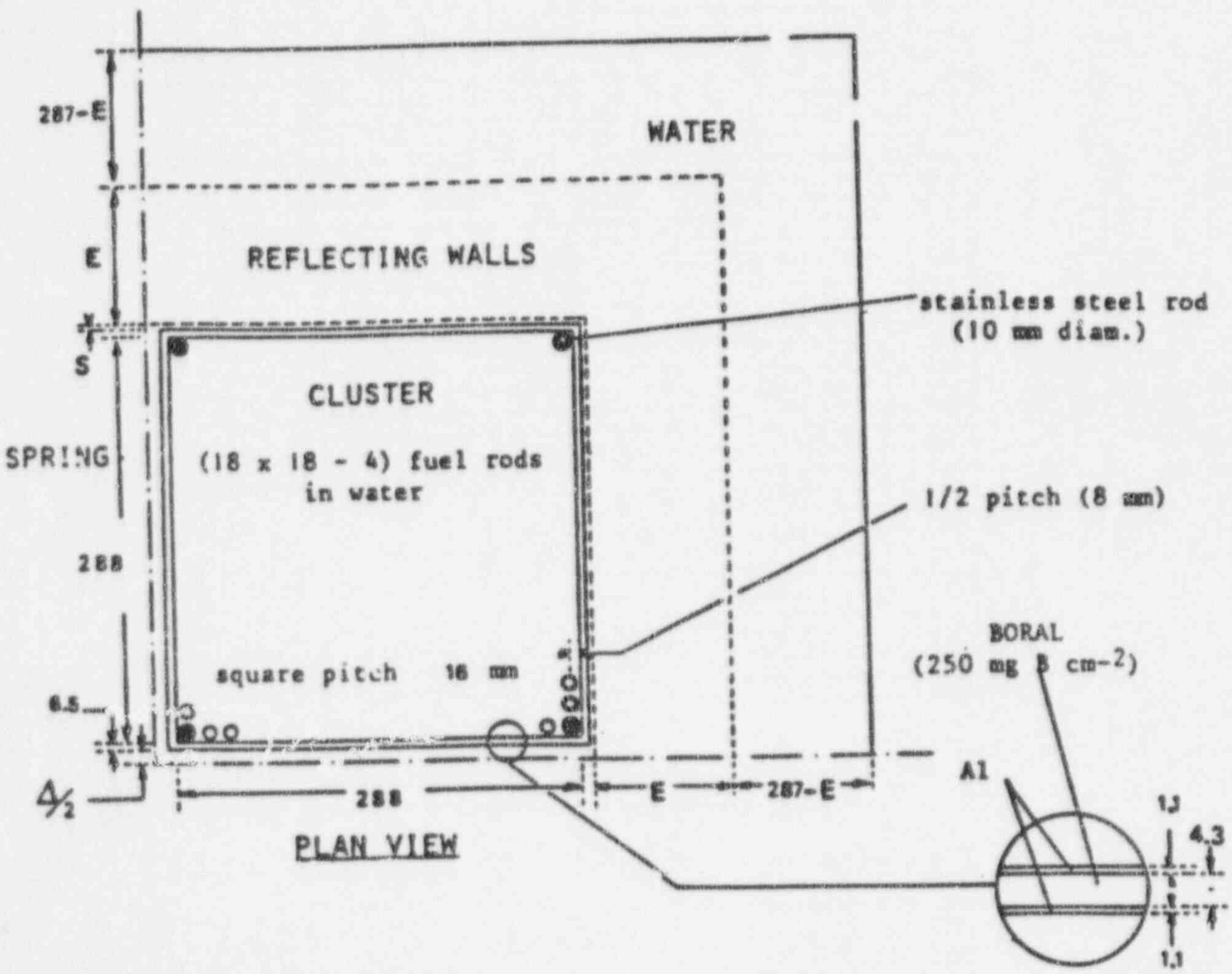


Figure 2.40 Quarter-assembly configuration for experiments from PATRAM'80. *Source*: Ref. 23 (Reprinted with permission by author)

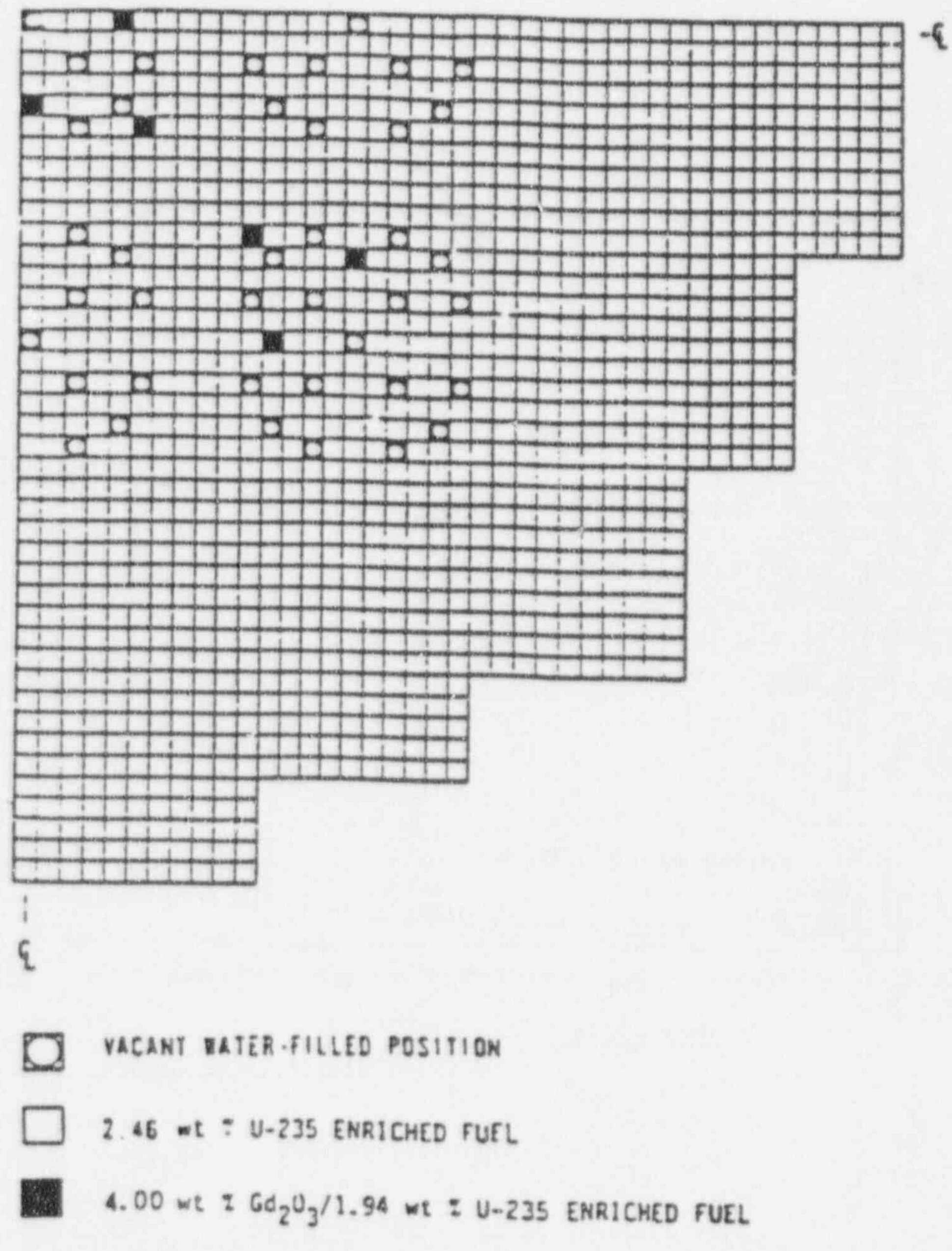


Figure 2.41 Quarter-core loading diagram for BW1810A. _Source_: Ref. 24

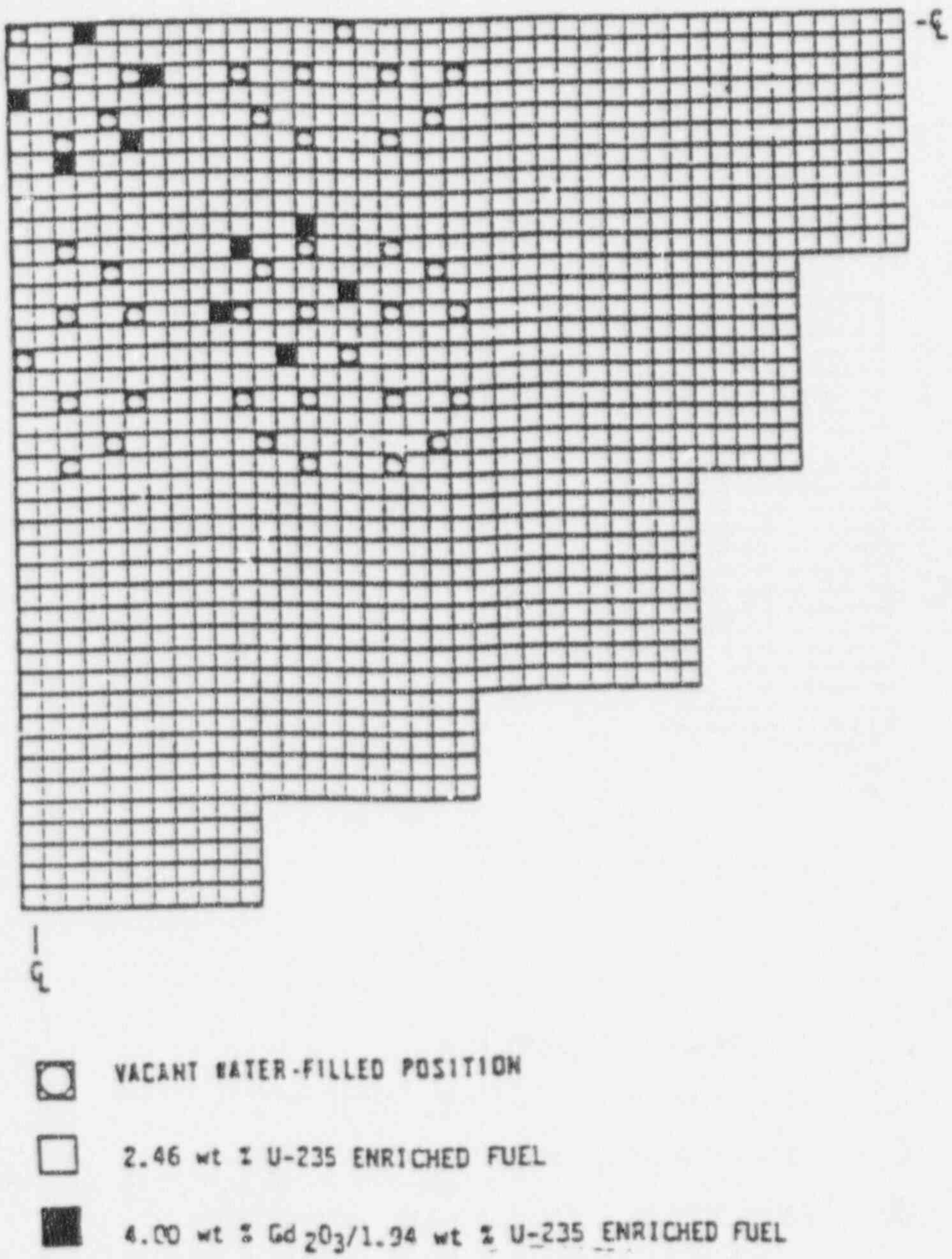


Figure 2.42 Quarter-core loading diagram for **BW1810B**. <u>Source</u>: Ref. 24

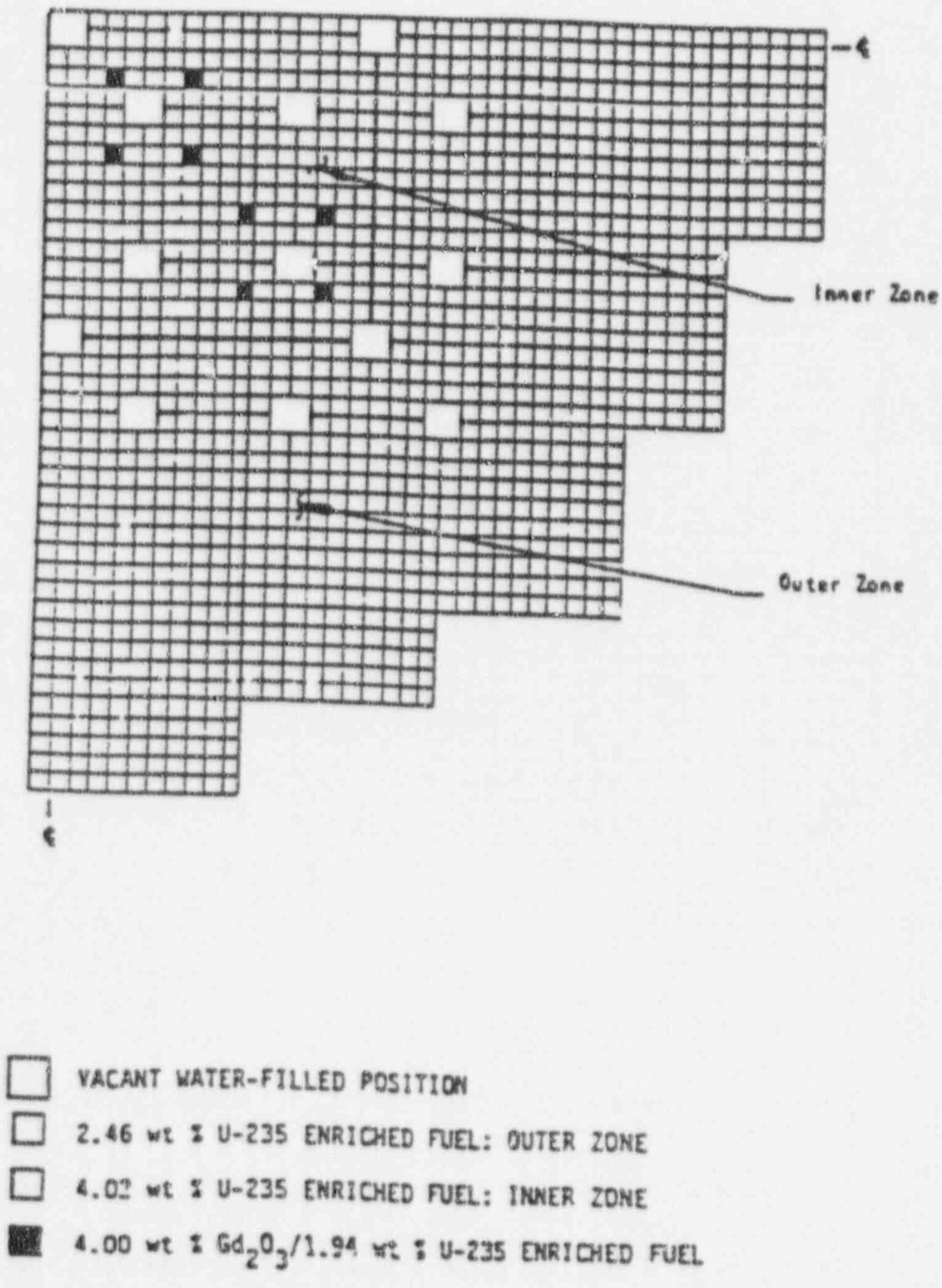


Figure 2.43 Quarter-core loading diagram for BW1810C. *Source*: Ref. 24

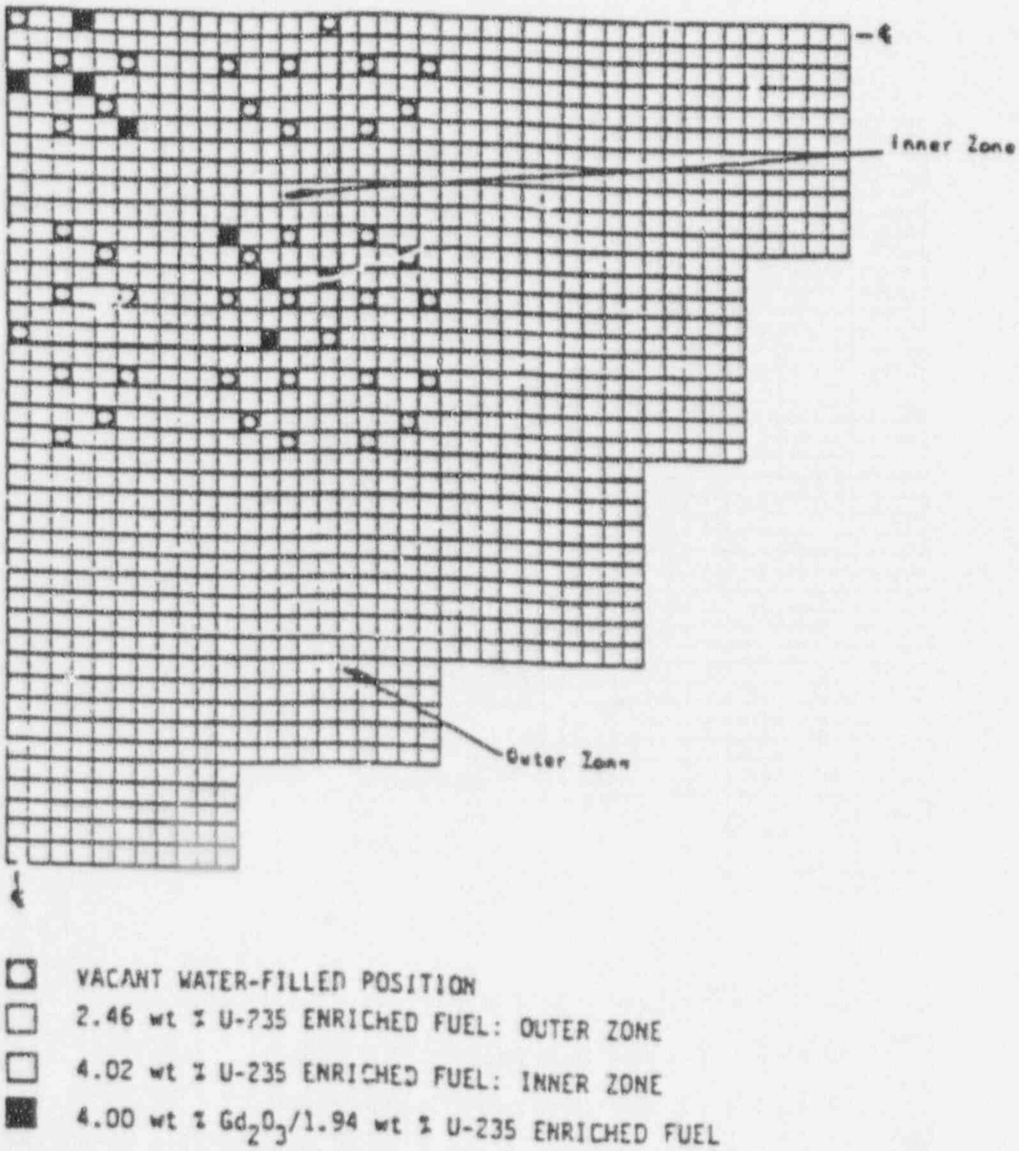


Figure 2.44 Quarter-core loading diagram for **BW1810D**. _Source_: Ref. 24

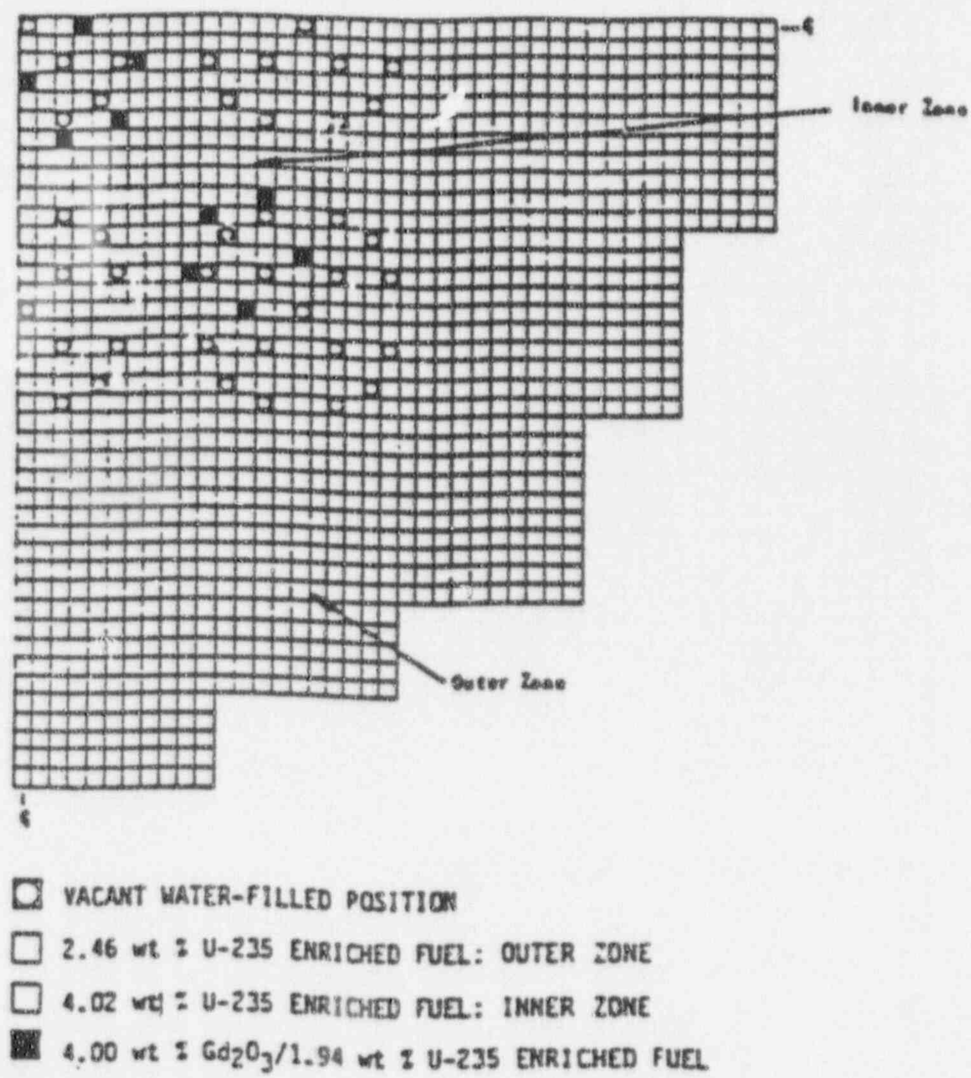


Figure 2.45 Quarter-core loading diagram for BW1810E. Source: Ref. 24

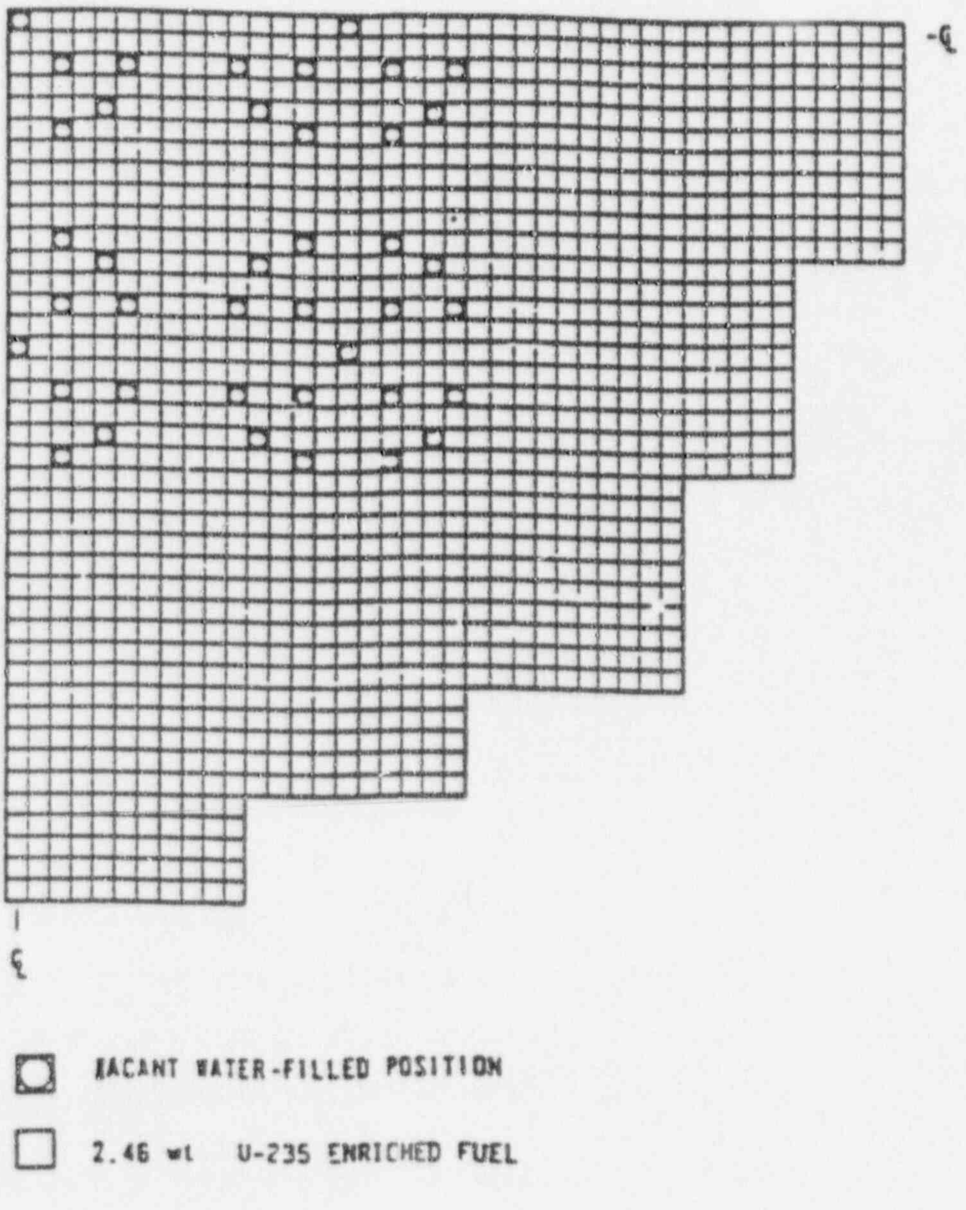


Figure 2.46 Quarter-core loading diagram for **BW1810F**. _Source_: Ref. 24

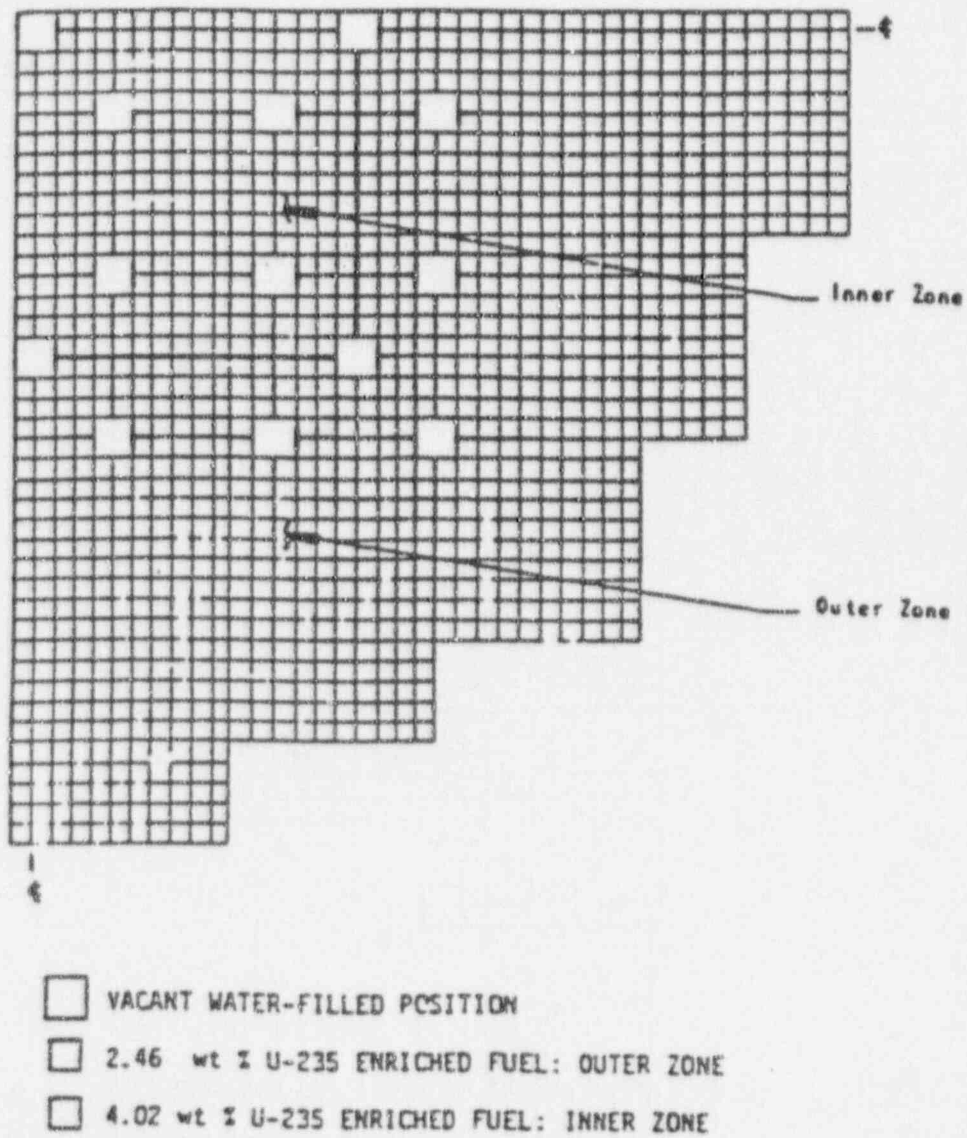


Figure 2.47 Quarter-core loading diagram for **BW1810G**. *Source*: Ref 24

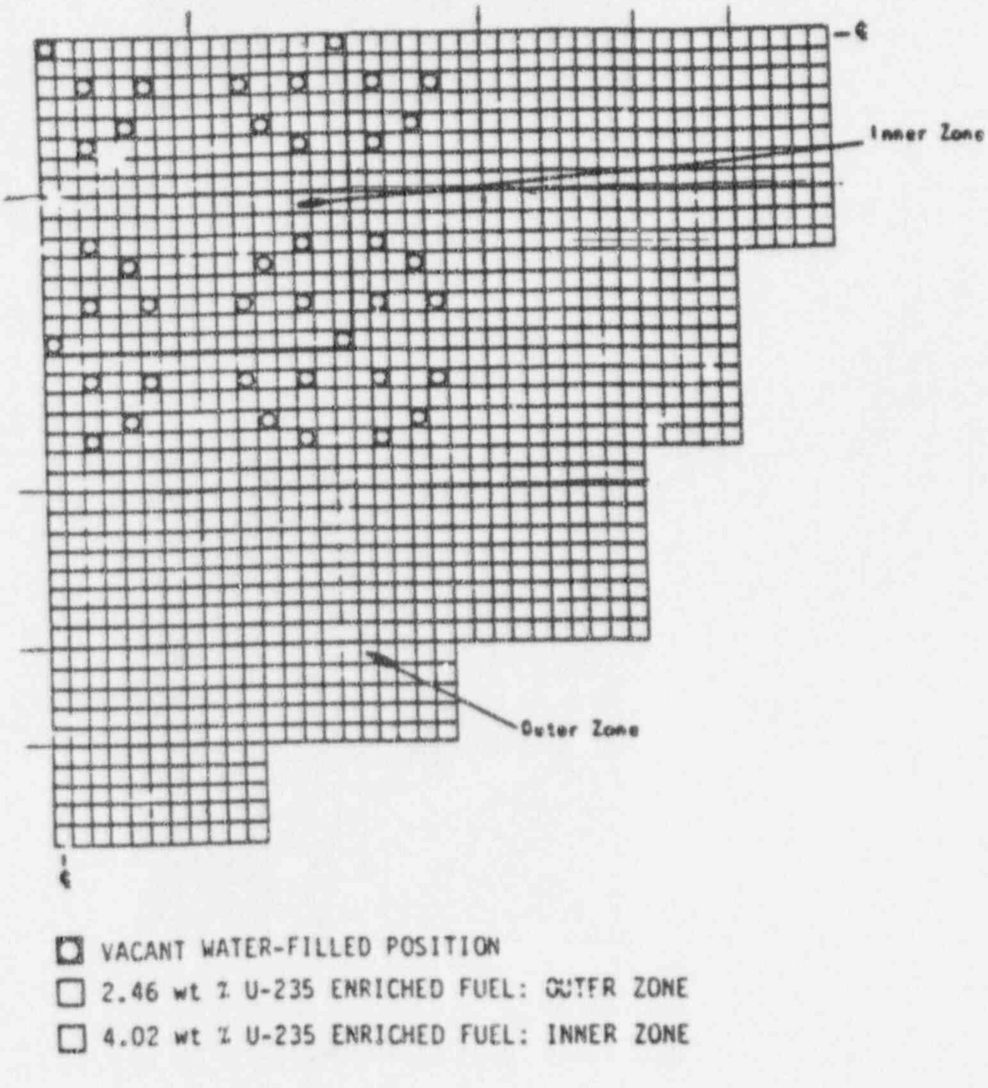
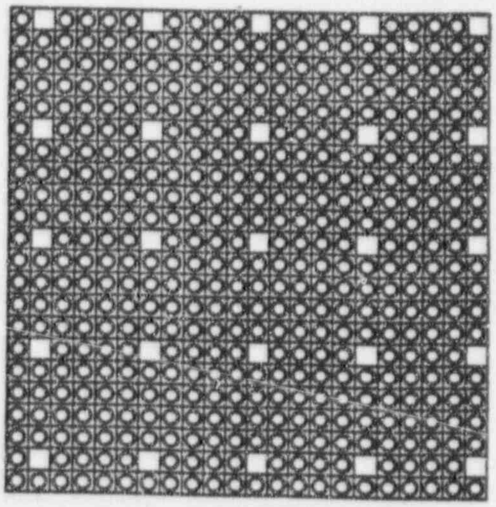
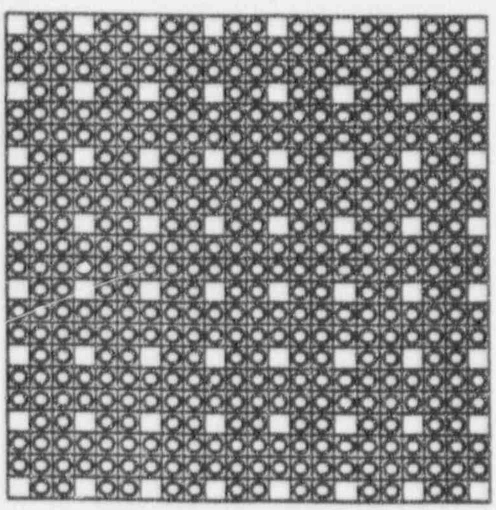


Figure 2.48 Quarter-core loading diagram for **BW1810H**. *Source*: Ref. 24

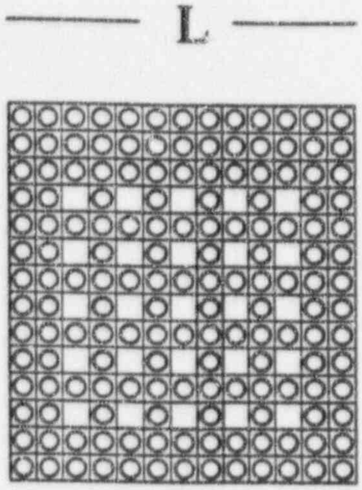


(a) NSE71W1

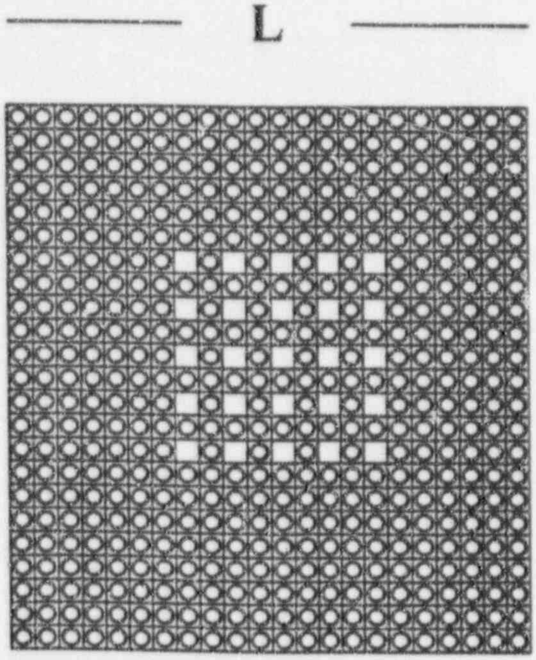


b) NSE71W2

Figure 2.49 Cross-sectional view of modeled NSE71W1 and NSE71W2 assemblies with water holes

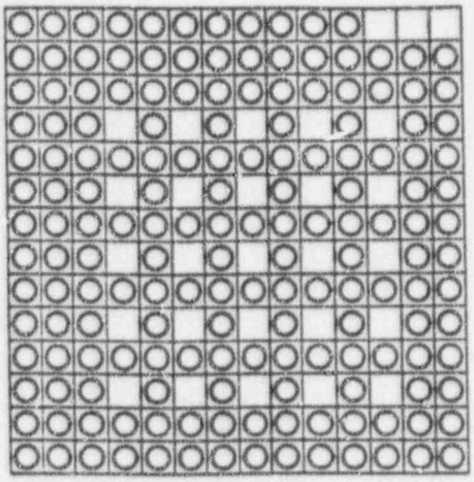


(a) 4.31 wt % UO_2 rods

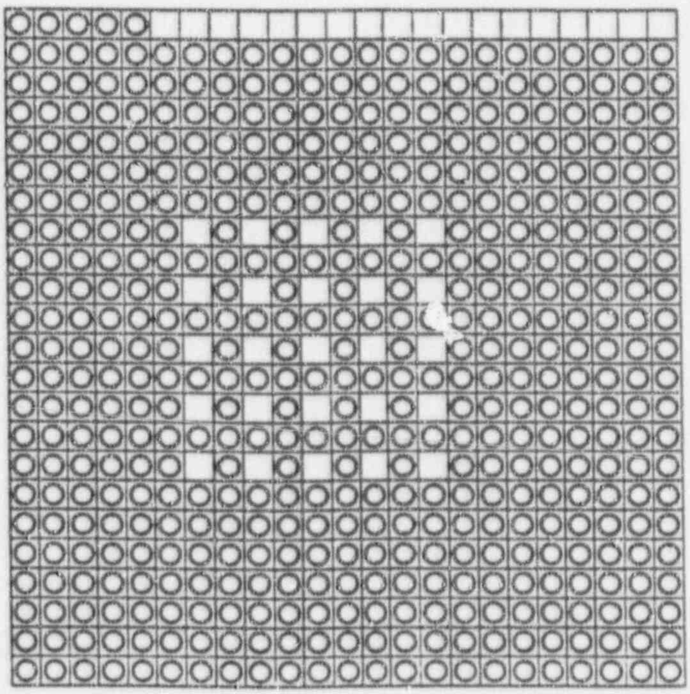


(b) 2.35 wt % UO_2 rods

Figure 2.50 Cross-sectional view of water hole experiments from PNL-3314

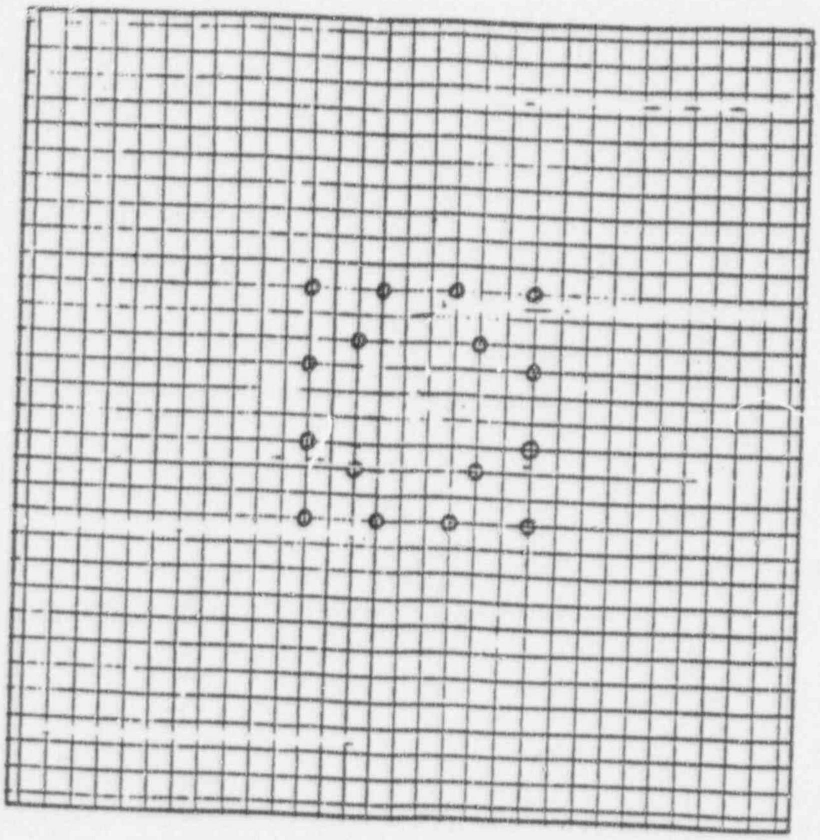


(a) P3314W1

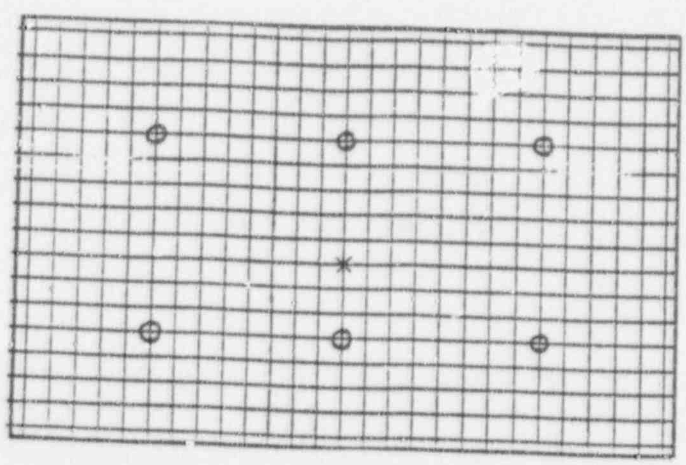


(b) P3314W2

Figure 2.51 Cross-sectional view of modeled P3314W1 and P3314W2 assemblies with water holes

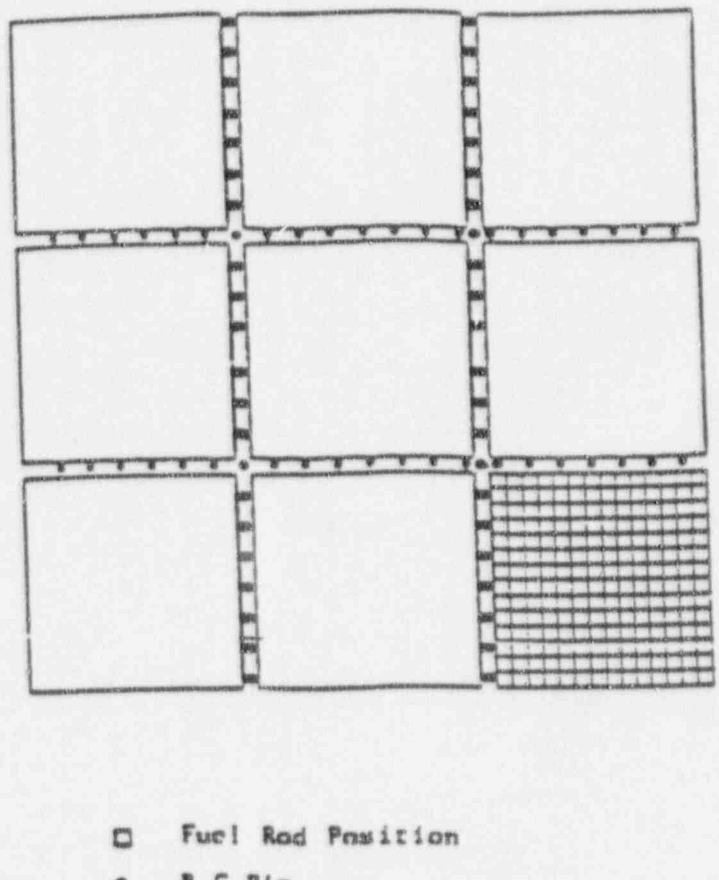


(a) W3269W1



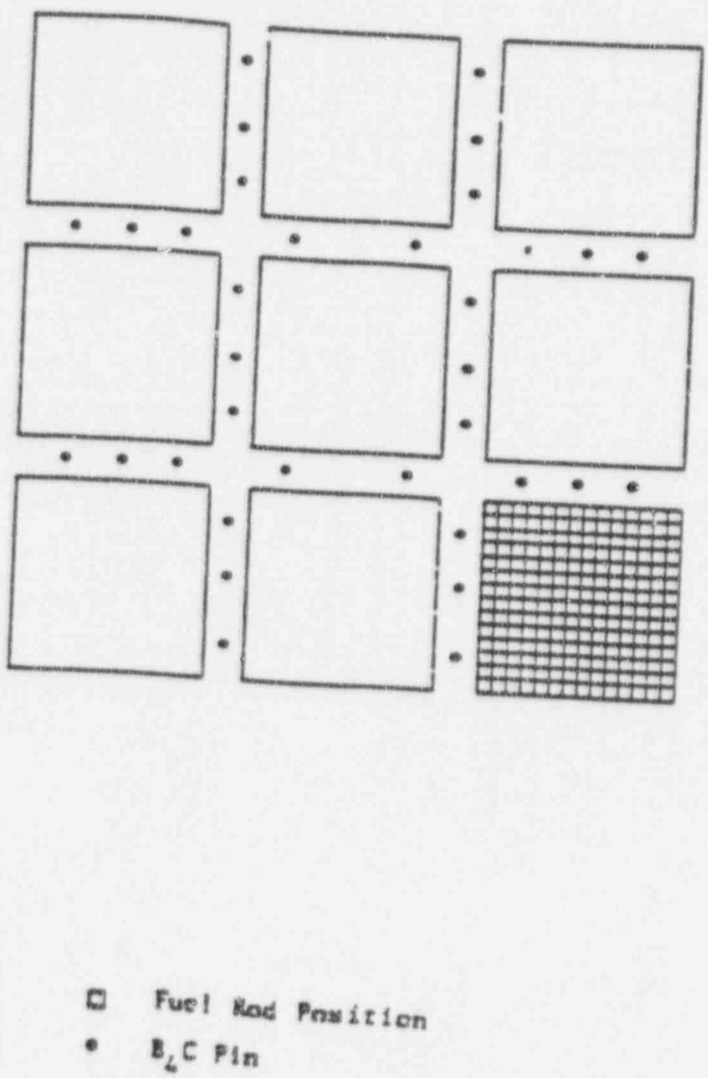
(b) W3269W2

Figure 2.52 Core layouts of W3269W1 and W3269W2 with water hole locations (circles)



Note: The large squares represent 14 × 14 fuel assemblies as shown in the lower right-hand corner.

Figure 2.53 Experiment **BW1484C1** core loading diagram. <u>Source</u>: Ref. 6



Note: The large squares represent 14 × 14 fuel assemblies as shown in the lower right-hand corner.

Figure 2.54 Experiment BWS1484C2 core loading diagram. <u>Source</u>: Ref. 6

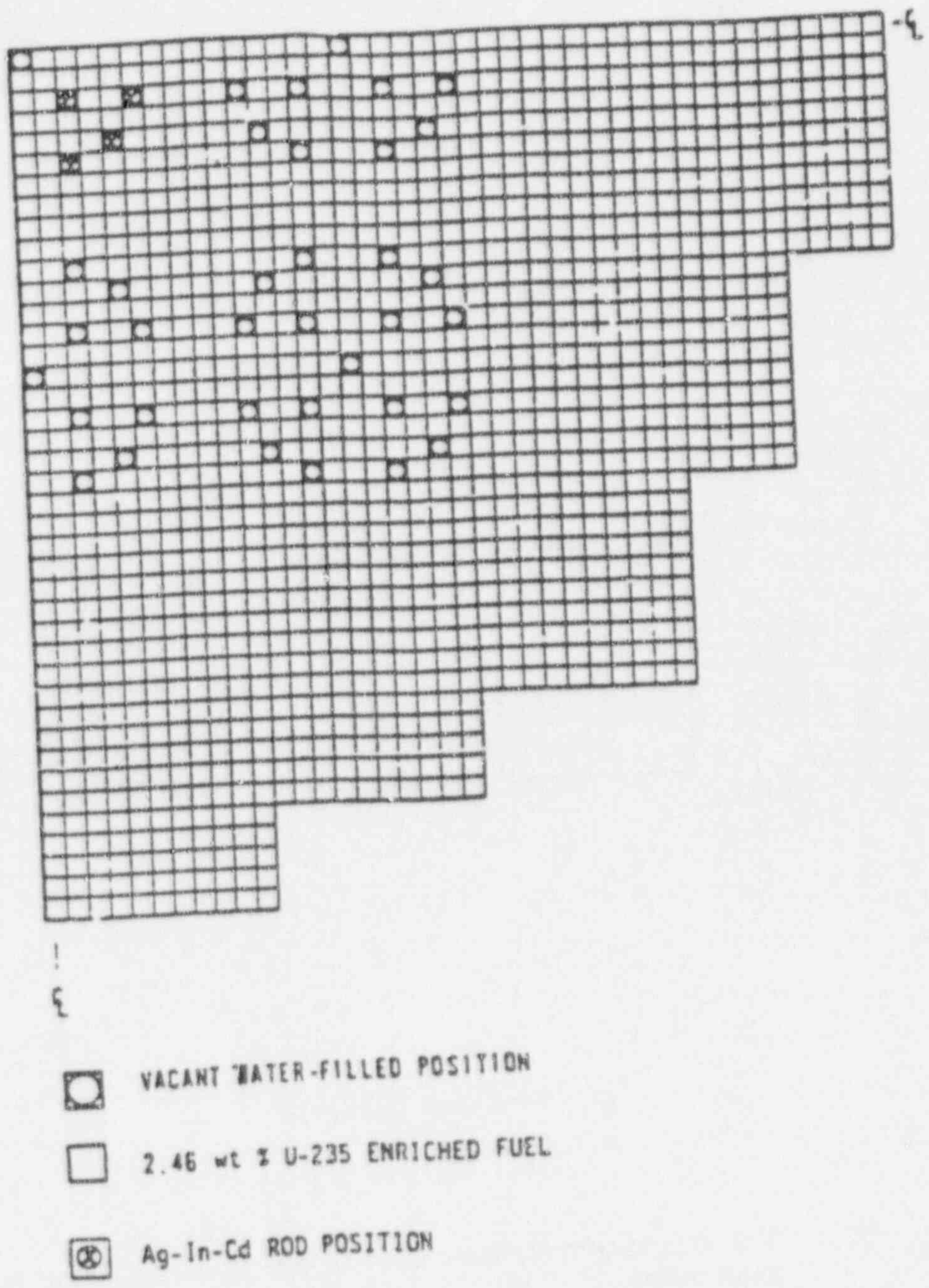


Figure 2.55 Core loading diagram for **BW1810I**. *Source*: Ref. 24

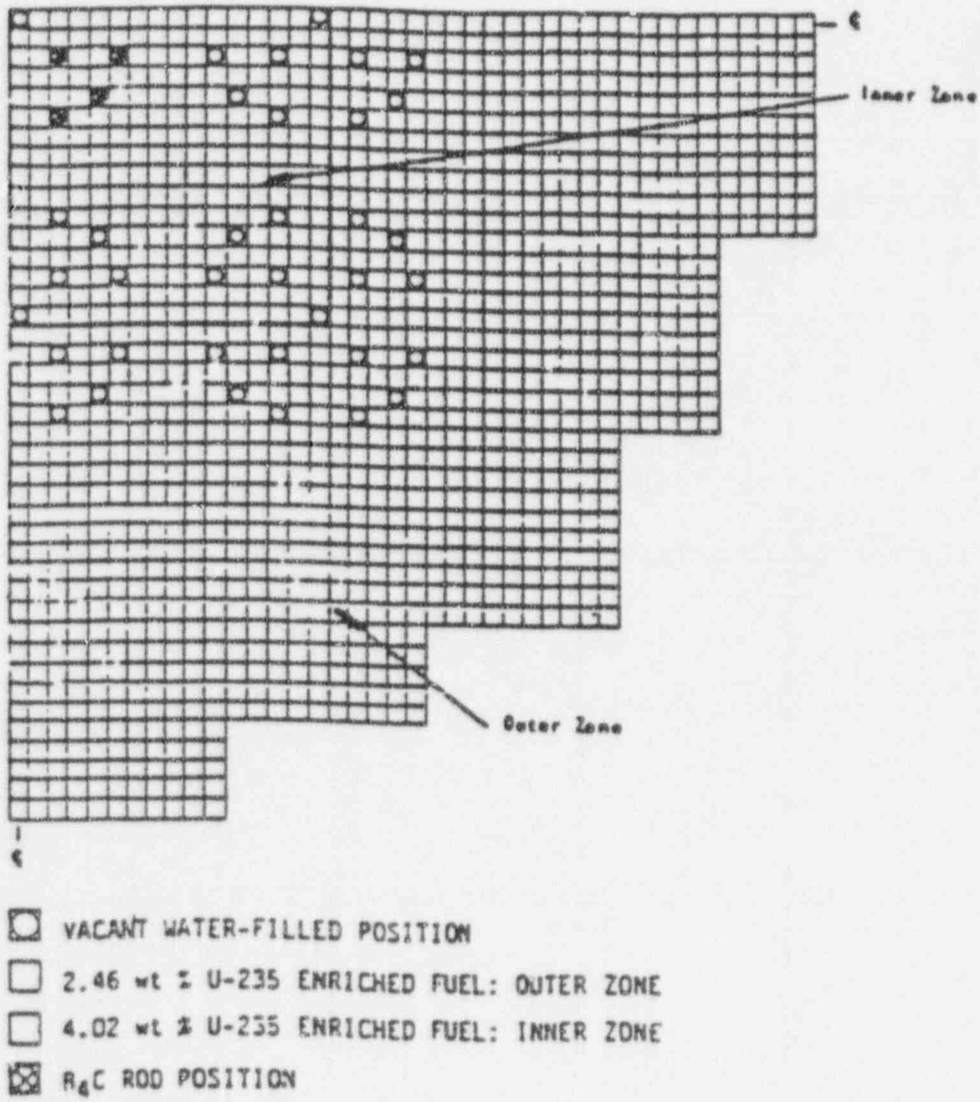


Figure 2.56 Core loading diagram for **BW1810J**. _Source_: Ref. 24

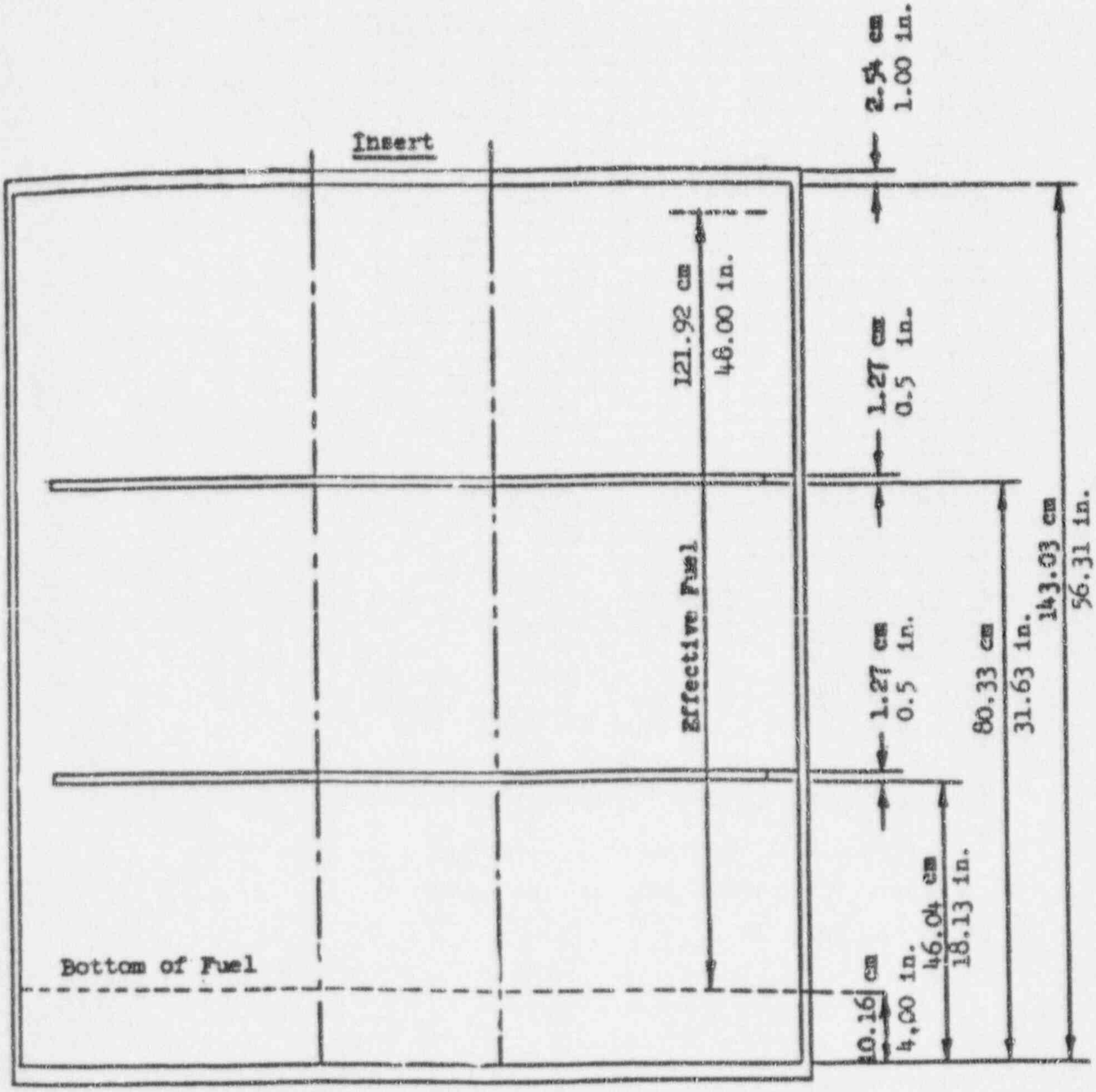


Figure 2.57 Vertical cross section of core assembly for experiments **W3269B1**, **W3269B2**, and **W3269B3**. *Source*: Ref. 15

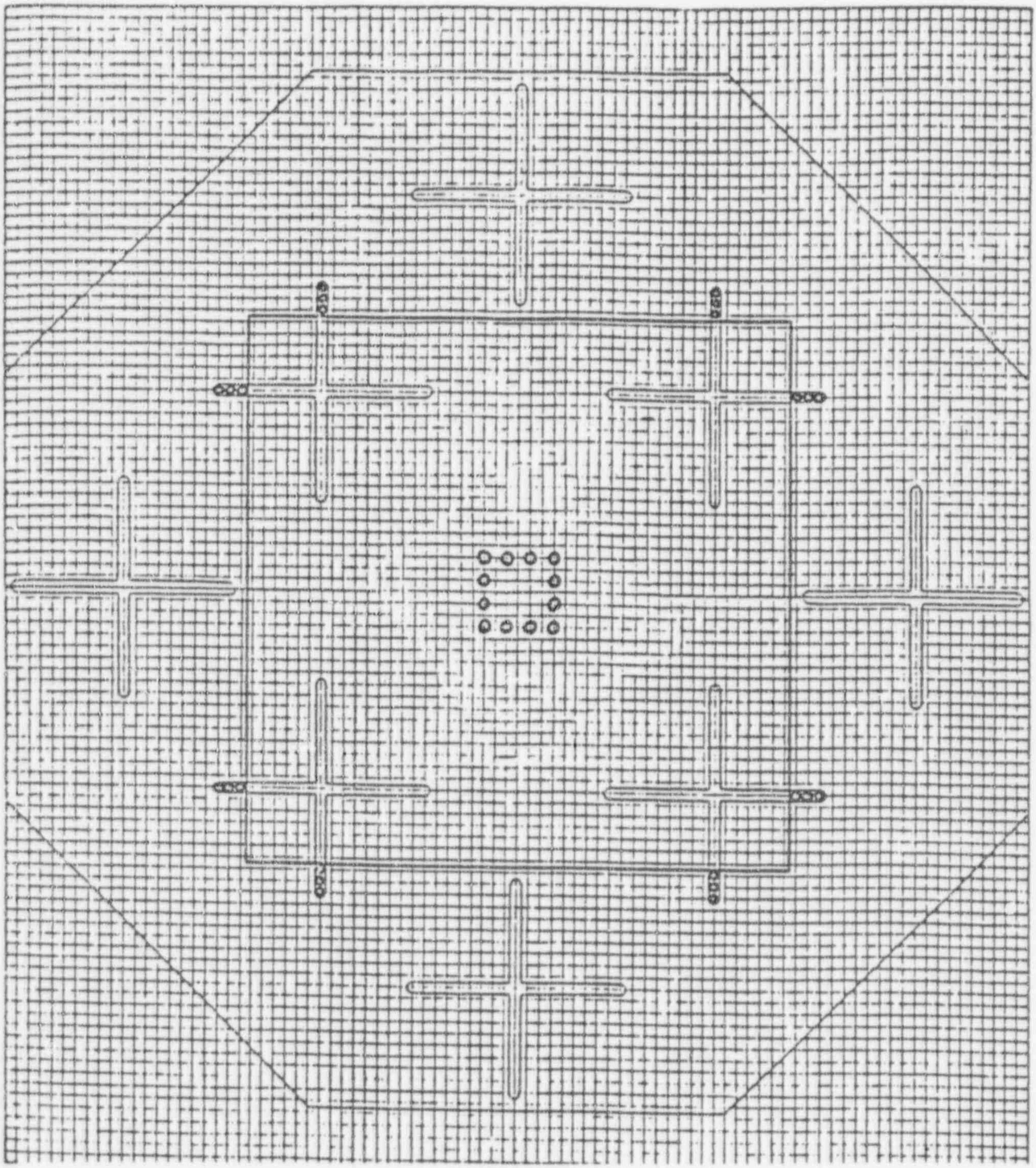


Figure 2.58 Core configuration for experiment **W3269B1**. *Source*: Ref. 15

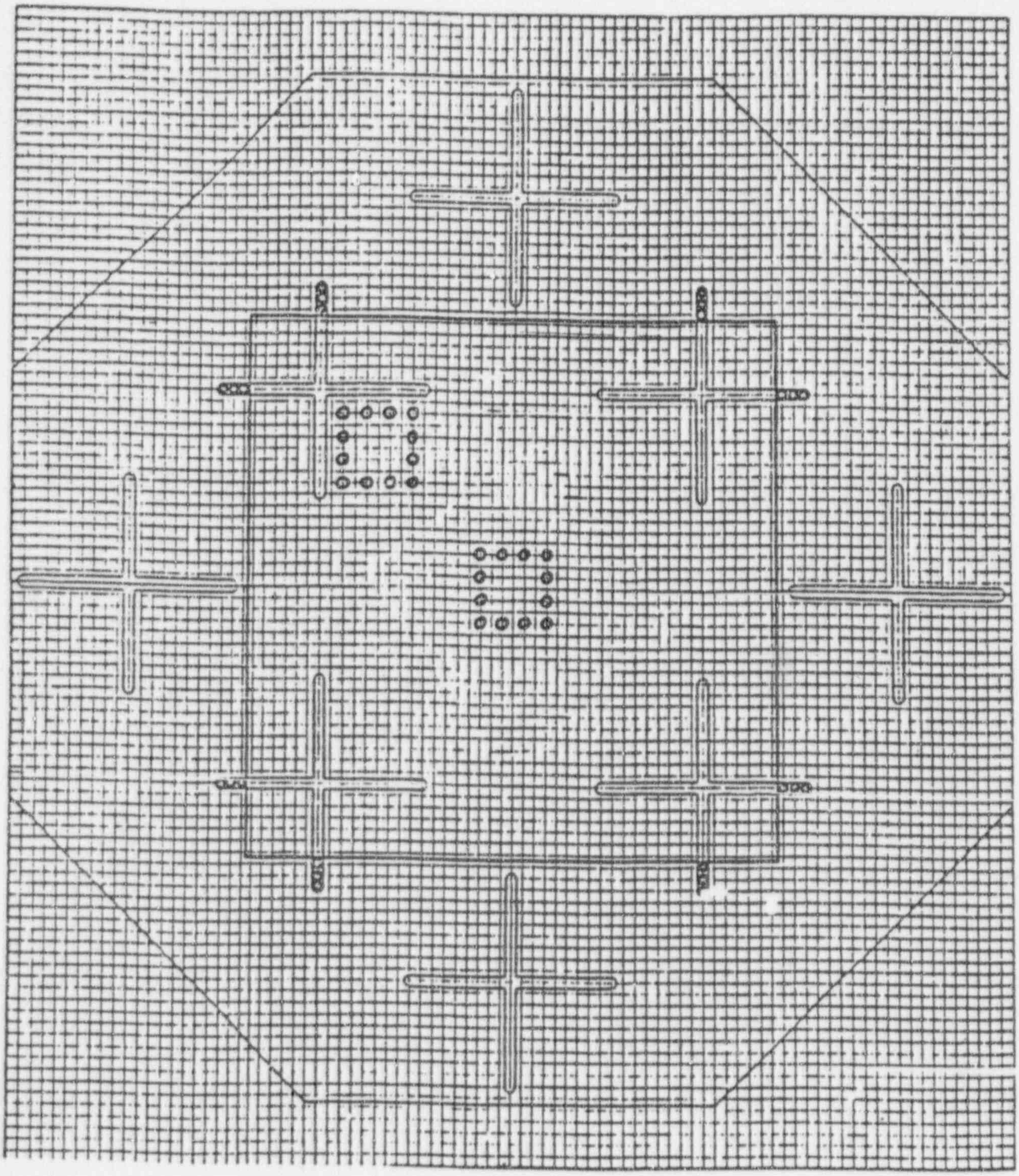


Figure 2.59 Core configuration for experiment **W3796B2**. *Source*: Ref. 15

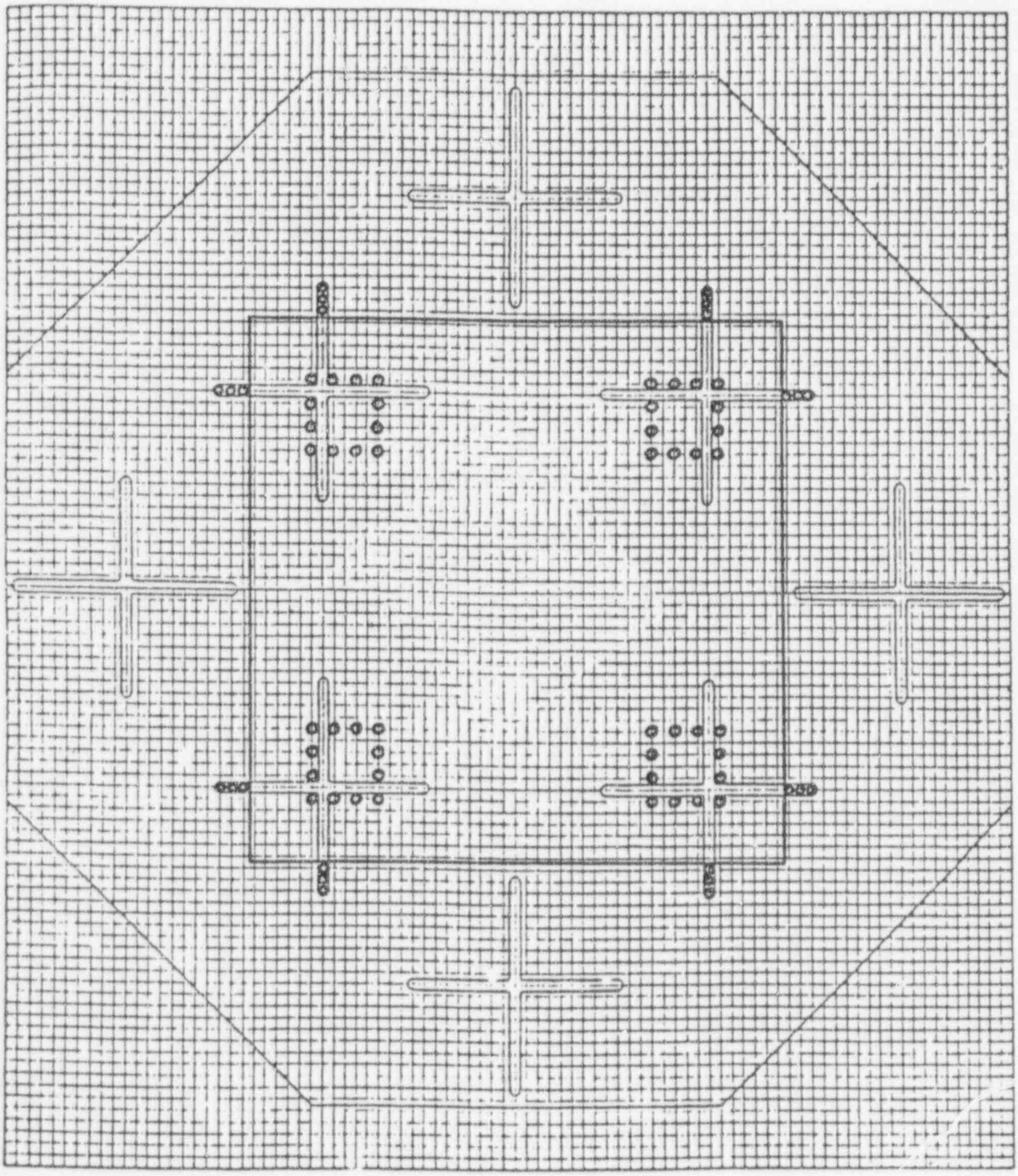
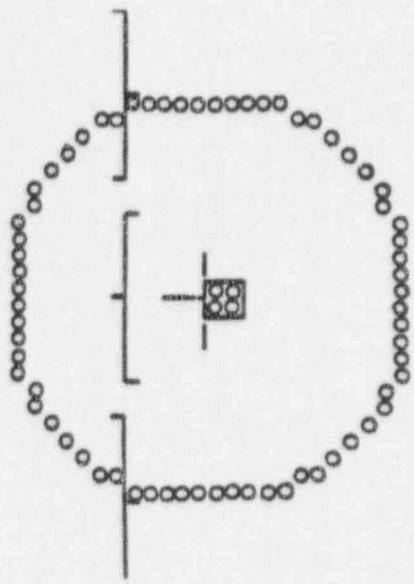
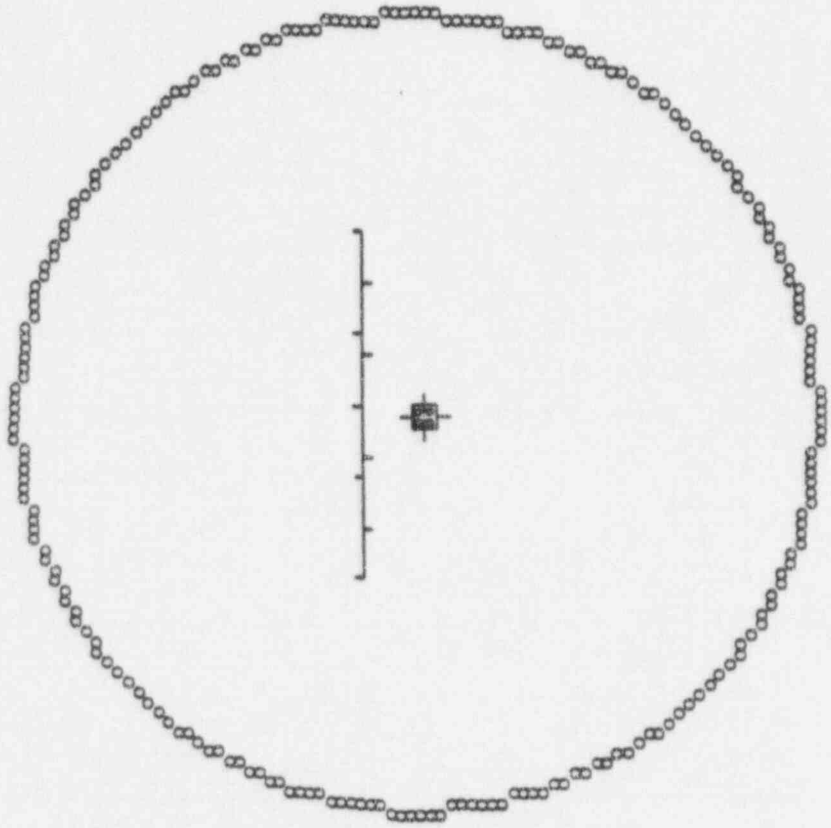


Figure 2.60 Core configuration for experiment W3269B3. *Source*: Ref. 15



(a) BW1231B1



(b) BW1231B2

Figure 2.61 Core diagrams for experiments from BAW-1231

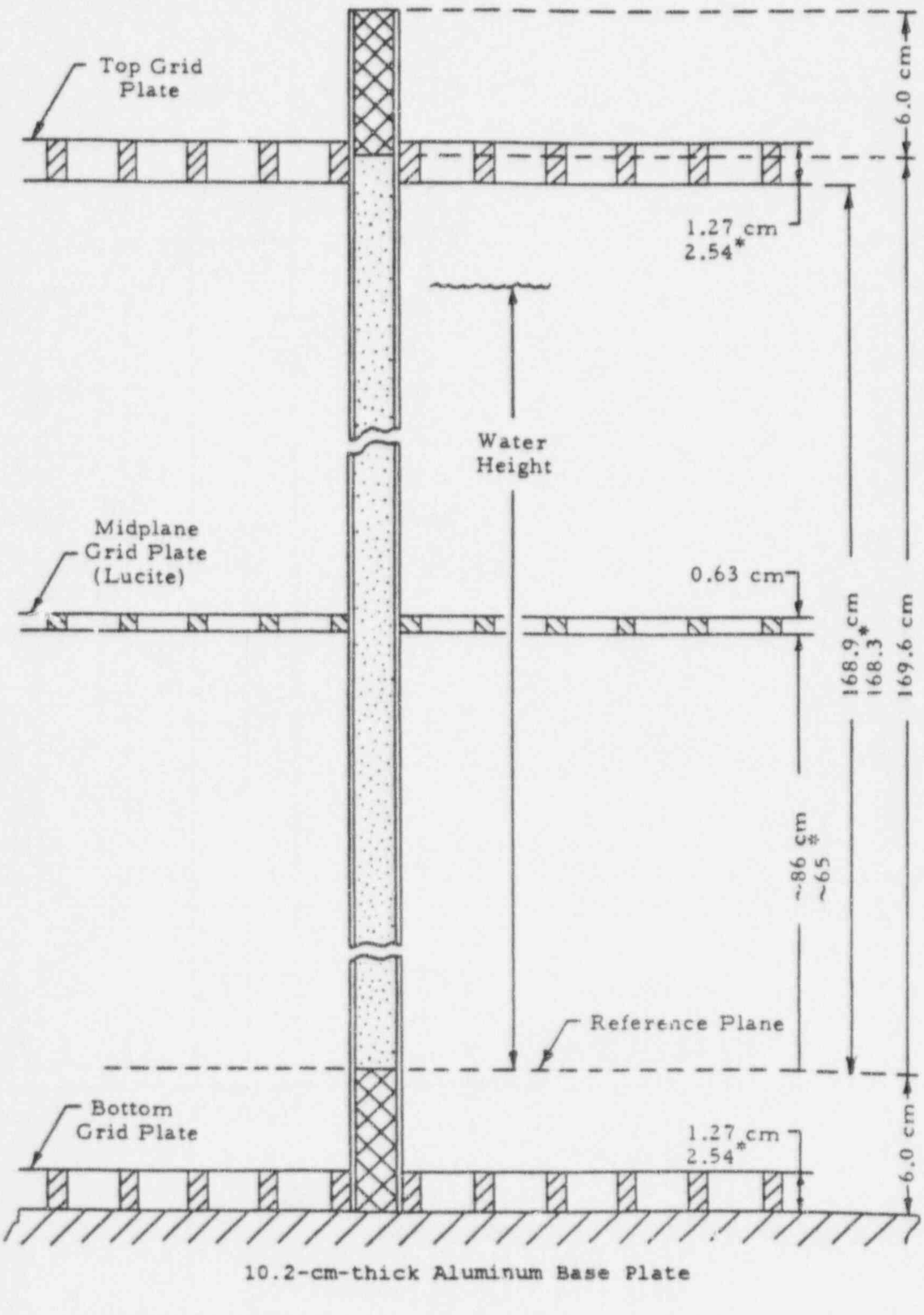


Figure 2.62 Vertical dimensions for **BW1231B1** and **BW1231B2**

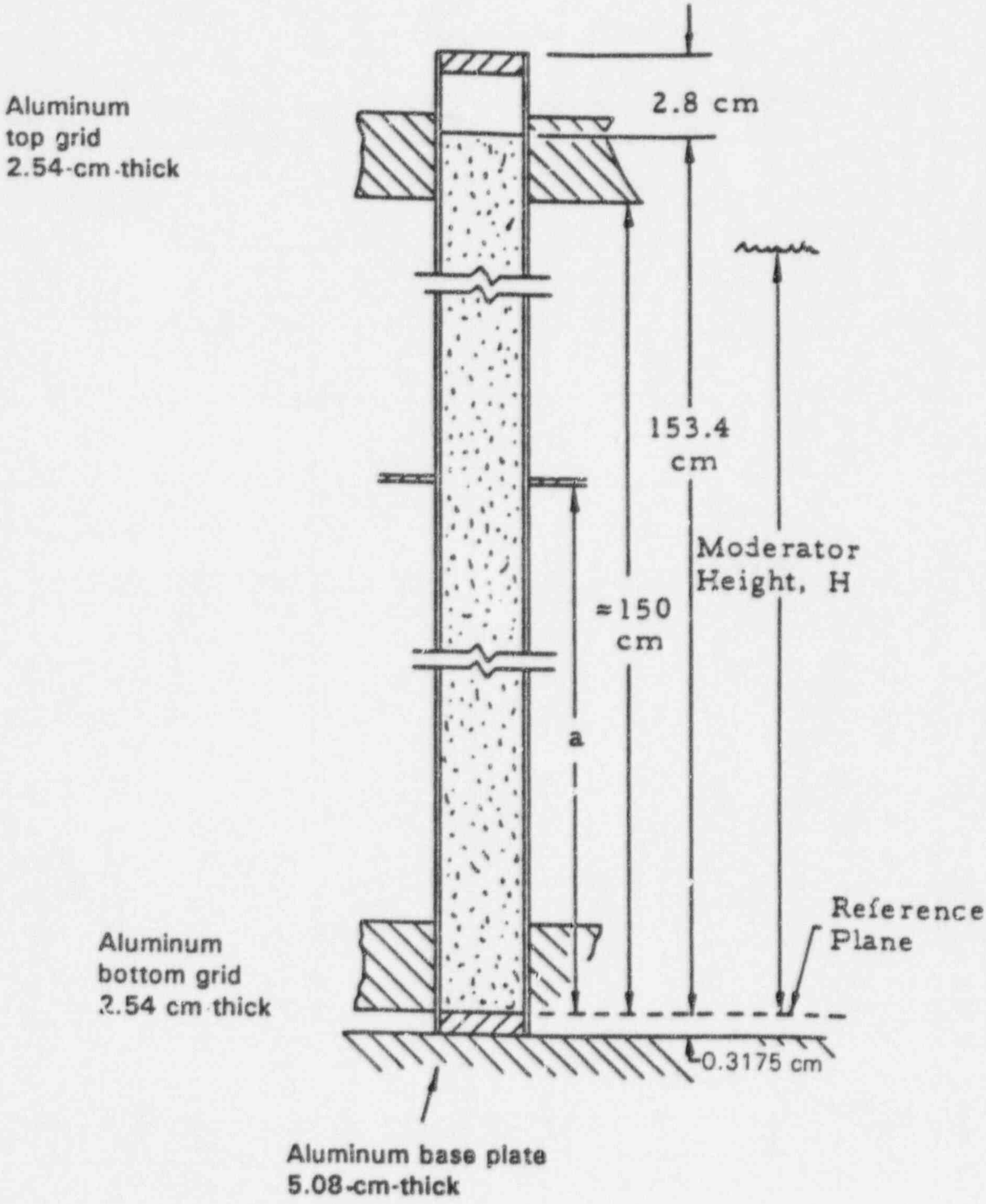


Figure 2.63 Vertical dimensions for BW1273M experiment

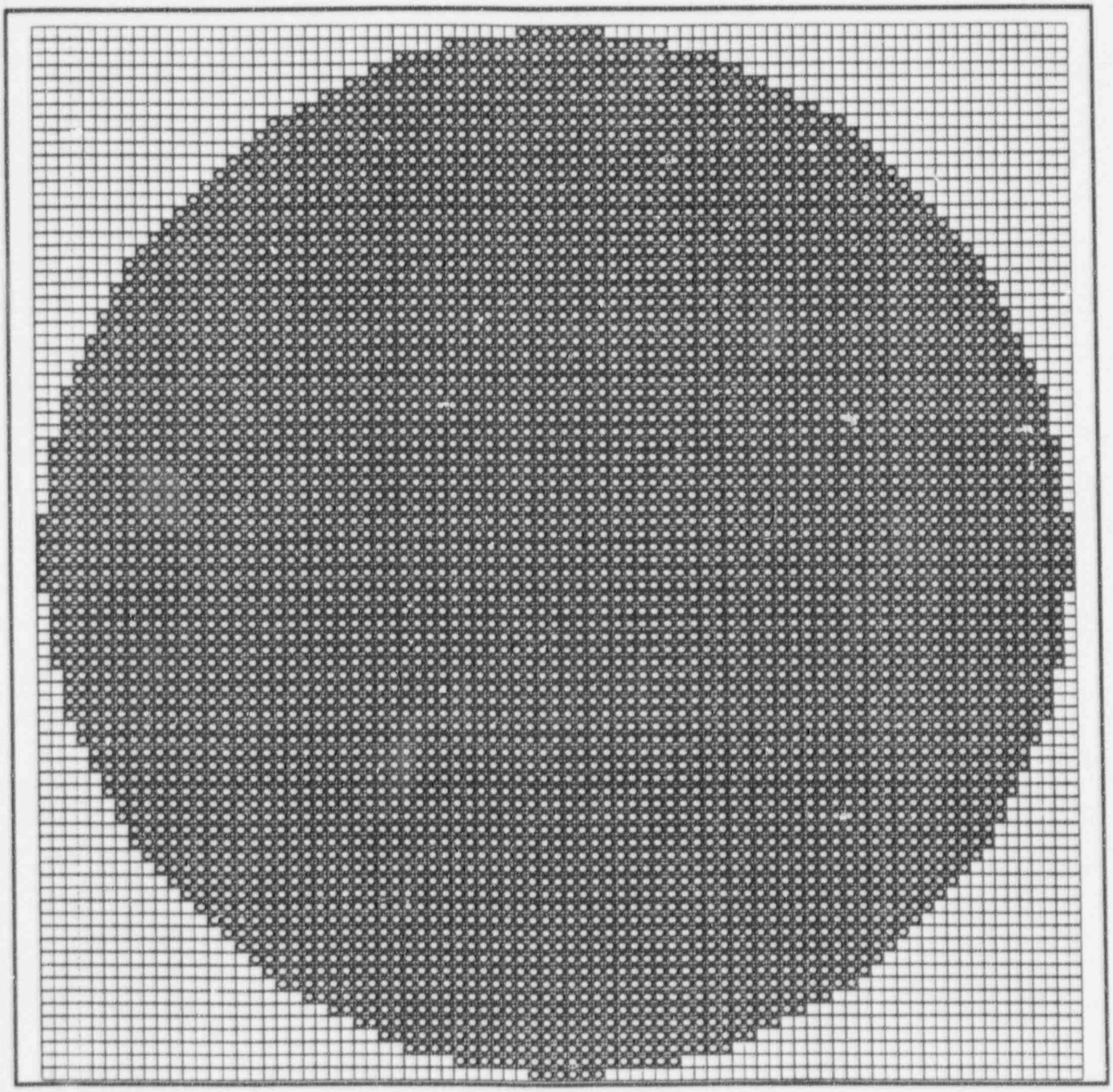


Figure 2.64 Cross-sectional view of modeled **BW1273M** core

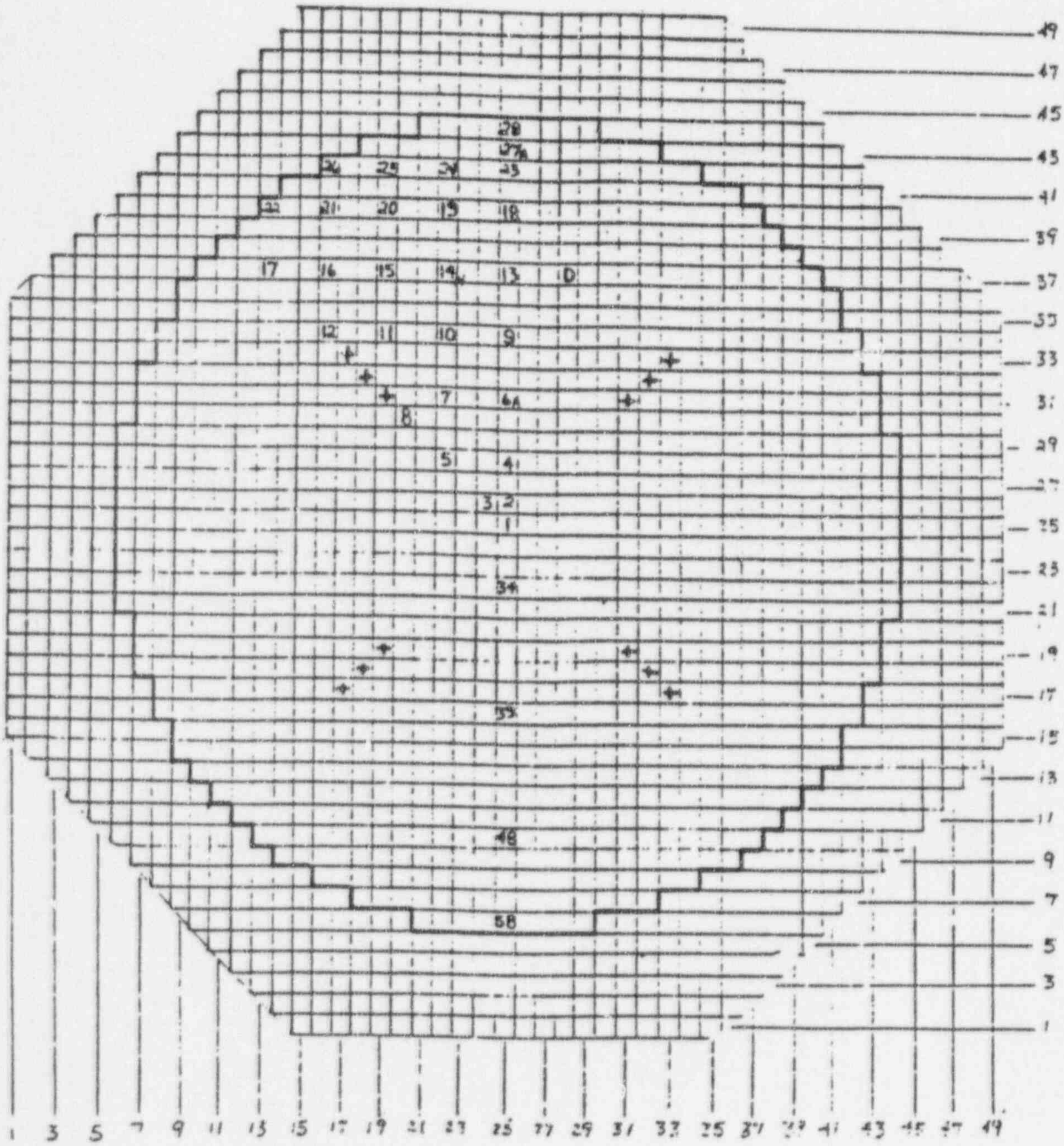


Figure 2.65 Core layout for **EPRU65B**. Source: Ref. 7 (Copyright © 1976. Electric Power Research Institute. EPRI NP-196. *Clean Critical Experiment Benchmarks for Plutonium Recycle in LWRs.* Reprinted with Permission.)

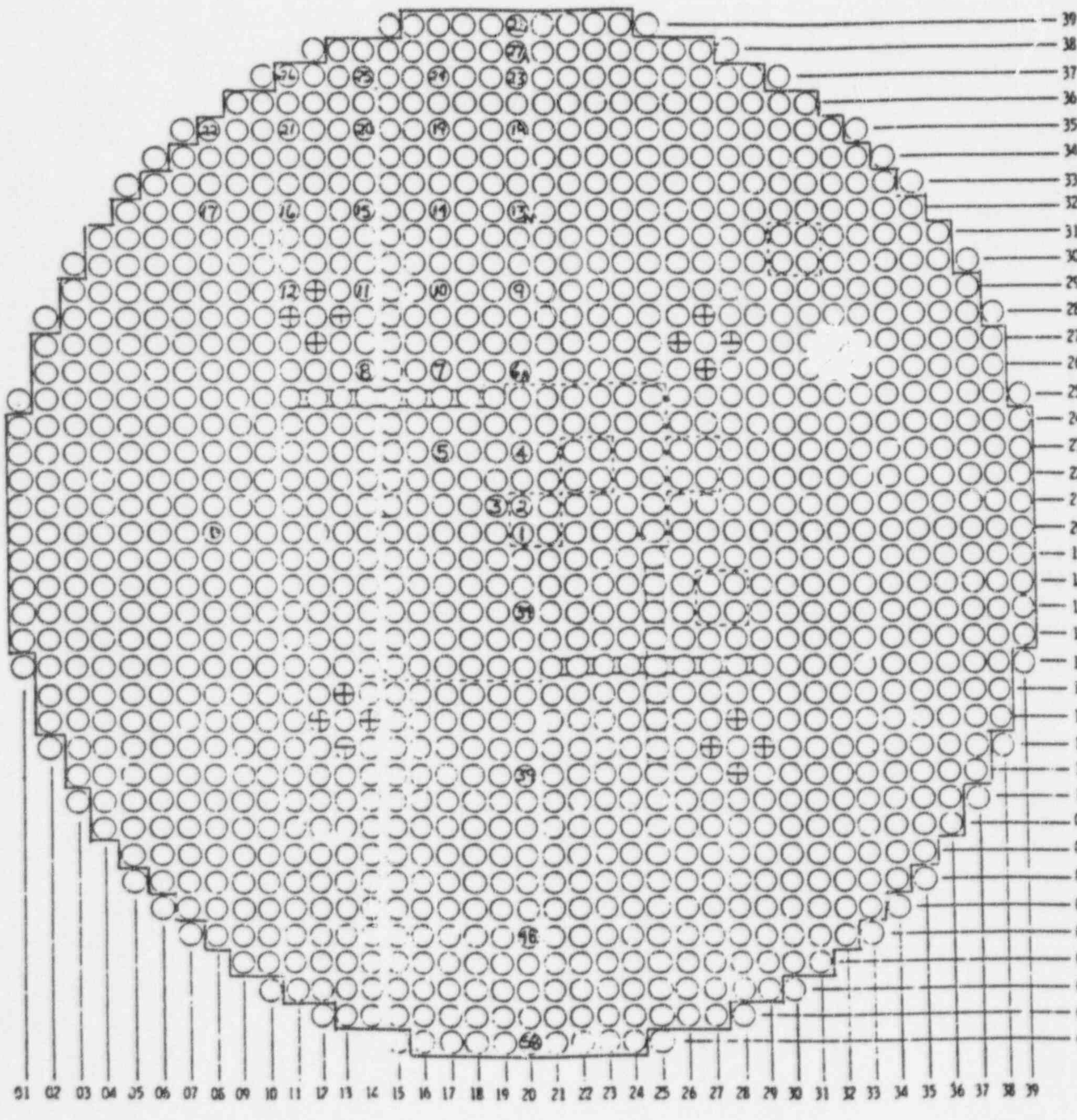


Figure 2.66 Core layout for **EPRU75B**. Source: Ref. 7 (Copyright © 1976. Electric Power Research Institute. EPRI NP-196. *Clean Critical Experiment Benchmarks for Plutonium Recycle in LWRs.* Reprinted with Permission.)

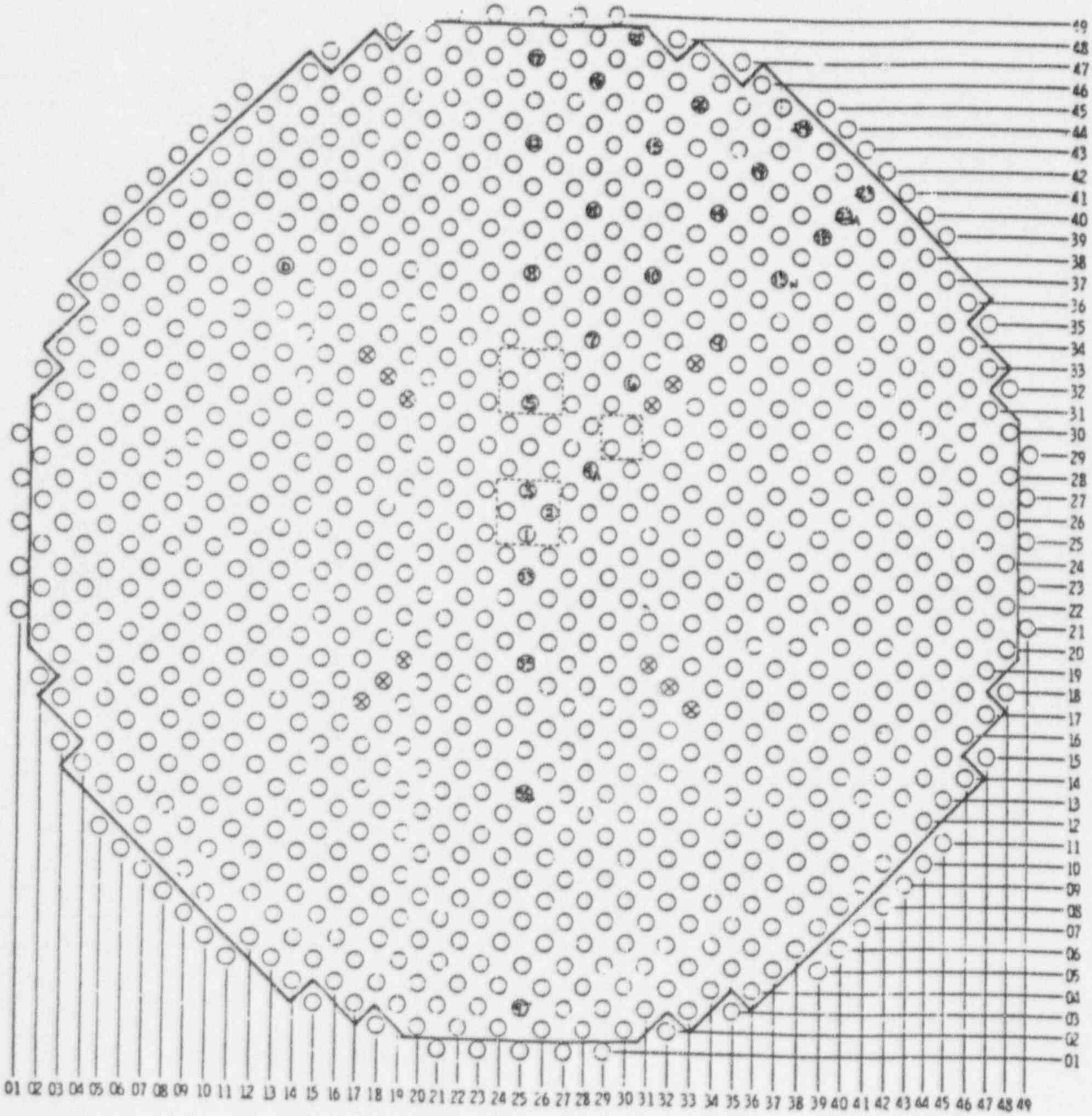
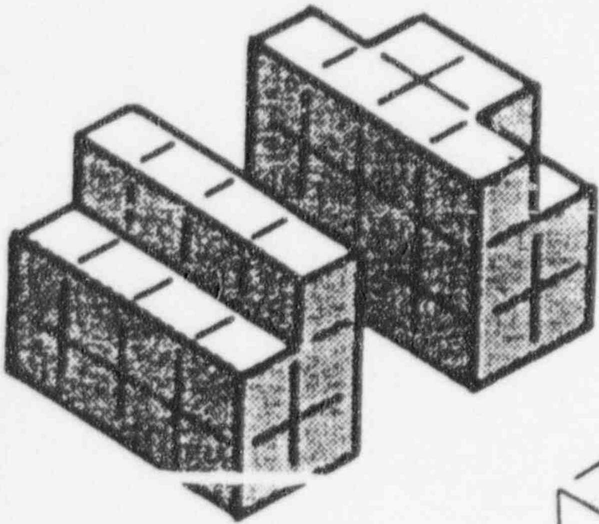
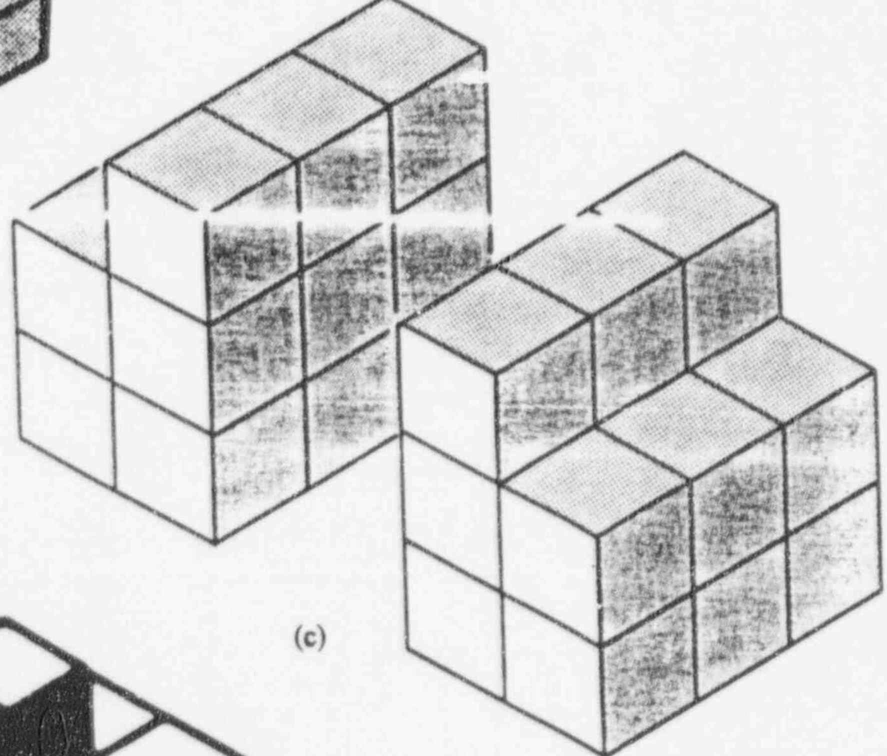


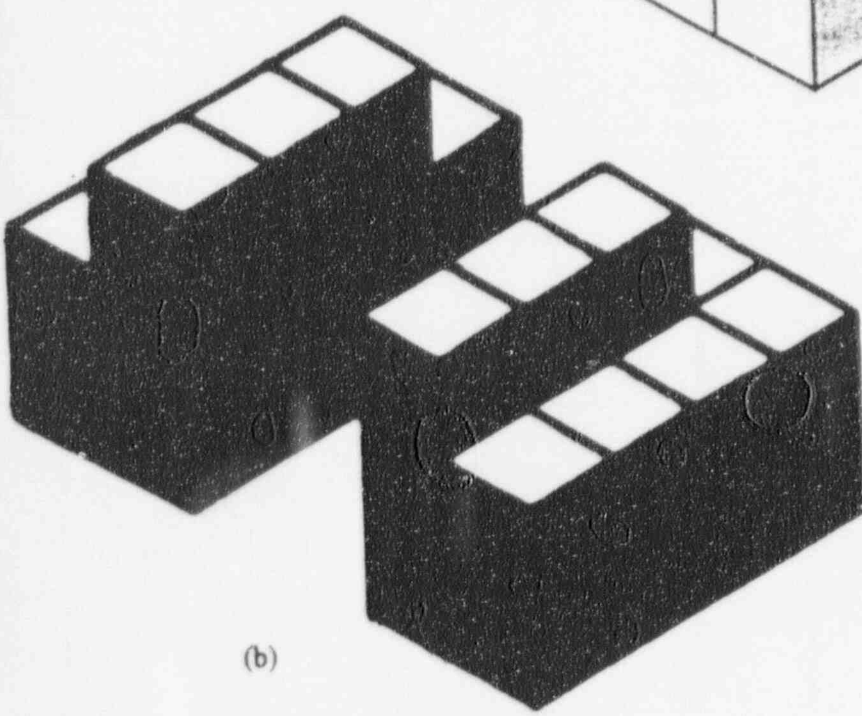
Figure 2.67 Core layout for **EPRU87B**. _Source_: Ref. 7 (Copyright © 1976. Electric Power Research Institute. EPRI NP-196. *Clean Critical Experiment Benchmarks for Plutonium Recycle in LWRs.* Reprinted with Permission.)



(a)



(c)



(b)

- Cans separated by 2.43-cm-thick nonfire-retardant Plexiglas blocks
- Two arrays of cans separated by 0.31, 1.26, and 0.57 cm of void for **CR1071AS, CR1653AS, and CR2500S**
- Moderator above second level is present in the vicinity of absent cans as well as behind the top layer can.

Figure 2.68 Isometric drawings of the (a) 42, (b) 38, and (c) 30 can configurations of experiments **CR1071AS, CR1653AS, CR2500S**. _Source_: Refs. 29--31.

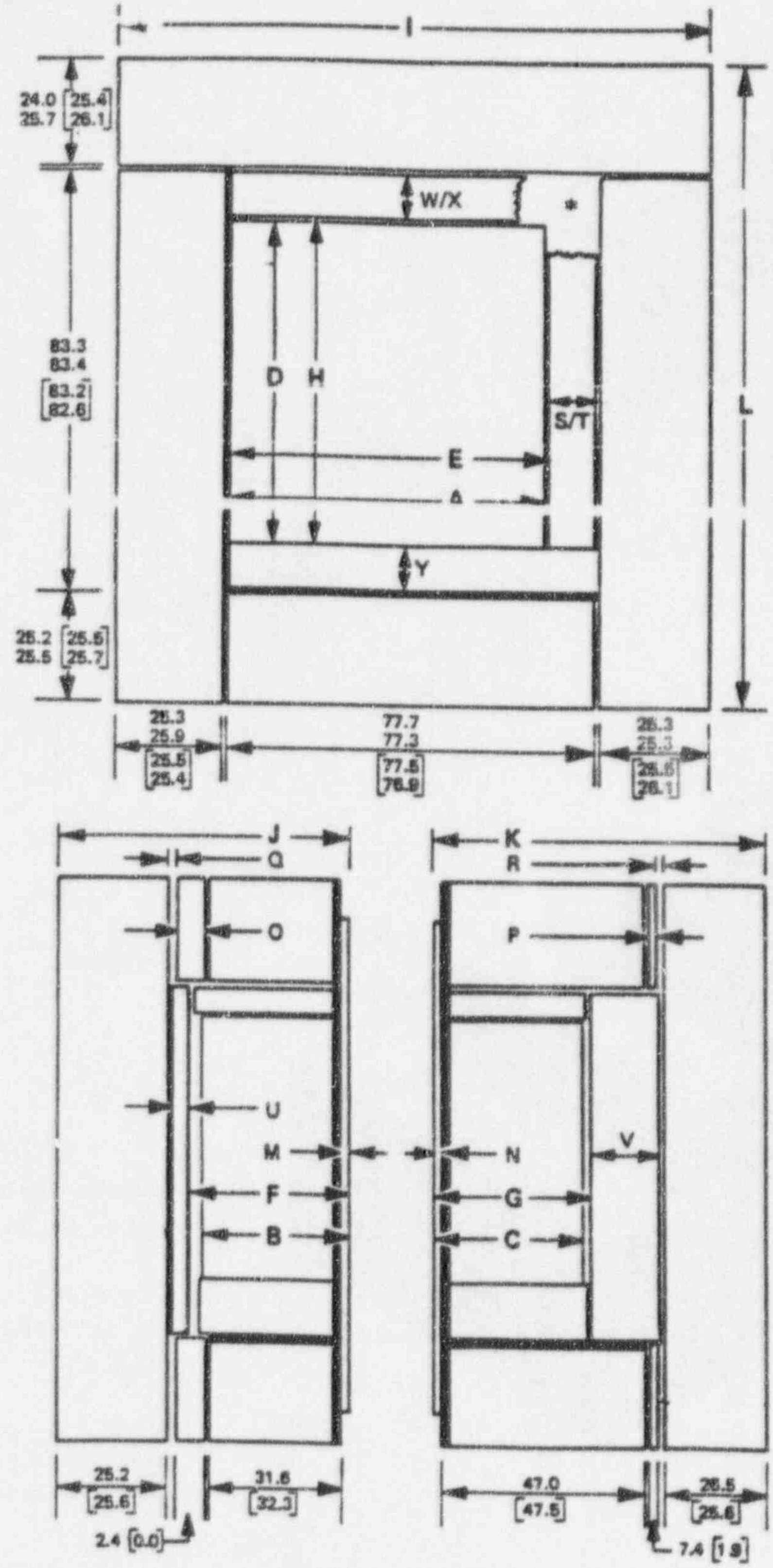


Figure 2.69 Planar and elevation view for **CR1071AS** (dimensions in cm, paired dimensions are for north and south tables). Source: Ref. 29

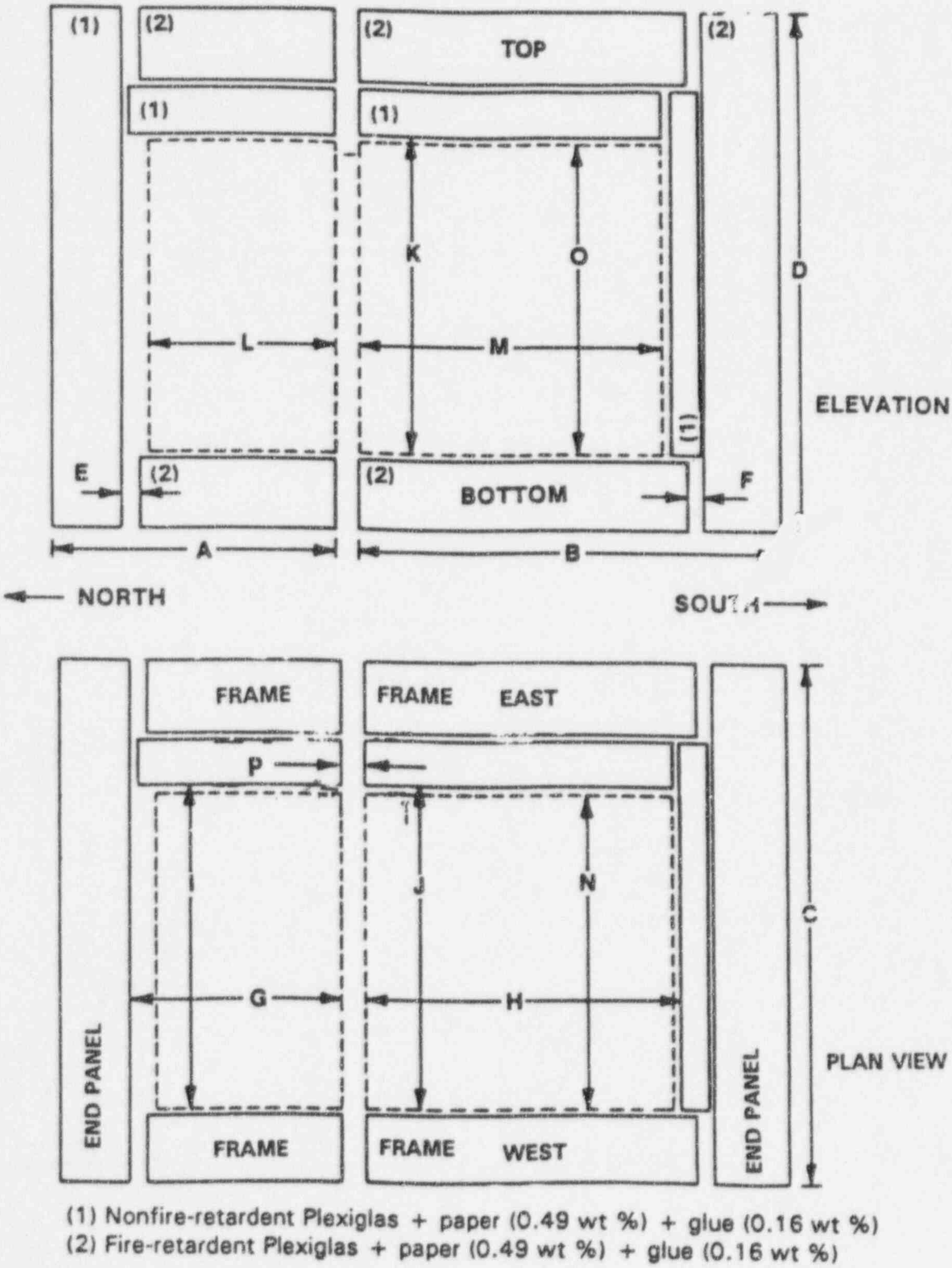


Figure 2.70 Planar and elevation view of core boundary (dashed lines) and reflector boundaries (solid lines) for **CR1653AS** and **CR2500AS**. _Source_: Ref. 30.

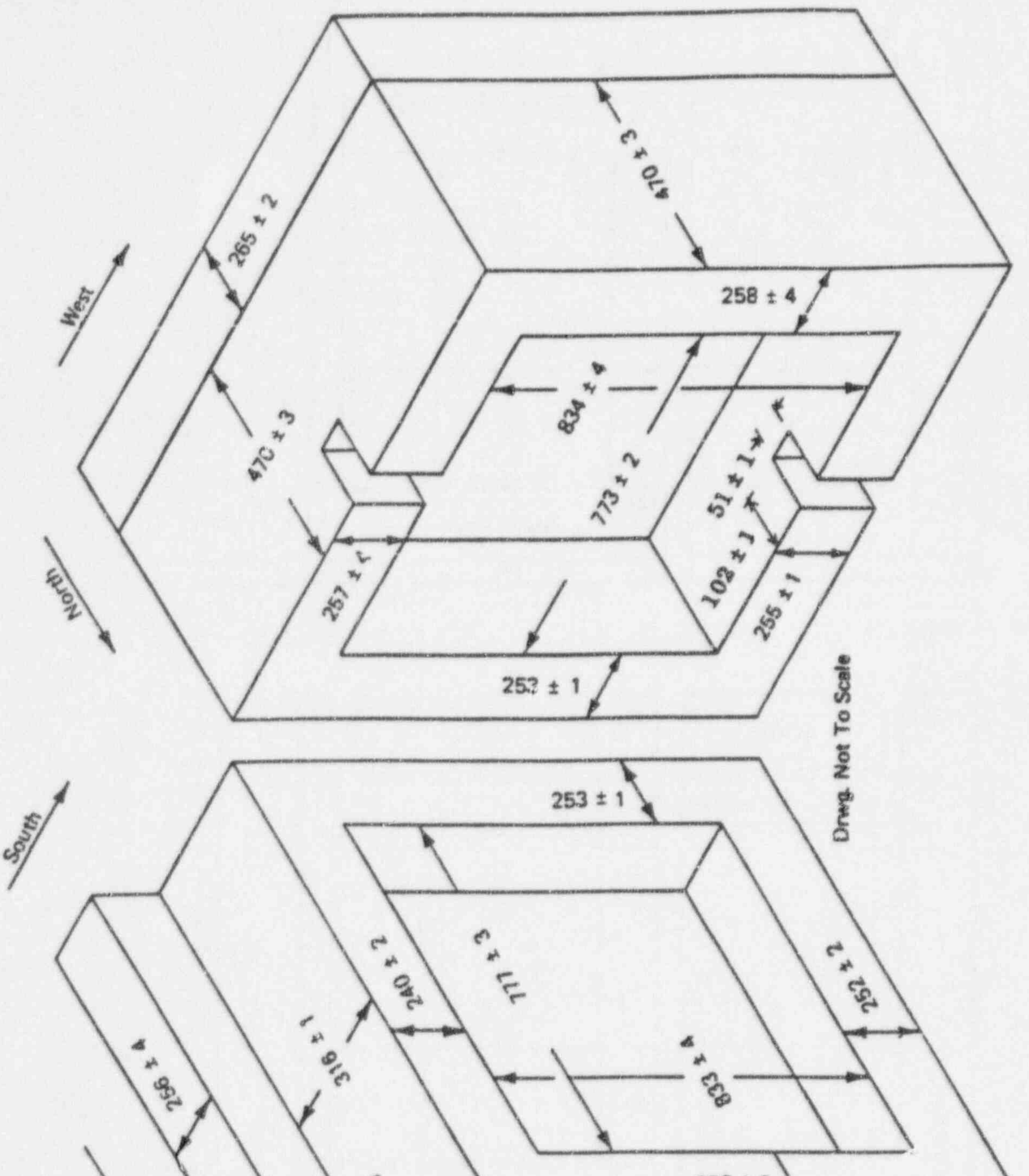


Figure 2.71 Dimension (mm) plastic reflector end panel and frame for CR1653AS. *Source*: Ref. 28

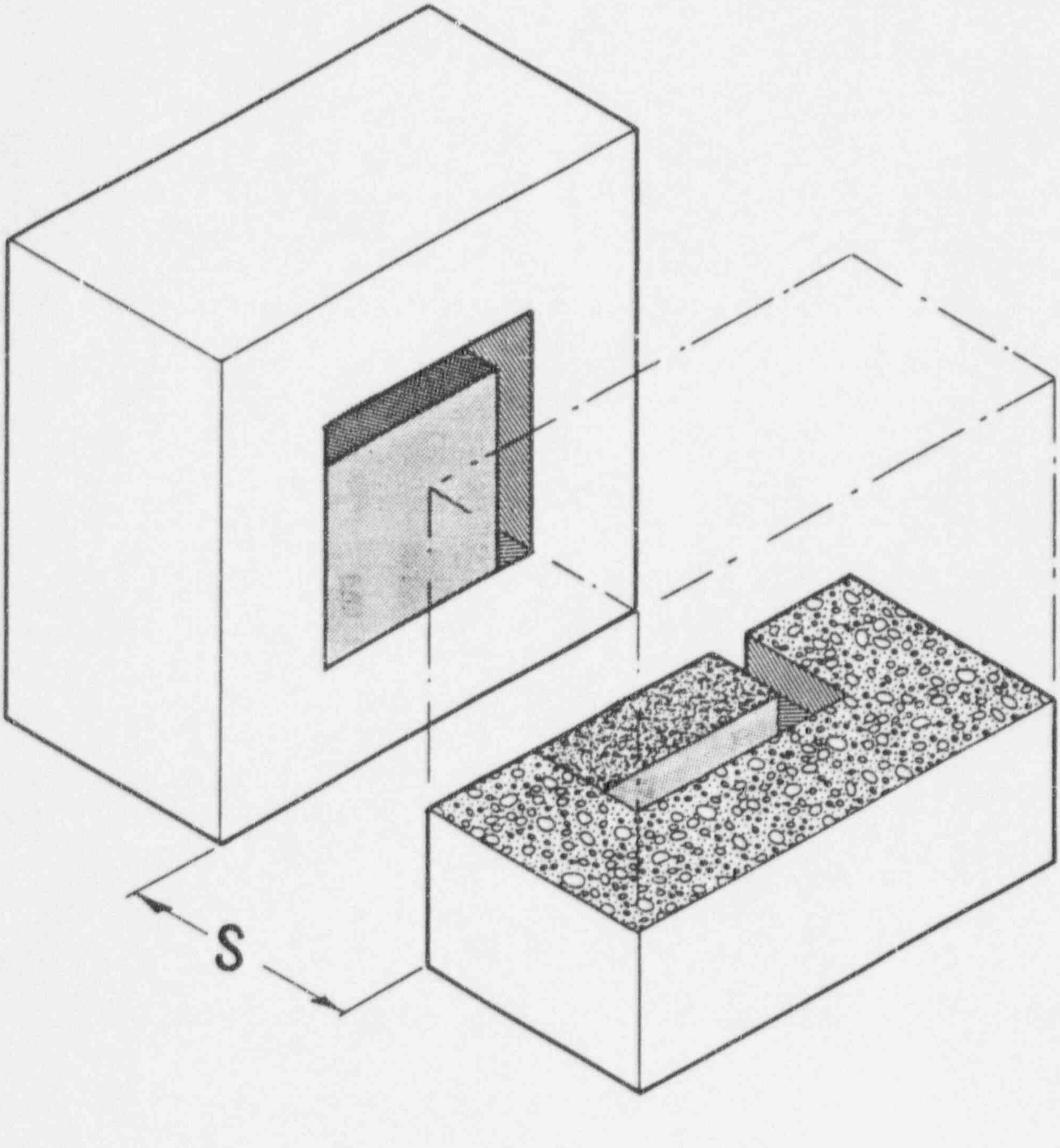


Figure 2.72 Three nested cuboids of **CR1071AS** and **CR2500S**: core, reflector interior, reflector exterior. *Source*: Ref. 29

3 Validation of the SCALE 44-Group ENDF/B-V Library with the LWR Critical Experiments

In order to demonstrate the applicability of the SCALE 44-group ENDF/B-V cross-section library (created on 5/16/96) for the range of conditions spanned by the fresh fuel experiments described in the previous section, computational models have been developed based on each experimental configuration. Structural components such as control and safety rod guides, support angles and channels, and tanks were neglected because they had no significant impact on the system k_{eff}. Specific modeling assumptions were noted in detail in Sect. 2. Chemical elements that appeared in materials in trace amounts were also considered negligible in the models. For reference, the SCALE-4.3 input files for these experiments are included in Appendix A.

The following subsection describes the sequences and modules of the SCALE-4.3 system used in the analysis of these computational models. This description is followed by a discussion of the results of calculations performed with SCALE-4.3 using these models, in terms of the classes of experiments described in Sect. 2.

3.1 Description of the SCALE Code System

SCALE is a computational system consisting of a set of well-established codes and data libraries suitable for analyses of nuclear fuel facility and package designs in the areas of criticality safety, radiation shielding, source term characterization, and heat transfer. The codes are compiled in a modular fashion and called by control modules that provide automated sequences for standard system analyses in each area.

The CSAS control module contains automated sequences that perform problem-dependent cross-section processing and three-dimensional (3-D) Monte Carlo calculations of neutron multiplication. Three CSAS control sequences, CSASN, CSAS25, and CSAS2X, were used to perform resonance processing and/or calculate effective neutron multiplication factors for the critical benchmark experiments supplied in this document. All neutronic control sequences use the SCALE Material Information Processor (MIP) to calculate material number densities and prepare geometry data for resonance self-shielding and optional flux-weighting cell calculations and to create data input files for the cross-section processing codes. The BONAMI[32] and NITAWL-II[33] codes are then used to perform problem-specific (resonance- and temperature-corrected) cross-section processing. BONAMI applies the Bondarenko method of resonance self-shielding for nuclides that have Bondarenko data included in the cross-section library. NITAWL-II uses the Nordheim integral treatment to perform resonance self-shielding corrections for nuclides that have resonance parameters included with their cross-section data. The CSASN sequence terminates at this point; the cross-section library produced from this calculation can be used as is or combined with other cross-section libraries and used in a subsequent criticality calculation.

The CSAS25 sequence then invokes KENO V.a,[34] a three-dimensional (3-D) multigroup Monte Carlo criticality code to determine the effective multiplication factor (k_{eff}) from the problem-dependent cross-section data and the user-specified geometry data. Other calculated KENO V.a quantities include average neutron lifetime and generation time, energy-dependent leakages, energy- and region-dependent absorptions, fissions, fluxes, and fission densities. The CSAS2X sequence invokes the one-dimensional (1-D) discrete-ordinates code XSDRNPM[35] to prepare cell-weighted cross sections prior to the execution of KENO V.a.

SCALE-4.3 includes the 238-group AMPX master-format neutron cross-section library[3] which contains data for all the nuclides available in ENDF/B-V and a broad structure 44-group neutron cross-section library[2] collapsed from the 238-group library. The group structure specification for each library was based on knowledge gained from the definition and use of the 218-group and 27-group libraries developed for the SCALE code system using ENDF/B-IV data.

The 238-group library has Bondarenko shielding factors included for nuclides with unresolved resonances, nuclides with Adler-Adler resonance data (^{233}U and ^{241}Pu), and the nonresonance nuclides ^{7}Li, ^{19}F, ^{27}Al, and ^{28}Si. Bondarenko factors are used for the latter nuclides because they exhibit resonance structure in the point data. This library includes s-, p-, and d-wave resonance data in the resonance parameters that are passed to NITAWL-II. The calculational effect of including these higher-order resonance data is addressed in Appendix B.

The broad-structure 44-group derivative of the fine-structure 238-group library was collapsed using a fuel cell spectrum based on a 17 × 17 Westinghouse pressurized-water-reactor (PWR) fuel assembly. The broad-group structure was designed to accommodate two windows in the oxygen cross-section spectrum, a window in the iron cross-section spectrum, the Maxwellian peak in the thermal range, and the 0.3-eV resonance in ^{239}Pu (which, due to low energy and lack of resonance data, cannot be modeled by the Nordheim Integral Treatment in NITAWL-II). The 44-group library has a group structure similar to the 27-group library, as shown in Table 3.1. All boundaries in the 27-group ENDF/ B-IV library correspond to those in the 44-group ENDF/B-V library except for the upper bound of group 23. Based on an analysis of a set of 93 thermal and fast critical experiments, the ENDF/B-V 44-group library demonstrated markedly improved performance over similar analyses performed with the ENDF/B-IV 27-group library.[2]

3.2 Modeling and Calculational Techniques

Several techniques for modeling the fuel region of particular experiments are addressed in Sect. 3.2.1. KENO V.a input parameters are discussed in Sect. 3.2.2.

3.2.1 Fuel Region Modeling

The experiments listed in Table 3.2 were explicitly modeled by considering the fuel rod regions submerged in and protruding from the moderator region. To accomplish this in CSAS, the Dancoff factors and resonance data had to be calculated for the fuel in the region void of moderator using a CSASN "PARM=CHECK" case and then explicitly specified in the CSAS25 calculation using the "MORE DATA" option. In all other experiments with fuel rods above the moderator, the contribution of the fuel in the region void of moderator was considered negligible and was not modeled.

In some instances more than one fissile mixture was present per experiment. Since only one CSAS unit cell specification is allowed per problem, the Dancoff factors and resonance data had to be calculated for the other unit cell descriptions using a CSASN "PARM=CHECK" case and then explicitly specified in the CSAS25 calculation using the "MORE DATA" option. The experiments with two or three fissile mixtures modeled using this method are listed in Table 3.3.

The experiments in Table 3.4 were modeled with CSAS2X in order to account for eccentricities of the control rod cruciform followers (the nine fuel rods of the follower veins were on a slightly different pitch than the core lattice). The followers were represented as nine core lattice positions containing mixture 500 that uses the XSDRNPM cell-weighted cross sections for the fuel and moderator. For the fuel rods of the core, the Dancoff factors and resonance data had to be calculated for the regions submerged in and protruding from the moderator region using CSASN and then explicitly specified in the CSAS25 calculation as in the other experiments above.

3.2.2 KENO V.a Parameter Data

All criticality calculations were run with 405 generations and 600 neutrons per generation for a total of 245,000 histories. The first five generations were omitted when calculating the average eigenvalue of the system. Default values were used for all other parameters including the start option of flat neutron distribution over the entire system. No albedo boundary conditions were applied; the default for each face is vacuum and is applied to the outermost region of every problem. No biasing was used to track neutrons in the water reflector region of each problem.

The calculated k_{eff} values throughout this report are estimates of the eigenvalues of systems and have associated uncertainties due to the statistical nature of the Monte Carlo codes.

3.3 Calculational Results Overview

The calculational results for the 173 LWR fuel pin lattice critical experiments described in Sect. 2.1 are presented and discussed in Sect. 3.4. The results for the seven homogeneous uranium systems described in Sect. 2.2 are presented and discussed in Sect. 3.5.

Two important calculated parameters in the presentation of results are the average energy group causing fission (AEG) and the energy of the average lethargy causing fission (AEF). AEG is a pseudo-neutron-spectra parameter calculated by KENO V.a that has been used historically as a single global parameter for correlating experiments to safety evaluation applications.[36] AEF has been added to the KENO V.a output in version 4.3 of SCALE and offers a single parameter in physical units (eV). Due to group structure and the techniques used to determine the average values, the energy that corresponds to AEG and the value of AEF may not be equivalent. AEG is a spectral index that is useful in validation but is not valid when comparing different cross-section libraries. On the other hand, AEF is more useful in interlibrary comparisons since it is a physically real parameter and not as dependent on the group structure of a library. For this reason, the remainder of this report will focus on AEF rather than AEG. Table 3.1 gives the group structure for the 44-group library used in this validation and is useful in locating an energy range corresponding to an AEG value. The table provides the upper energy bound of each broad group and the number of fine groups collapsed into it from the 238-group cross-section library.

In the following sections of this report, the validation results have been analyzed by grouping the experiments in terms of physical or neutronic characteristics as set forth in Sect. 2. For each group, the mean k_{eff} ($\bar{k}_{eff}$) and the range of calculated k_{eff} and AEF (eV) values are reported. The reported mean is the average of the nominal values of k_{eff} computed for each group of experiments. The standard deviation (σ_k) characterizes the distribution of the nominal values around this mean; this statistic does not include uncertainties associated with each individual Monte Carlo calculation.

In the discussions that follow, the term "positive bias" denotes a calculated k_{eff} value greater than the measured critical condition ($k_{eff} = 1$) and "negative bias" conversely denotes a calculated k_{eff} value less than 1. The remainder of this section presents the results of these analyses by group. A comparison of these results to those obtained with the 238-group library is provided in Appendix B.

3.4 Results for LWR Fuel Pin Lattices

This section reports the calculational results for 173 critical experiments classified as containing LWR fuel pin lattices. Table 3.5 contains nominal computed values of the effective neutron multiplication factor, k_{eff}, with associated standard deviation (σ), average energy group of neutrons causing fission (AEG), and energy of the average lethargy causing fission (AEF) for the LWR critical experiments. Figures 3.1 and 3.2 are histograms showing the frequency of k_{eff} and AEF for all 173 experiments in Table 3.5. Note the clustering of calculated k_{eff} near $k_{eff} = 1$ and the narrow range of AEF values that this validation encompasses. This distribuiton is remarkably normal, indicating no systematic biases on a global level. The nominal calculated k_{eff} values range from 0.9909 to 1.0129, with an average k_{eff} value of 0.9994 ± 0.0035 and an average bias of −0.06%. Sixty-eight percent of all k_{eff} values fall within 0.0035 of 0.9994 while 95% of all k_{eff} values fall within 0.0070 of 0.9994. AEF values ranged from 3.4451 to 0.0702 eV with more than 75% of the values within the range of 0.1 to 0.562 eV.

3.4.1 Simple Lattices

Descriptive statistics of the 21 simple (i.e., no absorbers, poisons, reflecting walls, etc.) square or hexagonal lattice calculations are given in Table 3.6. As can be seen from the table, the 17 square lattice calculations exhibited an average bias of −0.20% and spanned a relatively large range of AEF values, attesting to the variety of square lattice experiments used in the validation. The limited set of four hexagonal lattice calculations has a positive bias of 0.27%. Note that the hexagonal lattice experiments tend to have harder spectra than the square lattices and span a much larger energy range.

3.4.2 Lattices and Separator Plates Only

The calculated k_{eff} results for the 45 lattice with separator plate calculations are given in Table 3.7. The results of calculations of simple lattices with separator plates and borated moderator are given in Table 3.8, while Table 3.9 gives statistics of the calculational results of experiments with separator plates and voiding materials (i.e., flux traps). From Tables 3.7, 3.8, and 3.9, one can see that calculations involving aluminum separator plates have larger standard deviations associated with the average k_{eff} values, indicating a larger variation in results for these experiments. In all three tables, the highest k_{eff} values are recorded for calculations involving aluminum separator plates.

3.4.3 Lattices and Reflecting Walls Only

The calculational results of 35 lattice experiments with reflecting walls are summarized in Table 3.10. The largest positive bias in the validation of LWR-type fuel pin lattices for a group of more than four experiments is seen in the lead reflecting wall experiment calculations. For this group of experiments, the calculational bias is +0.37%. Only very small positive biases are observed for the calculations of the steel reflecting wall and the uranium reflecting wall experiments. The overall bias for all reflecting wall experiment calculations is +0.13%.

3.4.4 Lattices with Separator Plates and Reflecting Walls

The calculational results of 15 lattice experiments with separator plates and reflecting walls are presented in Table 3.11. The calculated k_{eff} values were scattered over a broad range from 0.9920 to 1.0040. As a group, the average calculational bias was −0.08%, and a narrow range of AEF values was observed (0.144–0.305 eV).

3.4.5 Lattices with Urania Gadolinia Rods

Table 3.12 gives descriptive statistics of the five lattices containing interspersed fuel rods with gadolinium in the form of UO_2-Gd_2O_3. This set of five calculations yielded nominal k_{eff} values over a small range from 0.9971 to 1.0005 with an average k_{eff} value of 0.9986 (Table 3.12). All of these experiments contained water holes and soluble boron. These cases give very consistent results but provide a very limited validation for urania gadolinia because the set consisted of only five critical experiments from one report with a small range in AEF values.

3.4.6 Lattices with Water Holes

A negative calculational bias of 0.15% is observed in the results in Table 3.13 for the six water-hole experiments with no soluble boron. For the three water-hole calculations where soluble boron was used in the moderator, a small bias of −0.08% and an increased average AEF (i.e., harder spectrum) were observed.

3.4.7 Lattices with B_4C or Ag-In-Cd Absorber Rods

Calculations of experiments with B_4C or Ag-In-Cd rods had average biases of −0.49% and −0.30%, respectively. One experiment in each group contained soluble boron and water holes. The total bias for the set of nine absorber rod calculations was −0.37%, given in Table 3.14 with other descriptive statistics of these calculations.

3.4.8 Simple Lattices with Soluble Boron

Fourteen simple lattice experiments contained soluble boron in the moderator. This set of calculations yielded calculated k_{eff} values ranging from 0.9947 to 1.0035 with an average k_{eff} value of 0.9992 (Table 3.15). AEF values spanned from 0.92 to 1.189 eV, a significant span of thermalized systems.

3.5 Results for Homogeneous Uranium Systems

This section reports the calculational results for seven low-enriched homogeneous uranium critical experiments. These experiments are included because some transportation packages may contain low-enriched fuel in geometric configurations other than the typical LWR fuel pin lattice geometry. Individual results are tabulated in Table 3.16. Group statistics are presented in Table 3.17.

The nominal calculated k_{eff} values ranged from 1.0011 to 1.0207 with an average bias of +1.29 %. This bias is attributed to the manner in which the library was generated. The 44-group library was collapsed to encompass the key spectral aspects of a different type of system, that of a typical LWR spent fuel package. Results obtained for these cases with the 238-group library show a much smaller bias, as can be seen in Table B.3. Only a small number of homogeneous systems have been considered in this validation. These few results for homogeneous systems indicate a larger bias tnan demonstrated for lattice systems. If the 44-group library is to be used for low-enriched fuel in other geometric configurations, care should be taken to ensure that adequate validation is performed for the particular application.

3.5.1 Homogeneous UF_4 in Paraffin

This set of calculations consisted of four experiments. Note that the 2.00 wt % ^{235}U cases agree well with the LWR fuel results (i.e., +0.29% bias). However, the 3.00 wt % cases exhibit a bias of approximately +1.4%. Although the reasons for this discrepancy are unknown, it is consistent with previous results for these cases.[37]

3.5.2 Damp Oxide

This set of calculations consisted of three experiments. The average calculated k_{eff} value is 1.9% high. This bias is consistent with previous results for these cases.[37]

Table 3.1 Broad-group structure of the 44GROUPNDF5 library

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

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

Table 3.2 Explicit fuel rod models for fuel above the moderator

ANS33AL1	ANS33STY	NSE71H1	W3269C
ANS33AL2	BW1231B1	NSE71H2	W3269SL1
ANS33AL3	BW1231B2	NSE71H3	W3269SL2
ANS33EB1	BW1273M	PAT80L1	W3269W1
ANS33EB2	DSN399-1	PAT80L2	W3269W2
ANS33EP1	DSN399-2	PAT80SS1	W3385SL1
ANS33EP2	DSN399-3	PAT80SS2	W3385SL2
ANS33SLG	DSN399-4	W3269A	

Table 3.3 Experiments with multiple fissile mixtures

Two fissile mixtures	Three fissile mixtures
BW1810A	BW1810J
BW1810B	BW1810C
BW1810G	BW1810D
BW1810H	BW1810E

Table 3.4 Experiments modeled with CSAS2X

W3269B1
W3269B2
W3269B3

Table 3.5 Calculational results using SCALE 44-group cross-section library

Case No.	Case name	k_{eff}	1σ	Enrich. (wt %)	Ref.	AEG	AEF (eV)	Pitch (cm)	H_2O/fuel vol.	H/X	Plate matl.[a]	Boron concen. (wt %)	Plate thick. (cm)	Wall matl.[b]	Wall separ. (cm)	No. of holes pins	Sol. boron[c]	Boron concen. (ppm)	Clad[d]	Other[e]	Lattice[f]	Assembly separ. (cm)	Dancoff factor
1	ANS33AL1	1.0027	0.0017	4.74	5	33.98	0.234478	1.35	2.302	138.4	AL	-	.30	-	-	-	N	-	AL	-	S	5.0	.20096
2	ANS33AL2	1.0129	0.0018	4.74	5	34.39	0.196837	1.35	2.302	138.4	AL	-	.30	-	-	-	N	-	AL	-	S	2.5	.20096
3	ANS33AL3	1.0035	0.0018	4.74	5	34.63	0.174878	1.35	2.302	138.4	AL	-	.30	-	-	-	N	-	AL	-	S	10.0	.20096
4	ANS33EB1	0.9979	0.0018	4.74	5	33.88	0.243861	1.35	2.302	138.4	AL	-	.30	-	-	-	N	-	AL	F3	S	2.5	.20096
5	ANS33EB2	1.0096	0.0017	4.74	5	34.29	0.205591	1.35	2.302	138.4	AL	-	.30	-	-	-	N	-	AL	F3	S	5.0	.20096
6	ANS33EP1	0.9964	0.0018	4.74	5	33.80	0.250214	1.35	2.302	138.4	AL	-	.30	-	-	-	N	-	AL	F3	S	2.5	.20096
7	ANS33EP2	1.0020	0.0018	4.74	5	34.09	0.221917	1.35	2.302	138.4	AL	-	.30	-	-	-	N	-	AL	F3	S	5.0	.20096
8	ANS33SLG	0.9964	0.0018	4.74	5	34.41	0.195652	1.35	2.302	138.4	-	-	-	-	-	-	N	-	AL	-	S	5.0	.20096
9	ANS33STY	0.9909	0.0019	4.74	5	33.65	0.266292	1.35	2.302	138.4	AL	-	.30	-	-	-	N	-	AL	F3	S	2.5	.20096
10	B1645SO1	0.9976	0.0013	2.46	17	32.82	0.401634	1.410	1.015	119.4	AL	-	-	-	-	-	Y	1068	AL	-	S	1.78	.34784
11	B1645SO2	1.0007	0.0014	2.46	17	32.76	0.411180	1.410	1.015	119.4	AL	-	-	-	-	-	Y	1156	AL	-	S	1.78	.34784
12	BW1231B1	0.9969	0.0014	4.02	25	31.13	0.727147	1.511	1.139	88.6	-	-	-	-	-	-	Y	1152	SS	-	S	-	.25722
13	BW1231B2	0.9985	0.0012	4.02	25	29.91	1.18903	1.511	1.139	88.6	-	-	-	-	-	-	Y	3389	SS	-	S	-	.25699
14	BW1273M	0.9947	0.0014	2.46	26	32.21	0.525212	1.511	1.376	161.5	-	-	-	-	-	-	Y	1675	AL	-	S	-	.26414
15	BW1484A1	0.9965	0.0015	2.46	6	34.55	0.193780	1.636	1.841	216.1	AL	1.6	.645	-	-	-	Y	15	AL	-	S	1.64	.19071
16	BW1484A2	0.9954	0.0016	2.46	6	35.16	0.152035	1.636	1.841	216.1	AL	1.1	.645	-	-	-	Y	72	AL	-	S	4.92	.19071
17	BW1484B1	0.9973	0.0014	2.46	6	33.95	0.247151	1.636	1.841	216.1	-	-	-	-	-	-	Y	1037	AL	-	S	-	.19062
18	BW1484B2	0.9973	0.0012	2.46	6	34.55	0.193879	1.636	1.841	216.1	-	-	-	-	-	-	Y	769	AL	-	S	1.64	.19065
19	BW1484B3	0.9992	0.0014	2.46	6	35.25	0.146615	1.636	1.841	216.1	-	-	-	-	-	-	Y	143	AL	-	S	4.92	.19070
20	BW1484C1	0.9937	0.0014	2.46	6	34.64	0.188354	1.636	1.841	216.1	-	-	-	-	-	-	N	-	AL	B	S	1.64	.19072
21	BW1484C2	0.9936	0.0016	2.46	6	35.23	0.148105	1.636	1.841	216.1	-	-	-	-	-	-	N	-	AL	B	S	1.64	.19072
22	BW1484S1	0.9981	0.0015	2.46	6	34.52	0.194990	1.636	1.841	216.1	SS	-	.462	-	-	-	Y	432	AL	-	S	1.64	.19069
23	BW1484S2	0.9989	0.0016	2.46	6	34.54	0.193171	1.636	1.841	216.1	SS	-	.462	-	-	-	Y	514	AL	-	S	1.64	.19068
24	BW1484SL	0.9966	0.0016	2.46	6	35.42	0.137530	1.636	1.841	216.1	-	-	-	-	-	-	N	-	AL	-	S	6.54	.19072
25	BW1645S1	1.0010	0.0016	2.46	17	30.11	1.32817	1.209	0.383	45.0	AL	-	-	-	-	-	Y	746	AL	-	S	1.78	.61533
26	BW1645S2	1.0035	0.0014	2.46	17	29.99	1.39167	1.209	0.383	45.0	AL	-	-	-	-	-	Y	886	AL	-	S	1.78	.61532
27	BW1645T1	1.0062	0.0016	2.46	17	29.18	2.15829	1.209	0.148	17.4	AL	-	.076	-	-	-	Y	335	AL	-	H	1.78	.76438
28	BW1645T2	1.0068	0.0015	2.46	17	29.04	2.28077	1.209	0.148	17.4	AL	-	.076	-	-	-	Y	435	AL	-	H	1.78	.76437
29	BW1645T3	1.0007	0.0016	2.46	17	30.05	1.50993	1.209	0.148	17.4	AL	-	.076	-	-	-	Y	361	AL	-	H	2.54	.76438
30	BW1645T4	0.9986	0.0016	2.46	17	31.17	0.968191	1.209	0.148	17.4	AL	-	.076	-	-	-	Y	121	AL	-	H	3.81	.76439
31	BW1810A	0.9971	0.0013	2.46	24	33.96	0.244783	1.636	1.841	216.1	-	-	-	-	-	.032	Y	1239	AL	G	S	-	.19043
32	BW1810B	0.9980	0.0013	2.46	24	33.98	0.243472	1.636	1.841	216.1	-	-	-	-	-	.032	Y	1170	AL	G	S	-	.19043
33	BW1810C	1.0005	0.0012	2.46	24	33.14	0.331369	1.636	1.841	216.1	-	-	-	-	-	.039	Y	1499	AL	G	S	-	.18973
				4.02					1.532	119.2									SS				.18527
34	BW1810D	0.9999	0.0012	2.46	24	33.10	0.336940	1.636	1.841	216.1	-	-	-	-	-	.032	Y	1654	AL	G	S	-	.18973
				4.02					1.532	119.2									SS				.18527
35	BW1810E	0.9976	0.0015	2.46	24	33.16	0.328183	1.636	1.841	216.1	-	-	-	-	-	.032	Y	1579	AL	G	S	-	.18973
				4.02					1.532	119.2									SS				.18527
36	BW1810F	1.0032	0.0010	2.46	24	33.96	0.244782	1.636	1.841	216.1	-	-	-	-	-	.032	Y	1337	AL	-	S	-	.18973
37	BW1810G	0.9971	0.0012	2.46	24	32.91	0.360952	1.636	1.841	216.1	-	-	-	-	-	.039	Y	1776	AL	-	S	-	.18973
				4.02					1.532	119.2									SS				.18527
38	BW1810H	0.9973	0.0013	2.46	24	32.95	0.354969	1.636	1.841	216.1	-	-	-	-	-	.032	Y	1899	AL	-	S	-	.18973
				4.02					1.532	119.2									SS				.18527
39	BW1810I	1.0022	0.0014	2.46	24	33.96	0.245038	1.636	1.841	216.1	-	-	-	-	-	.028	Y	1250	AL	A	S	-	.18973
40	BW1810J	0.9980	0.0013	2.46	24	33.13	0.332394	1.636	1.532	216.1	-	-	-	-	-	.028	Y	1635	AL	B	S	-	.18973
				4.02					1.532	119.2									SS				.18527
41	DSN399-1	1.0056	0.0019	4.74	18	33.94	0.232338	1.35	2.302	138.2	HF	-	.105	-	-	-	N	-	AL	-	S	1.8	.20101
42	DSN399-2	1.0010	0.0015	4.74	18	34.41	0.190708	1.35	2.302	138.2	HF	-	.105	-	-	-	N	-	AL	-	S	5.8	.20101

Table 3.5 (continued)

Case No.	Case name	k_{eff}	±σ	Enrich. (wt %)	Ref.	AEG	AEF(eV)	Pitch (cm)	H_2O/fuel vol.	H/X	Plate matl.[a]	Boron concen. (wt %)	Plate thick. (cm)	Wall matl.[b]	Wall separ. (cm)	No. of holes/pin	Sol. boron	Boron concen. (ppm)	Clad[c]	Other[d]	Lattice[e]	Assembly separ. (cm)	Dancoff factor
43	DSN399-3	1.0024	0.0017	4.74	18	35.32	0.130849	1.6	3.807	228.6	HF	-	.105	-	-	-	N	-	AL	-	S	-	.10503
44	DSN399-4	0.9965	0.0017	4.74	18	35.36	0.128298	1.6	3.807	228.6	HF	-	.105	-	-	-	N	-	AL	-	S	-	.10503
45	EPRU65	0.9977	0.0018	2.35	7	33.90	0.258691	1.562	1.196	163.6	-	-	-	-	-	-	N	-	AL	-	S	-	.27720
46	EPRU65B	0.9985	0.0018	2.35	7	33.41	0.315549	1.562	1.196	163.6	-	-	-	-	-	-	Y	463	AL	-	S	-	.27715
47	EPRU75	0.9974	0.0016	2.35	7	35.86	0.113352	1.905	2.408	329.4	-	-	-	-	-	-	N	-	AL	-	S	-	.11669
48	EPRU75B	1.0023	0.0011	2.35	7	35.28	0.143515	1.905	2.408	329.4	-	-	-	-	-	-	Y	568	AL	-	S	-	.11665
49	EPRU87	0.9986	0.0014	2.35	7	36.61	0.082692	2.210	3.687	504.2	-	-	-	-	-	-	N	-	AL	-	S	-	.05727
50	EPRU87B	0.9985	0.0014	2.35	7	36.33	0.092090	2.210	3.687	504.2	-	-	-	-	-	-	Y	286	AL	-	S	-	.05726
51	NSE71H1	0.9982	0.0019	4.74	8	33.52	0.272528	1.35	1.804	108.3	-	-	-	-	-	-	N	-	AL	-	H	-	.25747
52	NSE71H2	1.0009	0.0017	4.74	8	35.74	0.110404	1.72	3.311	228.8	-	-	-	-	-	-	N	-	AL	-	H	-	.10167
53	NSE71H3	1.0036	0.0021	4.74	8	36.88	0.070193	2.26	7.608	456.8	-	-	-	-	-	-	N	-	AL	-	H	-	.02984
54	NSE71SQ	1.0014	0.0017	4.74	8	33.79	0.243524	1.26	1.823	110.0	-	-	-	-	-	-	N	-	AL	-	S	-	.25719
55	NSE71W1	0.9993	0.0020	4.74	8	33.99	0.224204	1.26	1.823	110.0	-	-	-	-	-	.054	N	-	AL	-	S	-	.25719
56	NSE71W2	0.9976	0.0016	4.74	8	34.37	0.192011	1.26	1.823	110.0	-	-	-	-	-	.152	N	-	AL	-	S	-	.25719
57	P2438AL	0.9951	0.0016	2.35	9	36.30	0.094226	2.032	2.918	398.7	AL	-	.625	-	-	-	N	-	AL	-	S	8.67	.08629
58	P2438BA	0.9972	0.0015	2.35	9	36.22	0.097404	2.032	2.918	398.7	B	28.7	.713	-	-	-	N	-	AL	-	S	5.05	.08629
59	P2438CU	0.9957	0.0015	2.35	9	36.25	0.095990	2.032	2.918	398.7	CU	-	.646	-	-	-	N	-	AL	-	S	6.62	.08629
60	P2438SLG	0.9997	0.0012	2.35	9	36.29	0.094440	2.032	2.918	398.7	-	-	-	-	-	-	N	-	AL	-	S	8.39	.08629
61	P2438SS	0.9978	0.0014	2.35	9	36.26	0.095690	2.032	2.918	398.7	SS	-	.485	-	-	-	N	-	AL	-	S	6.88	.08629
62	P2438ZR	0.9956	0.0014	2.35	9	36.28	0.095115	2.032	2.918	398.7	ZR	-	.652	-	-	-	N	-	AL	-	S	8.79	.08629
63	P2615AL	1.0004	0.0016	4.31	19	35.74	0.114069	2.540	3.883	256.1	AL	-	.625	-	-	-	N	-	AL	-	S	10.72	.03889
64	P2615BA	0.9970	0.0017	4.31	19	35.72	0.115080	2.540	3.883	256.1	B	28.7	.713	-	-	-	N	-	AL	-	S	6.72	.03889
65	P2615CD1	0.9985	0.0017	4.31	19	35.74	0.114253	2.540	3.883	256.1	CD	-	.201	-	-	-	N	-	AL	-	S	7.82	.03889
66	P2615CD2	0.9990	0.0018	4.31	19	35.72	0.115015	2.540	3.883	256.1	CD	-	.201	-	-	-	N	-	AL	-	S	5.68	.03889
67	P2615CU	1.0003	0.0016	4.31	19	35.73	0.114411	2.540	3.883	256.1	CU	-	.646	-	-	-	N	-	AL	-	S	8.15	.03889
68	P2615SS	0.9998	0.0017	4.31	19	35.74	0.113821	2.540	3.883	256.1	SS	-	.485	-	-	-	N	-	AL	-	S	8.58	.03889
69	P2615ZR	0.9980	0.0018	4.31	19	35.75	0.113465	2.540	3.883	256.1	ZR	-	.652	-	-	-	N	-	AL	-	S	10.92	.03889
70	P2827L1	1.0023	0.0014	2.35	10	36.24	0.096202	2.032	2.918	398.7	-	-	-	L	0.66	-	N	-	AL	-	S	13.72	.08629
71	P2827L2	0.9997	0.0016	2.35	10	36.28	0.095061	2.032	2.918	398.7	-	-	-	L	2.62	-	N	-	AL	-	S	11.25	.08629
72	P2827L3	1.0081	0.0020	4.31	10	35.66	0.116654	2.540	3.883	256.1	-	-	-	L	0.66	-	N	-	AL	-	S	20.78	.03889
73	P2827L4	1.0073	0.0019	4.31	10	35.72	0.114400	2.540	3.883	256.1	-	-	-	L	1.32	-	N	-	AL	-	S	19.04	.03889
74	P2827SLG	0.9948	0.0015	2.35	10	36.29	0.094400	2.032	2.918	398.7	-	-	-	-	-	-	N	-	AL	-	S	8.31	.08629
75	P2827U1	1.0004	0.0015	2.35	10	34.74	0.212926	2.032	2.918	398.7	-	-	-	U	-	-	N	-	AL	-	S	11.83	.08629
76	P2827U2	0.9998	0.0014	2.35	10	35.15	0.173574	2.032	2.918	398.7	-	-	-	U	1.96	-	N	-	AL	-	S	14.11	.08629
77	P2827U3	1.0018	0.0018	4.31	10	33.43	0.385311	2.540	3.883	256.1	-	-	-	U	-	-	N	-	AL	-	S	15.38	.03889
78	P2827U4	1.0042	0.0017	4.31	10	34.09	0.280030	2.540	3.883	256.1	-	-	-	U	1.96	-	N	-	AL	-	S	15.32	.03889
79	P3314AL	0.9973	0.0020	4.31	11	33.96	0.237442	1.892	1.60	105.4	AL	-	.625	-	-	-	N	-	AL	-	S	9.04[g]	.17284
80	P3314BA	1.0002	0.0017	4.31	11	33.17	0.324124	1.892	1.60	105.4	B	28.7	.713	-	-	-	N	-	AL	-	S	4.80[g]	.17284
81	P3314BC	1.0008	0.0019	4.31	11	33.23	0.316489	1.892	1.60	105.4	B	31.9	.231	-	-	-	N	-	AL	-	S	3.53[g]	.17284
82	P3314BF1	1.0022	0.0017	4.31	11	33.22	0.317435	1.892	1.60	105.4	BF	-	.546	-	-	-	N	-	AL	-	S	3.60[g]	.17284
83	P3314BF2	0.9981	0.0019	4.31	11	33.21	0.318470	1.892	1.60	105.4	BF	-	.772	-	-	-	N	-	AL	-	S	4.94[g]	.17284
84	P3314BS1	0.9970	0.0016	2.35	11	34.84	0.174267	1.684	1.60	218.6	SS	1.1	.298	-	-	-	N	-	AL	-	S	3.86	.20179
85	P3314BS2	0.9959	0.0016	2.35	11	34.84	0.173578	1.684	1.60	218.6	SS	1.6	.298	-	-	-	N	-	AL	-	S	3.46	.20179
86	P3314BS3	0.9972	0.0016	4.31	11	33.41	0.294518	1.892	1.60	105.4	SS	1.1	.298	-	-	-	N	-	AL	-	S	7.23	.17284
87	P3314BS4	1.0005	0.0016	4.31	11	33.41	0.294168	1.892	1.60	105.4	SS	1.6	.298	-	-	-	N	-	AL	-	S	6.63	.17284
88	P3314CD1	1.0001	0.0016	4.31	11	33.30	0.305451	1.892	1.60	105.4	CD	-	.061	-	-	-	N	-	AL	-	S	5.30[g]	.17284
89	P3314CD2	0.9929	0.0018	2.35	11	34.80	0.176886	1.684	1.60	218.6	CD	-	.061	-	-	-	N	-	AL	-	S	3.04	.20179
90	P3314CU1	0.9941	0.0017	4.31	11	33.88	0.244311	1.892	1.60	105.4	CU	-	.337	-	-	-	N	-	AL	-	S	5.94[g]	.17284

Table 3.5 (continued)

Case No.	Case name	k_{eff}	±σ	Enrich. (wt %)	Ref.	AEG	AEF(eV)	Pitch (cm)	H_2O/fuel vol.	H/X	Plate matl.[a]	Boron concen. (wt %)	Plate thick. (cm)	Wall matl.[b]	Wall separ. (cm)	No. of holes/ pin	Sol. boron	Boron concen. (ppm)	Clad[d]	Other[e]	Lattice[f]	Assembly separ. (cm)	Dancoff factor
91	P3314CU2	1.0005	0.0017	4.31	11	33.70	0.260474	1.892	1.60	105.4	CU	-	.646	-	-	-	N	-	AL	-	S	2.67[g]	.17284
92	P3314CU3	0.9972	0.0016	4.31	11	33.50	0.283800	1.892	1.60	105.4	CU	-	.337	-	-	-	N	-	AL	-	S	10.36	.17284
93	P3314CU4	0.9992	0.0018	4.31	11	33.43	0.292385	1.892	1.60	105.4	UD	-	.357	-	-	-	N	-	AL	-	S	7.61	.17284
94	P3314CU5	0.9938	0.0017	2.35	11	34.98	0.164629	1.684	1.60	218.6	CU	-	.337	-	-	-	N	-	AL	-	S	5.24	.20179
95	P3314CU6	0.9958	0.0016	2.35	11	34.86	0.172536	1.684	1.60	218.6	UD	-	.357	-	-	-	N	-	AL	-	S	2.60	.20179
96	P3314SLG	0.9982	0.0017	4.31	11	33.97	0.235686	1.892	1.60	105.4	-	-	-	-	-	-	N	-	AL	-	S	10.86[g]	.17284
97	P3314SS1	0.9969	0.0015	4.31	11	33.95	0.235781	1.892	1.60	105.4	SS	-	.302	-	-	-	N	-	AL	-	S	3.38[g]	.17284
98	P3314SS2	1.0011	0.0016	4.31	11	33.77	0.255004	1.892	1.60	105.4	SS	-	.302	-	-	-	N	-	AL	-	S	11.55[g]	.17284
99	P3314SS3	0.9990	0.0018	4.31	11	33.88	0.243407	1.892	1.60	105.4	SS	-	.485	-	-	-	N	-	AL	-	S	4.47[g]	.17284
100	P3314SS4	0.9957	0.0018	4.31	11	33.74	0.257511	1.892	1.60	105.4	SS	-	.485	-	-	-	N	-	AL	-	S	8.36[g]	.17284
101	P3314SS5	0.9944	0.0018	2.35	11	34.95	0.166761	1.684	1.60	218.6	SS	-	.302	-	-	-	N	-	AL	-	S	7.80	.20179
102	P3314SS6	1.0003	0.0018	4.31	11	33.52	0.282203	1.892	1.60	105.4	SS	-	.302	-	-	-	N	-	AL	-	S	10.52	.17284
103	P3314W1	1.0015	0.0017	4.31	11	34.38	0.199212	1.892	1.60	105.4	-	-	-	-	-	.149	N	-	AL	-	S	-	.17284
104	P3314W2	0.9958	0.0015	2.35	11	35.22	0.148243	1.684	1.60	218.6	-	-	-	-	-	.051	N	-	AL	-	S	-	.20179
105	P3314ZR	0.9978	0.0016	4.31	11	33.97	0.235701	1.892	1.60	105.4	ZR	-	.652	-	-	-	N	-	AL	-	S	11.04[g]	.20179
106	P3602BB	0.9988	0.0015	4.31	22	33.31	0.304578	1.892	1.60	105.4	B	30.4	.292	SS	1.96	-	N	-	AL	-	S	8.30	.17284
107	P3602BS1	1.0000	0.0017	2.35	22	34.76	0.177973	1.684	1.60	218.6	SS	1.1	.298	SS	1.32	-	N	-	AL	-	S	4.80	.20179
108	P3602BS2	1.0001	0.0018	4.31	22	33.36	0.298546	1.892	1.60	105.4	SS	1.1	.298	SS	1.96	-	N	-	AL	-	S	9.83	.17284
109	P3602CD1	0.9988	0.0016	2.35	22	34.72	0.181191	1.684	1.60	218.6	CD	-	.061	SS	1.32	-	N	-	AL	-	S	3.86	.20179
110	P3602CD2	1.0002	0.0017	4.31	22	33.33	0.301071	1.892	1.60	105.4	CD	-	.061	SS	1.96	-	N	-	AL	-	S	8.94	.17284
111	P3602CU1	0.9964	0.0014	2.35	22	34.84	0.172511	1.684	1.60	218.6	CU	-	.337	SS	1.32	-	N	-	AL	-	S	7.79	.20179
112	P3602CU2	0.9980	0.0014	2.35	22	34.78	0.176071	1.684	1.60	218.6	UD	-	.357	SS	1.32	-	N	-	AL	-	S	5.43	.20179
113	P3602CU3	1.0039	0.0016	4.31	22	33.38	0.296714	1.892	1.60	105.4	CU	-	.337	SS	1.96	-	N	-	AL	-	S	13.47	.17284
114	P3602CU4	1.0040	0.0016	4.31	22	33.37	0.297224	1.892	1.60	105.4	UD	-	.357	SS	1.96	-	N	-	AL	-	S	10.57	.17284
115	P3602N11	1.0003	0.0018	2.35	22	34.73	0.180388	1.684	1.60	218.6	-	-	-	SS	-	-	N	-	AL	-	S	8.98	.20179
116	P3602N12	0.9963	0.0017	2.35	22	34.80	0.175283	1.684	1.60	218.6	-	-	-	SS	0.66	-	N	-	AL	-	S	9.58	.20179
117	P3602N13	0.9957	0.0016	2.35	22	34.92	0.167197	1.684	1.60	218.6	-	-	-	SS	1.68	-	N	-	AL	-	S	9.66	.20179
118	P3602N14	0.9984	0.0015	2.35	22	35.03	0.160446	1.684	1.60	218.6	-	-	-	SS	3.91	-	N	-	AL	-	S	8.54	.20179
119	P3602N21	0.9995	0.0015	2.35	22	36.27	0.094794	2.032	2.918	398.7	-	-	-	SS	2.62	-	N	-	AL	-	S	10.36	.08290
120	P3602N22	0.9967	0.0015	2.35	22	36.18	0.098047	2.032	2.918	398.7	-	-	-	SS	0.66	-	N	-	AL	-	S	11.20	.08290
121	P3602N31	1.0010	0.0018	4.31	22	33.19	0.317009	1.892	1.60	105.4	-	-	-	SS	0.00	-	N	-	AL	-	S	14.87	.17284
122	P3602N32	1.0015	0.0019	4.31	22	33.29	0.304586	1.892	1.60	105.4	-	-	-	SS	0.66	-	N	-	AL	-	S	15.74	.17284
123	P3602N33	1.0045	0.0019	4.31	22	33.37	0.295430	1.892	1.60	105.4	-	-	-	SS	1.32	-	N	-	AL	-	S	15.87	.17284
124	P3602N34	1.0027	0.0016	4.31	22	33.43	0.289835	1.892	1.60	105.4	-	-	-	SS	1.96	-	N	-	AL	-	S	15.84	.17284
125	P3602N35	1.0036	0.0018	4.31	22	33.48	0.284370	1.892	1.60	105.4	-	-	-	SS	2.62	-	N	-	AL	-	S	15.45	.17284
126	P3602N36	1.0009	0.0017	4.31	22	33.58	0.275421	1.892	1.60	105.4	-	-	-	SS	5.41	-	N	-	AL	-	S	13.82	.17284
127	P3602N41	1.0002	0.0016	4.31	22	35.50	0.123377	2.540	3.883	256.1	-	-	-	SS	-	-	N	-	AL	-	S	12.89	.03885
128	P3602N42	1.0019	0.0017	4.31	22	35.63	0.117741	2.540	3.883	256.1	-	-	-	SS	1.32	-	N	-	AL	-	S	14.12	.03885
129	P3602N43	0.9994	0.0017	4.31	22	35.74	0.113378	2.540	3.883	256.1	-	-	-	SS	2.62	-	N	-	AL	-	S	12.44	.03885
130	P3602SS1	0.9978	0.0016	2.35	22	34.87	0.170525	1.684	1.60	218.6	SS	-	.302	SS	1.32	-	N	-	AL	-	S	8.28	.20179
131	P3602SS2	1.0012	0.0018	4.31	22	33.40	0.292861	1.892	1.60	105.4	SS	-	.302	SS	1.96	-	N	-	AL	-	S	13.75	.17284
132	P3926L1	0.9996	0.0014	2.35	12	34.85	0.172514	1.684	1.60	218.6	-	-	-	L	-	-	N	-	AL	-	S	10.06	.20179
133	P3926L2	1.0028	0.0016	2.35	12	34.92	0.167446	1.684	1.60	218.6	-	-	-	L	0.66	-	N	-	AL	-	S	10.11	.20179
134	P3926L3	1.0017	0.0015	2.35	12	35.06	0.158275	1.684	1.60	218.6	-	-	-	L	3.28	-	N	-	AL	-	S	8.50	.20179
135	P3926L4	1.0055	0.0019	4.31	12	33.31	0.304464	1.892	1.60	105.4	-	-	-	L	-	-	N	-	AL	-	S	17.74	.17284
136	P3926L5	1.0070	0.0017	4.31	12	33.37	0.296797	1.892	1.60	105.4	-	-	-	L	0.66	-	N	-	AL	-	S	18.18	.17284
137	P3926L6	1.0026	0.0016	4.31	12	33.51	0.281808	1.892	1.60	105.4	-	-	-	L	1.96	-	N	-	AL	-	S	17.43	.17284
138	P3926SL1	0.9942	0.0015	2.35	12	35.07	0.159108	1.684	1.60	218.6	-	-	-	W	-	-	N	-	AL	-	S	6.59	.20179

Table 3.5 (continued)

Case No.	Case name	k_{eff}	±σ	Enrich. (wt %)	Ref.	AEG	AEF(eV)	Pitch (cm)	H_2O/ fuel/vol.	H/X	Plate matl.[a]	Boron concen. (wt %)	Plate thick. (cm)	Wall matl.[b]	Wall separ. (cm)	Hole/ pin	Sol. boron	Boron concen. (ppm)	Clad[d]	Other[e]	Lattice[f]	Assembly separ. (cm)	Dancoff factor
139	P3926SL2	0.9990	0.0019	4.31	12	33.55	.279386	1.892	1.60	105.4	-	-	-	-	-	-	N	-	AL	-	S	12.97	.17284
140	P3926U1	0.9979	0.0017	2.35	12	33.28	.403558	1.684	1.60	218.6	-	-	-	U	-	-	N	-	AL	-	S	8.06	.20179
141	P3926U2	0.9980	0.0017	2.35	12	33.62	.341429	1.684	1.60	218.6	-	-	-	U	1.32	-	N	-	AL	-	S	9.50	.20179
142	P3926U3	1.0001	0.0015	2.35	12	34.15	.263699	1.684	1.60	218.6	-	-	-	U	3.91	-	N	-	AL	-	S	9.19	.20179
143	P3926U4	1.0026	0.0017	4.31	12	31.93	.655172	1.892	1.60	105.4	-	-	-	U	-	-	N	-	AL	-	S	15.33	.17284
144	P3926U5	0.9999	0.0017	4.31	12	32.45	.511391	1.892	1.60	105.4	-	-	-	U	1.96	-	N	-	AL	-	S	19.24	.17284
145	P3926U6	1.0024	0.0016	4.31	12	32.74	.444529	1.892	1.60	105.4	-	-	-	U	3.28	-	N	-	AL	-	S	18.78	.17284
146	P4267B1	0.9969	0.0015	4.31	13	31.80	.548827	1.890	1.59	105.1	-	-	-	-	-	-	Y	2150	AL	-	S	-	.17349
147	P4267B2	1.0035	0.0013	4.31	13	31.54	.608525	1.890	1.59	105.1	-	-	-	-	-	-	Y	2550	AL	-	S	-	.17346
148	P4267B3	1.0025	0.0015	4.31	13	30.97	.794676	1.715	1.090	71.9	-	-	-	-	-	-	Y	1030	AL	-	S	-	.27021
149	P4267B4	0.9993	0.0016	4.31	13	30.51	.955273	1.715	1.090	71.9	-	-	-	-	-	-	Y	1820	AL	-	S	-	.27012
150	P4267B5	1.0031	0.0014	4.31	13	30.08	1.12803	1.715	1.090	71.9	-	-	-	-	-	-	Y	2550	AL	-	S	-	.27000
151	P4267SL1	0.9974	0.0018	4.31	13	33.44	.291929	1.890	1.59	105.1	-	-	-	-	-	-	N	-	AL	-	S	-	.17369
152	P4267SL2	0.9993	0.0017	4.31	13	31.95	.543594	1.715	1.090	71.9	-	-	-	-	-	-	N	-	AL	-	S	-	.27032
153	P49-194	1.0081	0.0016	4.31	14	27.62	3.44514	1.598	0.509	33.6	-	-	-	-	-	-	N	-	AL	-		-	.47372
154	P62FT231	1.0005	0.0018	4.31	20	32.92	.359262	1.891	1.60	105.0	B	35.6	.683	-	-	-	N	-	AL	-	S	5.67	.17338
155	P71F14F3	1.0029	0.0018	4.31	21	32.81	.376130	1.891	1.60	105.0	B	29.2	.673	-	-	-	N	-	AL	F1	S	5.19	.17388
156	P71F14V3	0.9973	0.0017	4.31	21	32.88	.364695	1.891	1.60	105.0	B	29.2	.673	-	-	-	N	-	AL	F2	S	5.19	.17388
157	P71F14V5	0.9977	0.0016	4.31	21	32.86	.367506	1.891	1.60	105.0	B	29.2	.673	-	-	-	N	-	AL	F2	S	5.19	.17388
158	P71F214R	1.0010	0.0020	4.31	21	32.88	.365283	1.891	1.60	105.0	B	29.2	.673	-	-	-	N	-	AL	-	S	5.19	.17388
159	PAT80L1	1.0031	0.0018	4.74	23	35.03	.148022	1.6	3.807	228.6	B	39.3	.11	L	0.23	-	N	-	AL	-	S	2.0	.10503
160	PAT80L2	0.9920	0.0018	4.74	23	35.08	.143839	1.6	3.807	228.6	B	39.3	.11	L	2.50	-	N	-	AL	-	S	2.0	.10503
161	PAT80SS1	1.0004	0.0017	4.74	23	35.00	.149442	1.6	3.807	226.6	B	39.3	.11	SS	0.23	-	N	-	AL	-	S	2.0	.10503
162	PAT80SS2	0.9926	0.0021	4.74	23	35.09	.143903	1.6	3.807	228.6	B	39.3	.11	SS	2.50	-	N	-	AL	-	S	2.0	.10503
163	W3269A	0.9934	0.0016	5.70	15	33.11	.311261	1.422	1.932	98.3	-	-	-	-	-	-	N	-	SS	-	S	-	.18534
164	W3269B1	0.9963	0.0015	3.70	15	32.36	.452602	1.105	1.447	111.0	-	-	-	-	-	-	N	-	SS	-	S	-	.04346
165	W3269B2	0.9964	0.0014	3.70	15	32.39	.447071	1.105	1.447	111.0	-	-	-	-	-	-	N	-	SS	A	S	-	.18534
166	W3269B3	0.9948	0.0016	3.70	15	32.26	.471281	1.105	1.447	111.0	-	-	-	-	-	-	N	-	SS	A	S	-	.37720
167	W3269C	0.9986	0.0015	2.72	15	33.75	.269691	1.524	1.495	156.1	-	-	-	-	-	-	N	-	SS	A	S	-	.37720
168	W3269SL1	0.9952	0.0017	2.72	15	33.35	.329668	1.524	1.495	156.1	-	-	-	-	-	-	N	-	SS	A	S	-	.37720
169	W3269SL2	1.0040	0.0020	5.70	15	33.08	.319337	1.422	1.932	98.3	-	-	-	-	-	-	N	-	ZR	A	S	-	.23385
170	W3269W1	0.9957	0.0018	5.70	15	33.50	.310025	1.524	1.495	156.1	-	-	-	-	-	-	N	-	ZR	-	S	-	.23388
171	W3269W2	1.0009	0.0017	5.70	15	33.18	.305719	1.422	1.932	98.3	-	-	-	-	-	-	N	-	SS	-	S	-	.18534
172	W3385SI1	0.9964	0.0017	5.74	16	33.21	.299510	1.422	1.933	97.6	-	-	-	-	-	.017	N	-	ZR	-	S	-	.23388
173	W3385SI2	1.0005	0.0020	5.74	16	35.86	.104227	2.011	5.067	255.9	-	-	-	-	-	.013	N	-	SS	-	S	-	.18534

[a]AL - aluminum; B - boral; BF - boroflex; CD - cadmium; CU - copper; HF - hafnium; SS - stainless steel; UD - copper-cadmium; ZR - Zircaloy.
[b]L - lead; SS - stainless steel; U - depleted uranium.
[c]Y - yes; N - no.
[d]AL - aluminum; SS - stainless steel; ZR - Zircaloy.
[e]A - Ag-In-Cd rods; B - B_4C rods; F1 - flux trap containing fuel rods; F2 - flux trap containing aluminum plates or rods; F3 - flux trap containing polyethylene or polystyrene; G - UO_2-Gd_2O_3 rods.
[f]H - hexagonal; S - square.
[g]Other separation distance is 2.83 cm.

Table 3.6 Descriptive statistics of simple lattice calculations

Description	No. of exp.	k_{eff} range	$\bar{k}_{eff}$	$\pm\sigma_k$	AEF range (eV)
Square	17	0.9942–1.0004	0.9980	0.0025	0.083–0.544
Hexagonal	4	0.9982–1.0081	1.0027	0.0042	0.070–3.445
TOTAL	21	0.9942–1.0081	0.9989	0.0033	0.070–3.445

Table 3.7. Descriptive statistics of separator plate only calculations

Description	No. of exp.	k_{eff} range	$\bar{k}_{eff}$	$\pm\sigma_k$	AEF range (eV)
Aluminum	6	0.9951–1.0129	1.0020	0.0062	0.094–0.237
Boral	6	0.9970–1.0010	0.9995	0.0018	0.097–0.365
Boroflex	2	0.9981–1.0022	1.0002	0.0029	0.317–0.318
Cadmium	4	0.9929–1.0001	0.9976	0.0032	0.114–0.305
Copper	6	0.9938–1.0005	0.9969	0.0029	0.096–0.283
Cu-Cd	2	0.9938–0.9992	0.9965	0.0038	0.173–0.292
Hafnium	4	0.9965–1.0056	1.0014	0.0038	0.128–0.232
Borated steel	4	0.9959–1.0005	0.9977	0.0020	0.174–0.295
Steel	8	0.9944–1.0011	0.9981	0.0023	0.097–0.282
Zircaloy	3	0.9956–0.9980	0.9971	0.0013	0.095–0.236
TOTAL	45	0.9929–1.0129	0.9989	0.0035	0.094–0.365

Table 3.8 Descriptive statistics of separator plate-soluble boron calculations

Plate lattice	No. of exp.	k_{eff} range	$\bar{k}_{eff}$	$\pm\sigma_k$	AEF range (eV)
Hexagonal					
Aluminum	4	0.9986–1.0068	1.0031	0.0041	0.968–2.281
Square					
Borated aluminum	2	0.9954–0.9965	0.9960	0.0008	0.152–0.194
Aluminum	4	0.9976–1.0035	1.0007	0.0024	0.402–1.392
Steel	2	0.9981–0.9989	0.9985	0.0006	0.193–0.195
TOTAL	12	0.9954–1.0068	1.0003	0.0036	0.152–2.281

Table 3.9 Descriptive statistics of separator plate-void material (flux trap) calculations

Description	No. of exp.	k_{eff} range	$\bar{k}_{eff}$	$\pm\sigma_k$	AEF range (eV)
Al-polyethylene	4	0.9964–1.0096	1.0015	0.0059	0.206–0.250
Al-polystyrene	1	0.9909	0.9909	0.0000	0.266
Boral-Al	2	0.9973–0.9977	0.9975	0.0003	0.365–0.368
Boral-fuel rods	1	1.0029	1.0029	0.0000	0.376
TOTAL	8	0.9909–1.0096	0.9993	0.0055	0.206–0.368

Table 3.10 Descriptive statistics of reflecting wall calculations

Description	No. of exp.	k_{eff} range	$\bar{k}_{eff}$	$\pm\sigma_k$	AEF range (eV)
Lead	10	0.9996–1.0081	1.0037	0.0031	0.095–0.304
Steel	15	0.9957–1.0045	1.0002	0.0026	0.095–0.317
Uranium	10	0.9979–1.0042	1.0007	0.0020	0.173–0.655
TOTAL	35	0.9957–1.0081	1.0013	0.0030	0.095–0.655

Table 3.11 Descriptive statistics of reflecting wall-separator plate calculations

Wall/plate material	No. of exp.	k_{eff} range	$\bar{k}_{eff}$	$\pm\sigma_k$	AEF range (eV)
Lead-Boral	2	0.9920–1.0031	0.9976	0.0078	0.144–0.148
Steel-Boral	3	0.9926–1.0004	0.9973	0.0041	0.144–0.305
Steel-Cadmium	2	0.9988–1.0002	0.9995	0.0010	0.181–0.301
Steel-Copper	2	0.9964–1.0039	1.0002	0.0053	0.173–0.297
Steel-Cu-Cd	2	0.9980–1.0040	1.0010	0.0042	0.176–0.297
Steel-Borated steel	2	1.0000–1.0001	1.0001	0.0001	0.178–0.299
Steel-Steel	2	0.9978–1.0012	0.9995	0.0024	0.171–0.293
TOTAL	15	0.9920–1.0040	0.9992	0.0035	0.144–0.305

Table 3.12 Descriptive statistics of urania gadolinia rod calculations

Description	No. of exp.	k_{eff} range	$\bar{k}_{eff}$	$\pm\sigma_k$	AEF range (eV)
Urania-gadolinia rods	5	0.9971–1.0005	0.9986	0.0015	0.243–0.337

Table 3.13 Descriptive statistics of water hole calculations

Description	No. of exp.	k_{eff} range	$\bar{k}_{eff}$	$\pm\sigma_k$	AEF range (eV)
Water holes	6	0.9957–1.0015	0.9985	0.0025	0.148–0.310
Water holes-soluble boron	3	0.9971–1.0032	0.9992	0.0035	0.245–0.355
TOTAL	9	0.9957–1.0032	0.9987	0.0027	0.148–0.355

Table 3.14 Descriptive statistics of absorber rod calculations

Description	No. of exp.	k_{eff} range	$\bar{k}_{eff}$	$\pm\sigma_k$	AEF range (eV)
B_4C	3	0.9936–0.9980	0.9951	0.0025	0.148–0.332
Ag-In-Cd	6	0.9934–1.0022	0.9970	0.0031	0.245–0.471
TOTAL	9	0.9936–1.0022	0.9963	0.0029	0.148–0.471

Table 3.15 Descriptive statistics of soluble boron calculations

Description	No. of exp.	k_{eff} range	$\bar{k}_{eff}$	$\pm\sigma_k$	AEF range (eV)
Borated water	14	0.9947–1.0035	0.9992	0.0027	0.92–1.189

Table 3.16 Calculational results and experimental parameters of homogenized uranium experiments

Case No.	Case desig.	k_{eff}	$\pm\sigma$	Enrichment	Ref.	AEG	AEF	H/X	Fuel form	Moderator	Moderator thickness	Reflector
174	CR1071AS	1.0207	0.0016	4.46	28,29,31	32.45	0.45405	17.12	U_3O_8	Plexiglas	2.43	Plexiglas
175	CR1653AS	1.0169	0.0018	4.48	28,30,31	32.78	0.38852	27.33	U_3O_8	Plexiglas	2.43	Plexiglas
176	CR2500S	1.0194	0.0018	4.48	28,31	33.20	0.31665	44.27	U_3O_8	Plexiglas	2.43	Plexiglas
177	YDR14PL2	1.0011	0.0015	2.00	27	36.49	0.08319	406.3	UF_4	Paraffin	0.0	Paraffin
178	YDR14PL3	1.0115	0.0017	3.00	27	33.86	0.23625	133.4	UF_4	Paraffin	0.0	Paraffin
179	YDR14UN2	1.0047	0.0015	2.00	27	35.39	0.13273	293.9	UF_4	Paraffin	0.0	None
180	YDR14UN3	1.0163	0.0017	3.00	27	33.10	0.32152	133.4	UF_4	Paraffin	0.0	None

Table 3.17 Descriptive statistics of homogenized uranium calculations

Description	No. of exp.	k_{eff} range	$\bar{k}_{eff}$	$\pm\sigma_k$	AEF range (eV)
UF_4 in paraffin	4	1.0011–1.0163	1.0084	0.0068	0.083–0.322
Damp oxide (U_3O_8)	3	1.0169–1.0207	1.0190	0.0019	0.317–0.454
TOTAL	7	1.0011–1.0207	1.0129	0.0075	0.083–0.454

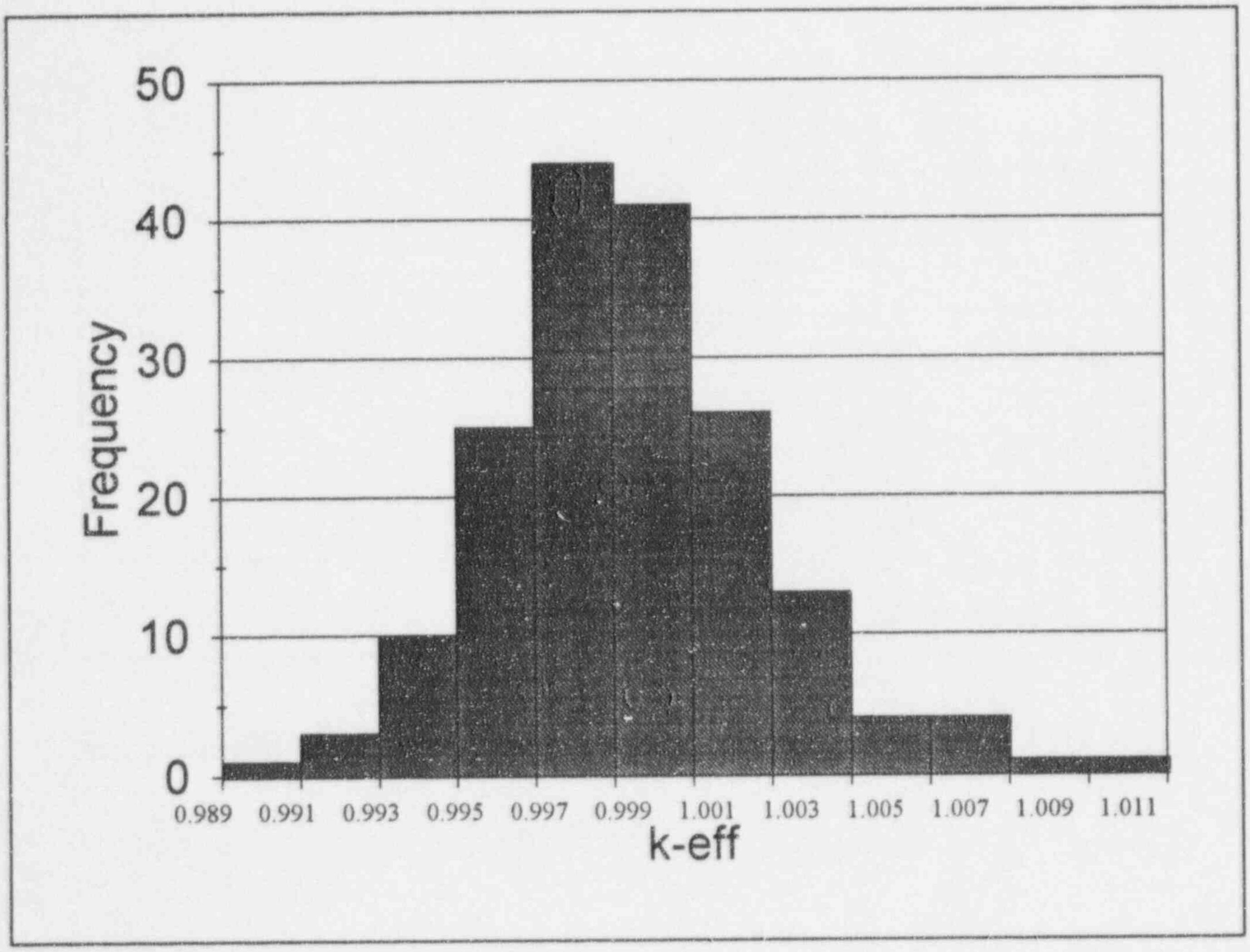


Figure 3.1 Frequency chart for calculated k_{eff} of 173 LWR fuel pin lattice experiments

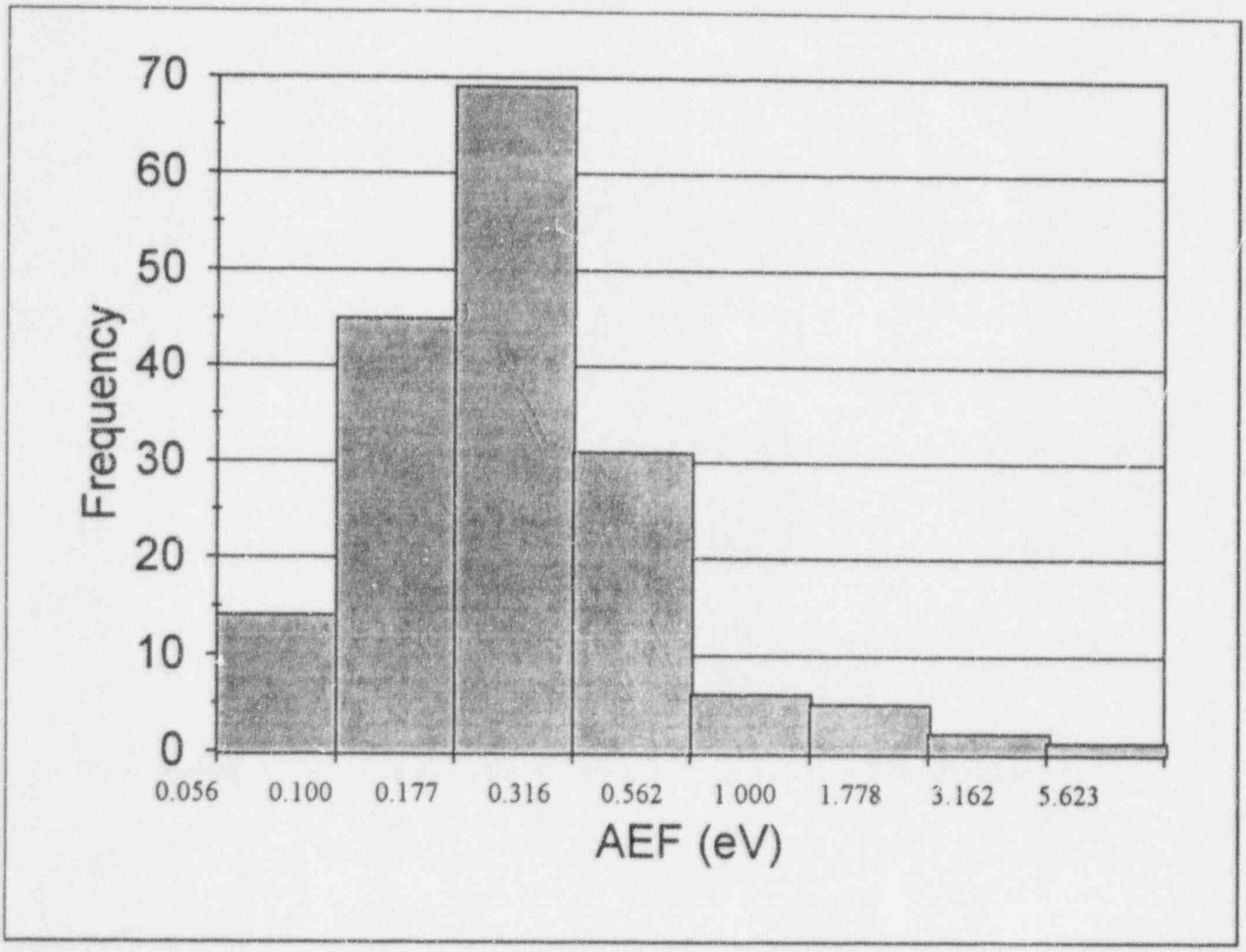


Figure 3.2 Frequency chart for calculated AEF of 173 LWR fuel pin lattice experiments

4 Determination of Bias and Subcritical Limits

Essential elements in the validation of a calculational method for criticality safety applications include the determination of calculational biases and the incorporation of these biases into subcritical limits. This section presents two methods for performing this task and then applies the methods to the validation of the SCALE 44-group library for the LWR lattice results in Sect. 3.

4.1 Establishment of an Upper Subcritical Limit

For a subcritical configuration, it is desirable to possess a confidence that the calculation of k_{eff} for a system guarantees sufficient subcriticality. This assurance of subcriticality requires the determination of an acceptable margin based on known biases and uncertainties associated with the codes and data used to calculate k_{eff}. This subsection describes two methods for the determination of an Upper Subcritical Limit (USL) from the bias and uncertainty terms associated with the calculation of criticality. These approaches are used to help define uncertainty and bias terms as they relate to criticality experiments and calculations.

The recommended approach for establishing subcriticality based on the numerical calculation of the neutron multiplication factor is prescribed in Sect. 5.1 of ANSI/ANS-8.17 (Ref. 38). The following paragraphs describe the recommended approach as set forth in the Standard.

The criteria to establish subcriticality requires that for a system to be considered subcritical the calculated multiplication factor for the system, k_s, must be less than or equal to an established maximum allowable multiplication factor based on benchmark calculations and uncertainty terms, that is,

$$k_s \le k_c - \Delta k_s - \Delta k_c - \Delta k_m \, , \tag{4.1}$$

where

- k_c = mean value of k_{eff} resulting from the calculation of benchmark criticality experiments using a specific calculational method and data,
- Δk_s = uncertainty in the value of k_s,
- Δk_c = uncertainty in the value of k_c,
- Δk_m = additional margin to ensure subcriticality.

Often Δk_m is arbitrarily assigned an administrative limit of 0.05; however, a value for this margin can also be estimated statistically.

If the calculational bias β is defined as $\beta = k_c - 1$, then the uncertainty in the bias is identical to the uncertainty in k_c (i.e., $\Delta k_c = \Delta\beta$). According to this definition of bias, the bias is negative if $k_c < 1$ and positive if $k_c > 1$. Thus the subcriticality condition may be rewritten as

$$k_s + \Delta k_s + \Delta k_m - \beta + \Delta\beta \le 1. \tag{4.2}$$

The value k_c and thus the bias β are not necessarily constant over the range of a parameter of interest. If trends exist which cause the benchmark values of k_{eff} to vary with one or more parameters (e.g., enrichment, AEF, etc.), then β can be determined from a best fit for the calculated k_{eff} values as a function of each of the parameters upon which it is dependent. Trends must be taken into account if extrapolation outside the range of validation is to be performed.

The set of critical experiments used as benchmarks in the computation of β should be representative of the composition, configuration, and nuclear characteristics of the system for which k_s is to be determined. However, ANSI/ANS-8.1 (Ref. 39) allows that the range of applicability may be extended beyond the range of conditions represented by the benchmark experiments by extrapolating the trends established for the bias. When the extrapolation is large relative to the range of data ("large" is not defined by the ANSI standard), the calculational method applied should be supplemented by other methods in order to better estimate the extrapolated bias.

In addition to the bias β determined based on a given computational method, data, and a suite of benchmarks, there is an uncertainty in the bias $\Delta\beta$. This uncertainty may include uncertainties in the critical experiments, statistical and/or convergence uncertainties in the benchmark calculations, uncertainties due to extrapolation beyond the range of experimental data, and uncertainties due to limitations or weaknesses in the geometrical or nuclear modeling of the critical experiments. Similarly, for a given subcritical system, there is an uncertainty, Δk_s, associated with the calculated k_{eff} value for the system, k_s. This uncertainty may include statistical/convergence and modeling uncertainties, as well as uncertainties in the materials and fabrication.

Based on the criteria for subcriticality set forth in ANSI/ANS-8.17 and described above, a USL may be determined based on the analysis of a number of critical systems. The USL is determined such that there is a high degree of confidence that a calculated result is subcritical; a system is considered acceptably subcritical if a calculated k_{eff} plus calculational uncertainties lies at or below this limit (i.e., $k_s + \Delta k_s \le USL$). Thus the USL is the magnitude of the sum of the biases, uncertainties, and administrative and/or statistical margins applied to a set of critical benchmarks, such that with a high degree of confidence

$$USL = 1 - \Delta k_m + \beta - \Delta\beta \,. \tag{4.3}$$

Based on a given set of critical experiments, USLs are determined as a function of key system parameters, such as AEF, fuel enrichment, or fuel/moderator ratio. Because both $\Delta\beta$ and β can vary with a given parameter, the USL is typically expressed as a function of the parameter, within an appropriate range of applicability derived from the parameter bounds.

In the two methods presented in the following sections, a minimum of 25 data points (i.e., calculated k_{eff} values) are required to verify normality, which is assumed in these methods. The software discussed below which implements these methods performs a crude test for whether or not the k_{eff} values as a group are normal around the mean value of k_{eff}. The test is commonly known as the "goodness of fit." The distribution of k_{eff} values around the mean are pooled into five equally probable bins. The test may not be reliable if there are fewer than 5 observations in each bin. Thus the test will always be flagged as not being reliable for cases where there are fewer than 25 observations and may be flagged for more observations if there are fewer than 5 observations in any bin. If there is an insufficient number of observations to ensure normality with this test, other statistical methods should be employed to determine normality or additional uncertainties to account for the paucity of data should be considered. Note in the example applications in Sect. 4.1.3 that contain less than 25 points, no additional uncertainty has been applied. These examples are only for illustration of the methods presented in Sects. 4.1.1 and 4.1.2.

4.1.1 USL Method 1: Confidence Band with Administrative Margin

The first method applies a statistical calculation of the bias and its uncertainty plus an administrative margin to a linear fit of critical experiment benchmark data. This approach is illustrated in Fig. 4.1. In this figure, the upper line (solid) represents a linear regression fit to a set of calculations based on critical experiments, $k_c(x)$. As indicated in the figure, $\beta(x)$ is given as $k_c(x) - 1$. The middle line (long dashes) represents the lower confidence band for a single additional calculation. The width of this band is determined statistically based on the existing data and a specified level of confidence; the greater the standard deviation in the data or the larger the confidence desired, the larger the band width will be. This confidence band, W, accounts for uncertainties in the experiments, the calculational approach, and in calculational data (e.g., cross sections), and is therefore a statistical basis for $\Delta\beta$, the uncertainty in the value of β. W is defined for a confidence level of $(1-\gamma_1)$ using the relationship

$$W = \max\left\{w(x)\big|_{x_{min},\, x_{max}}\right\} , \tag{4.4}$$

where

$$w(x) = t_{1-\gamma_1}\, s_p \left[1 + \frac{1}{n} + \frac{(x-\bar{x})^2}{\sum_{i=1,n}(x_i-\bar{x})^2}\right]^{\frac{1}{2}} \tag{4.5}$$

and

- n = the number of critical calculations used in establishing $k_c(x)$,
- $t_{1-\gamma_1}$ = the Student-t distribution statistic for $1 - \gamma_1$ and n-2 degrees of freedom (obtained from t tables[40])
- $\bar{x}$ = the mean value of parameter x in the set of calculations,
- s_p = the pooled standard deviation for the set of criticality calculations.

The function $w(x)$ is a curvilinear function. For simplicity, it is desirable to obtain a constant width margin. Hence, for conservatism, the confidence band width W is defined as the maximum of $(w(x_{min}),\ w(x_{max}))$, where x_{min} and x_{max} are the minimum and maximum values of the independent parameter x, respectively. Typically, W is determined at a 95% confidence level.

The pooled standard deviation is obtained from the pooled variance ($s_p = \sqrt{s_p^2}$), where s_p^2 is given as

$$s_p^2 = s_{k(x)}^2 + s_w^2 , \tag{4.6}$$

where $s_{k(x)}^2$ is the variance (or mean-square error) of the regression fit, and is given by:

$$s_{k(x)}^2 = \frac{1}{(n-2)}\left[\sum_{i=1,n}(k_i-\bar{k})^2 - \frac{\left\{\sum_{i=1,n}(x_i-\bar{x})(k_i-\bar{k})\right\}^2}{\sum_{i=1,n}(x_i-\bar{x})^2}\right] , \tag{4.7}$$

and s_w^2 is the within-variance of the data:

$$s_w^2 = \frac{1}{n}\sum_{i=1,n}\sigma_i^2 , \tag{4.8}$$

where σ_i is the standard deviation associated with k_i for a Monte Carlo calculation. For best results, it is recommended that the individual standard deviations for the Monte Carlo calculations be roughly uniform in value. For deterministic codes that do not have a standard deviation associated with a computed value of k, the standard deviation is zero. However, this term could be used as a mechanism to include known uncertainties in experimental data.

The bottom line (short dashes) in Fig. 4.1 represents the USL, based on an additional margin of subcriticality. Note in Fig. 4.2 that a "positive bias adjustment" line has been added to the line $k_c(x) - W$ at the point where $k_c(x) = 1$. This adjustment has been made to prevent taking credit for a positive bias $[\beta(x) > 0]$ by assuming $k_c(x) = 1$ everywhere that $k_c(x) > 1$. Likewise, the USL has been adjusted so that the margin of subcriticality is constant with respect to the positive-bias-adjusted form of $k_c(x) - W$. This additional margin provides further assurance of subcriticality, and represents the quantity Δk_m defined earlier. In USL Method 1, Δk_m is given an arbitrary administrative value; a minimum of 0.05 is recommended for application to transportation and storage packages. Using these formulations, the USL Method 1 is defined as

$$USL_1(x) = 1 - \Delta k_m - W + \beta(x). \tag{4.9}$$

In application to transportation and storage packages, the USL(x) value should not be greater than 0.95.

4.1.2 USL Method 2: Single-Sided Uniform Width Closed Interval Approach

In this method, sometimes referred to as a lower tolerance band (LTB) approach, statistical techniques with a rigorous basis[41-44] are applied in order to determine a combined lower confidence band plus subcritical margin. In other words, in the administrative margin approach Δk_m and $\Delta\beta$ are determined independently, while in the LTB method, a combined statistical lower bound is determined. The following discussion of Method 2 is taken from Ref. 45 and is based on equations and/or definitions from Refs. 43 and 44.

The purpose of this method is to determine a uniform tolerance band over a specified closed interval for a linear least-squares model. The level of confidence in the limit being calculated is α and is typically in the range from 0.90 to 0.999.

The USL Method 2 is defined as

$$USL_2(x) = 1.0 - (C_{\alpha/P} \cdot s_p) + \beta(x)\,, \tag{4.10}$$

where s_p is the pooled variance of k_c described earlier. The term $C_{\alpha/P} \cdot s_p$ provides a band for which there is a probability P with a confidence α that an additional calculation of k_{eff} for a critical system will lie within the band. For example, a $C_{95/99.5}$ multiplier produces a USL for which there is a 95% confidence that 995 out of 1000 future calculations of critical systems will yield a value of k_{eff} above the USL.

The analysis is over the closed interval from x = a to x = b. $C_{\alpha/P}$ is calculated according to the following equations:

$$g = \sqrt{\frac{1}{n} + \frac{(a-\bar{x})^2}{\sum_{i=1}^{n}(x_i-\bar{x})^2}} \tag{4.11}$$

$$h = \sqrt{\frac{1}{n} + \frac{(b - \bar{x})^2}{\sum_{i=1}^{n} (x_i - \bar{x})^2}} \tag{4.12}$$

$$\rho = \frac{1}{gh} \cdot \left\{ \frac{1}{n} + \frac{(a - \bar{x})(b - \bar{x})}{\sum_{i=1}^{n} (x_i - \bar{x})^2} \right\} \tag{4.13}$$

$$A = \frac{g}{h} \tag{4.14}$$

It should be noted that there is an inconsistency in the notation used in Refs. 43 and 44. In Ref. 44, the notation for the summation of x^2 actually means the summation of the quantity $(x - \bar{x})^2$.

A, ρ, and (n – 2) are used to determine the value of D from Table 3 in Ref. 43, which covers values of $0.5 \le A \le 1.5$. The procedure to follow when A is in this range is

$$C^* = D \cdot g . \tag{4.15}$$

When A is outside the above range, A is replaced by 1/A for the determination of D, and C* is given by

$$C^* = D \cdot h . \tag{4.16}$$

Next,

$$C_{\alpha/P} = C^* + z_P \cdot \sqrt{\frac{n - 2}{\chi^2}} , \tag{4.17}$$

where

z_P is the Student t statistic depending on n and P, and

χ^2 is the chi square distribution, a function of n – 2 and α.

This approach provides a more statistically based subcritical margin, Δk_m, which can be determined as the difference $(C_{\alpha/p} \cdot s_p) - W$. In criticality safety applications, such a statistically determined approach generally, but not necessarily, yields a margin of less than 0.05, which serves to illustrate the adequacy of the administrative margin. The recommended purpose of Method 2 is to apply it in tandem with Method 1 to verify that the administrative margin is conservative relative to a purely statistical basis. **This concurrent application of Method 2 is especially important when a limited number of data points are used in determination of $k_c(x)$, or when the**

calculated values have a large standard deviation. In these cases, the statistically based subcritical margin may indicate the need for a larger administrative margin.

Appendix C documents a computer program called USLSTATS that has been developed to perform the required statistical analysis and calculate USLs based on Methods 1 and 2.

4.1.3 Application of Upper Subcritical Limit Methods

Either of these two methods is generally considered applicable over the range of a given parameter in the set of calculations used to determine the USL. However, as discussed earlier, ANSI/ANS-8.1 allows the range of applicability to be extended beyond this range by extrapolating the trends established for the bias. No precise guidelines are specified for the limits of extrapolation. Thus engineering judgment and additional uncertainty should be applied when extrapolating beyond the range of the parameter bounds. Note that $w(x)$ should be used rather than W in performing any extrapolation because $k_c(x) - W$ is a straight line based on $w(x)$ and is only assured of being conservative within the range of the parameter bounds (Fig. 4.1).

Based on the critical experiments described earlier in this report, it is possible to determine a set of USLs based on any of the various parameters studied (e.g., AEF, pitch, H/X, water-to-fuel volume ratio, etc.). The remainder of this section will demonstrate the calculation of the USL as a function of these parameters using the two methods described above. These examples will demonstrate the approach of each method and may be used for guidance in applying each of the methods for any appropriate set of benchmarks, any given criticality code or code system, or for a different cross-section library.

Of primary importance in this analysis is the determination of parameters responsible for variations in k_{eff}. To determine each parameter's effectiveness in explaining variations in calculated k_{eff} values, linear regression analyses are employed. Of the 173 LWR cases, 167 cases contain data for k_{eff}, H/X, AEF, pitch, water-to-fuel volume ratio, enrichment, and Dancoff factor. The other six cases contain multiple enrichments and were therefore excluded from this parametric analysis.

The first step is to determine the correlation coefficients for different subsets of the 173 LWR critical experiments used in the validation. These values provide a measure of the statistical correlation between each independent variable and variations in the calculated k_{eff} values. The variable with the strongest correlation to the calculated k_{eff} values is then used in a linear regression equation to describe the variation in k_{eff}, $k_c(x)$, for determination of the USL.

The subsets of LWR critical experiments analyzed are tabulated in Table 4.1 versus the classes of experiments as presented in Sect. 3. The table shows how many experiments from each class were included in each subset. Other subsets could be constructed by selecting or combining different classes from the table. The results presented here are not intended to be exhaustive, but instructive in demonstrating the application of the USL methods discussed earlier.

A statistical summary of the variables included in this analysis is given in Table 4.2. For each variable, the number of experiments where that variable is applicable is listed, together with the mean, median, minimum, and maximum values of the variable. A breakdown of the independent variables applicable to each subset of experiments analyzed is shown in Table 4.3.

The results of these analyses are displayed in Table 4.4. For each subset, several independent variables exist, as listed in Table 4.3. A linear regression analysis was performed for each independent variable and the corresponding correlation coefficient, r, was calculated. An exact correlation between the dependent variable (i.e., k_{eff}) and an independent variable would be indicated by $|r| = 1$. No correlation whatsoever would be indicated by $r = 0$. The three variables with the greatest correlation are listed for each subset, along with their corresponding correlation coefficients.

The most strongly correlated variable is used to form the regression equation for $k_c(x)$. The standard error in the last column is the average error in the estimate of k_{eff} using the regression equation for $k_c(x)$.

Tables 4.5 and 4.6 summarize intermediate calculations and the final USL equations using the correlation of k_{eff} to key parameters for each of the subsets as listed in Table 4.3. The resulting USL equations are illustrated in Figs. 4.2–4.9. The calculated k_{eff} values are plotted against the lines representing the linear regression fit [$k_c(x)$], the 95% confidence band for a single calculation [$k_c(x)$-W], the USL based on Method 1 [$USL_1=k_c(x)-W-0.05$], and the USL based on Method 2 [$USL_2=k_c(x)-C_{95/99.5}\cdot s_p$]. As can be seen from the table and the figures, the statistically based subcritical margin is less than the assumed administrative margin of 0.05 used in Method 1 for all subsets of experiments considered. The correlations of results for all LWR experiments to AEF and enrichment are very weak as can be seen by the lack of any trends in Figs. 4.2 and 4.3. The plot of k_{eff} vs AEF in Fig. 4.2 was separated into two plots because the wide range of AEF values compressed the large number of low energy data points when all data were plotted together. The limited number of enrichments in the selected experiments also makes fuel enrichment a poor choice for an independent variable. No statistically significant correlation to any independent variable was found for the water hole experiment subset. The subsets of experiments with the strongest correlation of the calculated k_{eff} values to an independent variable were the separator plates and soluble boron experiments ($r = 0.908$ vs AEF) and the borated separator plates and reflecting walls experiments ($r = -0.815$ vs reflector separation). The correlation of the linear regression fits to the actual data for these subsets can be seen in Figs. 4.8 and 4.9, respectively.

In order to apply these USL methods to an application, it is necessary for the expected parameter value (design or calculational) to lie within the range of applicability of that parameter. To achieve this, one should first determine the values of the parameters from Table 4.2 that characterize the desired application. Next, the classes of experiments in Table 4.1 should be checked to determine which class(es) share similar geometry features to the application of concern. The parameter with the strongest correlation to the k_{eff} values should be used to generate the USL. The range of values of this key parameter defines the range of applicability for the USL. The value of the key parameter for the application of concern must lie within this range in order to apply the USL.

Table 4.1 Subsets of LWR-type fuel experiments

		Number of experiments in subsets							
Table No.	Class	All expts.	Separator plates	Reflecting walls	Soluble boron	Plates and walls	Plates and boron	Water holes	Borated plates and walls
3.6	Simple lattice	21							
3.7	Separator plate	45	45						
3.8	Plates w/soluble boron	12	12		12		12		
3.9	Flux trap	8	8						
3.10	Reflecting wall	35		35					
3.11	Plates w/walls	15	15	15		15			7
3.12	Urania gadolinia[a]	2			2			2	
3.13	Water holes[a]	7			1			7	
3.14	Absorber rods[a]	8			1			1	
3.15	Simple lattice w/boron	14			14				
	TOTAL	167	80	50	30		12	10	7

[a]One or more experiments were not included because they consisted of two types of fuel rods with different enrichments.

Table 4.2 Statistical summary of LWR-type fuel experiments

Variable	No. of experiments	Mean	Median	Minimum	Maximum
k_{eff}	173	0.9994	0.9992	0.9909	1.0129
AEG	173	33.94	33.95	27.62	36.88
AEF	173	0.3267	0.2443	0.0702	3.4451
Pitch	173	1.771	1.684	1.105	2.540
Enrichment	167	3.62	4.31	2.35	5.74
Water/fuel	167	2.100	1.6	0.148	9.004
Dancoff factor	167	0.1916	0.1739	0.0298	0.7644
H/X	167	183.5	155.9	17.2	541.1
Assembly separation	110	8.11	7.81	1.64	20.78
Plate thickness	76	0.371	0.302	0.061	0.772
Wall separation	50	1.51	1.32	0.00	5.41
Soluble boron conc.	36	1132	1110	15	3389
Plate boron conc.	22	21.3	29.0	1.1	39.3
Water hole/fuel pin	16	0.048	0.032	0.013	0.152

Table 4.3 Independent variables by subset

Variable	All expts.	Separator plates	Reflecting walls	Soluble boron	Plates and walls	Water holes	Plates and boron	Borated plates and walls
Enrichment	X	X	X	X	X	X	X	X
AEF	X	X	X	X	X	X	X	X
Pitch	X	X	X	X	X	X	X	X
H_2O/fuel	X	X	X	X	X	X	X	X
H/X	X	X	X	X	X	X	X	X
Dancoff	X	X	X	X	X	X	X	X
Assembly separation distance			X		X		X	X
Assembly-to-wall separation distance			X		X			X
Soluble boron concentration				X			X	
Plate thickness		X			X		X	X
Plate boron concentration								X
Water holes/fuel pin						X		

Table 4.4 Regression analyses results for subsets of LWR-type fuel experiments

Subset	No. of observ.	Correlated key parameters	Correlation coefficients, r	Regression equation	Standard error
All experiments	167	AEF, enr, H/X	0.307, 0.289, −0.183	$k_c(x) = 0.9985 + 2.7174E\text{-}3 * AEF$	0.0037
Separator plates	80	H/X, AEF, Dancoff	−0.370, 0.369, 0.295	$k_c(x) = 1.0019 - 1.6680E\text{-}5 * H/X$	0.0039
Reflecting walls	50	sep, pitch, enr	0.688, 0.462, 0.372	$k_c(x) = 0.9953 + 4.6483E\text{-}4 * sep$	0.0029
Soluble boron	30	AEF, Dancoff, w/f	0.632, 0.486, −0.402	$k_c(x) = 0.9976 + 3.2428E\text{-}3 * AEF$	0.0028
Separator plates and reflecting walls	15	AEF, pitch, H/X	0.553, 0.545, −0.537	$k_c(x) = 0.9931 + 2.7925E\text{-}2 * AEF$	0.0035
Separator plates and soluble boron	12	AEF, Dancoff, H/X	0.908, 0.737, −0.735	$k(x) = 0.9964 + 4.1672E\text{-}3 * AEF$	0.0022
Water holes	10	none	N/A	N/A	N/A
Borated separator plates and reflecting walls	7	ss	−0.815	$k_c(x) = 1.0035 - 3.5202E\text{-}3 * ss$	0.0032

[a] enr – enrichment; sep – assembly separation; w/f – water/fuel volume; ss - reflector wall separation distance.

Table 4.5 Summary of USL calculations of Figs. 4.4-4.13

Figure	No. of exp.	$k_c(x)$	Correlation coefficient, r	Most negative bias (β_{m})	W	Δk_m (USL_2)	Parameter bounds	Confidence band with administrative margin of 0.05, USL_1	Single-sided uniform width closed interval, USL_2
4.2, k_{eff} vs AEF (all experiments)	167	0.9985 + 2.7174E-3*AEF	0.307	−0.0091	7.2146E-3	0.015	0.070-3.445	0.9415–0.9428	0.9770–0.9782
4.3, k_{eff} vs enrichment (all experiments)	167	0.9959 + 9.6691E-4*enr	0.289	−0.0091	6.2707E-3	0.012	2.35-5.74	0.9419–0.9437	0.9796–0.9814
4.4, k_{eff} vs H/X (separator plates)	80	1.0019 – 1.6680E-5*H/X	−0.370	−0.0091	6.6660E-3	0.010	17.2-398.5	0.9433–0.9386	0.9836–0.9789
4.5, k_{eff} vs assembly separation (reflecting walls)	50	0.9953 + 4.6483E-4*sep	0.688	−0.0080	5.1381E-3	0.008	2.00-20.78	0.9411–0.9449	0.9829–0.9867
4.6, k_{eff} vs AEF (soluble boron)	30	0.9976 + 3.2428E-3*AEF	0.632	−0.0053	5.4354E-3	0.009	0.092-2.281	0.9425–0.9446	0.9831–0.9851
4.7, k_{eff} vs AEF (separator plates and reflecting walls)	15	0.9931 + 2.7925E-2*AEF	0.553	−0.0080	6.7130E-3	0.014	0.144-0.305	0.9403–0.9433	0.9761–0.9791
4.8, k_{eff} vs AEF (separator plates and soluble boron)	12	0.9964 + 4.1672E-3*AEF	0.908	−0.0046	4.6206E-3	0.010	0.152-2.281	0.9425–0.9454	0.9822–0.9851
4.9, k_{eff} vs reflecting wall separation (borated separator plates and reflecting walls)	7	1.0035 – 3.5202E-3*ss	−0.815	−0.0080	7.7476E-3	0.023	0.23-2.50	0.9423–0.9370	0.9696–0.9644

Table 4.6 USL equations for Figs. 4.4-4.12

Figure No.	Confidence band with administrative margin of 0.05, USL_1	Single-sided uniform width closed interval, USL_2
4.2	0.9413 + 2.7174E-3*AEF (AEF < 0.535) 0.9428 (AEF ≥ 0.535)	0.9768 + 2.7174E-3*AEF (AEF < 0.535) 0.9782 (AEF ≥ 0.535)
4.3	0.9397 + 9.6691E-4*enr (enr < 4.209) 0.9437 (enr. ≥ 4.209)	0.9773 + 9.6691E-4*enr (enr < 4.209) 0.9814 (enr ≥ 4.209)
4.4	0.9433 (H/X ≤ 116.8) 0.9453 – 1.6680E-5*H/X (H/X > 116.8)	0.9836 (H/X ≤ 116.8) 0.9856 – 1.6680E-5*H/X (H/X > 116.8)
4.5	0.9402 + 4.6483E-4*sep (sep < 10.073) 0.9449 (sep ≥ 10.073)	0.9820 + 4.6483E-4*sep (sep< 10.073) 0.9867 (sep ≥ 10.073)
4.6	0.9422 + 3.2428E-3*AEF (AEF < 0.731) 0.9446 (AEF ≥ 0.731)	0.9828 + 3.2428E-3*AEF (AEF < 0.731) 0.9851 (AEF ≥ 0.731)
4.7	0.9364 + 2.7925E-2*AEF (AEF < 0.247) 0.9433 (AEF ≥ 0.247)	0.9722 + 2.7925E-2*AEF (AEF < 0.247) 0.9791 (AEF ≥ 0.247)
4.8	0.9418 + 4.1672E-3*AEF (AEF < 0.852) 0.9454 (AEF ≥ 0.852)	0.9816 + 4.1672E-3*AEF (AEF < 0.852) 0.9851 (AEF ≥ 0.852)
4.9	0.9423 (ss ≤ 1.001) 0.9458 – 3.5202E-3*ss (ss > 1.001)	0.9696 (ss ≤ 1.001) 0.9732 – 3.5202E-3*ss (ss > 1.001)

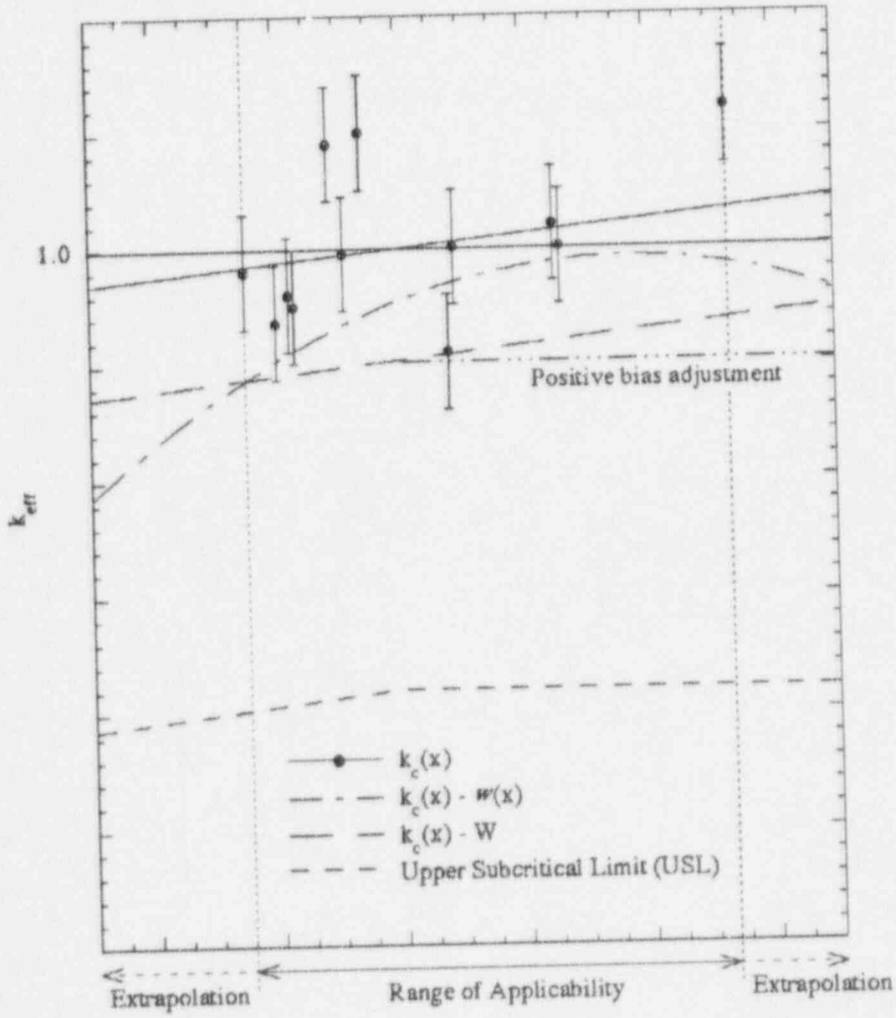


Figure 4.1 Confidence band and additional margin applied to a set of criticality calculations

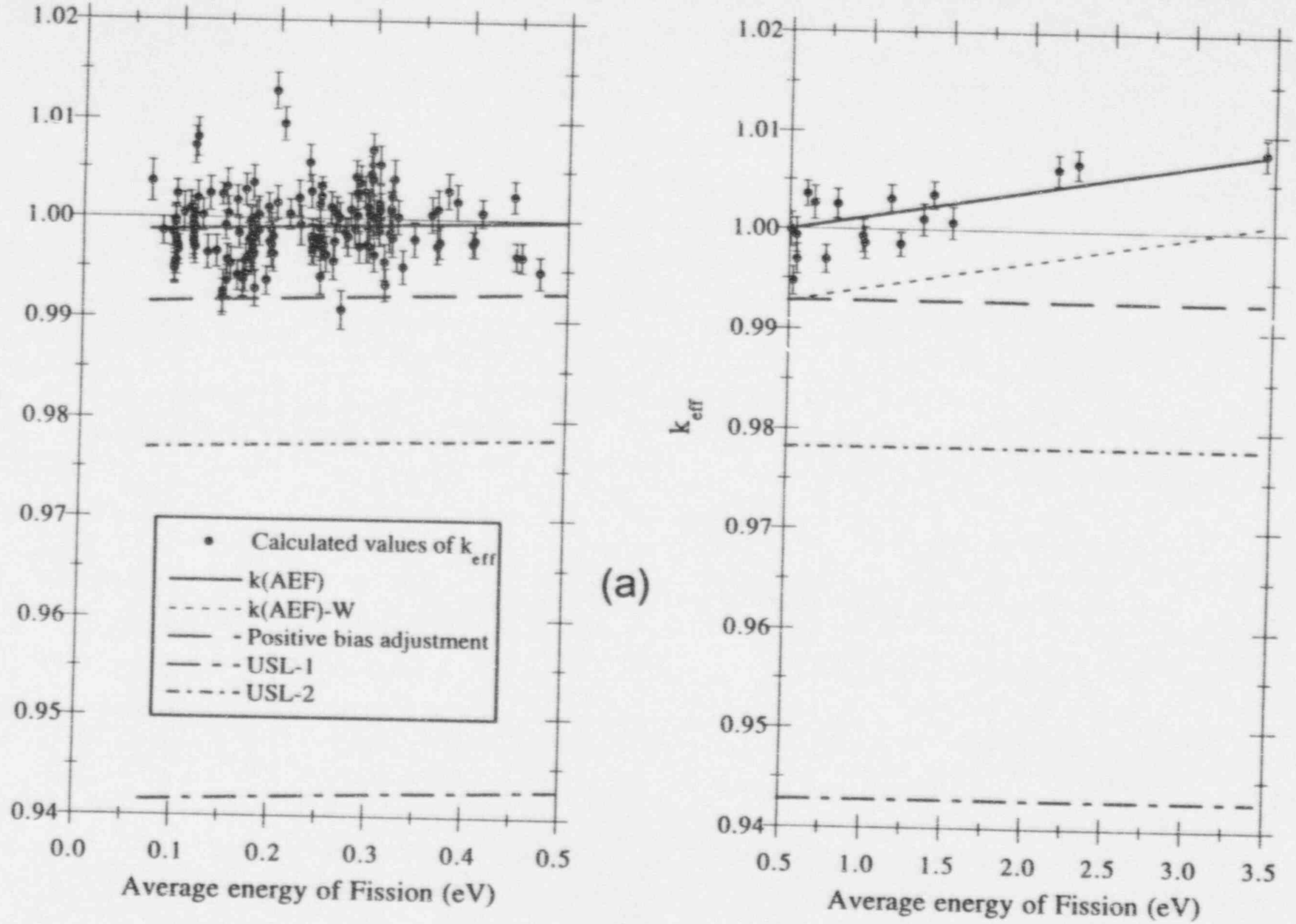


Figure 4.2 USLs for 167 LWR-type fuel critical experiments, k_{eff} vs enrichment

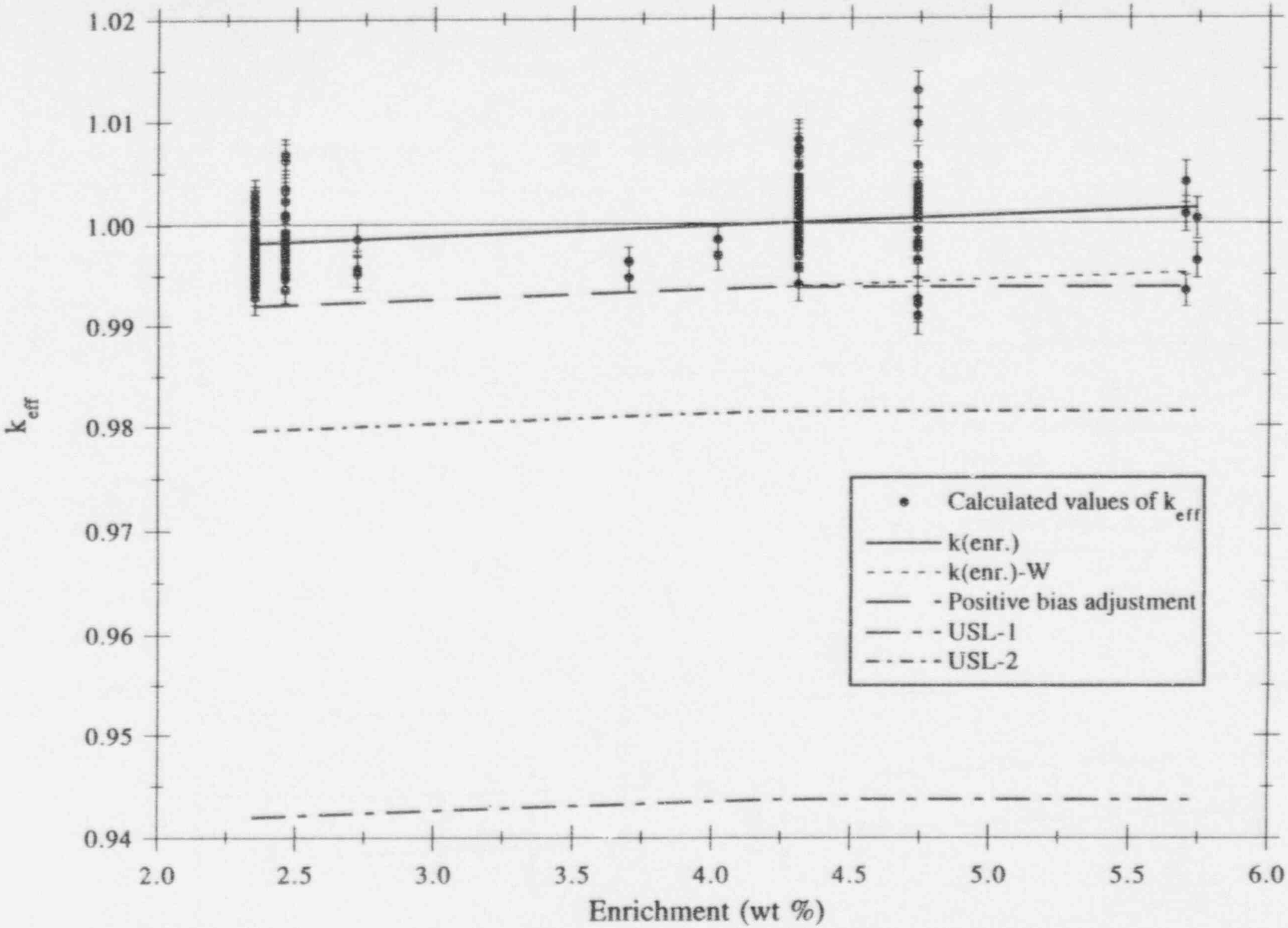


Figure 4.3 USLs for 167 LWR fuel pin lattice critical experiments, k_{eff} vs enrichment

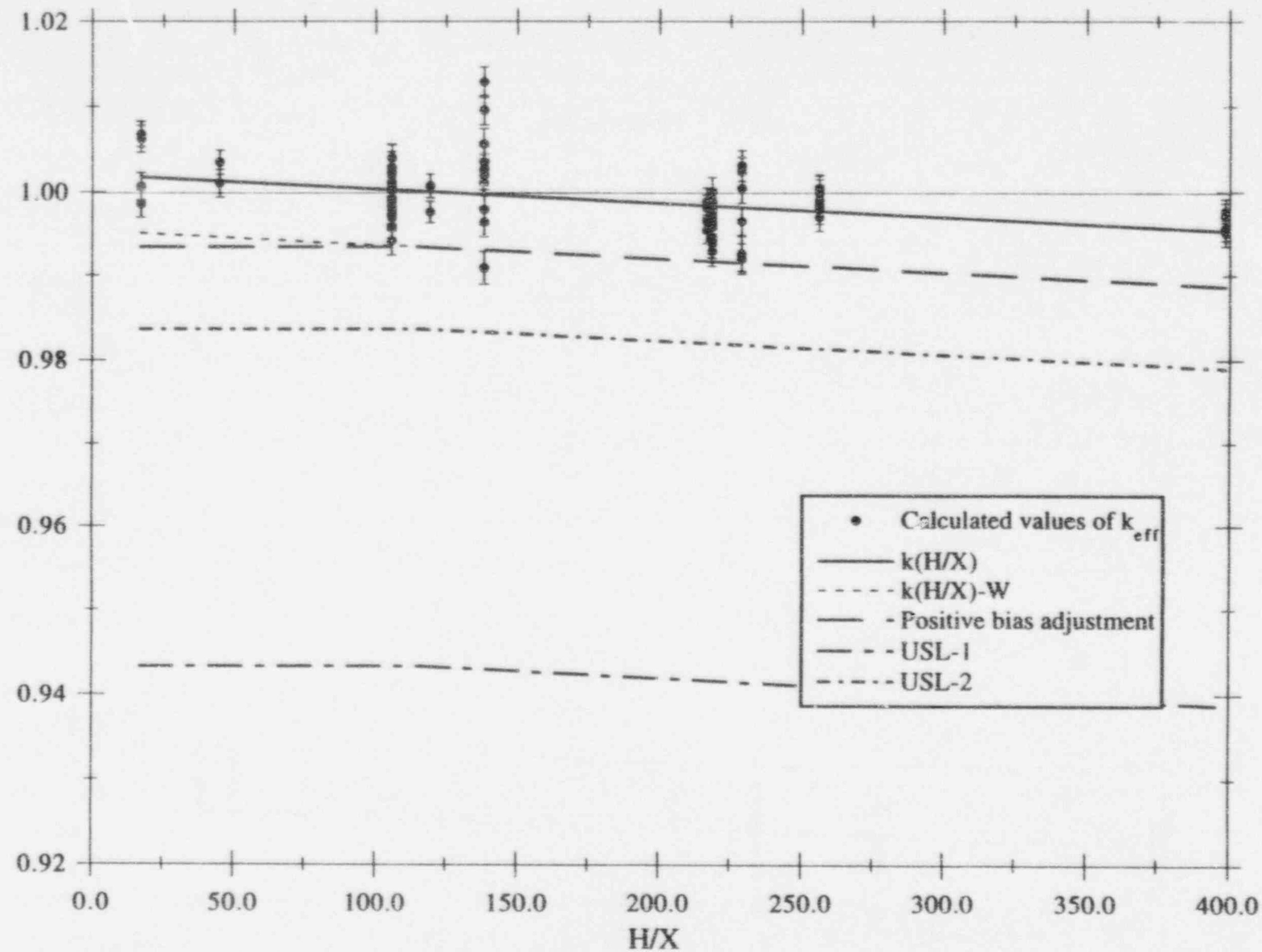


Figure 4.4 USLs for 80 separator plate critical experiments, k_{eff} vs H/X

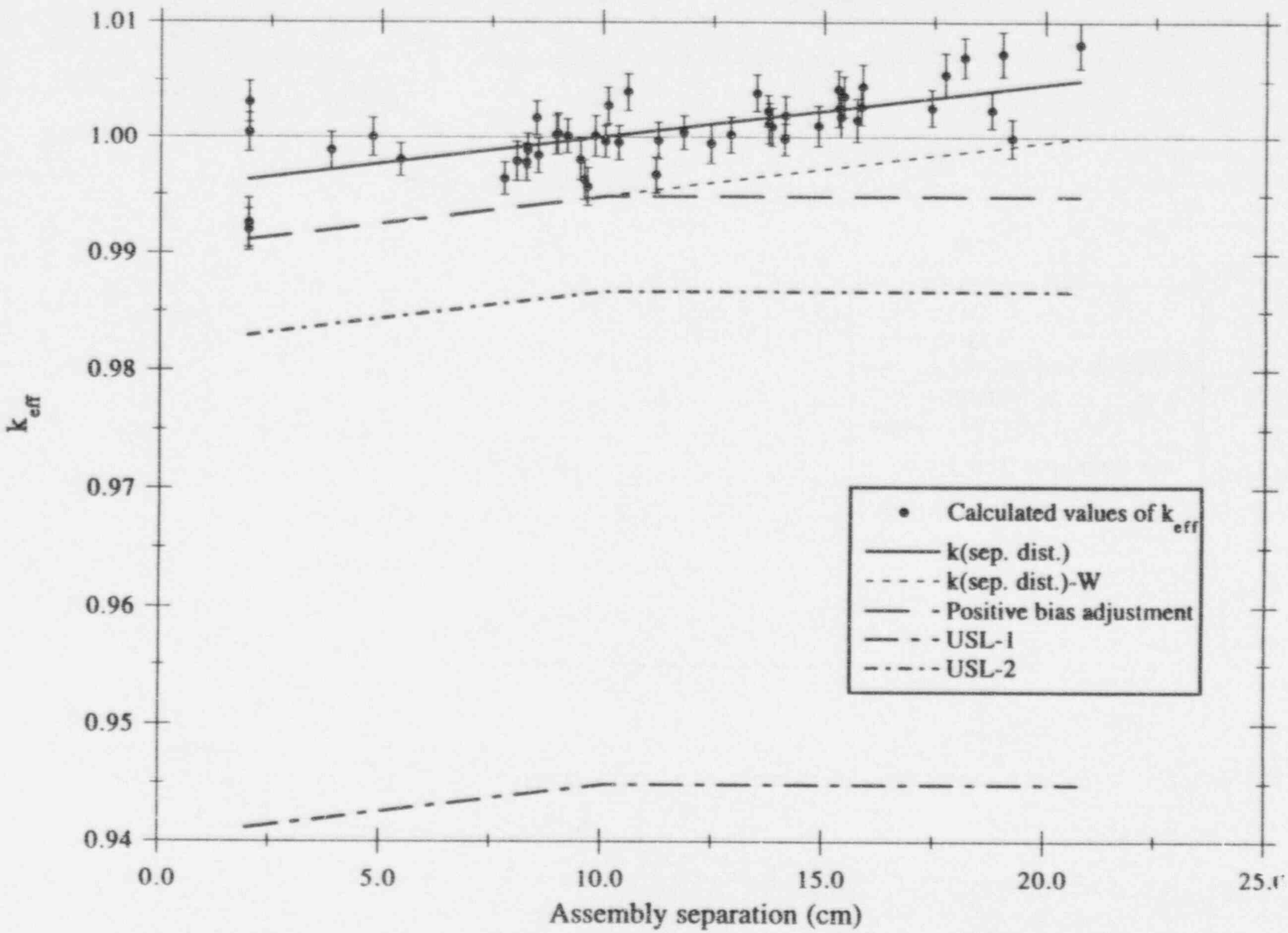


Figure 4.5 USLs for 50 reflecting wall critical experiments, k_{eff} vs assembly separation

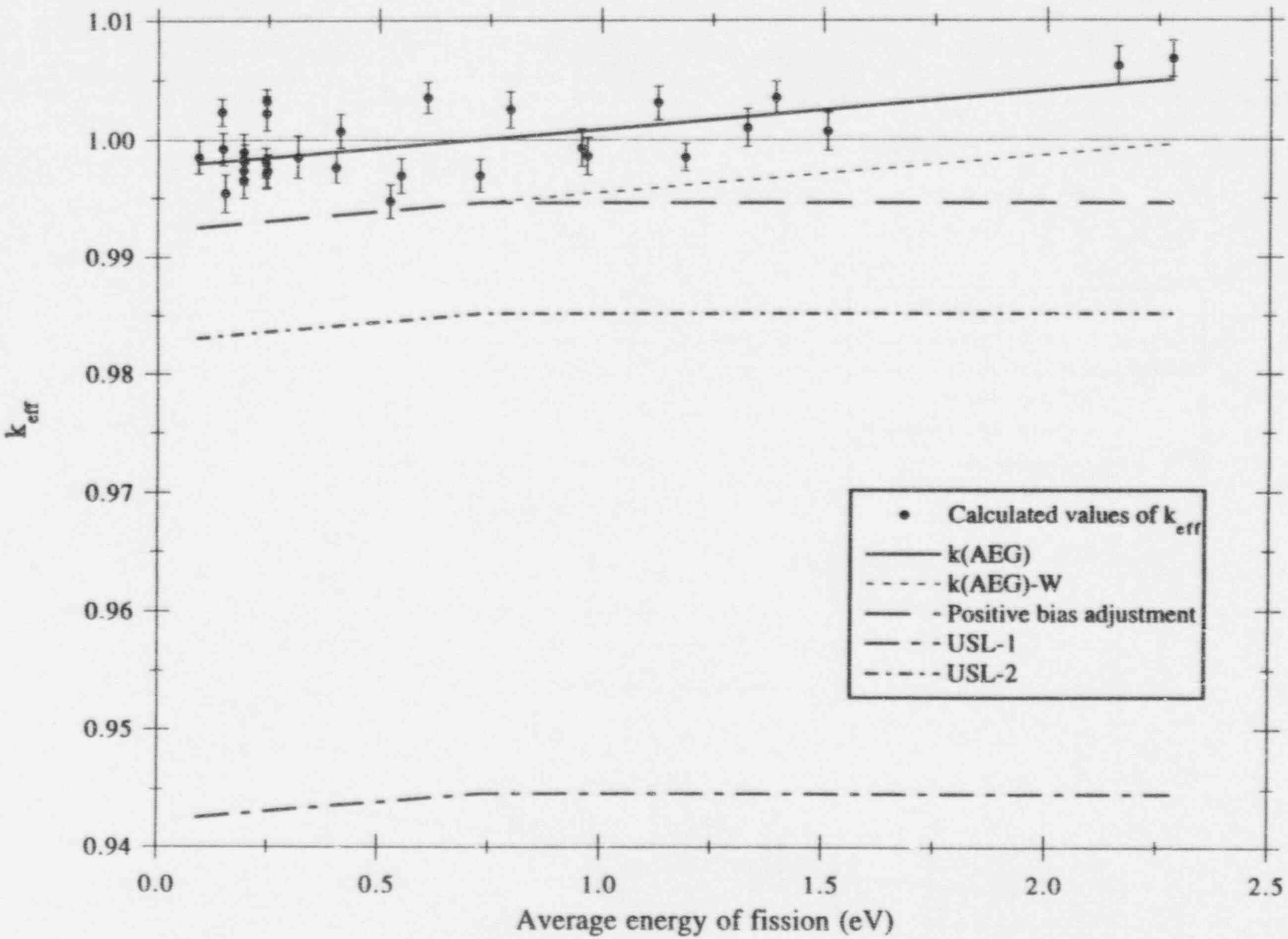


Figure 4.6 USLs for 30 soluble boron critical experiments, k_{eff} vs AEF

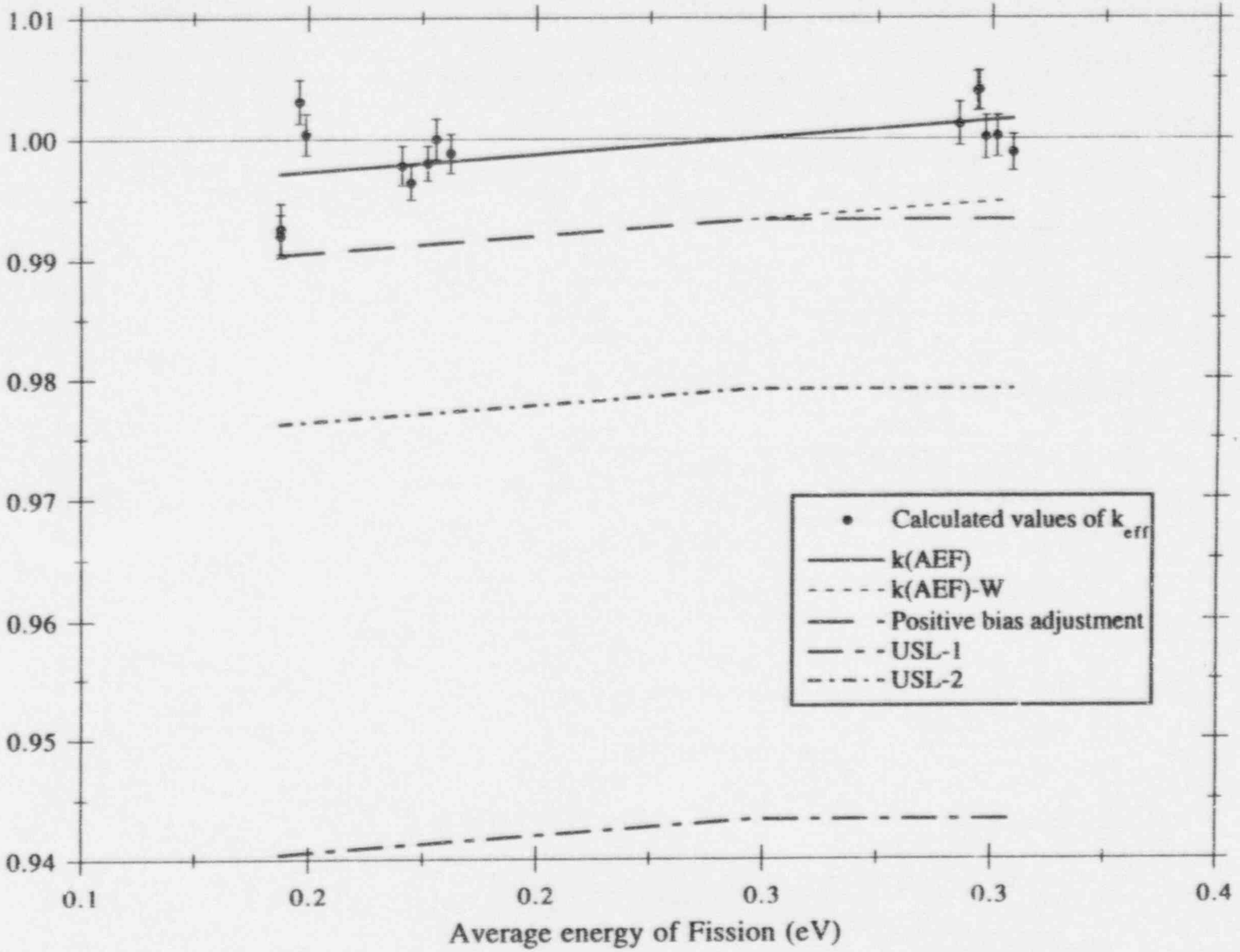


Figure 4.7 USLs for 15 separator plate and reflecting wall critical experiments, k_{eff} vs AEF

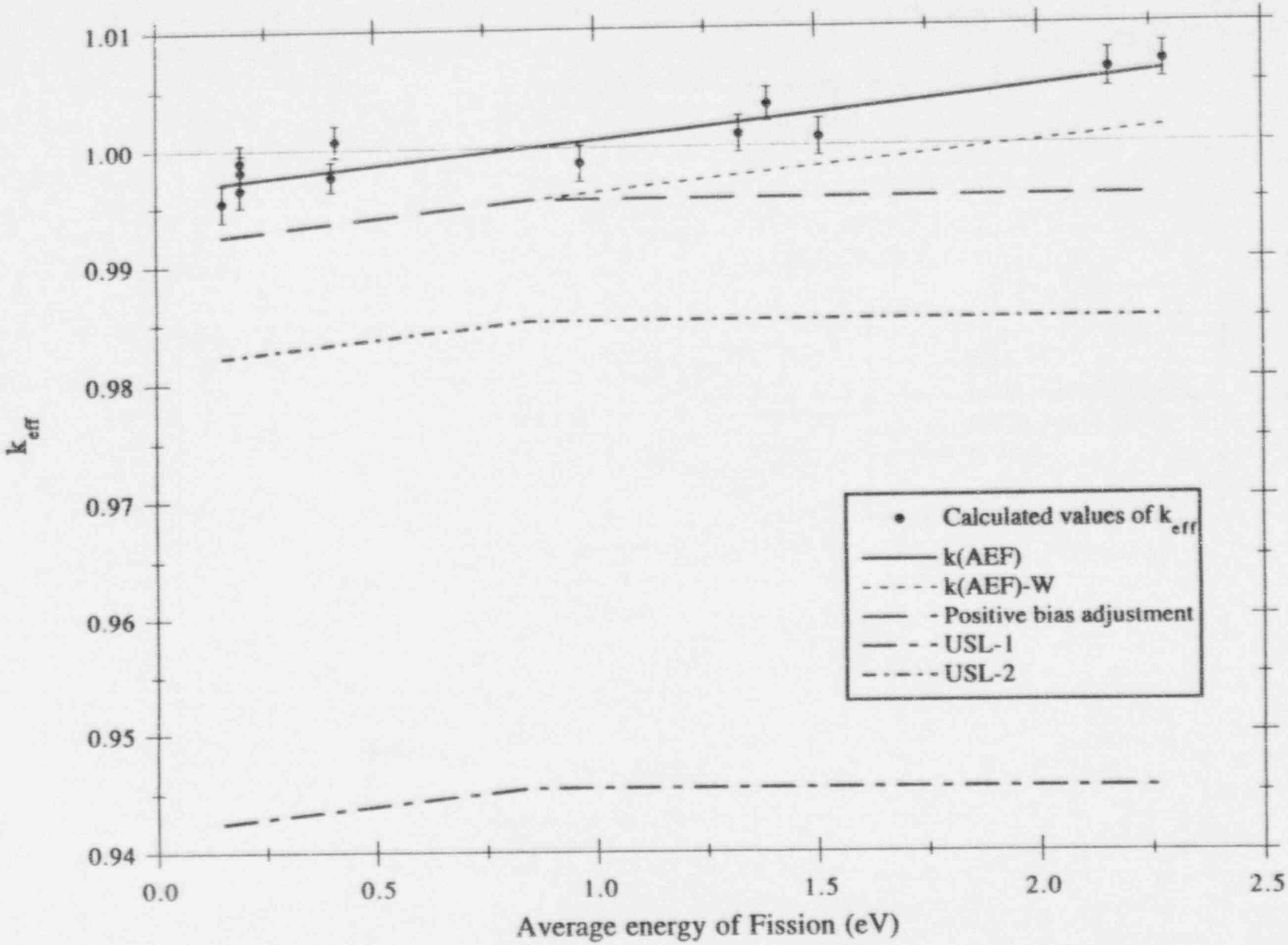


Figure 4.8 USLs for 12 separator plate, soluble boron critical experiments, k_{eff} vs AEF

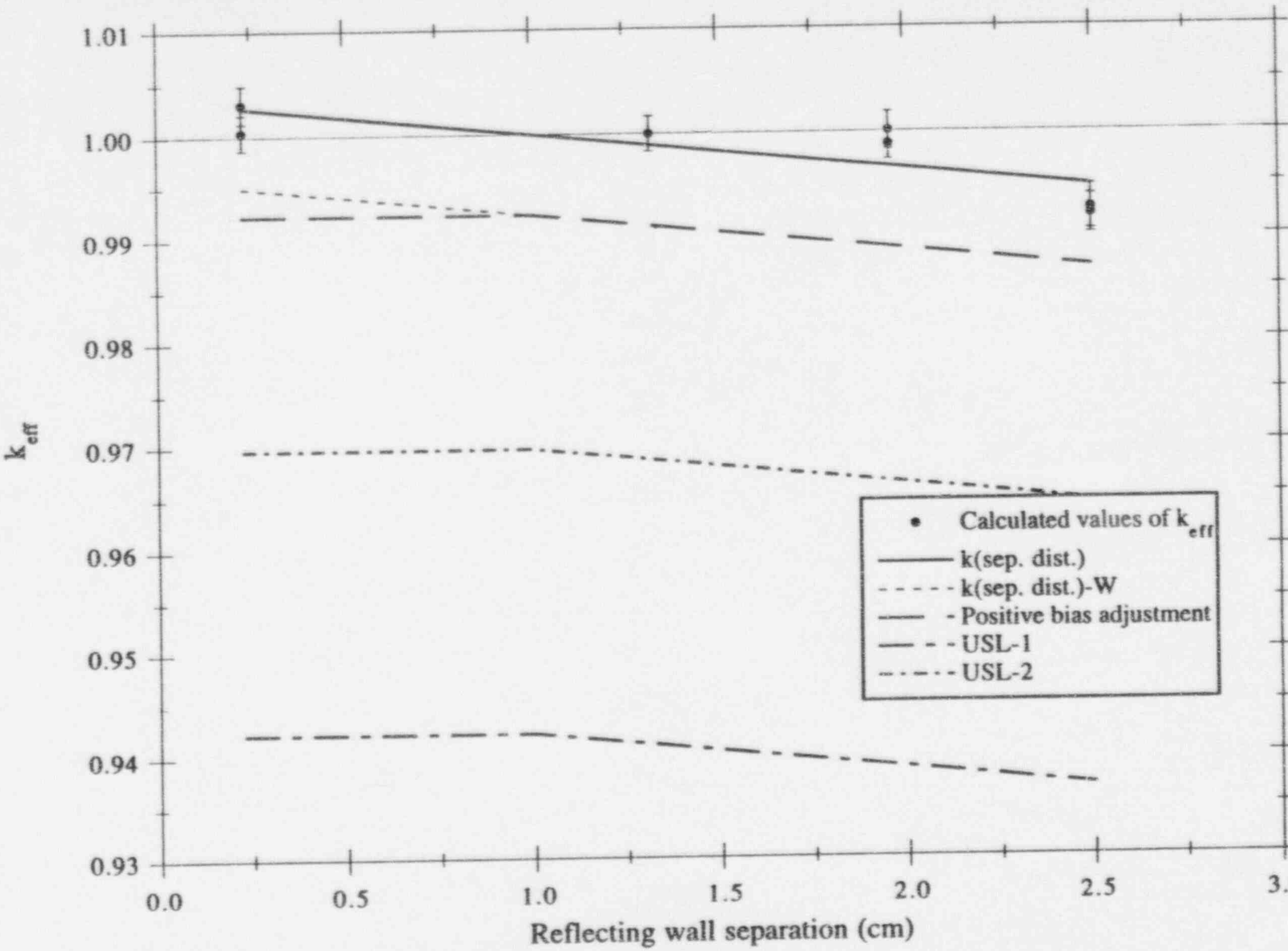


Figure 4.9 USLs for 7 borated separator plates and reflecting wall critical experiments, k_{eff} vs reflecting wall separation distance

5 Guidelines for Experiment Selection and Areas of Applicability

The calculation method used to establish the criticality safety of transportation and storage packages needs to be validated against measured data that have been shown to be applicable to the package under consideration. This section provides guidance in determining the applicable range for a validation study. Section 5.1 provides guidelines for selecting suitable experiments to use in the evaluation of transportation and storage package designs. The experiments used in the validation are parameterized in Sect. 5.2 for easy comparison to package designs under consideration.

5.1 Guidelines for Selecting Suitable Experiments

Historically, nuclear criticality experiments were performed to address specific fissionable material, reactor, fabrication/process, storage or transport design concerns. The experiments generally consisted of the same, or very nearly the same, configurations and materials requiring safety evaluation for the designs of interest. Aside from performing diagnostic measurements (e.g., flux wire traverses, threshold detector measurements, reaction rate ratios, replacement measurements, etc.), little effort was expended or needed to characterize the experiment for its intended application because the experiment itself was a "mockup" of the configuration of materials needing a safety evaluation. Many of the experiments were subsequently characterized according to elemental constituents, densities, and various parametric ratios. The use of uranium metal-to-water mass-, atom- and volume-ratios; uranium metal-to-carbon atom-ratios {e.g., [C/(Pu + U)], [H/(Pu + U)], C/X, H/X, where X refers to the fissile isotope}; fuel lattice pitches; solid angles; surface densities; and others came into broad usage with fair success. With the advent of more sophisticated computational techniques, parameters such as neutron leakage fraction and neutron absorption fraction became useful characterization parameters. Subsequently, a pseudo-neutron-spectra parameter, the computed average neutron energy group causing fission (AEG), was used as a single global parameter for correlating experiments to safety evaluation applications[36] for systems of similar fissile species, enrichments, degree of heterogeneity or homogeneity, and chemical form. Additionally, various neutron energy-weighted parameters, such as thermal neutron absorptions versus total neutron absorption, total neutron fissions versus fast neutron fissions, thermal neutron fissions versus thermal neutron absorptions, and the average neutron energy group weighted by fissions, were used for the characterization of systems and their concomitant computational biases.[46] A two-group diffusion theory parameter[47] for characterizing the neutron slowing down, resonance absorption characteristics, and thermal absorption characteristics has also been applied.

Most neutronics computer codes provide integral and energy dependent parameters that can be used for characterizing the spectra of a calculated system. Computer codes that have been historically used for nuclear criticality safety benchmarking and evaluations provide simplistic integral values such as average neutron energy group causing fission (AEG),[34] and more complex parametric categories[48] such as nonfuel absorption, leakage fraction, resonance absorption probability, fast fission probability, energy distribution of neutron absorption, and geometry effects as measured by the energy weighted ratios of neutron collisions in all materials divided by neutron collisions in fissile and fissionable materials.

There are three fundamental parameters that should be considered in the selection of suitable experiments[49] for use in the evaluation of transportation and storage package designs. They are the materials of construction (including fissionable material), the geometry of construction, and the inherent neutron energy spectrum affecting the fissionable material(s). There are substantial variances within each of these three categories that require further considerations.

Regarding materials of construction (including fissionable material):

Guidelines

- The fissionable species (e.g., ^{233}U, ^{235}U, ^{238}U, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, etc.) used in the benchmark experiments should be as similar as possible, including enrichment and relative masses and volumes, as those materials in the package design under normal and hypothetical accident conditions.

- The nonfissionable species (e.g., lead, stainless steel, boron, cadmium, phenolic foam, depleted uranium, water, etc.) used in the benchmark experiments should be as similar as possible, including relative masses and volumes, as those materials in the package design under normal and hypothetical accident conditions.

- Reflector and moderator materials in experiments should be as similar as possible to those in the package design under normal and hypothetical accident conditions.

- Physical form (e.g., metal, solution, compound) and temperature of materials should be as similar as possible.

- Ratio of nonfissionable materials to fissionable material should be similar as well.

Important items to consider regarding geometry of construction (including fissionable material):

- The relative geometric position and size of the construction materials

- Homogeneity or heterogeneity of system

- Shape of units and system

- Lattice pattern, spacing, and interstitial materials in arrays

- Reflection

Regarding the neutron energy spectrum, the neutron density versus energy should be considered by comparison of the following items from the benchmark experiments and the package design:

- Leakage

- Absorption

- Production

- Flux

The specific quantization of the above three categories of parameters is difficult at best and generally requires the use of alternative approaches by using benchmark experiments that are characterized by a limited set of physical and computed neutronic parameters that are then compared with the safety design computed neutronic parameters.

5.2 Parameterization of Validation Experiments

Several principal parameters have been identified for controlling the criticality of transportation packages:[50] (1) type, mass, and form of fissile material; (2) degree of moderation; (3) amount and distribution of absorber materials; (4) internal and external package geometry; and (5) reflector effectiveness. The fissile material, degree of moderation, and package geometry controls the neutron flux energy and spatial distributions. The degree of moderation, absorber materials, and package geometry are used to control the neutron loss rate through capture and leakage (in conjunction with reflector effectiveness).

These five parameters were used as guidelines in grouping the critical experiments considered by classes in the validation. Table 3.5 presents a parameterization of the 173 LWR-type fuel experiments documented in this report. The experiments are listed by case names, reference numbers, and case numbers. Case numbers are alphabetically assigned. The computed effective neutron multiplication factor (k_{eff}) and associated standard deviation are given for each case. The number of experiments associated with each characterization used in Table 3.5 is tabulated in Table 5.1.

The fissile material type, ^{235}U, and chemical form of the uranium compound, UO_2, were the same for all experiments and were therefore omitted from the table; however, the ^{235}U isotopic enrichment which affects neutron production rates was included since it varied from 2.35 wt % to 5.74 wt % across the experiments.

Fissile systems are often characterized by their degree of moderation. A direct characterization can be defined by the effective ratio of hydrogen(H)-to-fissile(X) material atom densities, or H/X of the system. Other parameters such as water-to-fuel volume ratio for a unit cell, average energy group for fission (AEG), and energy of average lethargy causing fission (AEF) can also give an indication of the degree of thermalization of a fissile system. These parameters usually correlate to the pitch and the Dancoff factor, which is a function of the pitch. Both of these parameters may be useful in the investigation of system moderation. The thermalization of lattice configurations can also be influenced by the presence of water holes. A parameter giving the ratio of the number of water holes to fuel pin positions is included in Table 3.5 for examination, along with H/X, AEG, AEF, pitch, and Dancoff factor.

Absorber materials are an effective means of criticality control for thermal systems such as those involving LWR-type fuel. Their effectiveness is dependent on the absorber material, distribution, and surface area. Three columns of Table 3.5 give this information in the form of separator plate material, boron weight percent per plate, and plate thickness. Experiments having homogeneous absorbers in the form of soluble boron in water have been singled out with their boron concentration specified. A final column labeled "Other" gives information about other absorbers in the system (e.g., Ag-In-Cd rods, B_4C rods, UO_2-Gd_2O_3 fuel rods). This column also specifies if the separator plates are part of a flux trap with voiding materials.

The geometry of heterogeneous fissile materials, the design and placement of absorber materials (previously discussed), and the separation between fissile materials affect the neutron flux energy and spatial distribution. The fissile material is in the form of fuel rods consisting of UO_2 pellets or powder encased in either aluminum, stainless steel, or Zircaloy cladding. Fuel rods are bundled in hexagonal or square lattices of 1.105-cm to 2.540-cm pitch. Table 3.5 lists the lattice type, pitch, cladding material, and separation distance of assemblies for each experiment. Most experiments have water reflection of at least 15 to 20 cm (20 cm of water reflection typically ensures a maximum increase in k_{eff} due to reflection) on the x, y, and z faces of the system. Notable exceptions are those systems that had fuel rods above the moderator surface. In addition to water reflectors, several experiments contained reflectors in the form of shielding materials (e.g., lead, steel, depleted uranium) that minimize neutron leakage. Such experiments were parameterized in Table 3.5 by reflecting wall material and separation distance from fuel assemblies.

The seven homogeneous uranium experiments were also parameterized. Experimental parameters and calculational results for these experiments are compiled in Table 3.16.

Table 5.1 Characterization variables of LWR-type fuel experiments

Variable	Values	Number of experiments
Other	A: Ag-In-Cd rods	6
	B: B_4C rods	3
	F: Flux trap with void materials	8
	G: UO_2Gd_3 rods	5
Total		**22**
Soluble boron	Y: yes	36
	N: no	137
Total		**173**
Clad	AL: aluminum	154
	SS: stainless steel	10
	ZR: zircaloy	3
Total		**167**
Pitch type	S: square	165
	H: hexagonal	8
Total		**173**
Plate material	Al: aluminum	21
	B: Boral	14
	BF: Boroflex	2
	CD: cadmium	6
	CU: copper	8
	HF: hafnium	4
	SS: stainless steel	18
	UD: copper-cadmium	4
	ZR: zircaloy	3
Total		**76**
Reflecting wall material	L: lead	12
	U: uranium	10
	SS: stainless steel	28
Total		**50**

6 Summary

The detailed experiment descriptions in this report provide a useful compendium of criticality benchmark data for validation of LWR fuel transportation and storage applications. Experiments are categorized by common features such as separator plates, reflecting walls, and soluble boron and parameterized by key variables such as enrichment, water-to-fuel volume ratio, H/X, AEF, and pitch. These data enable the analyst to readily identify appropriate experiments for a particular application.

Benchmark calculations have been performed for all of these cases using SCALE 4.3 and the 44-group ENDF/B-V cross-section library to provide a sample validation. In addition, the calculations were repeated with the 238-group library to determine the adequacy of the 44-group energy structure as shown in Appendix B. On average, the 238-group results were approximately 0.35% less. The 238-group results were more accurate for the homogeneous uranium critical experiments.

Two methods for statistical determination of calculational biases and USLs were presented: (1) a 95% confidence band for a single future calculation with an administrative subcritical margin and (2) a lower tolerance band (LTB) based on a 95% confidence band on 99.5% of all future calculations. The methods were demonstrated using several subsets of the 44-group validation results.

Finally, guidance was provided on the selection of appropriate criticality experiments that are applicable to validate a computational method for the system of concern. Important parameters that should be examined to demonstrate areas of applicability were discussed. The parameterization of the included experiments was described to assist the analyst in this process.

Hopefully, the large amount of experimental and calculational data compiled within this report along with the technical guidance provided will prove to be valuable assets for criticality safety analysts and reviewers of LWR fuel applications. Additional LWR-related experiments are available, however, as shown in Table 1.1. A user who may need experiment characterizations not identified in this report should investigate these experiments.

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APPENDIX A

SCALE Input File Listings

This appendix contains input files for all cases discussed in Sect. 3. These files are also available in electronic form from the SCALE home page on the World Wide Web (WWW). A pointer fo- the SCALE home page may be found at http://www.cad.ornl.gov.

INDEX OF CASES

<u>ans33al1</u>

```
#csas25
ans33al1
44group  latticecell
uo2        1 den=10.38 1.0 293 92235 4.742 92238 95.258         end
arbmag5    2.70 4 0 0 1 13027 98.85 12000 0.50 14000 0.43
           26000 0.22 2 1 293                                   end
h2o        3 1.0                                                end
arbmstl    7.90 3 0 0 1 26000 72.0 24000 18.0  28000 10.0 4 1   end
al         5 den=2.651 1.0                                      end
uo2        6 den=10.38 1.0 293 92235 4.742 92238 95.258         end
al         7 1.0                                                end
end comp
squarepitch  1.35  0.79   1 3 0.94  2 0.82  0                   end
more data res=6 cyl 0.395  dan(6)=0.989755                      end
4-18x18 assemblies separated by 0.3-cm-thick aluminum plates and 1.9
`cm of water, 25.66 cm water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  7 1  .470      0.0   -1.55
cuboid    3 1  4p.675    0.0   -1.55
reflector 4 1  5r0       0.4    1
unit 2
cylinder  7 1  .470      0.0   -0.25
cylinder  3 1  .500      0.0   -0.25
cuboid    4 1  4p.675    0.0   -0.25
unit 3
cylinder  1 1  .395    25.66   0.0
cylinder  0 1  .410    25.66   0.0
cylinder  2 1  .470    25.66   0.0
cuboid    3 1  4p.675  25.66   0.0
unit 4
array 1   3*0.0
reflector 3 1  0.0 0.3 0.0 0.3 2r0 1
reflector 5 1  0.3 0.0 0.3 0.0 2r0 1
unit 5
array 1   3*0.0
reflector 3 1  0.3 0.0 0.0 0.3 2r0 1
reflector 5 1  0.0 0.3 .3 0.0 2r0 1
unit 6
array 1   3*0.0
reflector 3 1  0.0 0.3 0.3 0.0 2r0 1
reflector 5 1  0.3 0.0 0.0 0.3 2r0 1
unit 7
array 1   3*0.0
reflector 3 1  0.3 0.0 0.3 0.0 2r0 1
reflector 5 1  0.0 0.3 0.0 0.3 2r0 1
unit 8
cuboid    3 1  2p0.95 2p12.30  27.56  0.0
reflector 5 1  2r0.0  0 0.3  0  0.3   1
unit 9
cuboid    3 1  2p12.30 2p0.95  27.56  0.0
reflector 5 1  0 0.3  2r0.0  0  0.3   1
unit 10
cuboid    3 1  2p0.95 2p0.95   27.56  0.0
reflector 5 1  5r0.0           0.3    1
unit 11
cuboid    3 1  2p12.30 2p0.95  27.56  0.0
reflector 5 1  0.3 0  2r0.0  0  0.3   1
unit 12
cuboid    3 1  2p0.95 2p12.30  27.56  0.0
reflector 5 1  2r0.0  0.3 0  0  0.3   1
unit 13
cylinder  6 1  .395    90.00      25.66
cylinder  0 1  .410    96.9       25.66
cylinder  2 1  .470    98.2       25.66
cuboid    0 1  4p.675  98.2       25.66
unit 14
array 2   3*0.0
reflector 0 1  0.0 0.3 0.0 0.3 2r0 1
reflector 5 1  0.3 0.0 0.3 0.0 2r0 1
unit 15
array 2   3*0.0
reflector 0 1  0.3 0.0 0.0 0.3 2r0 1
reflector 5 1  0.0 0.3 .3 0.0 2r0 1
unit 16
array 2   3*0.0
reflector 0 1  0.0 0.3 .3 0.0 2r0 1
reflector 5 1  0.3 0.0 0.0 0.3 2r0 1
unit 17
array 2   3*0.0
reflector 0 1  0.3 0.0 0.3 0.0 2r0 1
reflector 5 1  0.0 0.3 0.0 0.3 2r0 1
unit 18
cuboid    0 1  2p0.95 2p12.30  98.2  25.66
reflector 5 1  2r0.0  0 0.3  2r0      1
unit 19
cuboid    0 1  2p12.30 2p0.95  98.2  25.66
reflector 5 1  0 0.3  2r0.0  2r0      1
unit 20
cuboid    0 1  2p0.95 2p0.95   98.2  25.66
reflector 5 1  4r0.0           2r0    1
unit 21
cuboid    0 1  2p12.30 2p0.95  98.2  25.66
reflector 5 1  0.3 0  2r0.0  2r0      1
unit 22
cuboid    0 1  2p0.95 2p12.30  98.2  25.66
reflector 5 1  2r0.0  0.3 0  2r0      1
unit 23
```

```
array  3 3*0.0
reflector 3 1 4r20 2r01
reflector 4 1 5r0   .8 1
reflector 3 1 5r0   20 1
unit 24
array  4  3*0.0
reflector 0 1 4r20  2r0 1
global unit 25
array  5  3*0.0
end geom

read array
ara=1 nux=18 nuy=18 nuz=3 fill 324r1 324r2 324r3            end fill
ara=2 nux=18 nuy=18 nuz=1 fill 324r13                        end fill
ara=3 nux=3  nuy=3  nuz=1 fill 4 8 5 9 10 11 6 12 7          end fill
ara=4 nux=3  nuy=3  nuz=1 fill 14 18 15 19 20 21 16 22 17    end fill
ara=5 nux=1  nuy=1  nuz=2 fill 23 24                         end fill
end array
end data
end
```

<u>ans33al2</u>

```
#csas25
ans33al2
44group  latticecell
uo2      1 den=10.38 1.0 293 92235 4.742 92238 95.258          end
arbmag5  2.70 4 0 0 1 13027 98.85 12000 0.50 14000 0.43 26000
         0.22 2 1 293                                           end
h2o      3 1.0                                                  end
arbmstl  7.90 3 0 0 1 26000 72.0 24000 18.0 28000 10.0 4 1     end
al       5 den=2.651 1.0                                        end
uo2      6 den=10.38 1.0 293 92235 4.742 92238 95.258          end
al       7 1.0                                                  end
end comp
squarepitch  1.35  0.79   1 3 0.94  2 0.82  0                   end
more data res=6 cyl 0.395  dan(6)=0.989755                      end
4-18x18 assemblies separated by 0.3-cm-thick aluminum plates and 4.4
`cm of water, 32.78 cm water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  7 1  .470     0.0   -1.55
cuboid    3 1  4p.675   0.0   -1.55
reflector 4 1  5r0.0    0.4    1
unit 2
cylinder  7 1  .470     0.0   -0.25
cylinder  3 1  .500     0.0   -0.25
cuboid    4 1  4p.675   0.0   -0.25
unit 3
cylinder  1 1  .395     32.78   0.0
cylinder  0 1  .410     32.78   0.0
cylinder  2 1  .470     32.78   0.0
cuboid    3 1  4p.675   32.78   0.0
unit 4
array 1   3*0.0
reflector 3 1  0.0 0.3 0.0 0.3 2r0 1
reflector 5 1  0.3 0.0 0.3 0.0 2r0 1
unit 5
array 1   3*0.0
reflector 3 1  0.3 0.0 0.0 0.3 2r0 1
reflector 5 1  0.0 0.3 .3 0.0 2r0 1
unit 6
array 1   3*0.0
reflector 3 1  0.0 0.3 .3 0.0 2r0 1
reflector 5 1  0.3 0.0 0.0 0.3 2r0 1
unit 7
array 1   3*0.0
reflector 3 1  0.3 0.0 0.3 0.0 2r0 1
reflector 5 1  0.0 0.3 0.0 0.3 2r0 1
unit 8
cuboid    3 1  2p2.2  2p12.30  34.68  0.0
reflector 5 1  2r0.0  0 0.3  0  0.3   1
unit 9
cuboid    3 1  2p12.30 2p2.2   34.68  0.0
reflector 5 1  0 0.3  2r0.0  0  0.3   1
unit 10
cuboid    3 1  2p2.2 2p2.2     34.68  0.0
reflector 5 1  5r0.0            0.3   1
unit 11
cuboid    3 1  2p12.30 2p2.2   34.68  0.0
reflector 5 1  0.3 0  2r0.0  0  0.3   1
unit 12
cuboid    3 1  2p2.2  2p12.30  34.68  0.0
reflector 5 1  2r0.0  0.3 0  0  0.3   1
unit 13
cylinder  6 1  .395    90.00  32.78
cylinder  0 1  .410    96.9   32.78
cylinder  2 1  .470    98.2   32.78
cuboid    0 1  4p.675  98.2   32.78
unit 14
array 2   3*0.0
reflector 0 1  0.0 0.3 0.0 0.3 2r0 1
reflector 5 1  0.3 0.0 0.3 0.0 2r0 1
unit 15
array 2   3*0.0
reflector 0 1  0.3 0.0 0.0 0.3 2r0 1
reflector 5 1  0.0 0.3 .3 0.0 2r0 1
unit 16
array 2   3*0.0
reflector 0 1  0.0 0.3 .3 0.0 2r0 1
```

```
reflector 5 1  0.3 0.0 0.0 0.3 2r0 1
unit 17
array 2   3*0.0
reflector 0 1  0.3 0.0 0.3 0.0 2r0 1
reflector 5 1  0.0 0.3 0.0 0.3 2r0 1
unit 18
cuboid    0 1  2p2.2  2p12.30  98.2  32.78
reflector 5 1  2r0.0  0 0.3  2r0       1
unit 19
cuboid    0 1  2p12.30 2p2.2   98.2  32.78
reflector 5 1  0 0.3  2r0.0  2r0       1
unit 20
cuboid    0 1  2p2.2 2p2.2     98.2  32.78
reflector 5 1  4r0.0          2r0      1
unit 21
cuboid    0 1  2p12.30 2p2.2   98.2  32.78
reflector 5 1  0.3 0  2r0.0  2r0       1
unit 22
cuboid    0 1  2p2.2  2p12.30  98.2  32.78
reflector 5 1  2r0.0  0.3 0  2r0       1
unit 23
array 3 3*0.0
reflector 3 1 4r20 2r01
reflector 4 1 5r0    .8 1
reflector 3 1 5r0    20 1
unit 24
array  4  3*0.0
reflector 0 1 4r20  2r0 1
global unit 25
array  5  3*0.0
end geom

read array
ara=1 nux=18 nuy=18 nuz=3 fill 324r1 324r2 324r3          end fill
ara=2 nux=18 nuy=18 nuz=1 fill 324r13                     end fill
ara=3 nux=3  nuy=3  nuz=1 fill 4 8 5 9 10 11 6 12 7       end fill
ara=4 nux=3  nuy=3  nuz=1 fill 14 18 15 19 20 21 16 22 17 end fill
ara=5 nux=1  nuy=1  nuz=2 fill 23 24                      end fill
end array
end data
end
```

ans33al3

```
#csas25
ans33al3
44group  latticecell
uo2        1 den=10.38 1.0 293 92235 4.742 92238 95.258        end
arbmag5    2.70 4 0 0 1 13027 98.85 12000 0.50 14000 0.43 26000
           0.22 2 1 293                                        end
h2o        3 1.0                                               end
arbmstl    7.90 3 0 0 1 26000 72.00 24000 18.00 28000 10.0 4 1 end
al         5 den=2.651 1.0                                     end
uo2        6 den=10.38 1.0 293 92235 4.742 92238 95.258        end
al         7 1.0                                               end
end comp
squarepitch  1.35  0.79   1 3 0.94  2 0.82  0                  end
more data res=6 cyl 0.395  dan(6)=0.989755                     end
4-18x18 assemblies separated by 0.3-cm-thick aluminum plates and 9.4
`cm of water, 64.12 cm water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  7 1  .470     0.0   -1.55
cuboid    3 1  4p.675   0.0   -1.55
reflector 4 1  5r0      0.4    1
unit 2
cylinder  7 1  .470     0.0   -0.25
cylinder  3 1  .500     0.0   -0.25
cuboid    4 1  4p.675   0.0   -0.25
unit 3
cylinder  1 1  .395    64.12   0.0
cylinder  0 1  .410    64.12   0.0
cylinder  2 1  .470    64.12   0.0
cuboid    3 1  4p.675  64.12   0.0
unit 4
array 1   3*0.0
reflector 3 1  0.0 0.3 0.0 0.3 2r0 1
reflector 5 1  0.3 0.0 0.3 0.0 2r0 1
unit 5
array 1   3*0.0
reflector 3 1  0.3 0.0 0.0 0.3 2r0 1
reflector 5 1  0.0 0.3 .3 0.0 2r0 1
unit 6
array 1   3*0.0
reflector 3 1  0.0 0.3 .3 0.0 2r0 1
reflector 5 1  0.3 0.0 0.0 0.3 2r0 1
unit 7
array 1   3*0.0
reflector 3 1  0.3 0.0 0.3 0.0 2r0 1
reflector 5 1  0.0 0.3 0.0 0.3 2r0 1
unit 8
cuboid    3 1  2p4.7 2p12.30  66.02  0.0
reflector 5 1  2r0.0  0 0.3  0 0.3   1
unit 9
cuboid    3 1  2p12.30 2p4.7  66.02  0.0
reflector 5 1  0 0.3  2r0.0  0 0.3   1
unit 10
cuboid    3 1  2p4.7 2p4.7    66.02  0.0
reflector 5 1  5r0.0          0.3    1
unit 11
```

```
cuboid    3 1  2p12.30 2p4.7  66.02  0.0
reflector 5 1  0.3 0  2r0.0  0 0.3   1
unit 12
cuboid    3 1  2p4.7 2p12.30  66.02  0.0
reflector 5 1  2r0.0  0.3 0  0 0.3   1
unit 13
cylinder  6 1  .395       90.00 64.12
cylinder  0 1  .410       96.9  64.12
cylinder  2 1  .470       98.2  64.12
cuboid    0 1  4p.675     98.2  64.12
unit 14
array 2   3*0.0
reflector 0 1  0.0 0.3 0.0 0.3 2r0 1
reflector 5 1  0.3 0.0 0.3 0.0 2r0 1
unit 15
array 2   3*0.0
reflector 0 1  0.3 0.0 0.0 0.3 2r0 1
reflector 5 1  0.0 0.3 .3 0.0 2r0 1
unit 16
array 2   3*0.0
reflector 0 1  0.0 0.3 .3 0.0 2r0 1
reflector 5 1  0.3 0.0 0.0 0.3 2r0 1
unit 17
array 2   3*0.0
reflector 0 1  0.3 0.0 0.3 0.0 2r0 1
reflector 5 1  0.0 0.3 0.0 0.3 2r0 1
unit 18
cuboid    0 1  2p4.7 2p12.30  98.2  64.12
reflector 5 1  2r0.0  0 0.3  2r0      1
unit 19
cuboid    0 1  2p12.30 2p4.7  98.2  64.12
reflector 5 1  0 0.3  2r0.0  2r0      1
unit 20
cuboid    0 1  2p4.7 2p4.7     98.2  64.12
reflector 5 1  4r0.0           2r0    1
unit 21
cuboid    0 1  2p12.30 2p4.7  98.2  64.12
reflector 5 1  0.3 0  2r0.0  2r0      1
unit 22
cuboid    0 1  2p4.7 2p12.30  98.2  64.12
reflector 5 1  2r0.0  0.3 0  2r0      1
unit 23
array  3  3*0.0
reflector 3 1 4r20 2r0 1
reflector 4 1 5r0   .8 1
reflector 3 1 5r0   20 1
unit 24
array  4  3*0.0
reflector 0 1 4r20  2r0 1
global unit 25
```

```
array  5  3*0.0
end geom

read array
ara=1 nux=18 nuy=18 nuz=3 fill 324r1 324r2 324r3         end fill
ara=2 nux=18 nuy=18 nuz=1 fill 324r13                    end fill
ara=3 nux=3  nuy=3  nuz=1 fill 4 8 5 9 10 11 6 12 7      end fill
ara=4 nux=3  nuy=3  nuz=1 fill 14 18 15 19 20 21 16 22 17 end fill
ara=5 nux=1  nuy=1  nuz=2 fill 23 24                      end fill
end array
end data
end
```

<u>ans33eb1</u>

```
#csas25
ans33eb1
44group  latticecell
uo2          1 den=10.38 1.0 293 92235 4.742 92238 95.258          end
arbmag5      2.70 4 0 0 1 13027 98.85 12000 0.50 14000 0.43 26000
             0.22 2 1 293                                          end
h2o          3 1.0                                                 end
arbmstl      7.90 3 0 0 1 26000 72.0 24000 18.0 28000 10.0 4 1     end
polyethylene 5 den=0.5540 1.0                                      end
uo2          6 den=10.38 1.0 293 92235 4.742 92238 95.258          end
al           7 den=2.651 1.0                                       end
al           8 1.0                                                 end
end comp
squarepitch  1.35  0.79   1 3 0.94  2 0.82  0                      end
more data res=6 cyl 0.395  dan(6)=0.989755                         end
4-18x18 assemblies separated by 0.3-cm-thick aluminum plates and 1.9
 cm of polyethylene balls, 25.54 cm water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  8 1  .470      0.0   -1.55
cuboid    3 1  4p.675    0.0   -1.55
reflector 4 1  5r0       0.4    1
unit 2
cylinder  8 1  .470      0.0   -0.25
cylinder  3 1  .500      0.0   -0.25
cuboid    4 1  4p.675    0.0   -0.25
unit 3
cylinder  1 1  .395    25.54   0.0
cylinder  0 1  .410    25.54   0.0
cylinder  2 1  .470    25.54   0.0
cuboid    3 1  4p.675  25.54   0.0
unit 4
array 1   3*0.0
```

```
reflector 3 1  0.0 0.3 0.0 0.3 2r0 1
reflector 7 1  0.3 0.0 0.3 0.0 2r0 1
unit 5
array 1   3*0.0
reflector 3 1  0.3 0.0 0.0 0.3 2r0 1
reflector 7 1  0.0 0.3 .3 0.0 2r0 1
unit 6
array 1   3*0.0
reflector 3 1  0.0 0.3 .3 0.0 2r0 1
reflector 7 1  0.3 0.0 0.0 0.3 2r0 1
unit 7
array 1   3*0.0
reflector 3 1  0.3 0.0 0.3 0.0 2r0 1
reflector 7 1  0.0 0.3 0.0 0.3 2r0 1
unit 8
cuboid    5 1  2p0.95  2p12.30   27.44  0.0
reflector 7 1  2r0.0   0 0.3  0    0.3   1
unit 9
cuboid    5 1  2p12.30 2p0.95    27.44  0.0
reflector 7 1  0 0.3  2r0.0  0     0.3   1
unit 10
cuboid    5 1  2p0.95 2p0.95     27.44  0.0
reflector 7 1  5r0.0               0.3   1
unit 11
cuboid    5 1  2p12.30 2p0.95    27.44  0.0
reflector 7 1  0.3 0  2r0.0  0     0.3   1
unit 12
cuboid    5 1  2p0.95  2p12.30   27.44  0.0
reflector 7 1  2r0.0  0.3 0  0     0.3   1
unit 13
cylinder  6 1  .395     90.00    25.54
cylinder  0 1  .410     96.9     25.54
cylinder  2 1  .470     98.2     25.54
cuboid    0 1  4p.675   98.2     25.54
unit 14
array 2   3*0.0
reflector 0 1  0.0 0.3 0.0 0.3 2r0 1
reflector 7 1  0.3 0.0 0.3 0.0 2r0 1
unit 15
array 2   3*0.0
reflector 0 1  0.3 0.0 0.0 0.3 2r0 1
reflector 7 1  0.0 0.3 .3 0.0 2r0 1
unit 16
array 2   3*0.0
reflector 0 1  0.0 0.3 .3 0.0 2r0 1
reflector 7 1  0.3 0.0 0.0 0.3 2r0 1
unit 17
array 2   3*0.0
reflector 0 1  0.3 0.0 0.3 0.0 2r0 1
reflector 7 1  0.0 0.3 0.0 0.3 2r0 1
unit 18
cuboid    0 1  2p0.95  2p12.30  98.2  25.54
reflector 7 1  2r0.0  0 0.3  2r0        1
unit 19
cuboid    0 1  2p12.30 2p0.95   98.2  25.54
reflector 7 1  0 0.3  2r0.0  2r0        1
unit 20
cuboid    0 1  2p0.95 2p0.95    98.2  25.54
reflector 7 1  4r0.0         2r0        1
unit 21
cuboid    0 1  2p12.30 2p0.95   98.2  25.54
reflector 7 1  0.3 0  2r0.0  2r0        1
unit 22
cuboid    0 1  2p0.95  2p12.30  98.2  25.54
reflector 7 1  2r0.0  0.3 0  2r0        1
unit 23
array  3  3*0.0
reflector 3 1 4r20  2r0 1
reflector 4 1 5r0    .8 1
reflector 3 1 5r0    20 1
unit 24
array  4  3*0.0
reflector 0 1 4r20  2r0 1
global unit 25
array  5  3*0.0
end geom

read array
ara=1 nux=18 nuy=18 nuz=3 fill 324r1 324r2 324r3          end fill
ara=2 nux=18 nuy=18 nuz=1 fill 324r13                     end fill
ara=3 nux=3  nuy=3  nuz=1 fill 4 8 5 9 10 11 6 12 7       end fill
ara=4 nux=3  nuy=3  nuz=1 fill 14 18 15 19 20 21 16 22 17 end fill
ara=5 nux=1  nuy=1  nuz=2 fill 23 24                      end fill
end array
end data
end
```

<u>ans33eb2</u>

```
#csas25
ans33eb2
44group  latticecell
uo2           1 den=10.38 1.0 293 92235 4.742 92238 95.258         end
arbmag5       2.70 4 0 0 1  13027 98.85 12000 0.50 14000 0.43
              26000 0.22 2 1 293                                   end
h2o           3 1.0                                                end
arbmstl       7.90 3 0 0 1 26000 72.0 24000 18.0 28000 10.0 4 1    end
polyethylene  5 den=0.5796 1.0                                     end
uo2           6 den=10.38 1.0 293 92235 4.742 92238 95.258         end
al            7 den=2.651 1.0                                      end
al            8 1.0                                                end
end comp
```

```
squarepitch  1.35  0.79   1 3 0.94  2 0.82  0                    end
more data res=6 cyl 0.395  dan(6)=0.989755                       end
4-18x18 assemblies separated by 0.3-cm-thick aluminum plates and 4.4
 cm of polyethylene balls, 30.73 cm water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  8 1  .470      0.0    -1.55
cuboid    3 1  4p.675    0.0    -1.55
reflector 4 1  5r0       0.4     1
unit 2
cylinder  8 1  .470      0.0    -0.25
cylinder  3 1  .500      0.0    -0.25
cuboid    4 1  4p.675    0.0    -0.25
unit 3
cylinder  1 1  .395     30.73    0.0
cylinder  0 1  .410     30.73    0.0
cylinder  2 1  .470     30.73    0.0
cuboid    3 1  4p.675   30.73    0.0
unit 4
array 1   3*0.0
reflector 3 1  0.0 0.3 0.0 0.3 2r0 1
reflector 7 1  0.3 0.0 0.3 0.0 2r0 1
unit 5
array 1   3*0.0
reflector 3 1  0.3 0.0 0.0 0.3 2r0 1
reflector 7 1  0.0 0.3 .3 0.0 2r0 1
unit 6
array 1   3*0.0
reflector 3 1  0.0 0.3 .3 0.0 2r0 1
reflector 7 1  0.3 0.0 0.0 0.3 2r0 1
unit 7
array 1   3*0.0
reflector 3 1  0.3 0.0 0.3 0.0 2r0 1
reflector 7 1  0.0 0.3 0.0 0.3 2r0 1
unit 8
cuboid    5 1  2p2.2  2p12.30   32.63  0.0
reflector 7 1  2r0.0  0 0.3  0  0.3    1
unit 9
cuboid    5 1  2p12.30 2p2.2    32.63  0.0
reflector 7 1  0 0.3  2r0.0  0  0.3    1
unit 10
cuboid    5 1  2p2.2 2p2.2      32.63  0.0
reflector 7 1  5r0.0             0.3    1
unit 11
cuboid    5 1  2p12.30 2p2.2    32.63  0.0
reflector 7 1  0.3 0  2r0.0  0  0.3    1
unit 12
cuboid    5 1  2p2.2  2p12.30   32.63  0.0
reflector 7 1  2r0.0  0.3 0  0  0.3    1
unit 13
cylinder  6 1  .395     90.00  30.73
cylinder  0 1  .410     96.9   30.73
cylinder  2 1  .470     98.2          30.73
cuboid    0 1  4p.675   98.2          30.73
unit 14
array 2   3*0.0
reflector 0 1  0.0 0.3 0.0 0.3 2r0 1
reflector 7 1  0.3 0.0 0.3 0.0 2r0 1
unit 15
array 2   3*0.0
reflector 0 1  0.3 0.0 0.0 0.3 2r0 1
reflector 7 1  0.0 0.3 .3 0.0 2r0 1
unit 16
array 2   3*0.0
reflector 0 1  0.0 0.3 .3 0.0 2r0 1
reflector 7 1  0.3 0.0 0.0 0.3 2r0 1
unit 17
array 2   3*0.0
reflector 0 1  0.3 0.0 0.3 0.0 2r0 1
reflector 7 1  0.0 0.3 0.0 0.3 2r0 1
unit 18
cuboid    0 1  2p2.2  2p12.30  98.2  30.73
reflector 7 1  2r0.0  0 0.3  2r0      1
unit 19
cuboid    0 1  2p12.30 2p2.2    98.2  30.73
reflector 7 1  0 0.3  2r0.0  2r0      1
unit 20
cuboid    0 1  2p2.2 2p2.2      98.2  30.73
reflector 7 1  4r0.0          2r0      1
unit 21
cuboid    0 1  2p12.30 2p2.2    98.2  30.73
reflector 7 1  0.3 0  2r0.0  2r0      1
unit 22
cuboid    0 1  2p2.2  2p12.30  98.2  30.73
reflector 7 1  2r0.0  0.3 0  2r0      1
unit 23
array  3  3*0.0
reflector 3 1 4r20  2r0 1
reflector 4 1 5r0    .8 1
reflector 3 1 5r0    20 1
unit 24
array  4  3*0.0
reflector 0 1 4r20  2r0 1
global unit 25
array  5  3*0.0
end geom

read array
ara=1 nux=18 nuy=18 nuz=3 fill 324r1 324r2 324r3          end fill
ara=2 nux=18 nuy=18 nuz=1 fill 324r13                     end fill
```

```
ara=3 nux=3  nuy=3  nuz=1 fill 4 8 5 9 10 11 6 12 7        end fill
ara=4 nux=3  nuy=3  nuz=1 fill 14 18 15 19 20 21 16 22 17 end fill
ara=5 nux=1  nuy=1  nuz=2 fill 23 24                       end fill
end array
end data
end
```

ans33ep1

```
#csas25
ans33ep1
44group  latticecell
uo2         1 den=10.38 1.0 293 92235 4.742 92238 95.258         end
arbmag5     2.70 4 0 0 1 13027 98.85 12000 0.50 14000 0.43 26000
            0.22 2 1 293                                         end
h2o         3 1.0                                                end
poly(h2o) 4 den=.2879 1.0                                        end
arbmsti     7.90 3 0 0 1 26000 72.0 24000 18.0 28000 10.0 5 1    end
al          6 den=2.651 1.0                                      end
uo2         7 den=10.38 1.0 293 92235 4.742 92238 95.258         end
al          8 1.0                                                end
end comp
squarepitch  1.35  0.79   1 3 0.94  2 0.82  0                    end
more data res=7 cyl 0.395  dan(7)=0.989755                       end
4-18x18 assemblies separated by 0.3-cm-thick aluminum plates and 1.9
`cm of polyethylene powder, 26.98 cm water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  8 1  .470       0.0  -0.75
cuboid    3 1  4p.675     0.0  -1.55
reflector 4 1  5r0.0      0.4   1
unit 2
cylinder  8 1  .470       0.0  -0.25
cylinder  3 1  .500       0.0  -0.25
cuboid    5 1  4p.675     0.0  -0.25
unit 3
cylinder  1 1  .395      26.98  0.0
cylinder  0 1  .410      26.98  0.0
cylinder  2 1  .470      26.98  0.0
cuboid    3 1  4p.675    26.98  0.0
unit 4
array 1   3*0.0
reflector 3 1  0.0 0.3 0.0 0.3 2r0 1
reflector 6 1  0.3 0.0 0.3 0.0 2r0 1
unit 5
array 1   3*0.0
reflector 3 1  0.3 0.0 0.0 0.3 2r0 1
reflector 6 1  0.0 0.3 .3 0.0 2r0 1
unit 6
array 1   3*0.0
reflector 3 1  0.0 0.3 .3 0.0 2r0 1
reflector 6 1  0.3 0.0 0.0 0.3 2r0 1
unit 7
array 1   3*0.0
reflector 3 1  0.3 0.0 0.3 0.0 2r0 1
reflector 6 1  0.0 0.3 0.0 0.3 2r0 1
unit 8
cuboid    4 1  2p.95  2p12.30  28.88   0.0
reflector 6 1  2r0.0  0 0.3  0  0.3    1
unit 9
cuboid    4 1  2p12.30 2p.95   28.88   0.0
reflector 6 1  0 0.3  2r0.0  0  0.3    1
unit 10
cuboid    4 1  2p.95 2p.95     28.88   0.0
reflector 6 1  5r0.0            0.3    1
unit 11
cuboid    4 1  2p12.30 2p.95   28.88   0.0
reflector 6 1  0.3 0  2r0.0  0  0.3    1
unit 12
cuboid    4 1  2p.95  2p12.30  28.88   0.0
reflector 6 1  2r0.0  0.3 0  0  0.3    1
unit 13
cylinder  7 1  .395     90.00   26.98
cylinder  0 1  .410     96.9    26.98
cylinder  2 1  .470     98.2    26.98
cuboid    0 1  4p.675   98.2    26.98
unit 14
array 2   3*0.0
reflector 0 1  0.0 0.3 0.0 0.3 2r0 1
reflector 6 1  0.3 0.0 0.3 0.0 2r0 1
unit 15
array 2   3*0.0
reflector 0 1  0.3 0.0 0.0 0.3 2r0 1
reflector 6 1  0.0 0.3 .3 0.0 2r0 1
unit 16
array 2   3*0.0
reflector 0 1  0.0 0.3 .3 0.0 2r0 1
reflector 6 1  0.3 0.0 0.0 0.3 2r0 1
unit 17
array 2   3*0.0
reflector 0 1  0.3 0.0 0.3 0.0 2r0 1
reflector 6 1  0.0 0.3 0.0 0.3 2r0 1
unit 18
cuboid    0 1  2p.95  2p12.30  98.2  26.98
reflector 6 1  2r0.0  0 0.3  2r0       1
unit 19
cuboid    0 1  2p12.30 2p.95   98.2  26.98
reflector 6 1  0 0.3  2r0.0  2r0       1
unit 20
cuboid    0 1  2p.95 2p.95     98.2  26.98
```

```
reflector 6 1  4r0.0         2r0      1
unit 21
cuboid    0 1  2p12.30 2p.95   98.2  26.98
reflector 6 1  0.3 0  2r0.0  2r0      1
unit 22
cuboid    0 1  2p.95  2p12.30  98.2  26.98
reflector 6 1  2r0.0  0.3 0  2r0      1
unit 23
array  3  3*0.0
reflector 3 1 4r20 2r0  1
reflector 5 1 5r0    .8 1
reflector 3 1 5r     20 1
unit 24
array  4  3*0.0
reflector 0 1 4r20  2r0 1
global unit 25
array  5  3*0.0
end geom

read array
ara=1 nux=18 nuy=18 nuz=3 fill 324r1 324r2 324r3          end fill
ara=2 nux=18 nuy=18 nuz=1 fill 324r13                     end fill
ara=3 nux=3  nuy=3  nuz=1 fill 4 8 5 9 10 11 6 12 7       end fill
ara=4 nux=3  nuy=3  nuz=1 fill 14 18 15 19 20 21 16 22 17 end fill
ara=5 nux=1  nuy=1  nuz=2 fill 23 24                      end fill
end array
end data
end
```

<u>ans33ep2</u>

```
#csas25
ans33ep2
44group  latticecell
uo2        1 den=10.38 1.0 293 92235 4.742 92238 95.258          end
arbmag5    2.70 4 0 0 1 13027 98.85 12000 0.50 14000 0.43 26000
           0.22 2 1 293                                          end
h2o        3 1.0                                                 end
poly(h2o) 4 den=.3335 1.0                                        end
arbmstl    7.90 3 0 0 1 26000 72.0 24000 18.0 28000 10.0 5 1     end
al         6 den=2.651 1.0                                       end
uo2        7 den=10.38 1.0 293 92235 4.742 92238 95.258          end
al         8 1.0                                                 end
end comp
squarepitch  1.35  0.79   1 3 0.94  2 0.82  0                    end
more data res=7 cyl 0.395  dan(7)=0.989755                       end
4-18x18 assemblies separated by 0.3-cm-thick aluminum plates and 4.4
`cm of polyethylene powder, 30.16 cm water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm
```

```
read geom
unit 1
cylinder  8 1  .470      0.0   -0.75
cuboid    3 1  4p.675    0.0   -1.55
reflector 4 1  5r0.0     0.4    1
unit 2
cylinder  8 1  .470      0.0   -0.25
cylinder  3 1  .500      0.0   -0.25
cuboid    5 1  4p.675    0.0   -0.25
unit 3
cylinder  1 1  .395     30.16   0.0
cylinder  0 1  .410     30.16   0.0
cylinder  2 1  .470     30.16   0.0
cuboid    3 1  4p.675   30.16   0.0
unit 4
array 1   3*0.0
reflector 3 1  0.0 0.3 0.0 0.3 2r0 1
reflector 6 1  0.3 0.0 0.3 0.0 2r0 1
unit 5
array 1   3*0.0
reflector 3 1  0.3 0.0 0.0 0.3 2r0 1
reflector 6 1  0.0 0.3 .3 0.0 2r0 1
unit 6
array 1   3*0.0
reflector 3 1  0.0 0.3 .3 0.0 2r0 1
reflector 6 1  0.3 0.0 0.0 0.3 2r0 1
unit 7
array 1   3*0.0
reflector 3 1  0.3 0.0 0.3 0.0 2r0 1
reflector 6 1  0.0 0.3 0.0 0.3 2r0 1
unit 8
cuboid    4 1  2p2.2  2p12.30  32.06   0.0
reflector 6 1  2r0.0  0 0.3  0  0.3    1
unit 9
cuboid    4 1  2p12.30 2p2.2   32.06   0.0
reflector 6 1  0 0.3  2r0.0  0  0.3    1
unit 10
cuboid    4 1  2p2.2 2p2.2     32.06   0.0
reflector 6 1  5r0.0            0.3    1
unit 11
cuboid    4 1  2p12.30 2p2.2   32.06   0.0
reflector 6 1  0.3 0  2r0.0  0  0.3    1
unit 12
cuboid    4 1  2p2.2  2p12.30  32.06   0.0
reflector 6 1  2r0.0  0.3 0  0  0.3    1
unit 13
cylinder  7 1  .395    90.00  30.16
cylinder  0 1  .410    96.9   30.16
cylinder  2 1  .470    98.2   30.16
cuboid    0 1  4p.675  98.2   30.16
```

```
unit 14
array 2   3*0.0
reflector 0 1  0.0 0.3 0.0 0.3 2r0 1
reflector 6 1  0.3 0.0 0.3 0.0 2r0 1
unit 15
array 2   3*0.0
reflector 0 1  0.3 0.0 0.0 0.3 2r0 1
reflector 6 1  0.0 0.3 .3 0.0 2r0 1
unit 16
array 2   3*0.0
reflector 0 1  0.0 0.3 .3 0.0 2r0 1
reflector 6 1  0.3 0.0 0.0 0.3 2r0 1
unit 17
array 2   3*0.0
reflector 0 1  0.3 0.0 0.3 0.0 2r0 1
reflector 6 1  0.0 0.3 0.0 0.3 2r0 1
unit 18
cuboid    0 1  2p2.2  2p12.30  98.2  30.16
reflector 6 1  2r0.0  0 0.3  2r0       1
unit 19
cuboid    0 1  2p12.30 2p2.2   98.2  30.16
reflector 6 1  0 0.3  2r0.0  2r0       1
unit 20
cuboid    0 1  2p2.2 2p2.2     98.2  30.16
reflector 6 1  4r0.0          2r0      1
unit 21
cuboid    0 1  2p12.30 2p2.2   98.2  30.16
reflector 6 1  0.3 0  2r0.0  2r0       1
unit 22
cuboid    0 1  2p2.2  2p12.30  98.2  30.16
reflector 6 1  2r0.0  0.3 0  2r0       1
unit 23
array  3  3*0.0
reflector 3 1 4r20 2r0  1
reflector 5 1 5r0    .8 1
reflector 3 1 5r0    20 1
unit 24
array  4  3*0.0
reflector 0 1 4r20  2r0 1
global unit 25
array  5  3*0.0
end geom

read array
ara=1 nux=18 nuy=18 nuz=3 fill 324r1 324r2 324r3            end fill
ara=2 nux=18 nuy=18 nuz=1 fill 324r13                       end fill
ara=3 nux=3  nuy=3  nuz=1 fill 4 8 5 9 10 11 6 12 7         end fill
ara=4 nux=3  nuy=3  nuz=1 fill 14 18 15 19 20 21 16 22 17   end fill
ara=5 nux=1  nuy=1  nuz=2 fill 23 24                        end fill
end array
```

```
end data
end
```

<u>ans33slg</u>

```
#csas25
ans33slg
44group  latticecell
uo2        1 den=10.38 1.0 293 92235 4.742 92238 95.258         end
arbmag5    2.70 4 0 0 1 13027 98.85 12000 0.50 14000 0.43 26000
           0.22 2 1 293                                          end
h2o        3 1.0                                                 end
arbmstl    7.90 3 0 0 1 26000 72.00 24000 18.00 28000 10.0 4 1 end
uo2        5 den=10.38 1.0 293 92235 4.742 92238 95.258         end
al         6 den=2.651 1.0                                       end
al         7 1.0                                                  end
end comp
squarepitch  1.35  0.79   1 3 0.94  2 0.82  0                    end
more data res=5 cyl 0.395  dan(5)=0.989755                       end
4-18x18 assemblies separated by 5.0 cm of water, 28.61 cm water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  7 1  .470      0.0   -0.75
cuboid    3 1  4p.675    0.0   -1.55
reflector 4 1  5r0.0     0.4    1
unit 2
cylinder  7 1  .470      0.0   -0.25
cylinder  3 1  .500      0.0   -0.25
cuboid    4 1  4p.675    0.0   -0.25
unit 3
cylinder  1 1  .395    31.47   0.0
cylinder  0 1  .410    31.47   0.0
cylinder  2 1  .470    31.47   0.0
cuboid    3 1  4p.675  31.47   0.0
unit 4
array 1   3*0.0
reflector 3 1  4r.3       2r0 1
unit 5
array 1   3*0.0
reflector 3 1  4r.3       2r0 1
unit 6
array 1   3*0.0
reflector 3 1  4r.3       2r0 1
unit 7
array 1   3*0.0
reflector 3 1  4r.3       2r0 1
unit 8
cuboid    3 1  2p2.2 2p12.30   33.37  0.0
```

```
reflector 3 1  2r0.0  0 0.3  0  0.3   1
unit 9
cuboid    3 1  2p12.30 2p2.2   33.37  0.0
reflector 3 1  0 0.3  2r0.0  0  0.3   1
unit 10
cuboid    3 1  2p2.2 2p2.2     33.37  0.0
reflector 3 1  5r0.0            0.3   1
unit 11
cuboid    3 1  2p12.30 2p2.2   33.37  0.0
reflector 3 1  0.3 0  2r0.0  0  0.3   1
unit 12
cuboid    3 1  2p2.2  2p12.30  33.37  0.0
reflector 3 1  2r0.0  0.3 0  0  0.3   1
unit 13
cylinder  5 1  .395            90.00  31.47
cylinder  0 1  .410            96.9   31.47
cylinder  2 1  .470            98.2   31.47
cuboid    0 1  4p.675          98.2   31.47
unit 14
array 2   3*0.0
reflector 0 1  4r.3       2r0 1
unit 15
array 2   3*0.0
reflector 0 1  4r.3       2r0 1
unit 16
array 2   3*0.0
reflector 0 1  4r.3       2r0 1
unit 17
array 2   3*0.0
reflector 0 1  4r.3       2r0 1
unit 18
cuboid    0 1  2p2.2  2p12.30  98.2  31.47
reflector 0 1  2r0.0  0 0.3  2r0       1
unit 19
cuboid    0 1  2p12.30 2p2.2   98.2  31.47
reflector 0 1  0 0.3  2r0.0  2r0       1
unit 20
cuboid    0 1  2p2.2 2p2.2     98.2  31.47
unit 21
cuboid    0 1  2p12.30 2p2.2   98.2  31.47
reflector 0 1  0.3 0  2r0.0  2r0       1
unit 22
cuboid    0 1  2p2.2  2p12.30  98.2  31.47
reflector 0 1  2r0.0  0.3 0  2r0       1
unit 23
array  3  3*0.0
reflector 3 1 4r20 2r0 1
reflector 4 1 5r0     .8 1
reflector 3 1 5r0     20 1
unit 24
array  4  3*0.0
reflector 0 1 4r20  2r0 1
global unit 25
array  5  3*0.0
end geom

read array
ara=1 nux=18 nuy=18 nuz=3 fill 324r1 324r2 324r3          end fill
ara=2 nux=18 nuy=18 nuz=1 fill 324r13                     end fill
ara=3 nux=3  nuy=3  nuz=1 fill 4 8 5  9 10 11  6 12 7     end fill
ara=4  nux=3 nuy=3  nuz=1 fill 14 18 15 19 20 21 16 22 17 end fill
ara=5  nux=1 nuy=1  nuz=2 fill 23 24                      end fill
end array
end data
end
```

<u>ans33sty</u>

```
#csas25
ans33sty
44group  latticecell
uo2       1 den=10.38 1.0 293 92235 4.742 92238 95.258         end
arbmag5   2.70 4 0 0 1 13027 98.85 12000 0.50 14000 0.43 26000
          0.22 2 1 293                                         end
h2o       3 1.0                                                end
arbmpoly  0.0323 2 0 1 0 6312 8 1901 8 4 1                     end
arbmstl   7.90 3 0 0 1 26000 72.0 24000 18.0 28000 10.0 5 1    end
al        6 den=2.651 1.0                                      end
uo2       7 den=10.38 1.0 293 92235 4.742 92238 95.258         end
al        8 1.0                                                end
end comp
squarepitch  1.35  0.79   1 3 0.94  2 0.82  0                  end
more data res=7 cyl 0.395  dan(7)=0.989755                     end
4-18x18 assemblies separated by 0.3-cm-thick aluminum plates and 1.9
`cm of expanded polystyrene, 28.61 cm water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  8 1  .470     0.0    -.75
cuboid    3 1  4p.675   0.0    -1.55
reflector 5 1  5r0.0    0.4    1
unit 2
cylinder  8 1  .470     0.0    -0.25
cylinder  3 1  .500     0.0    -0.25
cuboid    5 1  4p.675   0.0    -0.25
unit 3
cylinder  1 1  .395    28.61   0.0
cylinder  0 1  .410    28.61   0.0
cylinder  2 1  .470    28.61   0.0
cuboid    3 1  4p.675  28.61   0.0
unit 4
```

```
array 1   3*0.0
reflector 3 1  0.0 0.3 0.0 0.3 2r0 1
reflector 6 1  0.3 0.0 0.3 0.0 2r0 1
unit 5
array 1   3*0.0
reflector 3 1  0.3 0.0 0.0 0.3 2r0 1
reflector 6 1  0.0 0.3 .3 0.0 2r0 1
unit 6
array 1   3*0.0
reflector 3 1  0.0 0.3 .3 0.0 2r0 1
reflector 6 1  0.3 0.0 0.0 0.3 2r0 1
unit 7
array 1   3*0.0
reflector 3 1  0.3 0.0 0.3 0.0 2r0 1
reflector 6 1  0.0 0.3 0.0 0.3 2r0 1
unit 8
cuboid    4 1  2p.95   2p12.30   30.51  0.0
reflector 6 1  2r0.0   0 0.3   0  0.3   1
unit 9
cuboid    4 1  2p12.30 2p.95     30.51  0.0
reflector 6 1  0 0.3   2r0.0   0  0.3   1
unit 10
cuboid    4 1  2p.95 2p.95       30.51  0.0
reflector 6 1  5r0.0              0.3   1
unit 11
cuboid    4 1  2p12.30 2p.95     30.51  0.0
reflector 6 1  0.3 0   2r0.0   0  0.3   1
unit 12
cuboid    4 1  2p.95   2p12.30   30.51  0.0
reflector 6 1  2r0.0   0.3 0   0  0.3   1
unit 13
cylinder  7 1  .395     90.00    28.61
cylinder  0 1  .410     96.9     28.61
cylinder  2 1  .470     98.2     28.61
cuboid    0 1  4p.675   98.2     28.61
unit 14
array 2   3*0.0
reflector 0 1  0.0 0.3 0.0 0.3 2r0 1
reflector 6 1  0.3 0.0 0.3 0.0 2r0 1
unit 15
array 2   3*0.0
reflector 0 1  0.3 0.0 0.0 0.3 2r0 1
reflector 6 1  0.0 0.3 .3 0.0 2r0 1
unit 16
array 2   3*0.0
reflector 0 1  0.0 0.3 .3 0.0 2r0 1
reflector 6 1  0.3 0.0 0.0 0.3 2r0 1
unit 17
array 2   3*0.0
reflector 0 1  0.3 0.0 0.3 0.0 2r0 1
reflector 6 1  0.0 0.3 0.0 0.3 2r0 1
unit 18
cuboid    0 1  2p 95   2p12.30  98.2  28.61
reflector 6 1  2r0.0   0 0.3  2r0      1
unit 19
cuboid    0 1  2p12.30 2p.95    98.2  28.61
reflector 6 1  0 0.3   2r0.0  2r0      1
unit 20
cuboid    0 1  2p.95 2p.95      98.2  28.61
reflector 6 1  4r0.0          2r0      1
unit 21
cuboid    0 1  2p12.30 2p.95    98.2  28.61
reflector 6 1  0.3 0   2r0.0  2r0      1
unit 22
cuboid    0 1  2p.95   2p12.30  98.2  28.61
reflector 6 1  2r0.0   0.3 0  2r0      1
unit 23
array  3  3*0.0
reflector 3 1 4r20 2r0  1
reflector 5 1 5r0     .8 1
reflector 3 1 5r0     20 1
unit 24
array  4  3*0.0
reflector 0 1 4r20  2r0 1
global unit 25
array  5  3*0.0
end geom

read array
ara=1 nux=18 nuy=18 nuz=3 fill 324r1 324r2 324r3             end fill
ara=2 nux=18 nuy=18 nuz=1 fill 324r13                        end fill
ara=3 nux=3  nuy=3  nuz=1 fill 4 8 5 9 10 11 6 12 7          end fill
ara=4 nux=3  nuy=3  nuz=1 fill 14 18 15 19 20 21 16 22 17 end fill
ara=5 nux=1  nuy=1  nuz=2 fill 23 24                         end fill
end array
end data
end
```

<u>b1645so1</u>

```
#csas25
b1645so1
44group                  latticecell
uo2            1  0.9325 293 92235 2.459 92238 97.541 end
al             2  1.0 293                              end
h2o            3  1.0 293                              end
boron          3  den=1068.0-6                         end
carbonsteel    4  1.0 293                              end
end comp
squarepitch 1.4097 1.0300 1  3  1.2060 2  1.0440 0    end
9-15x15 assemblies separated by 0.0762-cm-thick aluminum plates and
```

```
`1.6396 cm of water, 101.81 cm water height with 1068 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes end parm

read geom
unit  1
cylinder   2 1 .6030                  101.81 -.318
cuboid     3 1      4p0.70485         101.81 -.318
unit  2
cylinder   1 1 .5150                  101.81   0.0
cylinder   0 1 .5220                  101.81   0.0
cylinder   2 1 .6030                  101.81 -.318
cuboid     3 1      4p0.70485         101.81 -.318
unit  3
array      1   -9.1631 -9.1631 -0.318
cuboid     3 1 2p9.95725  2p9.1631  101.81 -.318
unit  4
cuboid     3 1 2p9.95725  2p0.79415 101.81 -.318
unit  5
cuboid     3 1 2p7.62      2p0.71795 101.81 -.318
cuboid     2 1 2p7.62      2p0.79415 101.81 -.318
cuboid     3 1 2p9.95725  2p0.79415 101.81 -.318
global unit  6
array      2   -49.78625 -48.9921           -.318
reflector  2 1 5r0          2.882          1
reflector  3 1 10 10 10 10 0  0            1
reflector  2 1 4r0      0   8.9            1
reflector  3 1 4r0      0   2.86           1
reflector  4 1 4r0      0   1.0            1
reflector  3 1 4r20     0   0              1
end geom

read array
ara=1 nux=13 nuy=13 nuz=1 fill 1 11r2 1 13r2 10q13 1 11r2 1 end fill
ara=2 nux=5  nuy=9  nuz=1 fill 5r3 4 3r5 4 3q10 5r3          end fill
end array
end data
end
```

b1645so2

```
#csas25
b1645so2
44group                 latticecell
uo2             1  0.9325 293 92235 2.459 92238 97.541 end
al              2  1.0 293                             end
h2o             3  1.0 293                             end
boron           3  den=1156.0-6                        end
carbonsteel     4  1.0 293                             end
end comp
squarepitch 1.4097 1.0300 1  3  1.2060 2  1.0440 0     end
9-15x15 assemblies separated by 0.0762-cm-thick aluminum plates and
```

```
`1.6396 cm of water, 144.85 cm water height with 1156 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes  end parm

read geom
unit  1
cylinder   2 1 .6030                 144.85 -.318
cuboid     3 1      4p0.70485        144.85 -.318
unit  2
cylinder   1 1 .5150                 144.85 0.0
cylinder   0 1 .5220                 144.85 0.0
cylinder   2 1 .6030                 144.85 -.318
cuboid     3 1      4p0.70485        144.85 -.318
unit  3
array      1   -9.1631 -9.1631 -0.318
cuboid     3 1 2p9.95725 2p9.1631  144.85 -.318
unit  4
cuboid     3 1 2p9.95725 2p0.79415 144.85 -.318
unit  5
cuboid     3 1 2p7.62     2p0.71795 144.85 -.318
cuboid     2 1 2p7.62     2p0.79415 144.85 -.318
cuboid     3 1 2p9.95725 2p0.79415 144.85 -.318
global unit  6
array      2   -49.78625 -48.9921          -.318
reflector  2 1 5r0          2.882         1
reflector  3 1 10 10 10 10 0  0           1
reflector  2 1 4r0      0   8.9           1
reflector  3 1 4r0      0   2.86          1
reflector  4 1 4r0      0   1.0           1
reflector  3 1 4r20     0   0             1
end geom

read array
ara=1 nux=13 nuy=13 nuz=1 fill 1 11r2 1 13r2 10q13 1 11r2 1 end fill
ara=2 nux=5  nuy=9  nuz=1 fill 5r3 4 3r5 4 3q10 5r3          end fill
end array
end data
end
```

bw1231b1

```
=csas25
bw1231b1
44group        latticecell
uo2          1  0.863  285   92235  4.02   92238  95.98   end
ss304        2  1.0    285                                end
h2o          3  1.0    285                                end
boron        3  den=.001152  1.0  285                     end
al           4  1.0    285                                end
plexiglas   5  1.0    285                                 end
uo2          6  0.863  285   92235  4.02   92238  95.98   end
```

```
end comp
squarepitch  1.511 1.128  1  3  1.208  2               end
more data res=6 cyl 0.564  dan(6)=0.901122             end
Core of 936 fuel rods, 167.5 cm water height with 1152 ppm boron
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  4 1  .564     2.365 0
cylinder  2 1  .604     2.365 0
cuboid    3 1 4p.7555   2.365 0
unit 2
cuboid    3 1 4p.7555   2.365 0
unit 10
cylinder  1 1  .564     86.0  0
cylinder  2 1  .604     86.0  0
cuboid    3 1 4p.7555   86.0  0
unit 11
cuboid    3 1 4p.7555   86.0  0
unit 20
cylinder  1 1  .564     0.63  0
cylinder  2 1  .604     0.63  0
cuboid    5 1 4p.7555   0.63  0
unit 21
cuboid    5 1 4p.7555   0.63  0
unit 30
cylinder  1 1  .564     80.87 0
cylinder  2 1  .604     80.87 0
cuboid    3 1 4p.7555   80.87 0
unit 31
cuboid    3 1 4p.7555   80.87 0
unit 40
cylinder  6 1  .564     1.4   0
cylinder  2 1  .604     1.4   0
cuboid    0 1 4p.7555   1.4   0
unit 41
cuboid    0 1 4p.7555   1.4   0
unit 50
cylinder  1 1  .564     0.7   0
cylinder  2 1  .604     0.7   0
cuboid    4 1 4p.7555   0.7   0
unit 51
cuboid    4 1 4p.7555   0.7   0
unit 60
array 1  3*0.0
reflector 3 1 4r30    2r0 1
reflector 4 1 5r0   11.47 1
unit 70
array 2  3*0.0
reflector 0 1 4r30    2r0 1
unit 80
array 3  3*0.0
reflector 4 1 4r30 6.57 0 1
global
unit 90
array 4  3*0.0
end geom

read array
ara=1 nux=34 nuy=34 nuz=4
fill
12r2  5r1 n17 9r2  8r1 n17 8r2  9r1 n17
 6r2 11r1 n17 5r2 12r1 n17 4r2 13r1 n17
 3r2 14r1 n17 3r2 14r1 n17 2r2 15r1 n17 1r2 16r1 n17
 1r2 16r1 n17 1r2 16r1 n17 170r1
n578
12r11  5r10 n17 9r11  8r10 n17 8r11  9r10 n17
 6r11 11r10 n17 5r11 12r10 n17 4r11 13r10 n17
 3r11 14r10 n17 3r11 14r10 n17 2r11 15r10 n17 1r11 16r10 n17
 1r11 16r10 n17 1r11 16r10 n17 170r10
n578
12r21  5r20 n17 9r21  8r20 n17 8r21  9r20 n17
 6r21 11r20 n17 5r21 12r20 n17 4r21 13r20 n17
 3r21 14r20 n17 3r21 14r20 n17 2r21 15r20 n17 1r21 16r20 n17
 1r21 16r20 n17 1r21 16r20 n17 170r20
n578
12r31  5r30 n17 9r31  8r30 n17 8r31  9r30 n17
 6r31 11r30 n17 5r31 12r30 n17 4r31 13r30 n17
 3r31 14r30 n17 3r31 14r30 n17 2r31 15r30 n17 1r31 16r30 n17
 1r31 16r30 n17 1r31 16r30 n17 170r30
n578 end fill
ara=2 nux=34 nuy=34 nuz=1
fill
12r41  5r40 n17 9r41  8r40 n17   8r41  9r40 n17
 6r41 11r40 n17 5r41 12r40 n17   4r41 13r40 n17
 3r41 14r40 n17 3r41 14r40 n17   2r41 15r40 n17 1r41 16r40 n17
 1r41 16r40 n17 1r41 16r40 n17 170r40
n578 end fill
ara=3 nux=34 nuy=34 nuz=1
fill
12r51  5r50 n17 9r51  8r50 n17 8r51  9r50 n17
 6r51 11r50 n17 5r51 12r50 n17 4r51 13r50 n17
 3r51 14r50 n17 3r51 14r50 n17 2r51 15r50 n17 1r51 16r50 n17
 1r51 16r50 n17 1r51 16r50 n17 170r50
n578 end fill
ara=4 nux=1 nuy=1 nuz=3 fill  60 70 80  end fill
end array
end data
end
```

bw1231b2

```
=csas25
bw1231b2
44group       latticecell
uo2          1  0.863  287  92235  4.02  92238  95.98    end
ss304        2  1.0  287                                 end
h2o          3  1.0  287                                 end
boron        3  den=.003389  1.0  287                    end
al           4  1.0  287                                 end
plexiglas  5  1.0  287                                  end
uo2          6  0.863  287  92235  4.02  92238  95.98    end
end comp
squarepitch  1.511 1.128  1  3  1.208  2                 end
more data res=6 cyl 0.564  dan(6)=0.901122               end
Core of 4904 fuel rods, 146.65 cm water height with 3389 ppm boron
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  4 1  .564     3.46  0
cylinder  2 1  .604     3.46  0
cuboid    3 1 4p.7555   3.46  0
unit 2
cuboid    3 1 4p.7555   3.46  0
unit 10
cylinder  1 1  .564     65.0  0
cylinder  2 1  .604     65.0  0
cuboid    3 1 4p.7555   65.0  0
unit 11
cuboid    3 1 4p.7555   65.0. 0
unit 20
cylinder  1 1  .564     0.63  0
cylinder  2 1  .604     0.63  0
cuboid    5 1 4p.7555   0.63  0
unit 21
cuboid    5 1 4p.7555   0.63  0
unit 30
cylinder  1 1  .564     81.02 0
cylinder  2 1  .604     81.02 0
cuboid    3 1 4p.7555   81.02 0
unit 31
cuboid    3 1 4p.7555   81.02 0
unit 40
cylinder  6 1  .564     21.65 0
cylinder  2 1  .604     21.65 0
cuboid    0 1 4p.7555   21.65 0
unit 41
cuboid    0 1 4p.7555   21.65 0
unit 50
cylinder  1 1  .564     1.3   0
cylinder  2 1  .604     1.3   0
cuboid    4 1 4p.7555   1.3   0
unit 51
cuboid    4 1 4p.7555   1.3   0
unit 60
array 1 3*0.0
reflector 3 1 4r30.0  2r0 1
reflector 4 1 5r0   12.74 1
unit 70
array 2 3*0.0
reflector 0 1 4r30    2r0 1
unit 80
array 3 3*0.0
reflector 4 1 4r30 7.24 0 1
global
unit 90
array 4 3*0.0
end geom

read array
ara=1   nux=80 nuy=80 nuz=4
fill
37r2 3r1  n40  31r2 9r1  n40  27r2 13r1 n40
25r2 15r1 n40  23r2 17r1 n40  21r2 19r1 n40
19r2 21r1 n40  18r2 22r1 n40  16r2 24r1 n40
15r2 25r1 n40  14r2 26r1 n40  13r2 27r1 n40
12r2 28r1 n40  11r2 29r1 n40  10r2 30r1 n40
 9r2 31r1 n40   8r2 32r1 n40   8r2 32r1 n40
 7r2 33r1 n40   6r2 34r1 n40   6r2 34r1 n40
 5r2 35r1 n40   5r2 35r1 n40   4r2 36r1 n40
 4r2 36r1 n40   3r2 37r1 n40   3r2 37r1 n40
 2r2 38r1 n40   2r2 38r1 n40   2r2 38r1 n40
 2r2 38r1 n40   1r2 39r1 n40   1r2 39r1 n40
 1r2 39r1 n40   1r2 39r1 n40   1r2 39r1 n40
 1r2 39r1 n40  40r1 n40  40r1 n40  40r1 n40
n3200
37r11 3r10  n40  31r11 9r10  n40  27r11 13r10 n40
25r11 15r10 n40  23r11 17r10 n40  21r11 19r10 n40
19r11 21r10 n40  18r11 22r10 n40  16r11 24r10 n40
15r11 25r10 n40  14r11 26r10 n40  13r11 27r10 n40
12r11 28r10 n40  11r11 29r10 n40  10r11 30r10 n40
 9r11 31r10 n40   8r11 32r10 n40   8r11 32r10 n40
 7r11 33r10 n40   6r11 34r10 n40   6r11 34r10 n40
 5r11 35r10 n40   5r11 35r10 n40   4r11 36r10 n40
 4r11 36r10 n40   3r11 37r10 n40   3r11 37r10 n40
 2r11 38r10 n40   2r11 38r10 n40   2r11 38r10 n40
 2r11 38r10 n40   1r11 39r10 n40   1r11 39r10 n40
 1r11 39r10 n40   1r11 39r10 n40   1r11 39r10 n40
 1r11 39r10 n40   40r10 n40  40r10 n40  40r10 n40
n3200
37r21 3r20  n40  31r21 9r20  n40  27r21 13r20 n40
```

```
25r21 15r20 n40  23r21 17r20 n40  21r21 19r20 n40
19r21 21r20 n40  18r21 22r20 n40  16r21 24r20 n40
15r21 25r20 n40  14r21 26r20 n40  13r21 27r20 n40
12r21 28r20 n40  11r21 29r20 n40  10r21 30r20 n40
 9r21 31r20 n40   8r21 32r20 n40   8r21 32r20 n40
 7r21 33r20 n40   6r21 34r20 n40   6r21 34r20 n40
 5r21 35r20 n40   5r21 35r20 n40   4r21 36r20 n40
 4r21 36r20 n40   3r21 37r20 n40   3r21 37r20 n40
 2r21 38r20 n40   2r21 38r20 n40   2r21 38r20 n40
 2r21 38r20 n40   1r21 39r20 n40   1r21 39r20 n40
 1r21 39r20 n40   1r21 39r20 n40   1r21 39r20 n40
 1r21 39r20 n40  40r20 n40  40r20 n40  40r20 n40
n3200
37r31 3r30  n40  31r31 9r30  n40  27r31 13r30 n40
25r31 15r30 n40  23r31 17r30 n40  21r31 19r30 n40
19r31 21r30 n40  18r31 22r30 n40  16r31 24r30 n40
15r31 25r30 n40  14r31 26r30 n40  13r31 27r30 n40
12r31 28r30 n40  11r31 29r30 n40  10r31 30r30 n40
 9r31 31r30 n40   8r31 32r30 n40   8r31 32r30 n40
 7r31 33r30 n40   6r31 34r30 n40   6r31 34r30 n40
 5r31 35r30 n40   5r31 35r30 n40   4r31 36r30 n40
 4r31 36r30 n40   3r31 37r30 n40   3r31 37r30 n40
 2r31 38r30 n40   2r31 38r30 n40   2r31 38r30 n40
 2r31 38r30 n40   1r31 39r30 n40   1r31 39r30 n40
 1r31 39r30 n40   1r31 39r30 n40   1r31 39r30 n40
 1r31 39r30 n40  40r30 n40  40r30 n40  40r30 n40
n3200
end fill
ara=2   nux=80 nuy=80 nuz=1
fill
37r41  3r40 n40  31r41 9r40  n40  27r41 13r40 n40
25r41 15r40 n40  23r41 17r40 n40  21r41 19r40 n40
19r41 21r40 n40  18r41 22r40 n40  16r41 24r40 n40
15r41 25r40 n40  14r41 26r40 n40  13r41 27r40 n40
12r41 28r40 n40  11r41 29r40 n40  10r41 30r40 n40
 9r41 31r40 n40   8r41 32r40 n40   8r41 32r40 n40
 7r41 33r40 n40   6r41 34r40 n40   6r41 34r40 n40
 5r41 35r40 n40   5r41 35r40 n40   4r41 36r40 n40
 4r41 36r40 n40   3r41 37r40 n40   3r41 37r40 n40
 2r41 38r40 n40   2r41 38r40 n40   2r41 38r40 n40
 2r41 38r40 n40   1r41 39r40 n40   1r41 39r40 n40
 1r41 39r40 n40   1r41 39r40 n40   1r41 39r40 n40
 1r41 39r40 n40  40r40    n40 40r40 n40  40r40 n40
n3200
end fill
ara=3   nux=80 nuy=80 nuz=1
fill
37r51 3r50  n40  31r51 9r50  n40  27r51 13r50 n40
25r51 15r50 n40  23r51 17r50 n40  21r51 19r50 n40
19r51 21r50 n40  18r51 22r50 n40  16r51 24r50 n40
15r51 25r50 n40  14r51 26r50 n40  13r51 27r50 n40
12r51 28r50 n40  11r51 29r50 n40  10r51 30r50 n40
 9r51 31r50 n40   8r51 32r50 n40   8r51 32r50 n40
 7r51 33r50 n40   6r51 34r50 n40   6r51 34r50 n40
 5r51 35r50 n40   5r51 35r50 n40   4r51 36r50 n40
 4r51 36r50 n40   3r51 37r50 n40   3r51 37r50 n40
 2r51 38r50 n40   2r51 38r50 n40   2r51 38r50 n40
 2r51 38r50 n40   1r51 39r50 n40   1r51 39r50 n40
 1r51 39r50 n40   1r51 39r50 n40   1r51 39r50 n40
 1r51 39r50 n40   40r50 n40  40r50 n40  40r50 n40
n3200
end fill
ara=4   nux=1 nuy=1 nuz=3 fill 60 70 80 end fill
end array
end data
end
```

<u>bw1273m</u>

```
#csas25
bw1273m
44group  latticecell
uo2        1 den=10.24 1.0 293 92235 2.459 92238 97.541 end
al         2 1.0                                         end
h2o        3 1.0                                         end
boron      3 den=1.675e-3                                end
uo2        4 den=10.24 1.0 293 92235 2.459 92238 97.541 end
plexiglas 5 1.0                                         end
end comp
squarepitch  1.511 1.030  1 3 1.206 2 1.044 0            end
more data  res=4 cyl 0.515  dan(4)=0.982883              end
Core of 5137 fuel rods, 93.2 cm water height with 1675 ppm boron
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  2 1  .603       .3175 0.0
cuboid    3 1  4p.7555    .3175 0.0
unit 2
cylinder  1 1  .515       2.54  0.0
cylinder  0 1  .522       2.54  0.0
cylinder  2 1  .603       2.54  0.0
cuboid    3 1  4p.615     2.54  0.0
cuboid    2 1  4p.7555    2.54  0.0
unit 3
cylinder  1 1  .515       46.46 0.0
cylinder  0 1  .522       46.46 0.0
cylinder  2 1  .603       46.46 0.0
cuboid    3 1  4p.7555    46.46 0.0
unit 4
cylinder  1 1  .515       .1588 0.0
cylinder  0 1  .522       .1588 0.0
```

```
cylinder  2 1  .603       .1588 0.0
cuboid    3 1  4p.615     .1588 0.0
cuboid    5 1  4p.7555    .1588 0.0
unit 5
cylinder  1 1  .515     32.8412 0.0
cylinder  0 1  .522     32.8412 0.0
cylinder  2 1  .603     32.8412 0.0
cuboid    3 1  4p.7555  32.8412 0.0
unit 6
cylinder  1 1  .515       .1588 0.0
cylinder  0 1  .522       .1588 0.0
cylinder  2 1  .603       .1588 0.0
cuboid    3 1  4p.615     .1588 0.0
cuboid    5 1  4p.7555    .1588 0.0
unit 7
cylinder  1 1  .515     11.0412 0.0
cylinder  0 1  .522     11.0412 0.0
cylinder  2 1  .603     11.0412 0.0
cuboid    3 1  4p.7555  11.0412 0.0
unit 8
cylinder  4 1  .515       60.2  0.0
cylinder  0 1  .522       60.2  0.0
cylinder  2 1  .603       60.2  0.0
cuboid    0 1  4p.7555    60.2  0.0
unit 10
cylinder  2 1  .603       .3175 0.0
cuboid    3 1  4p.7555    .3175 0.0
unit 11
cuboid    3 1  4p.615     2.54  0.0
cuboid    2 1  4p.7555    2.54  0.0
unit 12
cuboid    3 1  4p.7555   46.46  0.0
unit 13
cuboid    3 1  4p.615     .1588 0.0
cuboid    5 1  4p.7555    .1588 0.0
unit 14
cuboid    3 1  4p.7555  32.8412 0.0
unit 15
cuboid    3 1  4p.615     .1588 0.0
cuboid    5 1  4p.7555    .1588 0.0
unit 16
cuboid    3 1  4p.7555  11.0412 0.0
unit 17
cuboid    0 1  4p.7555    60.2  0.0
unit 20
array 1   3*0.0
unit 21
array 2   3*0.0
global unit 22
array  3  3*0.0
reflector 2 1  5r0    5.08 1
reflector 3 1  4r30    2r0 1
end geom

read array
ara=1 nux=1 nuy=1 nuz=8 fill 1 2 3 4 5 6 7 8              end fill
ara=2 nux=1 nuy=1 nuz=8 fill 10 11 12 13 14 15 16 17     end fill
ara=3  nux=82 nuy=82  nuz=1   fill
38r21  6r20 38r21 32r21 18r20 32r21 28r21 26r20 28r21 26r21 30r20
26r21
24r21 34r20 24r21 22r21 38r20 22r21 20r21 42r20 20r21 18r21 46r20
18r21
17r21 48r20 17r21 16r21 50r20 16r21 15r21 52r20 15r21 14r21 54r20
14r21
13r21 56r20 13r21 12r21 58r20 12r21 11r21 60r20 11r21 10r21 62r20
10r21
 9r21 64r20  9r21  8r21 66r20  8r21  7r21 68r20  7r21 q82
 6r21 70r20  6r21 q82         5r21 72r20  5r21  q82
 4r21 74r20  4r21 q82
 3r21 76r20  3r21 q82         2r21 78r20  2r21 3q82
 1r21 80r20  1r21 5q82        82r20             2q82
 n3280
38r21  7r20 37r21 end fill
end array
end data
end
```

<u>bw1484a1</u>

```
#csas25
bw1484a1
44group  latticecell
uo2    1 den=10.22 1.0 293 92235 2.459 92238 97.541 end
al     2 1.0                                         end
h2o    3 1.0                                         end
boron 3 den=15e-6                                    end
al     4 den=2.7 .98386                              end
boron 4 den=2.7 .01614                               end
end comp
squarepitch  1.636 1.030  1 3 1.206 2 1.044 0       end
9-14x14 assemblies separated by 0.645-cm-thick borated aluminum plates
'and 0.991 cm of water, plates-to-center assembly distance of 0.3725
'cm, 150.27 cm water height with 15 ppm boron
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 1 1   0.515     0.635    0.0
cylinder 0 1   0.522     0.635    0.0
cuboid   2 1 4p0.818     0.635    0.0
```

```
unit 2
cylinder 1 1   0.515      147.4125 0.0
cylinder 0 1   0.522      147.4125 0.0
cylinder 2 1   0.603      147.4125 0.0
cuboid   3 1 4p0.818      147.4125 0.0
unit 3
cuboid   2 1 4p0.818      0.635    0.0
unit 4
cylinder 2 1   0.635      147.4125 0.0
cuboid   3 1 4p0.818      147.4125 0.0
unit 5
array 1 3*0.0
unit 6
array 2 3*0.0
unit 7
array 3   2r-22.904  0.0
reflector 3 1  .6185 9.808 .6185 9.808  2r0  1
reflector 4 1  .3225 0.0   .3225        3r0  1
unit 8
array 3   2r-22.904  0.0
reflector 3 1  2r.3725 .6185 9.808      2r0  1
reflector 4 1  3r.3225                  3r0  1
unit 9
array 3   2r-22.904  0.0
reflector 3 1  9.808 .6185 .6185 9.808  2r0  1
reflector 4 1  0.0   2r.3225            3r0  1
unit 10
array 3   2r-22.904  0.0
reflector 3 1  .6185 9.808 2r.3725      2r0  1
reflector 4 1  .3225 0.0   2r.3225      2r0  1
unit 11
array 3   2r-22.904  0.0
reflector 3 1  4r.3725                  2r0  1
reflector 4 1  4r.3225                  2r0  1
unit 12
array 3   2r-22.904  0.0
reflector 3 1  9.808 .6185 2r.3725      2r0  1
reflector 4 1  0.0   3r.3225            2r0  1
unit 13
array 3   2r-22.904  0.0
reflector 3 1  .6185 9.808 9.808 .6185  2r0  1
reflector 4 1  .3225 2r0 .3225          2r0  1
unit 14
array 3   2r-22.904  0.0
reflector 3 1  2r.3725 9.808 .6185      2r0  1
reflector 4 1  2r.3225 0     .3225      2r0  1
unit 15
array 3   2r-22.904  0.0
reflector 3 1  9.808 .6185 9.808 .6185  2r0  1
reflector 4 1  0     .3225 0 .3225      2r0  1
global unit 16
array  4   2*-45.808 0.0
reflector 2 1  5r0.0 1.905 1
reflector 2 1  5r0 2.54    1
reflector 3 1  5r0 0.3175  1
reflector 2 1  5r0 5.08    1
reflector 3 1  4r20 2r0    1
end geom

read array
ara=1 nux=1  nuy=1  nuz=2 fill 1 2 end fill
ara=2 nux=1  nuy=1  nuz=2 fill 3 4 end fill
ara=3 nux=14 nuy=14 nuz=1 fill 6 12r5 6 14r5 11q14 6 12r5 6 end fill
ara=4 nux=3  nuy=3  nuz=1 fill 7 8 9 10 11 12 13 14 15       end fill
end array
end data
end
```

<u>bw1484a2</u>

```
#csas25
bw1484a2
44group  latticecell
uo2   1 den=10.22 1.0 293 92235 2.459 92238 97.541 end
al    2 1.0                                         end
h2o   3 1.0                                         end
boron 3 den=72e-6                                   end
al    4 den=2.7 .99899                              end
boron 4 den=2.7 .00101                              end
end comp
squarepitch  1.636 1.030  1 3 1.206 2 1.044 0       end
9-14x14 assemblies separated by 0.645-cm-thick borated aluminum plates
'and 4.263 cm of water, plates-to-center assembly distance of 0.3725
'cm, 151.69 cm water height with 72 ppm boron
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 1 1   0.515      0.635    0.0
cylinder 0 1   0.522      0.635    0.0
cuboid   2 1 4p0.818      0.635    0.0
unit 2
cylinder 1 1   0.515      148.8325 0.0
cylinder 0 1   0.522      148.8325 0.0
cylinder 2 1   0.603      148.8325 0.0
cuboid   3 1 4p0.818      148.8325 0.0
unit 3
cuboid   2 1 4p0.818      0.635    0.0
unit 4
cylinder 2 1   0.635      148.8325 0.0
cuboid   3 1 4p0.818      148.8325 0.0
unit 5
```

```
array 1 3*0.0
unit 6
array 2 3*0.0
unit 7
array 3   2r-22.904  0.0
reflector 3 1 3.8905 6.536 3.8905 6.536  2r0  1
reflector 4 1 .3225  0.0   .3225         3r0  1
unit 8
array 3   2r-22.904  0.0
reflector 3 1 2r.3725 3.8905 6.536       2r0  1
reflector 4 1 3r.3225                    3r0  1
unit 9
array 3   2r-22.904  0.0
reflector 3 1 6.536 3.8905 3.8905 6.536  2r0  1
reflector 4 1 0.0   2r.3225              3r0  1
unit 10
array 3   2r-22.904  0.0
reflector 3 1 3.8905 6.536 2r.3725       2r0  1
reflector 4 1 .3225  0.0   2r.3225       2r0  1
unit 11
array 3   2r-22.904  0.0
reflector 3 1 4r.3725                    2r0  1
reflector 4 1 4r.3225                    2r0  1
unit 12
array 3   2r-22.904  0.0
reflector 3 1 6.536 3.8905 2r.3725       2r0  1
reflector 4 1 0.0   3r.3225              2r0  1
unit 13
array 3   2r-22.904  0.0
reflector 3 1 3.8905 6.536 6.536 3.8905  2r0  1
reflector 4 1 .3225  2r0   .3225         2r0  1
unit 14
array 3   2r-22.904  0.0
reflector 3 1 2r.3725 6.536  3.8905      2r0  1
reflector 4 1 2r.3225 0 .3225            2r0  1
unit 15
array 3   2r-22.904  0.0
reflector 3 1 6.536 3.8905 6.536 3.8905  2r0  1
reflector 4 1 0.0   .3225  0.0 .3225     2r0  1
global unit 16
array 4   2*-45.808 0.0
reflector 2 1    5r0 1.905   1
reflector 2 1    5r0 2.54    1
reflector 3 1    5r0 0.3175  1
reflector 2 1    5r0 5.08    1
reflector 3 1    4r20 2r0    1
end geom

read array
ara=1 nux=1  nuy=1  nuz=2 fill 1 2 end fill
ara=2 nux=1  nuy=1  nuz=2 fill 3 4 end fill
ara=3 nux=14 nuy=14 nuz=1 fill 6 12r5 6 14r5 11q14 6 12r5 6 end fill
ara=4 nux=3  nuy=3  nuz=1 fill 7 8 9 10 11 12 13 14 15      end fill
end array
end data
end
```

<u>bw1484b1</u>

```
#csas25
bw1484b1
44group  latticecell
uo2   1 den=10.22 1.0 293 92235 2.459 92238 97.541              end
al    2 1.0                                                     end
h2o   3 1.0                                                     end
boron 3 den=1037e-6                                             end
end comp
squarepitch  1.636 1.030  1 3 1.206 2 1.044 0                   end
9-14x14 assemblies separated by 0.0 cm of water, 144.29 cm water
'height with 1037 ppm boron
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  2 1  0.603      .3175    0.0
cuboid    3 1 4p.818      .3175    0.0
unit 2
cylinder  1 1  0.515      2.54     0.0
cylinder  0 1  0.522      2.54     0.0
cylinder  2 1  0.603      2.54     0.0
cuboid    3 1 4p.615      2.54     0.0
cuboid    2 1 4p.818      2.54     0.0
unit 3
cylinder  1 1  0.515      141.4325 0.0
cylinder  0 1  0.522      141.4325 0.0
cylinder  2 1  0.603      141.4325 0.0
cuboid    3 1 4p.818      141.4325 0.0
unit 4
array 1   3*0.0
global unit 5
array  2   3*0.0
reflector 2 1 5r0.0 5.08 1
reflector 3 1 5r0.0 2.54 1
reflector 2 1 5r0.0 1.27 1
reflector 3 1 4r24   2r0 1
end geom

read array
ara=1 nux=14 nuy=14 nuz=3 fill 196r1 196r2 196r3 end fill
ara=2 nux=3  nuy=3  nuz=1 fill f4 end fill
end array
```

```
end data
end
```

bw1484b2

```
#csas25
bw1484b2
44group  latticecell
uo2   1 den=10.22 1.0 293 92235 2.459 92238 97.541          end
al    2 1.0                                                  end
h2o   3 1.0                                                  end
boron 3 den=702e-6                                           end
end comp
squarepitch  1.636 1.030  1 3 1.206 2 1.044 0                end
9-14x14 assemblies separated by 1.636 cm of water, 100.32 cm water
'height with 702 ppm boron
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  2 1  0.603      .3175    0.0
cuboid    3 1 4p.818      .3175    0.0
unit 2
cylinder  1 1  0.515      2.54     0.0
cylinder  0 1  0.522      2.54     0.0
cylinder  2 1  0.603      2.54     0.0
cuboid    3 1 4p.615      2.54     0.0
cuboid    2 1 4p.818      2.54     0.0
unit 3
cylinder  1 1  0.515      97.4625 0.0
cylinder  0 1  0.522      97.4625 0.0
cylinder  2 1  0.603      97.4625 0.0
cuboid    3 1 4p.818      97.4625 0.0
unit 4
array 1   3*0.0
reflector 3 1 4r.818 2r0 1
global unit 5
array  2   3*0.0
reflector 2 1 5r0.0 5.08 1
reflector 3 1 5r0.0 2.54 1
reflector 2 1 5r0.0 1.27 1
reflector 3 1 4r24   2r0 1
end geom

read array
ara=1 nux=14 nuy=14 nuz=3 fill 196r1 196r2 196r3 end fill
ara=2  nux=3 nuy=3  nuz=1 fill f4 end fill
end array
end data
end
```

bw1484b3

```
#csas25
bw1484b3
44group  latticecell
uo2   1 den=10.22 1.0 293 92235 2.459 92238 97.541          end
al    2 1.0                                                  end
h2o   3 1.0                                                  end
boron 3 den=1[illegible]e-6                                  end
end comp
squarepitch  1.636 1.030  1 3 1.206 2 1.044 0                end
9-14x14 assemblies separated by 4.908 cm of water, 149.12 cm water
'height with 143 ppm boron
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 1 1   0.515      0.635    0.0
cylinder 0 1   0.522      0.635    0.0
cuboid   2 1 4p0.818      0.635    0.0
unit 2
cylinder 1 1   0.515      148.8325 0.0
cylinder 0 1   0.522      148.8325 0.0
cylinder 2 1   0.603      148.8325 0.0
cuboid   3 1 4p0.818      148.8325 0.0
unit 3
cuboid   2 1 4p0.818      0.635    0.0
unit 4
cylinder 2 1   0.635      148.8325 0.0
cuboid   3 1 4p0.818      148.8325 0.0
unit 5
array 1 3*0.0
unit 6
array 2 3*0.0
unit 7
array 3   2r-22.904  0.0
reflector 3 1    2.454 9.808  2.454  9.808  2r0  1
unit 8
array 3   2r-22.904  0.0
reflector 3 1    2r2.454      2.454  9.808  2r0  1
unit 9
array 3   2r-22.904  0.0
reflector 3 1    9.808 2.454  2.454  9.808  2r0  1
unit 10
array 3   2r-22.904  0.0
reflector 3 1    2.454 9.808  2r2.454       2r0  1
unit 11
array 3   2r-22.904  0.0
reflector 3 1    4r2.454                    2r0  1
```

```
unit 12
array 3   2r-22.904  0.0
reflector 3 1    9.808 2.454  2r2.454        2r0  1
unit 13
array 3   2r-22.904  0.0
reflector 3 1    2.454 9.808  9.808  2.454  2r0  1
unit 14
array 3   2r-22.904  0.0
reflector 3 1    2r2.454       9.808  2.454  2r0  1
unit 15
array 3   2r-22.904  0.0
reflector 3 1    9.808 2.454  9.808  2.454  2r0  1
global unit 16
array  4  2*-45.808  0.0
reflector 2 1    5r0 1.905  1
reflector 2 1    5r0 2.54   1
reflector 3 1    5r0 0.3175 1
reflector 2 1    5r0 5.08   1
reflector 3 1    4r20 2r0   1
end geom

read array
ara=1 nux=1  nuy=1  nuz=2 fill   1 2                          end fill
ara=2 nux=1  nuy=1  nuz=2 fill   3 4                          end fill
ara=3 nux=14 nuy=14 nuz=1 fill 6 12r5 6 14r5 11q14 6 12r5 6 end fill
ara=4 nux=3  nuy=3  nuz=1 fill 7 8 9 10 11 12 13 14 15        end fill
end array
end data
end
```

<u>bw1484c1</u>

```
=csas25
bw1484c1
44group  latticecell
uo2    1 den=10.22 1.0 293 92235 2.459 92238 97.541        end
al     2 1.0                                               end
h2o    3 1.0                                               end
b4c    4 den=1.28 0.986                                    end
arbmb2o3 1.28 2 1 1 0 5000 2 8016 3 4 0.001                end
end comp
squarepitch  1.636 1.030  1 3 1.206 2 1.044 0             end
9-14x14 assemblies separated by 1.636 cm of water containing 84 B4C
`rods, 145.68 cm water height
read parm   run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  2 1  0.603      .3175     0.0
cuboid    3 1  4p0.818    .3175     0.0
unit 2
cylinder  2 1  0.5565     .3175     0.0
cuboid    3 1 4p0.818     .3175     0.0
unit 3
cuboid    3 1 4p0.818     .3175     0.0
unit 4
cylinder  1 1   0.515      2.54     0.0
cylinder  0 1   0.522      2.54     0.0
cylinder  2 1   0.603      2.54     0.0
cuboid    3 1 4p0.615      2.54     0.0
cuboid    2 1 4p0.818      2.54     0.0
unit 5
cylinder  2 1  0.4675      0.6345   0.0
cylinder  4 1  0.4675      2.54     0.0
cylinder  2 1  0.5565      2.54     0.0
cuboid    3 1 4p0.615      2.54     0.0
cuboid    2 1 4p0.818      2.54     0.0
unit 6
cuboid    3 1 4p0.615      2.54     0.0
cuboid    2 1 4p0.818      2.54     0.0
unit 7
cylinder  1 1   0.515      142.8225 0.0
cylinder  0 1   0.522      142.8225 0.0
cylinder  2 1   0.603      142.8225 0.0
cuboid    3 1 4p0.818      142.8225 0.0
unit 8
cylinder  4 1  0.4675      142.8225 0.0
cylinder  2 1  0.5565      142.8225 0.0
cuboid    3 1 4p0.818      142.8225 0.0
unit 9
cuboid    3 1 4p0.818      142.8225 0.0
unit 11
array 1   3*0.0
unit 12
array 2   3*0.0
unit 13
array 3   3*0.0
unit 14
array 4   3*0.0
unit 15
array 5   3*0.0
unit 16
array 6   3*0.0
unit 17
array 7   3*0.0
unit 18
array  8  3*0.0
unit 19
array  9  3*0.0
unit 20
array 10  3*0.0
unit 21
```

```
array 11  3*0.0
global unit 22
array  12  3*0.0
cuboid 2 1 71.984 0.0 71.984 0.0 145.68 -5.08
cuboid 3 1 71.984 0.0 71.984 0.0 145.68 -7.62
cuboid 2 1 71.984 0.0 71.984 0.0 145.68 -8.89
reflector 3 1 4r3 2r0 8
end geom

read array
ara=1  nux=1  nuy=1  nuz=3  fill 1 4 7       end fill
ara=2  nux=1  nuy=1  nuz=3  fill 2 5 8       end fill
ara=3  nux=1  nuy=1  nuz=3  fill 3 6 9       end fill
ara=4  nux=14 nuy=14 nuz=1  fill f11         end fill
ara=5  nux=1  nuy=14 nuz=1  fill 12 13 6q2  end fill
ara=6  nux=1  nuy=14 nuz=1
fill 13 12 2q2 13 13 12 13 2q2               end fill
ara=7  nux=1  nuy=14 nuz=1  fill 13 12 6q2  end fill
ara=8  nux=5  nuy=1  nuz=1
fill 14 15 14 15 14                          end fill
ara=9  nux=5  nuy=1  nuz=1
fill 14 16 14 16 14                          end fill
ara=10 nux=5  nuy=1  nuz=1
fill 14 17 14 17 14                          end fill
ara=11 nux=44 nuy=1  nuz=1
fill 13 13 12 13q2 12 12 13 6q2              end fill
ara=12 nux=1  nuy=5  nuz=1
fill 18 21 19 21 20                          end fill
end array
end data
end
```

<u>bw1484c2</u>

```
=csas25
bw1484c2
44group  latticecell
uo2     1 den=10.22 1.0 293 92235 2.459 92238 97.541        end
al      2 1.0                                               end
h2o     3 1.0                                               end
b4c     4 den=1.28 0.986                                    end
arbmb2o3 1.28 2 1 1 0 5000 2 8016 3 4 0.001                 end
end comp
squarepitch  1.636 1.030  1 3 1.206 2 1.044 0               end
9-14x14 assemblies separated by 4.908 cm of water containing 34 B4C
`rods, 111.49 cm water height
read parm   run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  2 1   0.603    .3175          0.0
cuboid    3 1 4p0.818    .3175                0.0
unit 2
cylinder  2 1  0.5565    .3175                0.0
cuboid    3 1 2p2.454   2p.818    0.3175 0.0
unit 3
cuboid    3 1 2p2.454   2p.818    0.3175 0.0
unit 4
cylinder  1 1   0.515     2.54                0.0
cylinder  0 1   0.522     2.54                0.0
cylinder  2 1   0.603     2.54                0.0
cuboid    3 1 4p0.615     2.54                0.0
cuboid    2 1 4p0.818     2.54                0.0
unit 5
cylinder  2 1  0.4675   0.6345                0.0
cylinder  4 1  0.4675     2.54                0.0
cylinder  2 1  0.5565     2.54                0.0
cuboid    3 1 4p0.615     2.54                0.0
cuboid    2 1 2p2.454   2p.818      2.54 0.0
unit 6
cuboid    3 1 4p0.615               2.54 0.0
cuboid    2 1 2p2.454   2p.818      2.54 0.0
unit 7
cylinder  1 1   0.515 108.6325                0.0
cylinder  0 1   0.522 108.6325                0.0
cylinder  2 1   0.603 108.6325                0.0
cuboid    3 1 4p0.818 108.6325                0.0
unit 8
cylinder  4 1  0.4675 108.6325                0.0
cylinder  2 1  0.5565 108.6325                0.0
cuboid    3 1 2p2.454   2p.818 108.6325 0.0
unit 9
cuboid    3 1 2p2.454   2p.818 108.6325 0.0
unit 10
cylinder  2 1  0.5565    .3175                0.0
cuboid    3 1 2p0.818  2p2.454    0.3175 0.0
unit 11
cylinder  2 1  0.4675   0.6345                0.0
cylinder  4 1  0.4675     2.54                0.0
cylinder  2 1  0.5565     2.54                0.0
cuboid    3 1 4p0.615     2.54                0.0
cuboid    2 1 2p0.818  2p2.454      2.54 0.0
unit 12
cylinder  4 1  0.4675 108.6325                0.0
cylinder  2 1  0.5565 108.6325                0.0
cuboid    3 1 2p0.818  2p2.454 108.6325 0.0
unit 13
cuboid    3 1 2p0.818  2p2.454    0.3175 0.0
unit 14
cuboid    3 1 4p0.615     2.54                0.0
cuboid    2 1 2p0.818  2p2.454      2.54 0.0
unit 15
```

```
cuboid    3 1 2p0.818  2p2.454 108.6325 0.0
unit 16
array 1   3*0.0
unit 17
array 2   3*0.0
unit 18
array 3   3*0.0
unit 19
array 4   3*0.0
unit 20
array 5   3*0.0
unit 21
array 6   3*0.0
unit 22
array 7   3*0.0
unit 23
array  8  3*0.0
unit 24
array 9   3*0.0
unit 25
array 10  3*0.0
unit 26
array 11  3*0.0
global unit 27
array  12  3*0.0
cuboid 2 1 78.528 0.0 78.528 0.0 111.49 -5.08
cuboid 3 1 78.528 0.0 78.528 0.0 111.49 -7.62
cuboid 2 1 78.528 0.0 78.528 0.0 111.49 -8.89
reflector 3 1 4r3 2r0 8
end geom

read array
ara=1  nux=1  nuy=1  nuz=3  fill 1 4 7    end fill
ara=2  nux=1  nuy=1  nuz=3  fill 2 5 8    end fill
ara=3  nux=1  nuy=1  nuz=3  fill 3 6 9    end fill
ara=4  nux=1  nuy=1  nuz=3  fill 10 11 12 end fill
ara=5  nux=1  nuy=1  nuz=3  fill 13 14 15 end fill
ara=6  nux=14 nuy=14 nuz=1  fill f16      end fill
ara=7  nux=1  nuy=14 nuz=1
fill 2r18 17 4r18 17 3r18 17 2r18         end fill
ara=8  nux=5  nuy=1  nuz=1
fill 21 22 21 22 21                       end fill
ara=9  nux=14 nuy=1  nuz=1
fill 2r20 19 3r20 19 3r20 19 3r20         end fill
ara=10 nux=20 nuy=1  nuz=1
fill 5r20 19 8r20 19 5r20                 end fill
ara=11 nux=3  nuy=1  nuz=1  fill 24 25 24 end fill
ara=12 nux=1  nuy=5  nuz=1
fill 23 26 23 26 23                       end fill
end array
```

```
end data
end
```

<u>bw1484s1</u>

```
#csas25
bw1484s1
44group  latticecell
uo2   1 den=10.22 1.0 293 92235 2.459 92238 97.541         end
al    2 1.0                                                end
h2o   3 1.0                                                end
boron 3 den=514e-6                                         end
c     4 0 2.012-4                                          end
mn    4 0 1.470-3                                          end
si    4 0 1.004-3                                          end
cr    4 0 1.677-2                                          end
ni    4 0 6.600-3                                          end
fe    4 0 6.184-2                                          end
end comp
squarepitch  1.636 1.030  1 3 1.206 2 1.044 0              end
9-14x14 assemblies separated by 0.645-cm-thick 304-L stainless steel
'plates and 0.991 cm of water, plates-to-center assembly distance of
'0.4525 cm, 149.90 cm water height with 514 ppm boron
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 1 1   0.515      0.635    0.0
cylinder 0 1   0.522      0.635    0.0
cuboid   2 1 4p0.818      0.635    0.0
unit 2
cylinder 1 1   0.515      147.0425 0.0
cylinder 0 1   0.522      147.0425 0.0
cylinder 2 1   0.603      147.0425 0.0
cuboid   3 1 4p0.818      147.0425 0.0
unit 3
cuboid   2 1 4p0.818      0.635    0.0
unit 4
cylinder 2 1   0.635      147.0425 0.0
cuboid   3 1 4p0.818      147.0425 0.0
unit 5
array 1 3*0.0
unit 6
array 2 3*0.0
unit 7
array 3   2r-22.904  0.0
reflector 3 1 0.7215 9.808 .7215 9.808       2r0  1
reflector 4 1 0.231 0. 0.231                 3r0  1
unit 8
array 3   2r-22.904  0.0
```

```
reflector 3 1 2r0.4525 0.7215 9.808         2r0  1
reflector 4 1 3r0.231                       3r0  1
unit 9
array 3   2r-22.904  0.0
reflector 3 1 9.808 0.7215 0.7215 9.808     2r0  1
reflector 4 1 0. 2r0.231                    3r0  1
unit 10
array 3   2r-22.904  0.0
reflector 3 1 0.7215 9.808 2r0.4525         2r0  1
reflector 4 1 0.231 0. 2r0.231              2r0  1
unit 11
array 3   2r-22.904  0.0
reflector 3 1 4r0.4525                      2r0  1
reflector 4 1 4r0.231                       2r0  1
unit 12
array 3   2r-22.904  0.0
reflector 3 1 9.808 0.7215 2r0.4525         2r0  1
reflector 4 1 0. 3r0.231                    2r0  1
unit 13
array 3   2r-22.904  0.0
reflector 3 1 0.7215 9.808 9.808 0.7215     2r0  1
reflector 4 1 0.231 2r0. 0.231              2r0  1
unit 14
array 3   2r-22.904  0.0
reflector 3 1 2r0.4525 9.808 0.7215         2r0  1
reflector 4 1 2r0.231 0. 0.231              2r0  1
unit 15
array 3   2r-22.904  0.0
reflector 3 1 9.808 0.7215 9.808 0.7215     2r0  1
reflector 4 1 0. 0.231 0. 0.231             2r0  1
global unit 16
array  4   2*-45.808 0.0
reflector 2 1 5r0 1.905  1
reflector 2 1 5r0 2.54   1
reflector 3 1 5r0 0.3175 1
reflector 2 1 5r0 5.08   1
reflector 3 1 4r20 2r0   1
end geom

read array
ara=1 nux=1  nuy=1  nuz=2 fill 1 2                           end fill
ara=2 nux=1  nuy=1  nuz=2 fill 3 4                           end fill
ara=3 nux=14 nuy=14 nuz=1 fill 6 12r5 6 14r5 11q14 6 12r5 6 end fill
ara=4 nux=3  nuy=3  nuz=1 fill 7 8 9 10 11 12 13 14 15       end fill
end array
end data
end
```

<u>bw1484s2</u>

```
#csas25
bw1484s2
44group  latticecell
uo2   1 den=10.22 1.0 293 92235 2.459 92238 97.541         end
al    2 1.0                                                end
h2o   3 1.0                                                end
boron 3 den=432e-6                                         end
c     4 0 2.012-4                                          end
mn    4 0 1.470-3                                          end
si    4 0 1.004-3                                          end
cr    4 0 1.677-2                                          end
ni    4 0 6.600-3                                          end
fe    4 0 6.184-2                                          end
end comp
squarepitch  1.636 1.030  1 3 1.206 2 1.044 0              end
9-14x14 assemblies separated by 0.645-cm-thick 304-L stainless steel
'plates and 0.991 cm of water, plates-to-center assembly distance of
'0.4525 cm, 100.89 cm water height with 432 ppm boron
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 1 1   0.515      0.635   0.0
cylinder 0 1   0.522      0.635   0.0
cuboid   2 1 4p0.818      0.635   0.0
unit 2
cylinder 1 1   0.515      98.0325 0.0
cylinder 0 1   0.522      98.0325 0.0
cylinder 2 1   0.603      98.0325 0.0
cuboid   3 1 4p0.818      98.0325 0.0
unit 3
cuboid   2 1 4p0.818      0.635   0.0
unit 4
cylinder 2 1   0.635      98.0325 0.0
cuboid   3 1 4p0.818      98.0325 0.0
unit 5
array 1 3*0.0
unit 6
array 2 3*0.0
unit 7
array 3   2r-22.904  0.0
reflector 3 1 0.7215 9.808 0.7215 9.808  2r0  1
reflector 4 1 0.231 0. 0.231             3r0  1
unit 8
array 3   2r-22.904  0.0
reflector 3 1 2r0.4525 0.7215 9.808      2r0  1
reflector 4 1 3r0.231                    3r0  1
```

```
unit 9
array 3   2r-22.904  [illegible]
reflector 3 1 9.808 0.[illegible] 0.7215 9.808  2r0  1
reflector 4 1 0. 2r0.231                  3r0  1
unit 10
array 3   2r-22.904  0.0
reflector 3 1 0.7215 9.808 2r0.4525       2r0  1
reflector 4 1 0.231 0. 2r0.231            2r0  1
unit 11
array 3   2r-22.904  0.0
reflector 3 1 4r0.4525                    2r0  1
reflector 4 1 4r0.231                     2r0  1
unit 12
array 3   2r-22.904  0.0
reflector 3 1 9.808 0.7215 2r0.4525       2r0  1
reflector 4 1 0. 3r0.231                  2r0  1
unit 13
array 3   2r-22.904  0.0
reflector 3 1 0.7215 9.808 9.808 0.7215  2r0  1
reflector 4 1 0.231 2r0. 0.231            2r0  1
unit 14
array 3   2r-22.904  0.0
reflector 3 1 2r0.4525 9.808 0.7215       2r0  1
reflector 4 1 2r0.231 0. 0.231            2r0  1
unit 15
array 3   2r-22.904  0.0
reflector 3 1 9.808 [illegible].7215 9.808 0.7215  2r0  1
reflector 4 1 0. [illegible] 0. 0.231            2r0  1
global unit 16
array  4   2*- [illegible] 0.0
reflector 2 1  [illegible] 905   1
reflector 2 [illegible] 2.54    1
reflector 3  [illegible] 0.3175 1
reflector 2  [illegible] 5.08    1
reflector 3 1 [illegible]r20 2r0     1
end geom

read array
ara=1 nux=1  nuy=1  nuz=2 fill 1 2                                end fill
ara=2 nux=1  nuy=1  nuz=2 fill 3 4                                end fill
ara=3 nux=14 nuy=14 nuz=1 fill 6 12r5 6 14r5 11q14 6 12r5 6 end fill
ara=4 nux=3  nuy=3  nuz=1 fill 7 8 9 10 11 12 13 14 15          end fill
end array
end data
end
```

bw1484sl

```
#csas25
bw1484sl
44group  latticecell
```

```
uo2   1 den=10.22 1.0 293 92235 2.459 92238 97.541          end
al    2 1.0                                                  end
h2o   3 1.0                                                  end
end comp
squarepitch  1.636 1.030  1 3 1.206 2 1.044 0               end
9-14x14 assemblies separated by 6.544 cm of water, 129.65 cm water
'height
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  2 1   0.603       .3175 0.0
cuboid    3 1 4p0.818      .3175 0.0
unit 2
cylinder  1 1   0.515        2.54 0.0
cylinder  0 1   0.522        2.54 0.0
cylinder  2 1   0.603        2.54 0.0
cuboid    3 1 4p0.615        2.54 0.0
cuboid    2 1 4p0.818        2.54 0.0
unit 3
cylinder  1 1   0.515    126.7925 0.0
cylinder  0 1   0.522    126.7925 0.0
cylinder  2 1   0.603    126.7925 0.0
cuboid    3 1 4p0.818    126.7925 0.0
unit 4
array 1   3*0.0
reflector 3 1 4r3.272 2r0 1
global unit 5
array  2  3*0.0
reflector 2 1 5r0.0 5.08 1
reflector 3 1 5r0.0 2.54 1
reflector 2 1 5r0.0 1.27 1
reflector 3 1 4r24. 2r0. 1
end geom

read array
ara=1 nux=14 nuy=14 nuz=3 fill 196r1 196r2 196r3 end fill
ara=2 nux=3  nuy=3  nuz=1 fill f4               end fill
end array
end data
end
```

bw1645s1

```
#csas25
bw1645s1
44group                latticecell
uo2        1  0.9325 293 92235 2.459 92238 97.541        end
al         2  1.0 293                                    end
h2o        3  1.0 293                                    end
boron      3  den=746.0-6                                end
```

```
al           4  .25 293                                     end
h2o          4  .75 293                                     end
boron        4  den=746.0-6 .75                             end
carbonsteel 5  1.0 293                                      end
end comp
squarepitch 1.2090 1.0300 1  3  1.2060 2  1.0440 0          end
9-15x15 assemblies separated by 0.0762-cm-thick aluminum plates and
`1.6256 cm of water, 100.24 cm water height with 746 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes  end parm

read geom
unit  1
cylinder   2 1  0.6030                100.24 -.318
cuboid     3 1 4p.6045                100.24 -.318
unit  2
cylinder   1 1  0.5150                100.24   0.0
cylinder   0 1  0.5220                100.24   0.0
cylinder   2 1  0.6030                100.24 -.318
cuboid     3 1 4p.6045                100.24 -.318
unit  3
array      1 -9.0675 -9.0675 -0.318
cuboid     3 1 2p9.955 2p9.0675       100.24 -.318
unit  4
cuboid     3 1 2p9.955 2p0.8875       100.24 -.318
unit  5
cuboid     3 1  2p7.62 2p0.8113       100.24 -.318
cuboid     2 1  2p7.62 2p0.8875       100.24 -.318
cuboid     3 1 2p9.955 2p0.8875       100.24 -.318
global unit  6
array      2 -49.775  -48.8875  -.318
reflector  4 1 5r0          1.067  1
reflector  2 1 5r0          1.815  1
reflector  3 1 10 10 10 10 0  0  1
reflector  2 1 4r0      0     8.9  1
reflector  3 1 4r0      0    2.86  1
reflector  5 1 4r0      0     1.0  1
reflector  3 1 4r20     0       0  1
end geom

read array
ara=1 nux=15 nuy=15 nuz=1
fill 1 13r2 1 15r2 12q15 1 13r2 1                    end fill
ara=2 nux=5  nuy=9  nuz=1 fill 5r3 4 3r5 4 3q10 5r3 end fill
end array
end data
end
```

<u>bw1645s2</u>

```
#csas25
 1645s2
44group                    latticecell
uo2          1  0.9325 293 92235 2.459 92238 97.541         end
al           2  1.0 293                                     end
h2o          3  1.0 293                                     end
boron        3  den=886.0-6                                 end
al           4  .25 293                                     end
h2o          4  .75 293                                     end
boron        4  den=886.0-6 .75                             end
carbonsteel 5  1.0 293                                      end
end comp
squarepitch 1.2090 1.0300 1  3  1.2060 2  1.0440 0          end
9-15x15 assemblies separated by 0.0762-cm-thick aluminum plates and
`1.6256 cm of water, 145.00 cm water height with 886 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes
end parm

read geom
unit  1
cylinder   2 1  0.6030               145.0  -.318
cuboid     3 1 4p.6045               145.0  -.318
unit  2
cylinder   1 1  0.5150               145.0    0.0
cylinder   0 1  0.5220               145.0    0.0
cylinder   2 1  0.6030               145.0  -.318
cuboid     3 1 4p.6045               145.0  -.318
unit  3
array      1 -9.0675 -9.0675 -0.318
cuboid     3 1 2p9.955 2p9.0675      145.0  -.318
unit  4
cuboid     3 1 2p9.955 2p0.8875      145.0  -.318
unit  5
cuboid     3 1  2p7.62 2p0.8113      145.0  -.318
cuboid     2 1  2p7.62 2p0.8875      145.0  -.318
cuboid     3 1 2p9.955 2p0.8875      145.0  -.318
global unit  6
array      2 -49.775  -48.8875  -.318
reflector  4 1 5r0          1.067  1
reflector  2 1 5r0          1.815  1
reflector  3 1 10 10 10 10 0  0  1
reflector  2 1 4r0      0     8.9  1
reflector  3 1 4r0      0    2.86  1
reflector  5 1 4r0      0     1.0  1
reflector  3 1 4r20     0       0  1
end geom

read array
ara=1 nux=15 nuy=15 nuz=1
fill 1 13r2 1 15r2 12q15 1 13r2 1 end fill
ara=2 nux=5  nuy=9  nuz=1
fill 5r3 4 3r5 4 3q10 5r3          end fill
```

```
end array
end data
end
```

bw1645t1

```
#csas25
bw1645t1
44group                  latticecell
uo2          1  den=10.22 1.0 293 92235 2.459 92238 97.541        end
al           2  1.0 293                                           end
h2o          3  1.0 293                                           end
boron        3  den=335.0-6                                       end
al           4  .25 293                                           end
h2o          4  .75 293                                           end
boron        4  den=335.0-6 .75                                   end
carbonsteel 5  1.0 293                                            end
end comp
triangpitch 1.2093 1.030  1  3  1.206  2  1.044  0                end
5x5 array of hexagonal lattice assemblies separated by 0.0762-cm-thick
'aluminum plates and 1.6256- and 1.7926-cm of water, 104.82 cm water
'height with 335 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes end parm

read geom
unit  1
zhemicyl-y 1 1    0.515                  104.82   0.0
zhemicyl-y 0 1    0.522                  104.82   0.0
zhemicyl-y 2 1    0.603                  104.82  -0.318
unit  2
zhemicyl+y 1 1    0.515                  104.82   0.0
zhemicyl+y 0 1    0.522                  104.82   0.0
zhemicyl+y 2 1    0.603                  104.82  -0.318
unit  3
zhemicyl-x 1 1    0.515                  104.82   0.0
zhemicyl-x 0 1    0.522                  104.82   0.0
zhemicyl-x 2 1    0.603                  104.82  -0.318
unit  4
zhemicyl+x 1 1    0.515                  104.82   0.0
zhemicyl+x 0 1    0.522                  104.82   0.0
zhemicyl+x 2 1    0.603                  104.82  -0.318
unit  5
zhemicyl-y 2 1    0.603                  104.82  -0.318
unit  6
zhemicyl+y 2 1    0.603                  104.82  -0.318
unit  11
zhemicyl-y 1 1    0.515                  104.82   0.0
zhemicyl-y 0 1    0.522                  104.82   0.0
zhemicyl-y 2 1    0.603                  104.82  -0.318
cuboid     3 1 2p0.6047 0 -2.0946        104.82  -0.318
hole       2    0          -2.0946  0
hole       3    +0.6047   -1.0473  0
hole       4    -0.6047   -1.0473  0
unit  12
zhemicyl-y 1 1    0.515                  104.82   0.0
zhemicyl-y 0 1    0.522                  104.82   0.0
zhemicyl-y 2 1    0.603                  104.82  -0.318
cuboid     3 1 2p0.6047 0 -2.0946        104.82  -0.318
hole       2    0          -2.0946  0
hole       3    +0.6047   -1.0473  0
unit  13
zhemicyl-y 1 1    0.515                  104.82   0.0
zhemicyl-y 0 1    0.522                  104.82   0.0
zhemicyl-y 2 1    0.603                  104.82  -0.318
cuboid     3 1 2p0.6047 0 -2.0946        104.82  -0.318
hole       2    0          -2.0946  0
hole       4    -0.6047   -1.0473  0
unit  14
zhemicyl-y 1 1    0.515                  104.82   0.0
zhemicyl-y 0 1    0.522                  104.82   0.0
zhemicyl-y 2 1    0.603                  104.82  -0.318
cuboid     3 1 2p0.6047 0 -2.0946        104.82  -0.318
hole       6    0          -2.0946  0
hole       3    +0.6047   -1.0473  0
unit  15
zhemicyl-y 1 1    0.515                  104.82   0.0
zhemicyl-y 0 1    0.522                  104.82   0.0
zhemicyl-y 2 1    0.603                  104.82  -0.318
cuboid     3 1 2p0.6047 0 -2.0946        104.82  -0.318
hole       6    0          -2.0946  0
hole       4    -0.6047   -1.0473  0
unit  16
zhemicyl-y 2 1    0.603                  104.82  -0.318
cuboid     3 1 2p0.6047 0 -2.0946        104.82  -0.318
hole       2    0          -2.0946  0
hole       3    +0.6047   -1.0473  0
unit  17
zhemicyl-y 2 1    0.603                  104.82  -0.318
cuboid     3 1 2p0.6047 0 -2.0946        104.82  -0.318
hole       2    0          -2.0946  0
hole       4    -0.6047   -1.0473  0
unit  18
zhemicyl-y 1 1    0.515                  104.82   0.0
zhemicyl-y 0 1    0.522                  104.82   0.0
zhemicyl-y 2 1    0.603                  104.82  -0.318
cuboid     3 1 2p0.6047 0 -.6047         104.82  -0.318
unit  19
zhemicyl+y 1 1    0.515                  104.82   0.0
zhemicyl+y 0 1    0.522                  104.82   0.0
zhemicyl+y 2 1    0.603                  104.82  -0.318
cuboid     3 1 2p0.6047 .6047  0         104.82  -0.318
```

```
unit  20
zhemicyl-y 2 1    0.603                  104.82  -0.318
cuboid     3 1 2p0.6047 0 -.6047         104.82  -0.318
unit  21
zhemicyl+y 2 1    0.603                  104.82  -0.318
cuboid     3 1 2p0.6047 .6047  0         104.82  -0.318
unit  31
array      1 -9.0705 -8.9831                     -0.318
cuboid     3 1 2p9.9578 2p8.9831         104.82  -0.318
unit  32
cuboid     3 1 2p9.9578 2p0.9708         104.82  -0.318
unit  33
cuboid     3 1   2p7.62 2p0.8946         104.82  -0.318
cuboid     2 1   2p7.62 2p0.9708         104.82  -0.318
cuboid     3 1 2p9.9578 2p0.9708         104.82  -0.318
global unit  34
array      2 -49.789  -48.7987                   -0.318
reflector  4 1 5r0                1.067  1
reflector  2 1 5r0                1.815  1
reflector  3 1 2r11.2025 2r12.5285 2r0  1
reflector  2 1 4r0      0           8.9  1
reflector  3 1 4r0      0          2.86  1
reflector  5 1 4r0      0           1.0  1
reflector  3 1 2r18.7975 2r17.4715 2r0  1
end geom

read array
ara=; nux=15 nuy=10 nuz=1 fill 20 13r18 20 14 13r11 15 12 13r11 13
5q15 16 13r11 17 21 13r19 21                              end fill
ara=2 nux=5  nuy=9  nuz=1 fill 5r31 32 3r33 32 3q10 5r31  end fill
end array
end data
end
```

bw1645t2

```
#csas25
bw1645t2
44group                 latticecell
uo2            1  den=10.22 1.0 293 92235 2.459 92238 97.541        end
al             2  1.0 293                                           end
h2o            3  1.0 293                                           end
boron          3  den=435.0-6                                       end
al             4  .25 293                                           end
h2o            4  .75 293                                           end
boron          4  den=435.0-6 .75                                   end
carbonsteel    5  1.0 293                                           end
end comp
triangpitch 1.2093 1.030  1  3  1.206  2  1.044  0                  end
5x5 array of hexagonal lattice assemblies separated by 0.0762-cm-thick
'aluminum plates and 1.6256- and 1.7926-cm of water, 143.96 cm water
'height with 435 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes end parm

read geom
unit  1
zhemicyl-y 1 1 .515                    143.96   0.0
zhemicyl-y 0 1 .522                    143.96   0.0
zhemicyl-y 2 1 .603                    143.96  -0.318
unit  2
zhemicyl+y 1 1 .515                    143.96   0.0
zhemicyl+y 0 1 .522                    143.96   0.0
zhemicyl+y 2 1 .603                    143.96  -0.318
unit  3
zhemicyl-x 1 1 .515                    143.96   0.0
zhemicyl-x 0 1 .522                    143.96   0.0
zhemicyl-x 2 1 .603                    143.96  -0.318
unit  4
zhemicyl+x 1 1 .515                    143.96   0.0
zhemicyl+x 0 1 .522                    143.96   0.0
zhemicyl+x 2 1 .603                    143.96  -0.318
unit  5
zhemicyl-y 2 1 .603                    143.96  -0.318
unit  6
zhemicyl+y 2 1 .603                    143.96  -0.318
unit  11
zhemicyl-y 1 1 .515                    143.96   0.0
zhemicyl-y 0 1 .522                    143.96   0.0
zhemicyl-y 2 1 .603                    143.96  -0.318
cuboid     3 1  2p.6047  0 -2.0946 143.96  -0.318
hole       2    0          -2.0946          -0.0
hole       3    +0.6047    -1.0473          -0.0
hole       4    -0.6047    -1.0473          -0.0
unit  12
zhemicyl-y 1 1 .515                    143.96   0.0
zhemicyl-y 0 1 .522                    143.96   0.0
zhemicyl-y 2 1 .603                    143.96  -0.318
cuboid     3 1  2p.6047  0 -2.0946 143.96  -0.318
hole       2    0          -2.0946          -0.0
hole       3    +0.6047    -1.0473          -0.0
unit  13
zhemicyl-y 1 1 .515                    143.96   0.0
zhemicyl-y 0 1 .522                    143.96   0.0
zhemicyl-y 2 1 .603                    143.96  -0.318
cuboid     3 1  2p.6047  0 -2.0946 143.96  -0.318
hole       2    0          -2.0946          -0.0
hole       4    -0.6047    -1.0473          -0.0
unit  14
zhemicyl-y 1 1 .515                    143.96   0.0
zhemicyl-y 0 1 .522                    143.96   0.0
zhemicyl-y 2 1 .603                    143.96  -0.318
cuboid     3 1  2p.6047  0 -2.0946 143.96  -0.318
```

```
hole        6    0            -2.0946           -0.0
hole        3    -0.6047      -1.0473           -0.0
unit  15
zhemicyl-y 1 1 .515                    143.96    0.0
zhemicyl-y 0 1 .522                    143.96    0.0
zhemicyl-y 2 1 .603                    143.96   -0.318
cuboid      3 1  2p.6047  0 -2.0946 143.96   -0.318
hole        6    0            -2.0946           -0.0
hole        4    -0.6047      -1.0473           -0.0
unit  16
zhemicyl-y 2 1 .603                    143.96   -0.318
cuboid      3 1  2p.6047  0 -2.0946 143.96   -0.318
hole        2    0            -2.0946           -0.0
hole        3    +0.6047      -1.0473           -0.0
unit  17
zhemicyl-y 2 1 .603                    143.96   -0.318
cuboid      3 1  2p.6047  0 -2.0946 143.96   -0.318
hole        2    0            -2.0946           -0.0
hole        4    -0.6047      -1.0473           -0.0
unit  18
zhemicyl-y 1 1 .515                    143.96    0.0
zhemicyl-y 0 1 .522                    143.96    0.0
zhemicyl-y 2 1 .603                    143.96   -0.318
cuboid      3 1  2p.6047  0 -.6047  143.96   -0.318
unit  19
zhemicyl+y 1 1 .515                    143.96    0.0
zhemicyl+y 0 1 .522                    143.96    0.0
zhemicyl+y 2 1 .603                    143.96   -0.318
cuboid      3 1  2p.6047  .6047  0  143.96   -0.318
unit  20
zhemicyl-y 2 1 .603                    143.96   -0.318
cuboid      3 1  2p.6047  0 -.6047  143.96   -0.318
unit  21
zhemicyl+y 2 1 .603                    143.96   -0.318
cuboid      3 1  2p.6047  .6047  0  143.96   -0.318
unit  31
array       1    -9.0705 -8.9831                -0.318
cuboid      3 1 2p9.9578  2p8.9831  143.96   -0.318
unit  32
cuboid      3 1 2p9.9578 2p0.9708   143.96   -0.318
unit  33
cuboid      3 1 2p7.62    2p0.8944  143.96   -0.318
cuboid      2 1 2p7.62    2p0.9708  143.96   -0.318
cuboid      3 1 2p9.9578 2p0.9708   143.96   -0.318
global unit  34
array       2    -49.789    -48.7987            -0.318
reflector  4 1 5r0           1.067        1
reflector  2 1 5r0           1.815        1
reflector  3 1 2r11.2025 2r12.5285 2r0 1
reflector  2 1 4r0       0   8.9          1
reflector  3 1 4r0       0   2.86         1
```

```
reflector  5 1 4r0      0   1.0          1
reflector  3 1 2r18.7975 2r17.4715 2r0 1
end geom

read array
ara=1 nux=15 nuy=10 nuz=1 fill 20 13r18 20 14 13r11 15 12 13r11 13
5q15 16 13r11 17 21 13r19 21                                     end fill
ara=2 nux=5  nuy=9  nuz=1 fill 5r31 32 3r33 32 3q10 5r31    end fill
end array
end data
end
```

<u>bw1645t3</u>

```
#csas25
bw1645t3
44group                    latticecell
uo2           1  den=10.22 1.0 293 92235 2.459 92238 97.541        end
al            2  1.0 293                                            end
h2o           3  1.0 293                                            end
boron         3  den=361.0-6                                        end
al            4  .25 293                                            end
h2o           4  .75 293                                            end
boron         4  den=361.0-6 .75                                    end
carbonsteel   5  1.0 293                                            end
end comp
triangpitch 1.2093 1.030  1  3  1.206  2  1.044  0                  end
5x5 array of hexagonal lattice assemblies separated by 0.762-cm-thick
'aluminum plates and 2.3866- and 2.5566-cm of water, 142.54 cm water
'height with 361 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes end parm

read geom
unit  1
zhemicyl-y 1 1 .515                  142.54   0.0
zhemicyl-y 0 1 .522                  142.54   0.0
zhemicyl-y 2 1 .603                  142.54  -0.318
unit  2
zhemicyl+y 1 1 .515                  142.54   0.0
zhemicyl+y 0 1 .522                  142.54   0.0
zhemicyl+y 2 1 .603                  142.54  -0.318
unit  3
zhemicyl-x 1 1 .515                  142.54   0.0
zhemicyl-x 0 1 .522                  142.54   0.0
zhemicyl-x 2 1 .603                  142.54  -0.318
unit  4
zhemicyl+x 1 1 .515                  142.54   0.0
zhemicyl+x 0 1 .522                  142.54   0.0
zhemicyl+x 2 1 .603                  142.54  -0.318
unit  5
zhemicyl-y 2 1 .603                  142.54  -0.318
```

```
unit  6
zhemicyl +y 2 1 .603                142.54  -0.318
unit  11
zhemicyl-y 1 1 .515                 142.54   0.0
zhemicyl-y 0 1 .522                 142.54   0.0
zhemicyl-y 2 1 .603                 142.54  -0.318
cuboid     3 1  2p.6047  0 -2.0946 142.54  -0.318
hole       2    0           -2.0946          -0.0
hole       3    +0.6047     -1.0473          -0.0
hole       4    -0.6047     -1.0473          -0.0
unit  12
zhemicyl-y 1 1 .515                 142.54   0.0
zhemicyl-y 0 1 .522                 142.54   0.0
zhemicyl-y 2 1 .603                 142.54  -0.318
cuboid     3 1  2p.6047  0 -2.0946 142.54  -0.318
hole       2    0           -2.0946          -0.0
hole       3    +0.6047     -1.0473          -0.0
unit  13
zhemicyl-y 1 1 .515                 142.54   0.0
zhemicyl-y 0 1 .522                 142.54   0.0
zhemicyl-y 2 1 .603                 142.54  -0.318
cuboid     3 1  2p.6047  0 -2.0946 142.54  -0.318
hole       2    0           -2.0946          -0.0
hole       4    -0.6047     -1.0473          -0.0
unit  14
zhemicyl-y 1 1 .515                 142.54   0.0
zhemicyl-y 0 1 .522                 142.54   0.0
zhemicyl-y 2 1 .603                 142.54  -0.318
cuboid     3 1  2p.6047  0 -2.0946 142.54  -0.318
hole       6    0           -2.0946          -0.0
hole       3    +0.6047     -1.0473          -0.0
unit  15
zhemicyl-y 1 1 .515                 142.54   0.0
zhemicyl-y 0 1 .522                 142.54   0.0
zhemicyl-y 2 1 .603                 142.54  -0.318
cuboid     3 1  2p.6047  0 -2.0946 142.54  -0.318
hole       6    0           -2.0946          -0.0
hole       4    -0.6047     -1.0473          -0.0
unit  16
zhemicyl-y 2 1 .603                 142.54  -0.318
cuboid     3 1  2p.6047  0 -2.0946 142.54  -0.318
hole       2    0           -2.0946          -0.0
hole       3    +0.6047     -1.0473          -0.0
unit  17
zhemicyl-y 2 1 .603                 142.54  -0.318
cuboid     3 1  2p.6047  0 -2.0946 142.54  -0.318
hole       2    0           -2.0946          -0.0
hole       4    -0.6047     -1.0473          -0.0
unit  18
zhemicyl-y 1 1 .515                 142.54   0.0
zhemicyl-y 0 1 .522                 142.54   0.0
zhemicyl-y 2 1 .603                 142.54  -0.318
cuboid     3 1  2p.6047  0 -.6047  142.54  -0.318
unit  19
zhemicyl+y 1 1 .515                 142.54   0.0
zhemicyl+y 0 1 .522                 142.54   0.0
zhemicyl+y 2 1 .603                 142.54  -0.318
cuboid     3 1  2p.6047  .6047  0  142.54  -0.318
unit  20
zhemicyl-y 2 1 .603                 142.54  -0.318
cuboid     3 1  2p.6047  0 -.6047  142.54  -0.318
unit  21
zhemicyl+y 2 1 .603                 142.54  -0.318
cuboid     3 1  2p.6047 .6047  0   142.54  -0.318
unit  31
array      1    -9.0705 -8.9831             -0.318
cuboid     3 1 2p10.4233 2p8.9831  142.54  -0.318
unit  32
cuboid     3 1 2p10.4233 2p1.3528  142.54  -0.318
unit  33
cuboid     3 1 2p7.62    2p1.2766  142.54  -0.318
cuboid     2 1 2p7.62    2p1.3528  142.54  -0.318
cuboid     3 1 2p10.4233 2p1.3528  142.54  -0.318
global unit  34
array      2    -52.1165 -50.267             -0.318
reflector  4 1 5r0           1.067     1
reflector  2 1 5r0           1.815     1
reflector  3 1 2r9.3 2r11.0065 2r0     1
reflector  2 1 4r0      0    8.9       1
reflector  3 1 4r0      0    2.86      1
reflector  5 1 4r0      0    1.0       1
reflector  3 1 2r20.7 2r18.9935 2r0    1
end geom

read array
ara=1 nux=15 nuy=10 nuz=1 fill 20 13r18 20 14 13r11 15 12 13r11 13
5q15 16 13r11 17 21 13r19 21                                end fill
ara=2 nux=5  nuy=9  nuz=1 fill 5r31 32 3r33 32 3q10 5r31    end fill
end array
end data
end
```

<u>bw1645t4</u>

```
#csas25
bw1645t4
44group                  latticecell
uo2           1  den=10.22 1.0 293 92235 2.459 92238 97.541       end
al            2  1.0 293                                          end
h2o           3  1.0 293                                          end
boron         3  den=121.0-6                                      end
al            4  .25 293                                          end
```

```
h2o           4  .75 293                                         end
boron         4  den=121.0-6 .75                                 end
carbonsteel   5  1.0 293                                         end
end comp
triangpitch 1.2093 1.030  1  3  1.206  2  1.044  0               end
5x5 array of hexagonal lattice assemblies separated by 0.0762-cm-thick
'aluminum plates and 3.6546- and 3.8236-cm of water, 145.64 cm water
:height with 121 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes end parm

read geom
unit  1
zhemicyl-y 1 1 .515                    145.64   0.0
zhemicyl-y 0 1 .522                    145.64   0.0
zhemicyl-y 2 1 .603                    145.64  -0.318
unit  2
zhemicyl+y 1 1 .515                    145.64   0.0
zhemicyl+y 0 1 .522                    145.64   0.0
zhemicyl+y 2 1 .603                    145.64  -0.318
unit  3
zhemicyl-x 1 1 .515                    145.64   0.0
zhemicyl-x 0 1 .522                    145.64   0.0
zhemicyl-x 2 1 .603                    145.64  -0.318
unit  4
zhemicyl+x 1 1 .515                    145.64   0.0
zhemicyl+x 0 1 .522                    145.64   0.0
zhemicyl+x 2 1 .603                    145.64  -0.318
unit  5
zhemicyl-y 2 1 .603                    145.64  -0.318
unit  6
zhemicyl+y 2 1 .603                    145.64  -0.318
unit  11
zhemicyl-y 1 1 .515                    145.64   0.0
zhemicyl-y 0 1 .522                    145.64   0.0
zhemicyl-y 2 1 .603                    145.64  -0.318
cuboid     3 1  2p.6047  0 -2.0946 145.64  -0.318
hole       2    0          -2.0946          -0.0
hole       3    +0.6047    -1.0473          -0.0
hole       4    -0.6047    -1.0473          -0.0
unit  12
zhemicyl-y 1 1 .515                    145.64   0.0
zhemicyl-y 0 1 .522                    145.64   0.0
zhemicyl-y 2 1 .603                    145.64  -0.318
cuboid     3 1  2p.6047  0 -2.0946 145.64  -0.318
hole       2    0          -2.0946          -0.0
hole       3    +0.6047    -1.0473          -0.0
unit  13
zhemicyl-y 1 1 .515                    145.64   0.0
zhemicyl-y 0 1 .522                    145.64   0.0
zhemicyl-y 2 1 .603                    145.64  -0.318
cuboid     3 1  2p.6047  0 -2.0946 145.64  -0.318
hole       2    0          -2.0946          -0.0
hole       4    -0.6047    -1.0473          -0.0
unit  14
zhemicyl-y 1 1 .515                    145.64   0.0
zhemicyl-y 0 1 .522                    145.64   0.0
zhemicyl-y 2 1 .603                    145.64  -0.318
cuboid     3 1  2p.6047  0 -2.0946 145.64  -0.318
hole       6    0          -2.0946          -0.0
hole       3    +0.6047    -1.0473          -0.0
unit  15
zhemicyl-y 1 1 .515                    145.64   0.0
zhemicyl-y 0 1 .522                    145.64   0.0
zhemicyl-y 2 1 .603                    145.64  -0.318
cuboid     3 1  2p.6047  0 -2.0946 145.64  -0.318
hole       6    0          -2.0946          -0.0
hole       4    -0.6047    -1.0473          -0.0
unit  16
zhemicyl-y 2 1 .603                    145.64  -0.318
cuboid     3 1  2p.6047  0 -2.0946 145.64  -0.318
hole       2    0          -2.0946          -0.0
hole       3    +0.6047    -1.0473          -0.0
unit  17
zhemicyl-y 2 1 .603                    145.64  -0.318
cuboid     3 1  2p.6047  0 -2.0946 145.64  -0.318
hole       2    0          -2.0946          -0.0
hole       4    -0.6047    -1.0473          -0.0
unit  18
zhemicyl-y 1 1 .515                    145.64   0.0
zhemicyl-y 0 1 .522                    145.64   0.0
zhemicyl-y 2 1 .603                    145.64  -0.318
cuboid     3 1  2p.6047  0 -.6047  145.64  -0.318
unit  19
zhemicyl+y 1 1 .515                    145.64   0.0
zhemicyl+y 0 1 .522                    145.64   0.0
zhemicyl+y 2 1 .603                    145.64  -0.318
cuboid     3 1  2p.6047  .6047  0  145.64  -0.318
unit  20
zhemicyl-y 2 1 .603                    145.64  -0.318
cuboid     3 1  2p.6047  0 -.6047  145.64  -0.318
unit  21
zhemicyl+y 2 1 .603                    145.64  -0.318
cuboid     3 1  2p.6047  .6047  0  145.64  -0.318
unit  31
array      1    -9.0705 -8.9831                 -0.318
cuboid     3 1 2p11.0568 2p8.9831   145.64   0.318
unit  32
cuboid     3 1 2p11.0568 2p1.963    145.64  -0.318
unit  33
cuboid     3 1 2p7.62    2p1.9101   145.64  -0.318
cuboid     2 1 2p7.62    2p1.963    145.64  -0.318
cuboid     3 1 2p11.0568 2p1.963    145.64  -0.318
```

```
global unit  34
array      2    -55.284  -52.8607            -0.318
reflector  4 1 5r0           1.067      1
reflector  2 1 5r0           1.815      1
reflector  3 1 2r6.125 2r8.4705 2r0     1
reflector  2 1 4r0     0   8.9          1
reflector  3 1 4r0     0   2.86         1
reflector  5 1 4r0     0   1.0          1
reflector  3 1 2r23.875 2r21.5295 2r0 1
end geom

read array
ara=1 nux=15 nuy=10 nuz=1 fill 20 13r18 20 14 13r11 15 12 13r11 13
5q15 16 13r11 17 21 13r19 21                                  end fill
ara=2 nux=5  nuy=9  nuz=1 fill 5r31 32 3r33 32 3q10 5r31      end fill
end array
end data
end
```

bw1810a

```
=csas25
bw1810a
44group                  latticecell
uo2     1 den=10.24  1.0  293 92235 2.459 92238 97.541      end
h2o     2 den=1.0    0.998761                               end
boron   2 den=1.0    0.001239                               end
al      3            1.0                                    end
uo2     4 den=10.24  0.96 293 92235 1.944 92238 98.056      end
gd-152 4 den=0.3555 0.002                                   end
gd-154 4 den=0.3555 0.0218                                  end
gd-155 4 den=0.3555 0.148                                   end
gd-156 4 den=0.3555 0.2047                                  end
gd-157 4 den=0.3555 0.1565                                  end
gd-158 4 den=0.3555 0.2484                                  end
gd-160 4 den=0.3555 0.2186                                  end
o       4 den=0.0541 1                                      end
end comp
squarepitch 1.636 1.0297 1 2 1.2060 3 1.0434 0              end
more data res=4 cylinder .51499 dan(4)=.189958 end more data
Core of 4788 2.459 wt% 235U UO2 fuel rods, 20 UO2-Gd2O3 fuel rods, 153
`water holes, 145.0 cm water height with 1239.3 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes  end parm

read geom
unit  2
cylinder    1 1 .5149   145 .3175
cylinder    0 1 .522    145 .3175
cylinder    3 1 .603    145  0
cuboid      2 1 .818 -.818 .818 -.818 145 0
unit  3
cuboid      2 1 .818 -.818 .818 -.818 145 0
unit  4
array 2  -49.898    -6.544    0
unit  5
array 3  -33.538    -8.180    0
unit  6
array 4  -33.538    -8.180    0
global unit 7
array  1  -66.258 -36.81      0
cylinder  2 1 76.2     145     0.0
hole  4    0     -43.3542     0
hole  4    0      43.3542     0
hole  5    0     -58.0784     0
hole  6    0      58.0784     0
cylinder  3 1 76.2     145    -5.08
cylinder  2 1 76.2     145    -7.62
cylinder  3 1 77.47    145    -8.890
cuboid    0 1 4p77.47 145     -8.890
unit  8
cylinder   4 1 .51499 145     0.3175
cylinder   0 1 .52197 145     0.3175
cylinder   3 1 .60325 145     0
cuboid     2 1 .818 -.818 .818 -.818 145 0
end geom

read array
ara=1 nux=81 nuy=45 fill
10r3 61r2 10r3
1q81
5r3 15r2 3r2 3 1q4 10r2 3 3r2 3b39
5r3 16r2 3 7r2 3 6r2 3 7r2 7b37
5r3 71r2 5r3
5r3 15r2 3 2r2 3 3r2 3 2r2 3 4r2 3 2r2 3 3r2 3b39
5r3 71r2 5r3
5r3 20r2 3 3r2 8 10r2 3 1b40
5r3 71r2 5r3
5r3 15r2 3 2r2 3 3r2 3 2r2 3 4r2 3 2r2 3 3r2 3b39
5r3 71r2 5r3
5r3 16r2 3 3r2 8 3r2 3 6r2 3 7r2 7b37
23r2 3 3r2 3 2r2 8 7r2 3 3r2 3b39
324r2
20r2 3r2 3 1q4 7r2 8 2r2 3 3r2 3b39
21r2 3 7r2 3 6r2 3 3r2 8 1b40
81r2
20r2 3 2r2 3 3r2 3 2r2 3 4r2 3 2r2 3 3r2 3b39
81r2
25r2 3 10r2 8 3r2 3 1b40
81b1782                                                  end fill
ara=2 nux=61 nuy=8 fill f2                               end fill
ara=3 nux=41 nuy=10  loop
2   1 41  1    1 10  1    1 1 1
```

```
3   1 10  1   1  5  1   1 1 1
3  32 41  1   1  5  1   1 1 1   end loop
ara=4 nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   6 10  1   1 1 1
3  32 41  1   6 10  1   1 1 1   end loop
end array
end data
end
```

<u>bw1810b</u>

```
=csas25
bw1810b
44group                  latticecell
uo2     1 den=10.24  1.0  293 92235 2.459 92238 97.541      end
h2o     2 den=1.0    0.998829                               end
boron   2 den=1.0    0.001171                               end
al      3            1.0                                    end
uo2     4 den=10.24  0.96 293 92235 1.944 92238 98.056      end
gd-152  4 den=0.3555 0.002                                  end
gd-154  4 den=0.3555 0.0218                                 end
gd-155  4 den=0.3555 0.148                                  end
gd-156  4 den=0.3555 0.2047                                 end
gd-157  4 den=0.3555 0.1565                                 end
gd-158  4 den=0.3555 0.2484                                 end
gd-160  4 den=0.3555 0.2186                                 end
o       4 den=0.0541 1                                      end
end comp
squarepitch 1.636 1.0297 1 2 1.2060 3 1.0434 0              end
more data res=4 cylinder .51499 dan(4)=.189958 end more data
Core of 4772 2.459 wt% 235U UO2 fuel rods, 36 UO2-Gd2O3 fuel rods, 153
 water holes, 145.0 cm water height with 1170.7 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes  end parm

read geom
unit  2
cylinder    1 1 .5149                        145  0.3175
cylinder    0 1 .522                         145  0.3175
cylinder    3 1 .603                         145  0
cuboid      2 1 .818 -.818 .818 -.818        145  0
unit  3
cuboid      2 1 .818 -.818 .818 -.818        145  0
unit  4
array 2  -49.898   -6.544    0
unit  5
array 3  -33.538   -8.180    0
unit  6
array 4  -33.538   -8.180    0
global unit 7
array  1  -66.258 -36.81     0
cylinder  2 1 76.2                           145  0.0
hole  4    0    -43.3542    0
hole  4    0     43.3542    0
hole  5    0    -58.0784    0
hole  6    0     58.0784    0
cylinder  3 1 76.2                           145 -5.08
cylinder  2 1 76.2                           145 -7.62
cylinder  3 1 77.47                          145 -8.890
cuboid    0 1 4p77.47                        145 -8.890
unit  8
cylinder   4 1 .51499                        145  0.3175
cylinder   0 1 .52197                        145  0.3175
cylinder   3 1 .60325                        145  0
cuboid     2 1 .818 -.818 .818 -.818         145  0
end geom

read array
ara=1 nux=81 nuy=45 fill
10r3 61r2 10r3
1q81
5r3 15r2 3r2 3 1q4 10r2 3 3r2 3b39
5r3 16r2 3 7r2 3 6r2 3 7r2 7b37
5r3 71r2 5r3
5r3 15r2 3 2r2 3 3r2 3 2r2 3 4r2 3 2r2 3 3r2 3b39
5r3 71r2 5r3
5r3 20r2 3 3r2 8 10r2 3 1b40
5r3 71r2 5r3
5r3 15r2 3 2r2 3 3r2 3 2r2 3 8 3r2 3 2r2 3 3r2 3b39
5r3 20r2 8 29r2 8 20r2 5r3
5r3 16r2 3 7r2 3 6r2 3 7r2 7b37
23r2 3 3r2 3 2r2 8 7r2 3 3r2 3b39
27r2 8 25r2 8 27r2
162r2
38r2 8 3r2 8 38r2
20r2 3r2 3 1q4 7r2 8 2r2 3 3r2 3b39
21r2 3 7r2 3 6r2 3 7r2 7b37
40r2 8 40r2
20r2 3 2r2 3 3r2 3 2r2 3 3r2 8 3 2r2 3 3r2 3b39
81r2
25r2 3 10r2 8 3r2 3 1b40
81b1782
end fill
ara=2 nux=61 nuy=8 fill f2 end fill
ara=3 nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   1  5  1   1 1 1
3  32 41  1   1  5  1   1 1 1   end loop
ara=4 nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   6 10  1   1 1 1
3  32 41  1   6 10  1   1 1 1   end loop
```

```
end array
end data
end
```

bw1810c

```
=csas25
bw1810c
44group                  latticecell
uo2    1 den=9.46   1.0  293 92235 4.02  92238 95.98        end
ss304  2            1.0                                     end
h2o    3 den=1.0    0.998501                                end
boron  3 den=1.0    0.001499                                end
uo2    4 den=10.24  1.0  293 92235 2.459 92238 97.541       end
al     5            1.0                                     end
uo2    6 den=10.24  0.96 293 92235 1.944 92238 98.056       end
gd-152 6 den=0.3555 0.002                                   end
gd-154 6 den=0.3555 0.0218                                  end
gd-155 6 den=0.3555 0.148                                   end
gd-156 6 den=0.3555 0.2047                                  end
gd-157 6 den=0.3555 0.1565                                  end
gd-158 6 den=0.3555 0.2484                                  end
gd-160 6 den=0.3555 0.2186                                  end
o      6 den=0.0541 1                                       end
end comp
squarepitch 1.636  1.128  1  3  1.208  2                    end
more data  res=4 cylinder .51486 dan(4)=.189732
res=6 cylinder .51499 dan(6)=.189958  end more data
Core of 3676 2.459 wt% UO2 fuel rods, 912 4.020 wt% UO2 fuel rods, 32
`UO2-Gd2O3 fuel rods, 180 water holes, 145.0 cm water height with
`1499.0 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes  end parm

read geom
unit  1
cylinder   1 1 .5639  145 5.969
cylinder   2 1 .6039  145 0
cuboid     3 1 .818 -.818 .818 -.818 145 0
unit  2
cylinder   4 1 .5149  145 .3175
cylinder   0 1 .5217  145 .3175
cylinder   5 1 .603   145  0
cuboid     3 1 .818 -.818 .818 -.818 145 0
unit  3
cuboid     3 1 .818 -.818 .818 -.818 145 0
unit  4
array 2  -49.898  -6.544   0
unit  5
array 3  -33.538  -8.180   0
unit  6
array 4  -33.538  -8.180   0
global unit 7
array  1 -66.258 -36.81     0
cylinder  3 1 76.2    145  0.0
hole  4    0   -43.3542    0
hole  4    0    43.3542    0
hole  5    0   -58.0784    0
hole  6    0    58.0784    0
cylinder  5 1 76.2     145  -5.08
cylinder  3 1 76.2     145  -7.62
cylinder  5 1 77.47    145  -8.890
cuboid    0 1 4p77.47 145  -8.890
unit  8
cylinder   6 1 .51499 145 .3175
cylinder   0 1 .52197 145 .3175
cylinder   5 1 .60325 145 0
cuboid     3 1     .818 -.818 .818 -.818 145 0
end geom

read array
ara=1 nux=81 nuy=45 fill
10r3 61r2 10r3
10r3 3r2 6r2 2r3 2q8 7r2 7b37
5r3 5r2 3r2 6r2 2r3 2q8 7r2 7b37
5r3 71r2 5r3
1q81
5r3 18r2 2r3 14r2 3r3 3b39
5r3 18r2 2r3 14r1 3r3 3b39
5r3 19r2 33r1 19r2 5r3
5r3 19r2 2r1 8 3r1 8 19r1 19b31
5r3 14r2 2r3 3r2 3r1 2r3 6r1 2r3 7r1 7b37
1q81
5r3 19r2 33r1 19r2 5r3
24r2 2r1 8 3r1 8 19r1 19b31
24r2 33r1 24r2
1q81
24r2 9r1 8 3r1 8 5r1 5b38
24r2 33r1 24r2
19r2 2r3 3r2 3r1 2r3 6r1 2r3 7r1 7b37
1q81
24r2 9r1 8 3r1 8 5r1 5b38
24r2 33r1 24r2
23r2 2r3 14r1 3r3 3b39
1q81
81b1782
end fill
ara=2 nux=61 nuy=8 fill f2  end fill
ara=3 nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   1  5  1   1 1 1
3  32 41  1   1  5  1   1 1 1   end loop
ara=4 nux=41 nuy=10  loop
```

```
2   1 41  1   1 10  1   1 1 1
3   1 10  1   6 10  1   1 1 1
3  32 41  1   6 10  1   1 1 1 hend loop
end array
end data
end
```

bw1810d

```
=csas25
bw1810d
44group                     latticecell
uo2     1 den=9.46    1.0  293 92235 4.02  92238 95.98        end
ss304  2              1.0                                     end
h2o     3 den=1.0     0.998346                                end
boron  3 den=1.0      0.001654                                end
uo2     4 den=10.24   1.0  293 92235 2.459 92238 97.541       end
al      5             1.0                                     end
uo2     6 den=10.24   0.96 293 92235 1.944 92238 98.056       end
gd-152 6 den=0.3555 0.002                                     end
gd-154 6 den=0.3555 0.0218                                    end
gd-155 6 den=0.3555 0.148                                     end
gd-156 6 den=0.3555 0.2047                                    end
gd-157 6 den=0.3555 0.1565                                    end
gd-158 6 den=0.3555 0.2484                                    end
gd-160 6 den=0.3555 0.2186                                    end
o       6 den=0.0541 1                                        end
end comp
squarepitch 1.636  1.128  1  3  1.208  2                      end
more data  res=4 cylinder .51486 dan(4)=.189732
res=6 cylinder .51499 dan(6)=.189958  end more data
Core of 3920 2.459 wt% 235U UO2 fuel rods, 860 4.020 wt% 235U UO2 fuel
rods, 28 UO2-Gd2O3 fuel rods, 153 water holes, 145.0 cm water height
with 1653.8 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes  end parm

read geom
unit  1
cylinder   1 1 .5639 145 5.969
cylinder   2 1 .6039 145 0
cuboid     3 1 .818 -.818 .818 -.818 145 0
unit  2
cylinder   4 1 .5149 145 .3175
cylinder   0 1 .5217 145 .3175
cylinder   5 1 .603  145  0
cuboid     3 1 .818 -.818 .818 -.818 145 0
unit  3
cuboid     3 1 .818 -.818 .818 -.818 145 0
unit  4
array 2  -49.898  -6.544   0
unit  5
array 3  -33.538  -8.180   0
unit  6
array 4  -33.538  -8.180   0
global unit 7
array  1 -66.258 -36.81    0
cylinder  3 1 76.2   145    0.0
hole  4     0   -43.3542    0
hole  4     0    43.3542    0
hole  5     0   -58.0784    0
hole  6     0          58.0784      0
cylinder  5 1 76.2                       145  -5.08
cylinder  3 1 76.2                       145  -7.62
cylinder  5 1 77.47                      145  -8.890
cuboid    0 1 4p77.47                    145  -8.890
unit  8
cylinder   6 1 .51499                    145   0.3175
cylinder   0 1 .52197                    145   0.3175
cylinder   5 1 .60325                    145   0
cuboid     3 1 .818 -.818 .818 -.818 145 0
end geom

read array
ara=1 nux=81 nuy=45 loop
2   1 81  1   1 45  1   1 1 1
1  26 56  1   8 38  1   1 1 1
3  24 54 15   3 33 15   1 1 1
3  28 58 15   3 33 15   1 1 1
3  24 54 15  13 43 15   1 1 1
3  28 58 15  13 43 15   1 1 1
3  22 52 15   4 34 15   1 1 1
3  30 60 15   4 34 15   1 1 1
3  22 52 15  12 42 15   1 1 1
3  30 60 15  12 42 15   1 1 1
3  21 51 15   6 36 15   1 1 1
3  24 54 15   6 36 15   1 1 1
3  28 58 15   6 36 15   1 1 1
3  31 61 15   6 36 15   1 1 1
3  21 51 15  10 40 15   1 1 1
3  24 54 15  10 40 15   1 1 1
3  28 58 15  10 40 15   1 1 1
3  31 61 15  10 40 15   1 1 1
3  26 56 15   8 38 15   1 1 1
3   1 10  1   1  2  1   1 1 1
3  72 81  1   1  2  1   1 1 1
3   1  5  1   3 12  1   1 1 1
3  77 81  1   3 12  1   1 1 1
3   1 10  1  44 45  1   1 1 1
3  72 81  1  44 45  1   1 1 1
3   1  5  1  34 43  1   1 1 1
3  77 81  1  34 43  1   1 1 1
8  29 53 24   8 38 30   1 1 1
```

```
8  26 56 30   11 35 24   1 1 1
8  29 53 24   11 35 24   1 1 1
8  31 51 20   13 33 20   1 1 1
8  36 46 10   18 28 10   1 1 1
8  38 44  6   20 26  6   1 1 1
8  38 44  6   23 23  1   1 1 1
8  41 41  1   20 26  6   1 1 1
  end loop
ara=2 nux=61 nuy=8 fill f2 end fill
ara=3 nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   1  5  1   1 1 1
3  32 41  1   1  5  1   1 1 1   end loop
ara=4 nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   6 10  1   1 1 1
3  32 41  1   6 10  1   1 1 1   end loop
end array
end data
end
```

bw1810e

```
=csas25
bw1810e
44group                    latticecell
uo2    1 den=9.46    1.0  293 92235 4.02   92238 95.98       end
ss304  2             1.0                                      end
h2o    3 den=1.0     0.998421                                 end
boron  3 den=1.0     0.001579                                 end
uo2    4 den=10.24   1.0  293 92235 2.459 92238 97.541       end
al     5             1.0                                      end
uo2    6 den=10.24   0.96 293 92235 1.944 92238 98.056       end
gd-152 6 den=0.3555 0.002                                     end
gd-154 6 den=0.3555 0.0218                                    end
gd-155 6 den=0.3555 0.148                                     end
gd-156 6 den=0.3555 0.2047                                    end
gd-157 6 den=0.3555 0.1565                                    end
gd-158 6 den=0.3555 0.2484                                    end
gd-160 6 den=0.3555 0.2186                                    end
o      6 den=0.0541 1                                         end
end comp
squarepitch 1.636  1.128  1  3  1.208  2                      end
more data res=4 cylinder .51486 dan(4)=.189732
res=6 cylinder .51499 dan(6)=.189958 end more data
Core of 3676 2.459 wt% 235U UO2 fuel rods, 852 4.020 wt% 235U UO2 fuel
`rods, 36 UO2-Gd2O3 fuel rods, 153 water holes, 145.0 cm water height
`with 1579.4 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes  end parm

read geom
unit  1
cylinder   1 1 .5639 145 5.969
cylinder   2 1 .6039 145 0
cuboid     3 1      .818 -.818 .818 -.818  145 0
unit  2
cylinder   4 1 .5149  145 .3175
cylinder   0 1 .5217  145 .3175
cylinder   5 1 .603   145  0
cuboid     3 1 .818 -.818 .818 -.818      145 0
unit  3
cuboid     3 1 .818 -.818 .818 -.818      145 0
unit  4
array 2  -49.898  -6.544    0
unit  5
array 3  -33.538  -8.180    0
unit  6
array 4  -33.538  -8.180    0
global unit 7
array  1 -66.258 -36.81     0
cylinder  3 1 76.2                         145 0.0
hole  4     0   -43.3542    0
hole  4     0    43.3542    0
hole  5     0   -58.0784    0
hole  6     0    58.0784    0
cylinder  5 1 76.2                         145 -5.08
cylinder  3 1 76.2                         145 -7.62
cylinder  5 1 77.47                        145 -8.890
cuboid    0 1 4p77.47                      145 -8.890
unit  8
cylinder   6 1 .51499                      145  0.3175
cylinder   0 1 .52197                      145  0.3175
cylinder   5 1 .60325                      145  0
cuboid     3 1 .818 -.818 .818 -.818       145  0
end geom

read array
ara=1 nux=81 nuy=45 loop
2   1 81  1    1 45  1   1 1 1
1  26 56  1    8 38  1   1 1 1
3  24 54 15    3 33 15   1 1 1
3  28 58 15    3 33 15   1 1 1
3  24 54 15   13 43 15   1 1 1
3  28 58 15   13 43 15   1 1 1
3  22 52 15    4 34 15   1 1 1
3  30 60 15    4 34 15   1 1 1
3  22 52 15   12 42 15   1 1 1
3  30 60 15   12 42 15   1 1 1
3  21 51 15    6 36 15   1 1 1
3  24 54 15    6 36 15   1 1 1
3  28 58 15    6 36 15   1 1 1
3  31 61 15    6 36 15   1 1 1
```

```
3  21 51 15  10 40 15  1 1 1
3  24 54 15  10 40 15  1 1 1
3  28 58 15  10 40 15  1 1 1
3  31 61 15  10 40 15  1 1 1
3  26 56 15   8 38 15  1 1 1
3   1 10  1   1  2  1  1 1 1
3  72 81  1   1  2  1  1 1 1
3   1  5  1   3 12  1  1 1 1
3  77 81  1   3 12  1  1 1 1
3   1 10  1  44 45  1  1 1 1
3  72 81  1  44 45  1  1 1 1
3   1  5  1  34 43  1  1 1 1
3  77 81  1  34 43  1  1 1 1
8  29 53 24   8 38 30  1 1 1
8  26 56 30  11 35 24  1 1 1
8  28 54 26  14 32 18  1 1 1
8  32 50 18  10 36 26  1 1 1
8  31 51 20  13 33 20  1 1 1
8  36 46 10  18 28 10  1 1 1
8  35 47 12  21 25  4  1 1 1
8  39 43  4  17 29 12  1 1 1
8  38 44  6  23 23  1  1 1 1
8  41 41  1  20 26  6  1 1 1
  end loop
ara=2 nux=61 nuy=8 fill f2  end fill
ara=3 nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   1  5  1   1 1 1
3  32 41  1   1  5  1   1 1 1   end loop
ara=4 nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   6 10  1   1 1 1
3  32 41  1   6 10  1   1 1 1   end loop
end array
end data
end
```

bw1810f

```
=csas25
bw1810f
44group                    latticecell
uo2    1 den=10.24  1.0 293 92235 2.459 92238 97.541       end
al     2            1.0                                    end
h2o    3 den=1.0    0.998663                               end
boron  3 den=1.0    0.001337                               end
end comp
squarepitch 1.636  1.125  1  3  1.206  2                   end
Core of 4808 2.459 wt% 235U UO2 fuel rods, 153 water holes, 145.0 cm
`water height with 1337.9 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes  end parm
read geom
unit  2
cylinder   1 1 .5149  145 .3175
cylinder   0 1 .5217  145 .3175
cylinder   2 1 .603   145  0
cuboid     3 1 .818 -.818 .818 -.818 145 0
unit  3
cuboid     3 1 .818 -.818 .818 -.818 145 0
unit  4
array 2  -49.898  -6.544    0
unit 5
array 3  -33.538  -8.180    0
unit 6
array 4  -33.538  -8.180    0
global unit 7
array  1 -66.258 -36.81     0
cylinder  3 1 76.2    145   0.0
hole  4    0     -43.3542   0
hole  4    0      43.3542   0
hole  5    0     -58.0784   0
hole  6    0      58.0784   0
cylinder  2 1 76.2     145  -5.08
cylinder  3 1 76.2     145  -7.62
cylinder  2 1 77.47    145  -8.890
cuboid    0 1 4p77.47 145  -8.890
end geom

read array
ara=1 nux=81 nuy=45 fill
10r3 61r2 10r3
1q81
5r3 15r2 3r2 3 1q4 10r2 3 3r2 3b39
5r3 16r2 3 7r2 3 6r2 3 7r2 7b37
5r3 71r2 5r3
5r3 15r2 3 2r2 3 3r2 3 2r2 3 4r2 3 2r2 3 3r2 3b39
5r3 71r2 5r3
5r3 20r2 3 3r2 2 10r2 3 1b40
5r3 71r2 5r3
5r3 15r2 3 2r2 3 3r2 3 2r2 3 4r2 3 2r2 3 3r2 3b39
5r3 71r2 5r3
5r3 16r2 3 3r2 2 3r2 3 6r2 3 7r2 7b37
23r2 3 3r2 3 2r2 2 7r2 3 3r2 3b39
324r2
20r2 3r2 3 1q4 7r2 2 2r2 3 3r2 3b39
21r2 3 7r2 3 6r2 3 3r2 2 1b40
81r2
20r2 3 2r2 3 3r2 3 2r2 3 4r2 3 2r2 3 3r2 3b39
81r2
25r2 3 10r2 2 3r2 3 1b40
81b1782
end fill
```

```
ara=2 nux=61 nuy=8 fill f2  end fill
ara=3 nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   1  5  1   1 1 1
3  32 41  1   1  5  1   1 1 1   end loop
ara=4 nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   6 10  1   1 1 1
3  32 41  1   6 10  1   1 1 1   end loop
end array
end data
end
```

<u>bw1810g</u>

```
=csas25
bw1810g
44group                    latticecell
uo2     1 den=9.46   1.0 293 92235 4.02  92238 95.98        end
ss304  2             1.0                                    end
h2o    3 den=1.0    0.998224                                end
boron  3 den=1.0    0.001776                                end
uo2     4 den=10.24  1.0 293 92235 2.459 92238 97.541       end
al      5             1.0                                   end
end comp
squarepitch 1.636  1.128  1  3  1.208  2                    end
more data res=4 cylinder .51486 dan(4)=.189732 end more data
Core of 3676 2.459 wt% 235U UO2 fuel rods, 944 4.020 235U wt% UO2 fuel
'rods, 180 water holes, 145.0 cm water height with 1776.8 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes end parm

read geom
unit  1
cylinder   1 1 .5639 145 5.969
cylinder   2 1 .6039 145 0
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  2
cylinder   4 1 .5149 145 .3175
cylinder   0 1 .5217 145 .3175
cylinder   5 1 .603  145  0
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  3
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  4
array 2  -49.898   -6.544  0
unit  5
array 3  -33.538     -8.180   0
unit  6
array 4  -33.538     -8.180   0
global unit 7
array  1  -66.258    -36.81    0
cylinder  3 1 76.2      145   0.0
hole  4    0       -43.3542    0
hole  4    0        43.3542    0
hole  5    0       -58.0784    0
hole  6    0        58.0784    0
cylinder  5 1 76.2      145  -5.08
cylinder  3 1 76.2      145  -7.62
cylinder  5 1 77.47     145  -8.890
cuboid    0 1 4p77.47   145  -8.890
end geom

read array
ara=1 nux=81 nuy=45 fill
10r3 61r2 10r3
10r3 3r2 6r2 2r3 2q8 7r2 7b37
5r3 5r2 3r2 6r2 2r3 2q8 7r2 7b37
5r3 71r2 5r3
1q81
5r3 18r2 2r3 14r2 3r3 3b39
5r3 18r2 2r3 14r1 3r3 3b39
5r3 19r2 33r1 19r2 5r3
1q81
5r3 14r2 2r3 3r2 3r1 2r3 6r1 2r3 7r1 7b37
1q81
24r2 33r1 24r2
5q81
19r2 2r3 3r2 3r1 2r3 6r1 2r3 7r1 7b37
1q81
24r2 33r1 24r2
1q81
23r2 2r3 14r1 3r3 3b39
1q81
81b1782
end fill
ara=2 nux=61 nuy=8 fill f2 end fill
ara=3 nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   1  5  1   1 1 1
3  32 41  1   1  5  1   1 1 1   end loop
ara=4 nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   6 10  1   1 1 1
3  32 41  1   6 10  1   1 1 1   end loop
end array
end data
end
```

<u>bw1810h</u>

```
=csas25
bw1810h
```

```
44group              latticecell
uo2   1  den=9.46 1.0  293 92235 4.02  92238 95.98 end
ss304 2  1.0 293                                         end
h2o   3  den=1.0  0.998101                               end
boron 3  den=1.0  0.001899                               end
uo2   4  den=10.24 1.0 293 92235 2.459 92238 97.541      end
al    5  1.0 293                                         end
end comp
squarepitch 1.636  1.128  1  3  1.208  2                 end
more data res=4 cylinder .51486 dan(4)=.189732 end more data
Core of 3920 2.459 wt% 235U UO2 fuel rods, 888 4.020 wt% 235U UO2 fuel
`rods, 153 water holes, 145.0 cm water height with 1899.3 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes  end parm

read geom
unit  1
cylinder   1 1 .5639 145 5.969
cylinder   2 1 .6039 145 0
cuboid     3 1 .818 -.818 .818 -.818 145 0
unit  2
cylinder   4 1 .5149 145 .3175
cylinder   0 1 .5217 145 .3175
cylinder   5 1 .603  145  0
cuboid     3 1 .818 -.818 .818 -.818 145 0
unit  3
cuboid     3 1 .818 -.818 .818 -.818 145 0
unit  4
array 2  -49.898   -6.544    0
unit 5
array 3  -33.538   -8.180    0
unit 6
array 4  -33.538   -8.180    0
global unit 7
array  1 -66.258 -36.81     0
cylinder  3 1 76.2   145    0.0
hole  4     0    -43.3542    0
hole  4     0     43.3542    0
hole  5     0    -58.0784    0
hole  6     0     58.0784    0
cylinder  5 1 76.2     145   -5.08
cylinder  3 1 76.2     145   -7.62
cylinder  5 1 77.47    145   -8.890
cuboid    0 1 4p77.47  145   -8.890
end geom

read array
ara=1 nux=81 nuy=45 loop
2    1 81  1    1 45  1   1 1 1
1   26 56  1    8 38  1   1 1 1
3   24 54 15    3 33 15   1 1 1
3   28 58 15    3 33 15   1 1 1
3   24 54 15   13 43 15   1 1 1
3   28 58 15   13 43 15   1 1 1
3   22 52 15    4 34 15   1 1 1
3   30 60 15    4 34 15   1 1 1
3   22 52 15   12 42 15   1 1 1
3   30 60 15   12 42 15   1 1 1
3   21 51 15    6 36 15   1 1 1
3   24 54 15    6 36 15   1 1 1
3   28 58 15    6 36 15   1 1 1
3   31 61 15    6 36 15   1 1 1
3   21 51 15   10 40 15   1 1 1
3   24 54 15   10 40 15   1 1 1
3   28 58 15   10 40 15   1 1 1
3   31 61 15   10 40 15   1 1 1
3   26 56 15    8 38 15   1 1 1
3    1 10  1    1  2  1   1 1 1
3   72 81  1    1  2  1   1 1 1
3    1  5  1    3 12  1   1 1 1
3   77 81  1    3 12  1   1 1 1
3    1 10  1   44 45  1   1 1 1
3   72 81  1   44 45  1   1 1 1
3    1  5  1   34 43  1   1 1 1
3   77 81  1   34 43  1   1 1 1
  end loop
ara=2 nux=61 nuy=8 fill f2  end fill
ara=3 nux=41 nuy=10  loop
2   1 41  1    1 10  1    1 1 1
3   1 10  1    1  5  1    1 1 1
3  32 41  1    1  5  1    1 1 1   end loop
ara=4 nux=41 nuy=10  loop
2   1 41  1    1 10  1    1 1 1
3   1 10  1    6 10  1    1 1 1
3  32 41  1    6 10  1    1 1 1   end loop
end array
end data
end
```

bw1810i

```
=csas25
bw1810i
44group                  latticecell
uo2     1 den=10.24   1.0 293 92235 2.459 92238 97.541       end
al      2             1.0                                    end
h2o     3 den=1.0     0.99875                                end
boron   3 den=1.0     0.00125                                end
ag      4 den=10.15   0.797                                  end
in      4 den=10.15   0.151                                  end
cd      4 den=10.15   0.052                                  end
end comp
squarepitch 1.636  1.125  1  3  1.206  2                     end
```

Core of 4808 2.459 wt% ^{235}U UO_2 fuel rods, 16 Ag-In-Cd rods, 137 water
`holes, 145.0 cm water height with 1250.0 ppm boron

```
read parm gen=405 npg=600 nsk=5 nub=yes run=yes   end parm

read geom
unit  1
cylinder   4 1 .508    145 .3175
cylinder   0 1 .5219   145 .3175
cylinder   2 1 .6033   145  0
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  2
cylinder   1 1 .5149   145 .3175
cylinder   0 1 .5217   145 .3175
cylinder   2 1 .603    145  0
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  3
cuboid     3 1     .818 -.818 .818 -.818 145 0
unit  4
array 2  -49.898  -6.544   0
unit 5
array 3  -33.538  -8.180    0
unit 6
array 4  -33.538  -8.180    0
global unit 7
array  1 -66.258 -36.81     0
cylinder  3 1 76.2     145  0.0
hole  4     0    -43.3542    0
hole  4     0     43.3542    0
hole  5     0    -58.0784    0
hole  6     0     58.0784    0
cylinder  2 1 76.2      145  -5.08
cylinder  3 1 76.2      145  -7.62
cylinder  2 1 77.47     145  -8.890
cuboid    0 1 4p77.47 145   -8.890
end geom

read array
ara=1 nux=81 nuy=45 fill
10r3 61r2 10r3
1q81
5r3 15r2 3r2 3 1q4 10r2 3 3r2 3b39
5r3 16r2 3 7r2 3 6r2 3 7r2 7b37
5r3 71r2 5r3
5r3 15r2 3 2r2 3 3r2 3 2r2 3 4r2 3 2r2 3 3r2 3b39
5r3 71r2 5r3
5r3 20r2 3 3r2 2 10r2 3 1b40
5r3 71r2 5r3
5r3 15r2 3 2r2 3 3r2 3 2r2 3 4r2 3 2r2 3 3r2 3b39
5r3 71r2 5r3
5r3 16r2 3 3r2 2 3r2 3 6r2 3 7r2 7b37
23r2 3 3r2 3 2r2 2 7r2 3 3r2 3b39
324r2
20r2 3r2 3 1q4 7r2 2 2r2 1 3r2 3b39
21r2 3 7r2 3 6r2 1 3r2 2 1b40
81r2
20r2 3 2r2 3 3r2 3 2r2 3 4r2 1 2r2 1 3r2 3b39
81r2
25r2 3 10r2 2 3r2 3 1b40
81b1782
end fill
ara=2 nux=61 nuy=8 fill f2  end fill
ara=3 nux=41 nuy=10  loop
2   1 41  1    1 10  1    1 1 1
3   1 10  1    1  5  1    1 1 1
3  32 41  1    1  5  1    1 1 1   end loop
ara=4 nux=41 nuy=10  loop
2   1 41  1    1 10  1    1 1 1
3   1 10  1    6 10  1    1 1 1
3  32 41  1    6 10  1    1 1 1   end loop
end array
end data
end
```

<u>bw1810j</u>

```
=csas25
bw1810j
44group                        latticecell
uo2    1 den=9.46  1.0 293 92235 4.02   92238 95.98                    end
ss304  2 1.0 293                                                       end
h2o    3 den=1.0 0.998365                                              end
boron  3 den=1.0 0.001635                                              end
uo2    4 den=10.24 1.0 293 92235 2.459 92238 97.541                    end
al     5 1.0 293                                                       end
b4c    6 den=1.28 0.986                                                end
end comp
squarepitch 1.636  1.128  1  3  1.208  2                               end
more data res=4 cylinder .51486 dan(4)=.189732 end more data
```

Core of 3920 2.459 wt% ^{235}U UO_2 fuel rods, 888 4.020 wt% ^{235}U UO_2 fuel
`rods, 16 B_4C rods, 137 water holes, 145.0 cm water height with 1635.4
`ppm boron

```
read parm gen=405 npg=600 nsk=5 nub=yes run=yes  end parm

read geom
unit  1
cylinder   1 1 .5639 145 5.969
cylinder   2 1 .6039 145 0
cuboid     3 1 .818 -.818 .818 -.818 145 0
unit  2
cylinder   4 1 .5149 145 .3175
cylinder   0 1 .5217 145 .3175
cylinder   5 1 .603  145  0
```

```
cuboid     3 1 .818 -.818 .818 -.818 145 0
unit  3
cuboid     3 1 .818 -.818 .818 -.818 145 0
unit  4
array 2  -49.898  -6.544     0
unit  5
array 3  -33.538  -8.180     0
unit  6
array 4  -33.538  -8.180     0
global unit 7
array  1 -66.258 -36.81      0
cylinder  3 1 76.2     145    0.0
hole  4    0      -43.3542    0
hole  4    0       43.3542    0
hole  5    0      -58.0784    0
hole  6    0       58.0784    0
cylinder  5 1 76.2     145   -5.08
cylinder  3 1 76.2     145   -7.62
cylinder  5 1 77.47    145   -8.890
cuboid    0 1 4p77.47 145   -8.890
unit  8
cylinder  6 1 .46736   145    0.3175
cylinder  5 1 .55626   145    0.0
cuboid    3 1 4p.818   145    0.0
end geom

read array
ara=1 nux=81 nuy=45 fill
10r3 61r2 10r3
1q81
5r3 15r2 3r2 3 1q4 10r2 3 3r2 3b39
5r3 16r2 3 7r2 3 6r2 3 7r2 7b37
5r3 71r2 5r3
5r3 15r2 3 2r2 3 3r2 3 2r2 3 4r2 3 2r2 3 3r2 3b39
5r3 71r2 5r3
5r3 20r2 3 14r1 3 1b40
5r3 20r2 31r1 20r2 5r3
5r3 15r2 3 2r2 3 2 2r1 3 1q3 4r1 3 2r1 3 3r1 3b39
5r3 20r2 31r1 20r2 5r3
5r3 16r2 3 3r2 4r1 3 6r1 3 7r1 7b37
23r2 3 2 2r1 3 10r1 3 3r1 3b39
25r2 31r1 25r2
3q81
23r2 3 2 2r1 3 10r1 8 3r1 3b39
21r2 3 3r2 4r1 3 6r1 8 7r1 7b37
25r2 31r1 25r2
20r2 3 2r2 3 2 2r1 3 1q3 4r1 8 2r1 8 3r1 3b39
25r2 31r1 25r2
25r2 3 14r1 3 1b40
81b1782
end fill
ara=2 nux=61 nuy=8 fill f2 end fill
ara=3 nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   1  5  1   1 1 1
3  32 41  1   1  5  1   1 1 1   end loop
ara=4 nux=41 nuy=10  loop
2   1 41  1   1 10  1   1 1 1
3   1 10  1   6 10  1   1 1 1
3  32 41  1   6 10  1   1 1 1   end loop
end array
end data
end
```

<u>cr1071as</u>

```
=csas25
cr1071as
44group            latticecell
u3o8               1 den=4.54 1 293.0 92234 0.03 92235 4.48 92236
                    0.09 92238 95.4                                 end
h2o                1 den=.09316                                     end
arbm-baggie        1.596-2 3 0 0 0 6012 84.9 1001 14.01 8016 1.20 1 end
arbm-al1100        2.713 4 0 0 1 13027 99.33 26000 0.42 29000 0.12
                   14000 0.1  2                                     end
arbm-tape(vinyl) 1.374-2 7 0 0 0 6012 45.91 1001 5.92  8016  10.82
                   17000 25.73 20000 6.9 22000 1.6 82000 1.1 2      end
arbm-tape(mylar) 1.832-2 3 0 0 0 6012 65.50 1001 6.83 8016 27.02 2 end
arbm-moderator     1.185   3 0 0 0 6012 59.49 1001 7.83 8016 32.48 3 end
arbm-plex(reg)     1.185   3 0 0 0 6012 59.59 1001 7.84 8016 32.23 4
                  9935                                              end
arbm-plex(paper) 0.766     3 0 0 0 6012 42.17 1001 6.48 8016 49.5 4
                  .0049                                             end
arbm-plex(glue)    0.728   3 0 0 0 6012 86.29 1001 11.67 8016 1.20 4
                  .0016                                             end
arbm-plex(tris)    1.284   8 0 0 1  6012 52.03 1001 7.16  7014 0 .16
                  8016 29.82  15031 1.02 17000 1.81 35079 3.55 35081
                  3.55 5 .9935                                      end
arbm-plex(paper) 0.766   3 0 0 0  6012 42.17 1001 6.48  8016  49.5
                  5 .0049                                           end
arbm-plex(glue)  0.728   3 0 0 0  6012 86.29 1001 11.67 8016  1.20
                  5 .0016                                           end
arbm-filler       1.185   3 0 0 0  6012 59.49 1001 7.83  8016 32.48
                  6  1.0                                            end
end comp
symmslabcell 17.67 14.92 1 3 15.24 2                                end
38 cans of damp uranium oxide,U3O8, separated by 2.43 cm of Plexiglas,
`Plexiglas reflected
read parm run=yes npg=600 gen=405 nsk=5 nub=yes end parm

read geom
unit  51
```

```
com='fuel box with moderator +x,+y,+z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 1.215 0.0 1.215 0.0 1.215 0.0  1
unit  52
com='fuel box with moderator -x,+y,+z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 0.0 1.215  1.215 0.0 1.215 0.0 1
unit  53
com='fuel box with moderator +x,+y,-y,+z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 1.215 0.0 2r1.215 1.215 0.0 1
unit  54
com='fuel box with moderator -x,+y,-y,+z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 0.0 1.215  2r1.215 1.215 0.0 1
unit  55
com='fuel box with moderator +x,-y,+z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 1.215 0.0 0.0 1.215 1.215 0.0 1
unit  56
com='fuel box with moderator -x,-y,+z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 0.0 1.215 0.0 1.215 1.215 0.0 1
unit  57
com='fuel box with moderator +x,+y,+z,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 1.215 0.0 1.215 0.0 2r1.215 1
unit  58
com='fuel box with moderator -x,+y,+z,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 0.0 1.215 1.215 0.0 2r1.215  1
unit  59
com='fuel box with moderator +x,+y,-y,+z,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 1.215 0.0 4r1.215      1
unit  60
com='fuel box with moderator -x,+y,-y,+z,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 0.0 5r1.215  1
unit  61
com='fuel box with moderator +x,-y,+z,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 1.215 0.0 0.0 1.215 2r1.215  1
unit  62
com='fuel box with moderator -x,-y,+z,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 0.0 1.215 0.0 1.215 2r1.215  1
unit  63
com='fuel box with moderator -x,+y,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 0.0 1.215 1.215 0.0 0.0 1.215  1
unit  64
com='fuel box with moderator +x,+y,-y,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 1.215 0.0 2r1.215 0.0 1.215  1
unit  65
com='fuel box with moderator -x,+y,-y,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 0.0 1.215 2r1.215 0.0 1.215  1
unit  66
com='fuel box with moderator -x,-y,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 0.0 1.215 0.0 1.215 0.0 1.215  1
unit  67
com='fuel box with moderator +x,+y,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 1.215 0.0 1.215 0.0 0.0 1.215  1
unit  68
com='fuel box with moderator +x,-y,-z'
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
reflector  3 1 1.215 0.0 0.0 1.215 0.0 1.215  1
unit  69
com='empty fuel location edge'
cuboid  0 1 6p8.2275
unit  70
com='empty fuel location middle'
cuboid  0 1 2p8.2275 2p8.835 2p8.2275
unit  11
com='north split table core'
array 1 3*0.0
cuboid 0 1 32.91 -.59 68.25 0.0  50.58 0.0
reflector 6 1 0 4.9 8.5 0.0 7.3 26.1 1
reflector 0 1 0 0.6 .75 3*0 1
unit  12
```

```
com='south split table core'
array 2 3*0.0
cuboid 0 1 33.5  0.0  68.25 0.0  50.58 0.0
reflector 6 1 12.2 0 8.5 0.0 7.3 26.1 1
reflector 0 1 1.3  0 .75 3*0 1
unit  21
com='north bottom reflector '
cuboid  3 1 7.4   0.0 2p64.05 2p12.60
cuboid  5 1 39.0  0.0 2p64.05 2p12.60
unit  22
com='north top reflector '
cuboid  3 1 7.4   0.0 2p64.05 2p12.00
cuboid  5 1 39.0  0.0 2p64.05 2p12.00
unit  23
com='north side reflector '
cuboid  3 1 7.4   0.0 2p12.65 57.88 -26.1
cuboid  5 1 39.0  0.0 2p12.65 57.88 -26.1
unit  24
com='south bottom reflector with tris'
cuboid  0 1 10.2  0.0 2p2.55  2p12.60
cuboid  5 1 47.0  0.0 2p64.05 2p12.60
unit  25
com='south top reflector with tris'
cuboid  0 1 10.2  0.0 2p2.55  2p12.00
cuboid  5 1 47.0  0.0 2p64.05 2p12.00
unit  26
com='south side reflector with tris'
cuboid  5 1 47.0  0.0 2p12.65 57.88 -26.1
unit  31
com='north array core+side'
array 3 3*0.0
unit  32
com='south array core+side'
array 4 3*0.0
unit  33
com='north array'
array 5 3*0.0
reflector 4 1 0 25.2 4r0.0 1
reflector 3 1 1.23 0 4r0.0 1
unit  34
com='south array'
array 6 3*0.0
reflector 5 1 26.5   5r0.0 1
reflector 3 1 0 1.23 4r0.0 1
reflector 0 1 0 .31  4r0.0 1
global
unit  35
com='total'
array 7 3*0.0
end geometry
```

```
read array
ara=1  nux=2 nuy=4 nuz=3
com='north split table core'
fill 51 52 53 54 1q2   55 56  57 58 59 60 1q2  61 62 69 63 64
65 1q2   69 66                                              end fill
ara=2  nux=2 nuy=4 nuz=3
com='south split table core'
fill 51 52 53 54 1q2   55 56  57 58 59 60 1q2  61 62 67 69 64
70 1q2   68 69                                              end fill
ara=3  nux=1 nuy=3 nuz=1
com='north core with side wall'
fill 23 11 23                                               end fill
ara=4  nux=1 nuy=3 nuz=1
com='south core with side wall'
fill 26 12 26                                               end fill
ara=5  nux=1 nuy=1 nuz=3
com='north assembly'
fill 21 31 22                                               end fill
ara=6  nux=1 nuy=1 nuz=3
com='south assembly'
fill 24 32 25                                               end fill
ara=7  nux=2 nuy=1 nuz=1
com='total'
fill 33 34                                                  end fill
end array
end data
end
```

<u>cr1653as</u>

```
=csas25
cr1653as
44group           latticecell
u3o8              1 den=4.54 1 293.0 92234 0.03 92235 4.48 92236
                   0.09 92238 95.4                                  end
h2o               1 den=.16060                                      end
arbm-baggie       1.596-2 3 0 0 0  6012 84.9 1001 14.01 8016 1.20 1 end
arbm-al1100       2.713 4 0 0 1 13027 99.33 26000 0.42 29000 0.12
                  14000 0.1 2                                       end
arbm-tape(vinyl)  1.374-2 7 0 0 0  6012 45.91 1001 5.92 8016 10.82
                  17000 25.73 20000 6.9 22000 1.6 82000 1.1 2       end
arbm-tape(mylar)  1.832-2 3 0 0 0 6012 65.50 1001 6.83 8016 27.02 2 end
arbm-moderator    1.185 3 0 0 0  6012 59.49 1001 7.83  8016 32.48 3 end
arbm-plex(reg)    1.185 3 0 0 0  6012 59.59 1001 7.84  8016
                  32.23 4 .9935                                     end
arbm-plex(paper)  0.766 3 0 0 0  6012 42.17 1001 6.48  8016
                  49.5  4 .0049                                     end
arbm-plex(glue)   0.728 3 0 0 0  6012 86.29 1001 11.67 8016
                  1.20  4 .0016                                     end
arbm-plex(tris)   1.284 3 0 0 1  6012 52.03 1001 7.16 7014 0.16 8016
                  29.82  15031 1.02 17000 1.81 35079 3.55 35081
```

```
                 3.55 5 .9935                                           end
arbm-plex(paper) 0.766 3 0 0 0  6012 42.17 1001 6.48  8016  49.5
                 5 .0049                                                end
arbm-plex(glue)  0.728 3 0 0 0  6012 86.29 1001 11.67 8016  1.20
                 5 .0016                                                end
arbm-filler      1.185 3 0 0 0  6012 59.49 1001 7.83  8016  32.48
                 6 1.0                                                  end
end comp
symmslabcell 17.67 14.92 1 3 15.24 2                                    end
38 cans of damp uranium oxide,U3O8, separated by 2.43 cm of Plexiglas,
`Plexiglas reflected
read parm run=yes npg=600 gen=405 nsk=5 nub=yes end parm

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

```
global
unit  35
com='total'

array 7 3*0.0
end geometry

read array
ara=1  nux=3 nuy=7 nuz=5
com='north split table core'
fill  1 2 1 3 5 3 2q6 1 2 1
      4 7 4 6 8 6 2q6 4 7 4
      1q42
      51 2 1 53 5 3 2q6 51 52 51 end fill
ara=2  nux=3 nuy=7 nuz=5
com='south split table core'
fill  1 2 1 3 5 3 2q6 1 2 1
      4 7 4 6 8 6 2q6 4 7 4
      1q42
      1 2 51 3 5 53 2q6 51 52 51 end fill
ara=3  nux=1 nuy=3 nuz=1
com='north core with side wall'
fill 23 11 23                   end fill
ara=4  nux=1 nuy=3 nuz=1
com='south core with side wall'
fill 26 12 26                   end fill
ara=5  nux=1 nuy=1 nuz=3
com='north assembly'
fill 21 31 22                   end fill
ara=6  nux=1 nuy=1 nuz=3
com='south assembly'
fill 24 32 25                   end fill
ara=7  nux=2 nuy=1 nuz=1
com='total'
fill 33 34                      end fill
end array
end data
end
```

cr2500s

```
=csas25
cr2500s
44group          latticecell
u3o8             1 den=4.54 1 293.0 92234 0.03 92235 4.48 92236
                 0.09 92238 95.4                                    end
h2o              1 den=.27248                                       end
arbm-baggie      1.596-2 3 0 0 0  6012 84.9 1001 14.01 8016 1.20 1 end
arbm-al1100      2.713 4 0 0 1 13027 99.33 26000 0.42 29000 0.12
                 14000 0.1 2                                        end
arbm-tape(vinyl) 1.374-2 7 0 0 0  6012 45.91 1001  5.92 8016  10.82
                 17000 25.73 20000 6.9 22000 1.6   82000 1.1 2     end
arbm-tape(mylar) 2.748-2 3 0 0 0  6012 65.50 1001  6.83 8016  27.02
                 2                                                 end
arbm-moderator   1.185 3 0 0 0  6012 59.49 1001 7.83  8016 32.48 3 end
arbm-plex(reg)   1.185 3 0 0 0  6012 59.59 1001 7.84  8016 32.23 4
                 .9935                                             end
arbm-plex(paper) 0.766 3 0 0 0  6012 42.17 1001 6.48  8016 49.5  4
                 .0049                                             end
arbm-plex(glue)  0.728 3 0 0 0  6012 86.29 1001 11.67 8016 1.20  4
                 .0016                                             end
arbm-plex(tris)  1.284 8 0 0 1  6012 52.03 1001 7.16  7014 0.16
                 8016 29.82 15031 1.02 17000 1.81 35079  3.55 35081
                 3.55 5 .9935                                      end
arbm-plex(paper) 0.766 3 0 0 0  6012 42.17 1001 6.48  8016  49.5
                 5 .0049                                           end
arbm-plex(glue)  0.728 3 0 0 0  6012 86.29 1001 11.67 8016  1.20  5
                 .0016                                             end
arbm-filler      1.185 3 0 0 0  6012 59.49 1001 7.83  8016  32.48 6
                 1.0                                               end
end comp
symmslabcell 17.67 14.92 1 3 15.24 2                               end
30 cans of damp uranium oxide,U3O8, separated by 2.43 cm of Plexiglas,
`Plexiglas reflected
read parm  run=yes npg=600 gen=405 nsk=5 nub=yes end parm

read geom
unit  1
com='fuel box 15.24 cm on a side with .16 cm walls '
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
unit  2
com='x-face interstitial moderator'
cuboid  3 1 2p1.215 4p7.62
unit  3
com='y-face interstitial moderator'
cuboid  3 1 2p7.62 2p1.215 2p7.62
unit  4
com='z-face interstitial moderator'
cuboid  3 1 4p7.62 2p1.215
unit  5
com='more x-face moderator'
cuboid  3 1 4p1.215 2p7.62
unit  6
com='more y-face moderator'
cuboid  3 1 2p7.62 4p1.215
unit  7
com='more z-face moderator'
cuboid  3 1 2p1.215 2p7.62 2p1.215
unit  8
com='last of interstitial moderator'
cuboid  3 1 6p1.215
```

```
global
unit  35
com='total'

array 7 3*0.0
end geometry

read array
ara=1  nux=3 nuy=7 nuz=5
com='north split table core'
fill  1 2 1 3 5 3 2q6 1 2 1
      4 7 4 6 8 6 2q6 4 7 4
      1q42
      51 2 1 53 5 3 2q6 51 52 51 end fill
ara=2  nux=3 nuy=7 nuz=5
com='south split table core'
fill  1 2 1 3 5 3 2q6 1 2 1
      4 7 4 6 8 6 2q6 4 7 4
      1q42
      1 2 51 3 5 53 2q6 51 52 51 end fill
ara=3  nux=1 nuy=3 nuz=1
com='north core with side wall'
fill 23 11 23                    end fill
ara=4  nux=1 nuy=3 nuz=1
com='south core with side wall'
fill 26 12 26                    end fill
ara=5  nux=1 nuy=1 nuz=3
com='north assembly'
fill 21 31 22                    end fill
ara=6  nux=1 nuy=1 nuz=3
com='south assembly'
fill 24 32 25                    end fill
ara=7  nux=2 nuy=1 nuz=1
com='total'
fill 33 34                       end fill
end array
end data
end
```

<u>cr2500s</u>

```
=csas25
cr2500s
44group          latticecell
u3o8             1 den=4.54 1 293.0 92234 0.03 92235 4.48 92236
                 0.09 92238 95.4                                   end
h2o              1 den=.27248                                      end
arbm-baggie      1.596-2 3 0 0 0  6012 84.9 1001 14.01 8016 1.20 1 end
arbm-al1100      2.713 4 0 0 1 13027 99.33 26000 0.42 29000 0.12
                 14000 0.1 2                                       end
arbm-tape(vinyl) 1.374-2 7 0 0 0  6012 45.91 1001  5.92 8016  10.82
                 17000 25.73 20000 6.9 22000 1.6   82000 1.1 2     end
arbm-tape(mylar) 2.748-2 3 0 0 0  6012 65.50 1001  6.83 8016  27.02
                 2                                                 end
arbm-moderator   1.185 3 0 0 0  6012 59.49 1001 7.83  8016 32.48 3 end
arbm-plex(reg)   1.185 3 0 0 0  6012 59.59 1001 7.84  8016 32.23 4
                 .9935                                             end
arbm-plex(paper) 0.766 3 0 0 0  6012 42.17 1001 6.48  8016 49.5  4
                 .0049                                             end
arbm-plex(glue)  0.728 3 0 0 0  6012 86.29 1001 11.67 8016 1.20  4
                 .0016                                             end
arbm-plex(tris)  1.284 8 0 0 1  6012 52.03 1001 7.16  7014 0.16
                 8016 29.82 15031 1.02 17000 1.81 35079  3.55 35081
                 3.55 5 .9935                                      end
arbm-plex(paper) 0.766 3 0 0 0  6012 42.17 1001 6.48  8016  49.5
                 5 .0049                                           end
arbm-plex(glue)  0.728 3 0 0 0  6012 86.29 1001 11.67 8016  1.20  5
                 .0016                                             end
arbm-filler      1.185 3 0 0 0  6012 59.49 1001 7.83  8016  32.48 6
                 1.0                                               end
end comp
symmslabcell 17.67 14.92 1 3 15.24 2                               end
30 cans of damp uranium oxide,U3O8, separated by 2.43 cm of Plexiglas,
`Plexiglas reflected
read parm  run=yes npg=600 gen=405 nsk=5 nub=yes end parm

read geom
unit  1
com='fuel box 15.24 cm on a side with .16 cm walls '
cuboid  1 1 6p7.46
cuboid  2 1 6p7.62
unit  2
com='x-face interstitial moderator'
cuboid  3 1 2p1.215 4p7.62
unit  3
com='y-face interstitial moderator'
cuboid  3 1 2p7.62 2p1.215 2p7.62
unit  4
com='z-face interstitial moderator'
cuboid  3 1 4p7.62 2p1.215
unit  5
com='more x-face moderator'
cuboid  3 1 4p1.215 2p7.62
unit  6
com='more y-face moderator'
cuboid  3 1 2p7.62 4p1.215
unit  7
com='more z-face moderator'
cuboid  3 1 2p1.215 2p7.62 2p1.215
unit  8
com='last of interstitial moderator'
cuboid  3 1 6p1.215
```

```
unit  51
com='empty fuel location'
cuboid  0 1 6p7.620
unit  53
com='y-face moderator void'
cuboid  0 1 2p7.62 2p1.215 2p7.62
unit  11
com='north split table core'
array 1 3*0.0
cuboid 0 1 32.91 -.59 77.50 0.0  50.58 0.0
reflector 6 1 4*0 2.42 30.0 1
reflector 0 1 0 0 0 0 0.3 0 1
unit  12
com='south split table core'
array 2 3*0.0
cuboid 0 1 33.5  0.0  77.50 0.0  50.58 0.0
reflector 6 1 13.5 3*0 2.42 30.0 1
reflector 0 1 0 0 0 0 0.3 0 1
unit  21
com='north bottom reflector '
cuboid  3 1 1.90  0.0 2p64.05 2p12.60
cuboid  5 1 33.50 0.0 2p64.05 2p12.60
unit  22
com='north top reflector '
cuboid  3 1 1.90  0.0 2p64.05 2p12.00
cuboid  5 1 33.50 0.0 2p64.05 2p12.00
unit  23
com='north side reflector '
cuboid  3 1 1.90  0.0 2p12.65 53.3 -30.0
cuboid  5 1 33.50 0.0 2p12.65 53.3 -30.0
unit  24
com='south bottom reflector with tris'
cuboid  0 1 10.2  0.0 2p2.55  2p12.60
cuboid  5 1 47.0  0.0 2p64.05 2p12.60
unit  25
com='south top reflector with tris'
cuboid  0 1 10.2  0.0 2p2.55  2p12.00
cuboid  5 1 47.0  0.0 2p64.05 2p12.00
unit  26
com='south side reflector with tris'
cuboid  5 1 47.0  0.0 2p12.65 53.3 -30.0
unit  31
com='north array core+side'
array 3 3*0.0
unit  32
com='south array core+side'
array 4 3*0.0
unit  33
com='north array'
array 5 3*0.0
reflector 4 1 0 25.2 4r0.0 1
reflector 3 1 1.23 0 4r0.0 1
unit  34
com='south array'
array 6 3*0.0
reflector 5 1 26.5   5r0.0 1
reflector 3 1 0 1.23 4r0.0 1
reflector 0 1 0 .57  4r0.0 1
global
unit  35
com='total'
array 7 3*0.0
end geometry

read array
ara=1  nux=3 nuy=5 nuz=5
com='north split table core'
fill  1 2 1 3 5 3 1q6 1 2 1
      4 7 4 6 8 6 1q6 4 7 4
      1q30
      51 2 1 53 5 3 1q6 51 2 1 end fill
ara=2  nux=3 nuy=5 nuz=5
com='south split table core'
fill  1 2 1 3 5 3 1q6 1 2 1
      4 7 4 6 8 6 1q6 4 7 4
      1q30
      1 2 51 3 5 53 1q6 1 2 51 end fill
ara=3  nux=1 nuy=3 nuz=1
com='north core with side wall'
fill 23 11 23                    end fill
ara=4  nux=1 nuy=3 nuz=1
com='south core with side wall'
fill 26 12 26                    end fill
ara=5  nux=1 nuy=1 nuz=3
com='north assembly'
fill 21 31 22                    end fill
ara=6  nux=1 nuy=1 nuz=3
com='south assembly'
fill 24 32 25                    end fill
ara=7  nux=2 nuy=1 nuz=1
com='total'
fill 33 34                       end fill
end array
end data
end
```

<u>dsn399-1</u>

```
=csas25
dsn399-1
44group latticecell
uo2    1 0.947 293 92235 4.742 92238 95.258              end
```

```
al      2 1.0                                                    end
h2o     3 1.0                                                    end
arbmss 7.90 3 0 0 1 24304 19.17 26304 71.40 28304 9.37 4        end
hf      5 den=13.29                                              end
uo2     6 0.947 293 92235 4.742 92238 95.258                     end
end comp
squarepitch 1.35 0.79 1 3 0.94 2 0.82 0                          end
more data res=6 cylinder .395  dan(6)=.989923 end more
4-18x18 assemblies separated by 0.1046-cm-thick hafnium plates and
`1.6954 cm of water, plate-to-assembly distance of 0.9 cm, 37.66 cm
`water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 1 1 0.395           37.66 0.0
cylinder 0 1 0.410           37.66 0.0
cylinder 2 1 0.470           37.66 0.0
cuboid   3 1 4p0.675         37.66 0.0
unit 2
cylinder 2 1 0.470           0.25  0.0
cylinder 3 1 0.500           0.25  0.0
cuboid   4 1 4p0.675         0.25  0.0
unit 3
cylinder 2 1 0.470           2.75  1.75
cuboid   3 1 4p0.675         2.75  1.2
cuboid   4 1 4p0.675         2.75  0.0
unit 4
array 1 3*0.0
reflector 3 1 0 24.8 4r0 1
unit 5
cuboid    5 1 2p.0523    24.3 0   40.66 0.8
cuboid    3 1 2p.9       24.3 0   40.66 0.8
cuboid    4 1 2p.9       24.3 0   40.66 0.0
unit 6
array 1 3*0.0
reflector 3 1 24.8 0 4r0 1
unit 7
array 2 3*0.0
unit 8
cuboid    3 1 49.9477 0 24.8 0   40.66 0.8
cuboid    5 1 50.0523 0 24.8 0   40.66 0.8
cuboid    3 1 100.    0 24.8 0   40.66 0.8
cuboid    4 1 100.    0 24.8 0   40.66 0.0
unit 9
cuboid    3 1 49.9477 0 0.8477 0 40.66 0.8
cuboid    5 1 50.0523 0 0.8477 0 40.66 0.8
cuboid    3 1 100     0 0.8477 0 40.66 0.8
cuboid    5 1 100     0 0.9523 0 40.66 0.8
cuboid    4 1 100     0 0.9523 0 40.66 0.0
unit 10
cuboid    3 1 49.9477 0 0.8477 0 40.66 0.8
cuboid    5 1 50.0523 0 0.8477 0 40.66 0.8
cuboid    3 1 100     0 0.8477 0 40.66 0.8
cuboid    4 1 100     0 0.8477 0 40.66 0.0
unit 11
array 3 3*0.0
reflector 3 1 4r20.0 0.0 20.0 1
unit 12
cylinder 6 1 0.395           90.00 37.66
cylinder 0 1 0.410           90.00 37.66
cylinder 2 1 0.470           90.00 37.66
cuboid   0 1 4p0.675         90.00 37.66
unit 13
array 4 3*0.0
reflector 0 1 0 24.8 2r0 7.8 0.0 1
unit 14
cuboid    5 1 2p.0523 24.3 0 97.80 37.66
cuboid    0 1 2p.9    24.3 0 97.80 37.66
unit 15
array 4 3*0.0
reflector 0 1 24.8 0 2r0 7.8 0.0 1
unit 16
array 5 3*0.0
unit 17
cuboid    0 1 49.9477 0 24.8 0 97.80 37.66
cuboid    5 1 50.0523 0 24.8   0 97.80 37.66
cuboid    0 1 100     0 24.8   0 97.80 37.66
unit 18
cuboid    0 1 49.9477 0  0.8477 0 97.80 37.66
cuboid    5 1 50.0523 0  0.8477 0 97.80 37.66
cuboid    0 1 100     0  0.8477 0 97.80 37.66
cuboid    5 1 100     0  0.9523 0 97.80 37.66
unit 19
cuboid    0 1 49.9477 0  0.8477 0 97.80 37.66
cuboid    5 1 50.0523 0  0.8477 0 97.80 37.66
cuboid    0 1 100     0  0.8477 0 97.80 37.66
unit 20
array 6 3*0.0
reflector 0 1 4r20.0 2r0.0 1
global
unit 21
array 7 3*0.0
end geom

read array
ara=1 nux=18 nuy=18 nuz=3 fill 324r3 324r2 324r1 end fill
ara=2 nux=3  nuy=1  nuz=1 fill 4 5 6              end fill
ara=3 nux=1  nuy=6  nuz=1 fill 8 7 9 10 7 8       end fill
ara=4 nux=18 nuy=18 nuz=1 fill 324r12             end fill
ara=5 nux=3  nuy=1  nuz=1 fill 13 14 15           end fill
ara=6 nux=1  nuy=6  nuz=1 fill 17 16 18 19 16 17 end fill
```

```
ara=7 nux=1  nuy=1  nuz=2 fill 11 20             end fill
end array
end data
end
```

dsn399-2

```
=csas25
dsn399-2
44group latticecell
uo2    1 0.947 293 92235 4.742 92238 95.258              end
al     2 1.0                                             end
h2o    3 1.0                                             end
arbmss 7.90 3 0 0 1 24304 19.17 26304 71.40 28304 9.37 4  end
hf     5 den=13.29                                       end
uo2    6 0.947 293 92235 4.742 92238 95.258              end
end comp
squarepitch 1.35 0.79 1 3 0.94 2 0.82 0                  end
more data res=6 cylinder .395  dan(6)=.989923 end more
4-18x18 assemblies separated by 0.1046-cm-thick hafnium plates and
`5.6954 cm of water, plate-to-assembly distance of 2.9 cm, 53.40 cm
`water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 1 1 0.395          53.40 0.0
cylinder 0 1 0.410          53.40 0.0
cylinder 2 1 0.470          53.40 0.0
cuboid   3 1 4p0.675        53.40 0.0
unit 2
cylinder 2 1 0.470          0.25  0.0
cylinder 3 1 0.500          0.25  0.0
cuboid   4 1 4p0.675        0.25  0.0
unit 3
cylinder 2 1 0.470          2.75  1.75
cuboid   3 1 4p0.675        2.75  1.2
cuboid   4 1 4p0.675        2.75  0.0
unit 4
array 1 3*0.0
reflector 3 1 0 22.8 4r0 1
unit 5
cuboid    5 1 2p.0523   24.3   0 56.40 0.8
cuboid    3 1 2p2.9     24.3   0 56.40 0.8
cuboid    4 1 2p2.9     24.3   0 56.40 0.0
unit 6
array 1 3*0.0
reflector 3 1 22.8 0 4r0 1
unit 7
array 2 3*0.0
unit 8
cuboid    3 1 49.9477 0 22.8    0 56.40 0.8
cuboid    5 1 50.0523 0 22.8    0 56.40 0.8
cuboid    3 1 100.    0 22.8    0 56.40 0.8
cuboid    4 1 100.    0 22.8    0 56.40 0.0
unit 9
cuboid    3 1 49.9477 0 2.8477 0 56.40 .8
cuboid    5 1 50.0523 0 2.8477 0 56.40 .8
cuboid    3 1 100     0 2.8477 0 56.40 .8
cuboid    5 1 100     0 2.9523 0 56.40 .8
cuboid    4 1 100     0 2.9523 0 56.40 .0
unit 10
cuboid    3 1 49.9477 0 2.8477 0 56.40 .8
cuboid    5 1 50.0523 0 2.8477 0 56.40 .8
cuboid    3 1 100     0 2.8477 0 56.40 .8
cuboid    4 1 100     0 2.8477 0 56.40 .0
unit 11
array 3 3*0.0
reflector 3 1 4r20.0 0.0 20.0 1
unit 12
cylinder 6 1 0.395          90.00 53.40
cylinder 0 1 0.410          90.00 53.40
cylinder 2 1 0.470          90.00 53.40
cuboid   0 1 4p0.675        90.00 53.40
unit 13
array 4 3*0.0
reflector 0 1 0 22.8 2r0 7.8 0.0 1
unit 14
cuboid    5 1 2p.0523   24.3    0 97.80 53.40
cuboid    0 1 2p2.9     24.3    0 97.80 53.40
unit 15
array 4 3*0.0
reflector 0 1 22.8 0 2r0 7.8 0.0 1
unit 16
array 5 3*0.0
unit 17
cuboid    0 1 49.9477 0 22.8    0 97.80 53.40
cuboid    5 1 50.0523 0 22.8    0 97.80 53.40
cuboid    0 1 100     0 22.8    0 97.80 53.40
unit 18
cuboid    0 1 49.9477 0   2.8477 0 97.80 53.40
cuboid    5 1 50.0523 0   2.8477 0 97.80 53.40
cuboid    0 1 100     0   2.8477 0 97.80 53.40
cuboid    5 1 100     0   2.9523 0 97.80 53.40
unit 19
cuboid    0 1 49.9477 0   2.8477 0 97.80 53.40
cuboid    5 1 50.0523 0   2.8477 0 97.80 53.40
cuboid    0 1 100     0   2.8477 0 97.80 53.40
unit 20
array 6 3*0.0
reflector 0 1 4r20.0 2r0.0 1
global
```

```
unit 21
array 7 3*0.0
end geom

read array
ara=1 nux=18 nuy=18 nuz=3 fill 324r3 324r2 324r1 end fill
ara=2 nux=3  nuy=1  nuz=1 fill 4 5 6             end fill
ara=3 nux=1  nuy=6  nuz=1 fill 8 7 9 10 7 8      end fill
ara=4 nux=18 nuy=18 nuz=1 fill 324r12            end fill
ara=5 nux=3  nuy=1  nuz=1 fill 13 14 15          end fill
ara=6 nux=1  nuy=6  nuz=1 fill 17 16 18 19 16 17 end fill
ara=7 nux=1  nuy=1  nuz=2 fill 11 20             end fill
end array
end data
end
```

<u>dsn399-3</u>

```
=csas25
dsn399-3
44group latticecell
uo2    1 0.947 293 92235 4.742 92238 95.258              end
al     2 1.0                                             end
h2o    3 1.0                                             end
arbmss 7.90 3 0 0 1 24304 19.17 26304 71.40 28304 9.37 4 end
hf     5 den=13.29                                       end
uo2    6 0.947 293 92235 4.742 92238 95.258              end
end comp
squarepitch 1.60 0.79 1 3 0.94 2 0.82 0                  end
more data res=6 cylinder .395  dan(6)=.991569 end more
1-21x21 assembly surrounded by 0.1046-cm-thick hafnium plates and 0.8
`cm of water, plate-to-assembly distance of 0.8 cm, 49.99 cm water
`height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 1 1 0.395        49.99 0.0
cylinder 0 1 0.410        49.99 0.0
cylinder 2 1 0.470        49.99 0.0
cuboid   3 1 4p0.8        49.99 0.0
unit 2
cylinder 2 1 0.470        0.25  0.0
cylinder 3 1 0.500        0.25  0.0
cuboid   4 1 4p0.8        0.25  0.0
unit 3
cylinder 2 1 0.470        2.35  1.35
cuboid   3 1 4p0.8        2.35  0.8
cuboid   4 1 4p0.8        2.35  0.0
unit 4
cuboid    3 1 16.2954 0 16.2954  0      52.59 0.8
cuboid    5 1 16.4    0 16.2954  0      52.59 0.8
cuboid    3 1 66.4    0 16.2954  0      52.59 0.8
cuboid    4 1 66.4    0 16.2954  0      52.59 0.0
unit 5
cuboid    5 1 16.2954 0  0.0    -0.1046 52.59 0.8
cuboid    3 1 16.2954 0 33.7046 -0.1046 52.59 0.8
cuboid    4 1 16.2954 0 33.7046 -0.1046 52.59 0.0
unit 6
array 1 3*0.0
reflector 5 1 4r0.1046 2r0.0 1
unit 7
cuboid    3 1 16.2954 0 33.7046 0.0     52.59 0.8
cuboid    5 1 16.2954 0 33.7046 -.1046  52.59 0.8
cuboid    4 1 16.2954 0 33.7046 -.1046  52.59 0.0
unit 8
array 2 3*0.0
unit 9
cuboid    3 1 50.     0 16.2954 0       52.59 0.8
cuboid    5 1 50.1046 0 16.2954 0       52.59 0.8
cuboid    3 1 66.4    0 16.2954 0       52.59 0.8
cuboid    4 1 66.4    0 16.2954 0       52.59 0.0
unit 10
array 3 3*0.0
reflector 3 1 4r20.0 0.0 20.0 1
unit 11
cylinder 6 1 0.395                      90.00 49.99
cylinder 0 1 0.410                      90.00 49.99
cylinder 2 1 0.470                      90.00 49.99
cuboid   0 1 4p0.8                      90.00 49.99
unit 12
cuboid    0 1 16.2954 0 16.2954 0       98.20 49.99
cuboid    5 1 16.4    0 16.2954 0       98.20 49.99
cuboid    0 1 66.4    0 16.2954 0       98.20 49.99
unit 13
cuboid    5 1 16.2954 0  0.0    -0.1046 98.20 49.99
cuboid    0 1 16.2954 0 33.7046 -0.1046 98.20 49.99
unit 14
array 4 3*0.0
reflector 5 1 4r0.1046 2r0.0 1
reflector 0 1 4r0.0    8.2 0 1
unit 15
cuboid    0 1 16.2954 0 33.7046 0.0     98.20 49.99
cuboid    5 1 16.2954 0 33.7046 -.1046  98.20 49.99
unit 16
array 5 3*0.0
unit 17
cuboid    0 1 50.     0 16.2954 0       98.20 49.99
cuboid    5 1 50.1046 0 16.2954 0       98.20 49.99
cuboid    0 1 66.4    0 16.2954 0       98.20 49.99
unit 18
array 6 3*0.0
```

```
reflector 0 1 4r20.0 2r0.0 1
global
unit 19
array 7 3*0.0
end geom

read array
ara=1 nux=21 nuy=21 nuz=3 fill 441r3 441r2 441r1 end fill
ara=2 nux=3   nuy=1 nuz=1 fill 5 6 7           end fill
ara=3 nux=1  nuy=3  nuz=1 fill 9 8 4           end fill
ara=4 nux=21 nuy=21 nuz=1 fill 441r11          end fill
ara=5 nux=3  nuy=1  nuz=1 fill 13 14 15        end fill
ara=6 nux=1  nuy=3  nuz=1 fill 17 16 12        end fill
ara=7 nux=1  nuy=1  nuz=2 fill 10 18           end fill
end array
end data
end
```

dsn399-4

```
=csas25
dsn399-4
44group latticecell
uo2    1 0.947 293 92235 4.742 92238 95.258             end
al     2 1.0                                            end
h2o    3 1.0                                            end
arbmss 7.90 3 0 0 1 24304 19.17 26304 71.40 28304 9.37 4  end
hf     5 den=13.29                                      end
uo2    6 0.947 293 92235 4.742 92238 95.258             end
end comp
squarepitch 1.60 0.79 1 3 0.94 2 0.82 0                 end
more data res=6 cylinder .395  dan(6)=.991569 end more
1-20x20 assembly surrounded by 0.1046-cm-thick hafnium plates and 2.4
`cm of water, plate-to-assembly distance of 2.4 cm, 52.83 cm water
`height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 1 1 0.395               52.83  0.0
cylinder 0 1 0.410               52.83  0.0
cylinder 2 1 0.470               52.83  0.0
cuboid   3 1 4p0.8               52.83  0.0
unit 2
cylinder 2 1 0.470                0.25  0.0
cylinder 3 1 0.500                0.25  0.0
cuboid   4 1 4p0.8                0.25  0.0
unit 3
cylinder 2 1 0.470                2.35  1.35
cuboid   3 1 4p0.8                2.35  0.8
unit 4
cuboid    3 1 16.2954  0 16.2954 0 55.43  0.8
cuboid    5 1 16.4     0 16.2954 0 55.43  0.8
cuboid    3 1 66.4     0 16.2954 0 55.43  0.8
unit 5
cuboid    5 1 16.2954  0  0.1046 0 55.43  0.8
cuboid    3 1 16.2954  0 33.8092 0 55.43  0.8
unit 6
array 1 3*0.0
reflector 3 1 1.6 0 1.6 0 2r0.0 1
reflector 5 1 4r0.1046 2r0.0 1
unit 7
cuboid    3 1 16.2954  0 33.7046 0 55.43  0.8
cuboid    5 1 16.2954  0 33.8092 0 55.43  0.8
unit 8
array 2 3*0.0
unit 9
cuboid    3 1 50.      0 16.2954  0 55.43  0.8
cuboid    5 1 50.1046 0 16.2954  0 55.43  0.8
cuboid    3 1 66.4     0 16.2954  0 55.43  0.8
unit 10
array 3 3*0.0
reflector 4 1 5r0.0       0.8 1
reflector 3 1 4r20.0 0.0 20.0 1
unit 11
cylinder 6 1 0.395                     90.00 52.83
cylinder 0 1 0.410                     90.00 52.83
cylinder 2 1 0.470                     90.00 52.83
cuboid   0 1 4p0.8                     90.00 52.83
unit 12
cuboid    0 1 16.2954    0 16.2954 0  98.20 52.83
cuboid    5 1 16.4       0 16.2954 0  98.20 52.83
cuboid    0 1 66.4       0 16.2954 0  98.20 52.83
unit 13
cuboid    5 1 16.2954    0  0.1046 0  98.20 52.83
cuboid    0 1 16.2954    0 33.8092 0  98.20 52.83
unit 14
array 4 3*0.0
reflector 0 1 1.6 0 1.6 0 8.2 0 1
reflector 5 1 4r0.1046 2r0.0 1
unit 15
cuboid    0 1 16.2954    0 33.7046 0  98.20 52.83
cuboid    5 1 16.2954    0 33.8092 0  98.20 52.83
unit 16
array 5 3*0.0
unit 17
cuboid    0 1 50.        0 16.2954 0  98.20 52.83
cuboid    5 1 50.1046    0 16.2954 0  98.20 52.83
cuboid    0 1 66.4       0 16.2954 0  98.20 52.83
unit 18
array 6 3*0.0
reflector 0 1 4r20.0 2r0.0 1
```

```
global
unit 19
array 7 3*0.0
end geom

read array
ara=1 nux=20 nuy=20 nuz=3 fill 400r3 400r2 400r1 end fill
ara=2 nux=3  nuy=1  nuz=1 fill 5 6 7             end fill
ara=3 nux=1  nuy=3  nuz=1 fill 9 8 4             end fill
ara=4 nux=20 nuy=20 nuz=1 fill 400r11            end fill
ara=5 nux=3  nuy=1  nuz=1 fill 13 14 15          end fill
ara=6 nux=1  nuy=3  nuz=1 fill 17 16 12          end fill
ara=7 nux=1  nuy=1  nuz=2 fill 10 18             end fill
end array
end data
end
```

<u>epru65</u>

```
#csas25
epru65
44group                          latticecell
uo2  1  den=9.20 1.0 293 92234 0.0137  92235 2.35  92236
     0.0171 92238 97.62                                    end
al   3  1.0 293                                            end
h2o  4  1.0 293                                            end
pb   5  1.0 293                                            end
end comp
squarepitch 1.5621 1.1176 1 4  1.2700 3                    end
Core of 708 fuel rods, 111.76 cm water height with 0.9 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes  end parm

read geom
unit  1
cylinder   3 1 .635 2.540 2.2225
cuboid     4 1     .78105 -.78105 .78105 -.78105 2.540        2.2225
cuboid     3 1     .78105 -.78105 .78105 -.78105 2.540        0
unit  2
cylinder   3 1 .635 5.080 2.540
cuboid     4 1     .66675 -.66675 .66675 -.66675 5.080        2.540
cuboid     3 1     .78105 -.78105 .78105 -.78105 5.080        2.540
unit  3
cylinder   3 1 .5588 7.3025                                   5.080
cylinder   1 1 .5588 95.885                                   5.080
cylinder   3 1 .635 95.885                                    5.080
cuboid     4 1     .78105 -.78105 .78105 -.78105      95.885 5.080
unit  4
cylinder   1 1 .5588 98.4250                          95.885
cylinder   3 1 .635  98.4250                          95.885
cuboid     4 1 .74041 -.74041 .74041 -.74041 98.4250  95.885
cuboid     3 1 .78105 -.78105 .78105 -.78105 98.4250  95.885
unit  5
cylinder   1 1 .5588 98.7425 98.4250
cylinder   3 1 .635 100.0125 98.4250
cuboid     4 1 .78105 -.78105 .78105 -.78105 100.0125 98.4250
cuboid     5 1 .78105 -.78105 .78105 -.78105 100.965  98.4250
unit  6
cuboid     4 1 .78105 -.78105 .78105 -.78105 2.540             2.2225
cuboid     3 1 .78105 -.78105 .78105 -.78105 2.540             0
unit  7
cuboid     4 1 .66675 -.66675 .66675 -.66675 5.080             2.540
cuboid     3 1 .78105 -.78105 .78105 -.78105 5.080             2.540
unit  8
cuboid     4 1 .78105 -.78105 .78105 -.78105          95.885  5.080
unit  9
cuboid     4 1 .74041 -.74041 .74041 -.74041 98.4250  95.885
cuboid     3 1 .78105 -.78105 .78105 -.78105 98.4250  95.885
unit  10
cuboid     4 1 .78105 -.78105 .78105 -.78105 100.0125 98.4250
cuboid     5 1 .78105 -.78105 .78105 -.78105 100.965  98.4250
global unit  11
array     1   0 0 0
reflector  4 1 30 30 30 30 15.24 30  *
end geom

read array
ara=1 nux=31 nuy=31 nuz=5
fill
 13r6  5r1 23r6  11r1 18r6  15r1 15r6  17r1 13r6  19r1 11r6  21r1 9r6
      23r1  7r6  25r1  5r6  27r1  2r6  1q31  1r6  29r1  1r6  2q31
 154r1 1r6 155b403
 13r7  5r2 23r7  11r2 18r7  15r2 15r7  17r2 13r7  19r2 11r7  21r2 9r7
      23r2  7r7  25r2  5r7  27r2  2r7  1q31  1r7  29r2  1r7  2q31
 154r2 1r7 155b403
 13r8  5r3 23r8  11r3 18r8  15r3 15r8  17r3 13r8  19r3 11r8  21r3 9r8
      23r3  7r8  25r3  5r8  27r3  2r8  1q31  1r8  29r3  1r8  2q31
 154r3 1r8 155b403
 13r9  5r4 23r9  11r4 18r9  15r4 15r9  17r4 13r9  19r4 11r9  21r4 9r9
      23r4  7r9  25r4  5r9  27r4  2r9  1q31  1r9  29r4  1r9  2q31
 154r4 1r9 155b403
 13r10 5r5 23r10 11r5 18r10 15r5 15r10 17r5 13r10 19r5 11r10 21r5 9r10
      23r5  7r10 25r5  5r10 27r5  2r10 1q31  1r10 29r5  1r10 2q31
 154r5 1r10 155b403
end fill
end array
end data
end
```

<u>epru65b</u>

```
=csas25
epru65
```

```
44group                 latticecell
uo2   1  den=9.20 1.0 293 92234 0.0137  92235 2.35  92236
          0.0171  92238 97.62                                end
al    3  1.0 293                                             end
h2o   4  1.0 293                                             end
boron 4  den=463.8-6                                         end
end comp
squarepitch 1.5621 1.1176 1 4  1.2700 3                      end
Core of 1201 fuel rods, 111.76 cm water height with 463.8 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes  end parm

read geom
unit  1
cylinder   3 1 .635 2.540 2.2225
cuboid     4 1     .78105 -.78105 .78105 -.78105 2.540      2.2225
cuboid     3 1     .78105 -.78105 .78105 -.78105 2.540 0
unit  2
cylinder   3 1 .635 5.080 2.540
cuboid     4 1     .66675 -.66675 .66675 -.66675 5.080 2.540
cuboid     3 1     .78105 -.78105 .78105 -.78105 5.080 2.540
unit  3
cylinder   3 1 .5588 7.3025 5.080
cylinder   1 1 .5588 95.885 5.080
cylinder   3 1 .635 95.885 5.080
cuboid     4 1     .78105 -.78105 .78105 -.78105 95.885     5.080
unit  4
cylinder   1 1 .5588 98.4250 95.885
cylinder   3 1 .635 98.4250 95.885
cuboid     4 1     .74041 -.74041 .74041 -.74041 98.4250  95.885
cuboid     3 1     .78105 -.78105 .78105 -.78105 98.4250  95.885
unit  5
cylinder   1 1 .5588 98.7425 98.4250
cylinder   3 1 .635 100.0125 98.4250
cuboid     4 1     .78105 -.78105 .78105 -.78105 100.0125 98.4250
unit  6
cuboid     4 1     .78105 -.78105 .78105 -.78105 2.540      2.2225
cuboid     3 1     .78105 -.78105 .78105 -.78105 2.540 0
unit  7
cuboid     4 1     .66675 -.66675 .66675 -.66675 5.080      2.540
cuboid     3 1     .78105 -.78105 .78105 -.78105 5.080      2.540
unit  8
cuboid     4 1     .78105 -.78105 .78105 -.78105 95.885     5.080
unit  9
cuboid     4 1     .74041 -.74041 .74041 -.74041 98.4250  95.885
cuboid     3 1     .78105 -.78105 .78105 -.78105 98.4250  95.885
unit  10
cuboid     4 1     .78105 -.78105 .78105 -.78105 100.0125 98.4250
global unit  11
array      1   0 0 0
reflector  4 1 30 30 30 30 15.24 30  1
end geom
```

```
read array
ara=1 nux=39 nuy=39 nuz=5
fill
 15r6  9r1 27r6  15r1 22r6  19r1 18r6  23r1 15r6  25r1 13r6
 27r1 11r6
 29r1  9r6  31r1  7r6  33r1  3r6  1q39  2r6  35r1  2r6  1q39
 1r6 37r1   1r6 2q39 351r1 351b585
 15r7  9r2 27r7  15r2 22r7  19r2 18r7  23r2 15r7  25r2 13r7
 27r2 11r7
      29r2  9r7  31r2  7r7  33r2  3r7  1q39  2r7  35r2  2r7  1q39
       1r7 37r2   1r7 2q39 351r2 351b585
 15r8  9r3 27r8  15r3 22r8  19r3 18r8  23r3 15r8  25r3 13r8  27r3 11r8
      29r3  9r8  31r3  7r8  33r3  3r8  1q39  2r8  35r3  2r8  1q39
       1r8 37r3   1r8 2q39 351r3 351b585
 15r9  9r4 27r9  15r4 22r9  19r4 18r9  23r4 15r9  25r4 13r9  27r4 11r9
      29r4  9r9  31r4  7r9  33r4  3r9  1q39  2r9  35r4  2r9  1q39
       1r9 37r4   1r9 2q39 351r4 351b585
 15r10 9r5 27r10 15r5 22r10 19r5 18r10 23r5 15r10 25r5 13r10 27r5 1r10
      29r5  9r10 31r5  7r10 33r5  3r10 1q39  2r10 35r5  2r10 1q39
       1r10 37r5  1r10 2q39 351r5 351b585
end fill
end array
end data
end
```

epru75

```
#csas25
epru75
44group                 latticecell
uo2 1  den=9.20 1.0 293 92234 0.0137  92235 2.35  92236
        0.0171 92238 97.62                                end
al  3  1.0 293                                            end
h2o 4  1.0 293                                            end
end comp
squarepitch 1.905  1.1176 1 4  1.2700 3                   end
Core of 383 fuel rods, 112.08 cm water height with 0.5 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes  end parm

read geom
unit  1
cylinder   3 1 .635 5.080 3.175
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 5.080 3.175
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 5.080 0
unit  2
cylinder   3 1 .635   6.985 5.080
cylinder   4 1 .74422 6.985 5.080
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 6.985 5.080
unit  3
cylinder   1 1 .5588 93.98 6.985
cylinder   3 1 .635 93.98 6.985
```

```
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 93.98 6.985
unit  4
cylinder   1 1 .5588  95.8850 93.98
cylinder   3 1 .635   95.8850 93.98
cylinder   4 1 .74422 95.8850 93.98
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 95.8850 93.98
unit  5
cylinder   1 1 .5588 98.425  95.8850
cylinder   3 1 .635  99.695  95.8850
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525  99.695 95.8850
unit  6
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 5.080 3.175
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 5.080 0
unit  7
cylinder   4 1 .74422 6.985 5.080
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 6.985 5.080
unit  8
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 93.98 6.985
unit  9
cylinder   4 1 .74422 95.8850 93.98
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525  95.8850 93.98
unit  10
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525  99.695   95.8850
global unit  11
array      1   0 0 0
reflector  4 1 30 30 30 30 15.24 30  1
end geom

read array
ara=1 nux=21 nuy=21 nuz=5
fill
  8r6  5r1  9r6  19r1  1r6  5q21  1r6  145r1 1r6  147b147
  8r7  5r2  9r7  19r2  1r7  5q21  1r7  145r2 1r7  147b147
  8r8  5r3  9r8  19r3  1r8  5q21  1r8  145r3 1r8  147b147
  8r9  5r4  9r9  19r4  1r9  5q21  1r9  145r4 1r9  147b147
  8r10 5r5  9r10 19r5  1r10 5q21  1r10 145r5 1r10 147b147
end fill
end array
end data
end
```

epru75b

```
#csas25
epru75b
44groupndf5                  latticecell
uo2  1  den=9.20 1.0 293 92234 0.0137  92235 2.35  92236
          0.0171 92238 97.62                                end
al    3  1.0 293                                            end
h2o   4  1.0 293                                            end
boron 4 den=568.1-6                                         end
end comp
squarepitch 1.905  1.1176 1 4  1.2700 3                     end
Core of 1201 fuel rods, 112.08 cm water height with 568 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes  end parm

read geom
unit  1
cylinder   3 1 .635 5.080 3.175
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 5.080 3.175
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 5.080 0
unit  2
cylinder   3 1 .635   6.985 5.080
cylinder   4 1 .74422 6.985 5.080
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 6.985 5.080
unit  3
cylinder   1 1 .5588 93.98 6.985
cylinder   3 1 .635 93.98 6.985
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 93.98 6.985
unit  4
cylinder   1 1 .5588  95.8850 93.98
cylinder   3 1 .635   95.8850 93.98
cylinder   4 1 .74422 95.8850 93.98
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 95.8850 93.98
unit  5
cylinder   1 1 .5588 98.425  95.8850
cylinder   3 1 .635  99.695  95.8850
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 99.695  95.8850
unit  6
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 5.080 3.175
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 5.080 0
unit  7
cylinder   4 1 .74422 6.985 5.080
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 6.985 5.080
unit  8
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 93.98 6.985
unit  9
cylinder   4 1 .74422 95.8850 93.98
cuboid     3 1     0.9525 -0.9525 0.9525 -0.9525 95.8850 93.98
unit  10
cuboid     4 1     0.9525 -0.9525 0.9525 -0.9525 99.695  95.8850
global unit  11
array      1   0 0 0
reflector  4 1 30 30 30 30 15.24 30  1
end geom

read array
ara=1 nux=39 nuy=39 nuz=5
fill
 15r6  9r1 27r6  15r1 22r6  19r1 18r6  23r1 15r6  25r1 13r6  27r1 11r6
      29r1  9r6  31r1  7r6  33r1  3r6  1q39  2r6  35r1  2r6  1q39
       1r6 37r1   1r6 2q39 351r1 351b585
```

```
15r7  9r2 27r7  15r2 22r7  19r2 18r7  23r2 15r7  25r2 13r7  27r2 11r7
      29r2  9r7  31r2  7r7  33r2  3r7  1q39  2r7  35r2  2r7  1q39
       1r7 37r2   1r7 2q39 351r2 351b585
15r8  9r3 27r8  15r3 22r8  19r3 18r8  23r3 15r8  25r3 13r8  27r3 11r8
      29r3  9r8  31r3  7r8  33r3  3r8  1q39  2r8  35r3  2r8  1q39
       1r8 37r3   1r8 2q39 351r3 351b585
15r9  9r4 27r9  15r4 22r9  19r4 18r9  23r4 15r9  25r4 13r9  27r4 11r9
      29r4  9r9  31r4  7r9  33r4  3r9  1q39  2r9  35r4  2r9  1q39
       1r9 37r4   1r9 2q39 351r4 351b585
15r10 9r5 27r10 15r5 22r10 19r5 18r10 23r5 15r10 25r5 13r10 27r5 1r10
      29r5  9r10 31r5  7r10 33r5  3r10 1q39  2r10 35r5  2r10 1q39
      1r10 37r5  1r10 2q39 351r5 351b585
end fill
end array
end data
end
```

<u>epru87</u>

```
#csas25
epru87
44group             latticecell
uo2  1  den=9.20 1.0 293 92234 0.0137  92235 2.35  92236
         0.0171 92238 97.62                                 end
al   3  1.0 293                                             end
h2o  4  1.0 293                                             end
pb   5  1.0 293                                             end
end comp
squarepitch 2.2098 1.1176 1 4  1.2700 3                     end
Core of 342 fuel rods, 111.76 cm water height with 0.9 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes  end parm

read geom
unit  1
cylinder   3 1 .635 2.540 2.225
cuboid     4 1     .78105 -.78105 .78105 -.78105 2.540 2.225
cuboid     3 1     .78105 -.78105 .78105 -.78105 2.540 0
unit  2
cylinder   3 1 .635 5.080 2.540
cuboid     4 1     .66675 -.66675 .66675 -.66675 5.080 2.540
cuboid     3 1     .78105 -.78105 .78105 -.78105 5.080 2.540
unit  3
cylinder   3 1 .5588 7.3025 5.080
cylinder   1 1 .5588 95.885 5.080
cylinder   3 1 .635 95.885 5.080
cuboid     4 1     .78105 -.78105 .78105 -.78105 95.885 5.080
unit  4
cylinder   1 1 .5588 98.4250 95.885
cylinder   3 1 .635 98.4250 95.885
cuboid     4 1     .74041 -.74041 .74041 -.74041 98.4250 95.885
cuboid     3 1     .78105 -.78105 .78105 -.78105 98.4250 95.885
unit  5
cylinder   1 1 .5588 98.7425 98.4250
cylinder   3 1 .635 100.0125 98.4250
cuboid     4 1     .78105 -.78105 .78105 -.78105 100.0125 98.4250
cuboid     5 1     .78105 -.78105 .78105 -.78105 100.965  98.4250
unit  6
cuboid     4 1     .78105 -.78105 .78105 -.78105 2.540 2.225
cuboid     3 1     .78105 -.78105 .78105 -.78105 2.540 0
unit  7
cuboid     4 1     .66675 -.66675 .66675 -.66675 5.080 2.540
cuboid     3 1     .78105 -.78105 .78105 -.78105 5.080 2.540
unit  8
cuboid     4 1     .78105 -.78105 .78105 -.78105 95.885 5.080
unit  9
cuboid     4 1     .74041 -.74041 .74041 -.74041 98.4250 95.885
cuboid     3 1     .78105 -.78105 .78105 -.78105 98.4250 95.885
unit  10
cuboid     4 1     .78105 -.78105 .78105 -.78105 100.0125 98.4250
cuboid     5 1     .78105 -.78105 .78105 -.78105 100.965  98.4250
global unit  11
array     1   0 0 0
reflector  4 1 30 30 30 30 15.24 30  1
end geom

read array
ara=1 nux=29 nuy=29 nuz=5
fill
 10r6 1 6 4q2  9r6  9r6 1 6 6q2  6r6  6r6 1 6 8q2 5r6  5r6 1 6 9q2 4r6
  4r6 1 6 10q2 3r6  3r6 1 6 11q2 2r6  2r6 1 6 12q2 6         1q58
      6 1 13q2 6         1 6 13q2 1        4q58       261b232
  9r6 1 6 5q2  8r6  10r6 1 6 4q2 9r6
 10r7 2 7 4q2  9r7  9r7 2 7 6q2  6r7  6r7 2 7 8q2 5r7  5r7 2 7 9q2 4r7
  4r7 2 7 10q2 3r7  3r7 2 7 11q2 2r7  2r7 2 7 12q2 7         1q58
      7 2 13q2 7         2 7 13q2 2        4q58       261b232
  9r7 2 7 5q2  8r7  10r7 2 7 4q2 9r7
 10r8 3 8 4q2  9r8  9r8 3 8 6q2  6r8  6r8 3 8 8q2 5r8  5r8 3 8 9q2 4r8
  4r8 3 8 10q2 3r8  3r8 3 8 11q2 2r8  2r8 3 8 12q2 8         1q58
      8 3 13q2 8         3 8 13q2 3        4q58       261b232
  9r8 3 8 5q2  8r8  10r8 3 8 4q2 9r8
 10r9 4 9 4q2  9r9  9r9 4 9 6q2  6r9  6r9 4 9 8q2 5r9  5r9 4 9 9q2 4r9
  4r9 4 9 10q2 3r9  3r9 4 9 11q2 2r9  2r9 4 9 12q2 9         1q58
      9 4 13q2 9         4 9 13q2 4        4q58       261b232
  9r9 4 9 5q2  8r9  10r9 4 9 4q2 9r9
 10r10 5 10 4q2 9r10 9r10 5 10 6q2 6r10 6r10 5 10 8q2 5r10 5r10 5 10
9q2 4r10
  4r10 5 10 10q2 3r10 3r10 5 10 11q2 2r10 2r10 5 10 12q2 10 1q58
      10 5 13q2 10       5 10 13q2 5       4q58       261b232
  9r10 5 10 5q2 8r10 10r10 5 10 4q2 9r10
end fill
end array
```

```
end data
end
```

epru87b

```
#csas25
epru87b
44group                    latticecell
uo2   1  den=9.20 1.0 293 92234 0.0137  92235 2.35  92236 0.0171
      92238 97.62                                         end
al    3  1.0 293                                          end
h2o   4  1.0 293                                          end
boron 4 den=285.8-6                                       end
end comp
squarepitch 2.2098 1.1176 1 4  1.2700 3                   end
Core of 885 fuel rods, 111.76 cm water height with 285.8 ppm boron
read parm gen=405 npg=600 nsk=5 nub=yes run=yes   end parm

read geom
unit  1
cylinder   3 1 .635 2.540 2.2225
cuboid     4 1      1.1049 -1.1049 1.1049 -1.1049 2.540 2.2225
cuboid     3 1      1.1049 -1.1049 1.1049 -1.1049 2.540 0
unit  2
cylinder   3 1 .635 5.080 2.540
cuboid     4 1      .99060 -.99060 .99060 -.99060 5.080 2.540
cuboid     3 1      1.1049 -1.1049 1.1049 -1.1049 5.080 2.540
unit  3
cylinder   3 1 .5588 7.3025 5.080
cylinder   1 1 .5588 95.885 5.080
cylinder   3 1 .635 95.885 5.080
cuboid     4 1      1.1049 -1.1049 1.1049 -1.1049 95.885 5.080
unit  4
cylinder   1 1 .5588 98.4250 95.885
cylinder   3 1 .635 98.4250 95.885
cuboid     4 1      1.06426 -1.06426 1.06426 -1.06426 98.4250 95.885
cuboid     3 1      1.1049 -1.1049 1.1049 -1.1049 98.4250 95.885
unit  5
cylinder   1 1 .5588 98.7425 98.4250
cylinder   3 1 .635 100.0125 98.4250
cuboid     4 1      1.1049 -1.1049 1.1049 -1.1049 100.0125 98.4250
unit  6
cuboid     4 1      1.1049 -1.1049 1.1049 -1.1049 2.540 2.2225
cuboid     3 1      1.1049 -1.1049 1.1049 -1.1049 2.540 0
unit  7
cuboid     4 1      .99060 -.99060 .99060 -.99060 5.080 2.540
cuboid     3 1      1.1049 -1.1049 1.1049 -1.1049 5.080 2.540
unit  8
cuboid     4 1      1.1049 -1.1049 1.1049 -1.1049 95.885 5.080
unit  9
cuboid     4 1      1.06426 -1.06426 1.06426 -1.06426 98.4250 95.885
cuboid     3 1      1.1049 -1.1049 1.1049 -1.1049 98.4250 95.885
unit  10
cuboid     4 1      1.1049 -1.1049 1.1049 -1.1049 100.0125 98.4250
global unit  11
array      1   0 0 0
reflector  4 1 30 30 30 30 15.24 30  1
end geom

read array
ara=1 nux=33 nuy=33 nuz=5
fill
 11r6 11r1 20r6  15r1 16r6  19r1 13r6  21r1 11r6  23r1  9r6  25r1 7r6
 27r1  5r6 29r1   2r6 1q33   1r6 31r1   1r6 1q33  363r1 363b363
 11r7 11r2 20r7  15r2 16r7  19r2 13r7  21r2 11r7  23r2  9r7  25r2 7r7
 27r2  5r7 29r2   2r7 1q33   1r7 31r2   1r7 1q33  363r2 363b363
 11r8 11r3 20r8  15r3 16r8  19r3 13r8  21r3 11r8  23r3  9r8  25r3 7r8
 27r3  5r8 29r3   2r8 1q33   1r8 31r3   1r8 1q33  363r3 363b363
 11r9 11r4 20r9  15r4 16r9  19r4 13r9  21r4 11r9  23r4  9r9  25r4 7r9
 27r4  5r9 29r4   2r9 1q33   1r9 31r4   1r9 1q33  363r4 363b363
11r10 11r5 20r10 15r5 16r10 19r5 13r10 21r5 11r10 23r5 9r10 25r5 7r10
 27r5  5r10 29r5  2r10 1q33  1r10 31r5  1r10 1q33 363r5 363b363
end fill
end array
end data
end
```

nse71h1

```
#csas25
nse71h1
44group  latticecell
uo2         1 den=10.38 1.0 293 92235 4.742 92238 95.258           end
arbmag5     2.70 4 0 0 1 13027 98.85 12000 0.47  14000 0.43
            26000 0.22 2 1 293                                     end
h2o         3 1.0                                                  end
arbmstl     7.90 3 0 0 1 26304 71.40 24304 19.16 28304 9.44 4 1    end
al          5 0.437                                                end
arbmstl     7.90 3 0 0 1 26304 71.40 24304 19.16 28304 9.44 5 .505 end
h2o         5 0.058                                                end
al          6 0.62                                                 end
h2o         6 0.038                                                end
uo2         7 0.946 293 92235 4.742 92238 95.258                   end
end comp
triangpitch  1.35  0.79   1 3 0.94  2 0.82  0                      end
more data res=7 cyl 0.395  dan(7)=.98636                           end
Core of 547 fuel rods in a hexagonal lattice, 60.93 cm water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit  2
zhemicyl+y 1 1 .395               60.93   0.0
```

```
zhemicyl+y 0 1 .410                60.93   0.0
zhemicyl+y 2 1 .470                60.93   0.0
unit  3
zhemicyl-x 1 1 .395                60.93   0.0
zhemicyl-x 0 1 .410                60.93   0.0
zhemicyl-x 2 1 .470                60.93   0.0
unit  4
zhemicyl+x 1 1 .395                60.93   0.0
zhemicyl+x 0 1 .410                60.93   0.0
zhemicyl+x 2 1 .470                60.93   0.0
unit  5
zhemicyl-y 1 1 .395                60.93   0.0
zhemicyl-y 0 1 .410                60.93   0.0
zhemicyl-y 2 1 .470                60.93   0.0
cuboid     3 1  2p1.1692  0 -1.35  60.93   0.0
hole       2    0           -1.35          0.0
hole       3    +1.1692     -0.675         0.0
hole       4    -1.1692     -0.675         0.0
unit  6
zhemicyl+y 1 1 .395                60.93   0.0
zhemicyl+y 0 1 .410                60.93   0.0
zhemicyl+y 2 1 .470                60.93   0.0
cuboid     3 1  2p1.1692 1.35   0  60.93   0.0
hole       3    +1.1692     +0.675         0.0
unit  7
zhemicyl+y 1 1 .395                60.93   0.0
zhemicyl+y 0 1 .410                60.93   0.0
zhemicyl+y 2 1 .470                60.93   0.0
cuboid     3 1  2p1.1692 1.35   0  60.93   0.0
hole       4    -1.1692     +0.675         0.0
unit  8
zhemicyl-y 1 1 .395                60.93   0.0
zhemicyl-y 0 1 .410                60.93   0.0
zhemicyl-y 2 1 .470                60.93   0.0
cuboid     3 1  2p1.1692  0 -1.35  60.93   0.0
hole       3    +1.1692     -0.675         0.0
unit  9
zhemicyl-y 1 1 .395                60.93   0.0
zhemicyl-y 0 1 .410                60.93   0.0
zhemicyl-y 2 1 .470                60.93   0.0
cuboid     3 1  2p1.1692  0 -1.35  60.93   0.0
hole       4    -1.1692     -0.675         0.0
unit  10
zhemicyl-y 1 1 .395                60.93   0.0
zhemicyl-y 0 1 .410                60.93   0.0
zhemicyl-y 2 1 .470                60.93   0.0
cuboid     3 1  2p1.1692  0 -1.35  60.93   0.0
unit  11
zhemicyl+y 1 1 .395                60.93   0.0
zhemicyl+y 0 1 .410                60.93   0.0
zhemicyl+y 2 1 .470                60.93   0.0
cuboid     3 1  2p1.1692 1.35   0  60.93   0.0
unit  12
cuboid     3 1  2p1.1692 1.35   0  60.93   0.0
hole       3    +1.1692     +0.675         0.0
unit  13
cuboid     3 1  2p1.1692 1.35   0  60.93   0.0
hole       4    -1.1692     +0.675         0.0
unit  14
cuboid     3 1  2p1.1692 1.35   0  60.93   0.0
unit  15
zhemicyl+y 7 1 .395                29.07   0.0
zhemicyl+y 0 1 .410                29.07   0.0
zhemicyl+y 2 1 .470                29.07   0.0
unit  16
zhemicyl-x 7 1 .395                29.07   0.0
zhemicyl-x 0 1 .410                29.07   0.0
zhemicyl-x 2 1 .470                29.07   0.0
unit  17
zhemicyl+x 7 1 .395                29.07   0.0
zhemicyl+x 0 1 .410                29.07   0.0
zhemicyl+x 2 1 .470                29.07   0.0
unit  18
zhemicyl-y 7 1 .395                29.07   0.0
zhemicyl-y 0 1 .410                29.07   0.0
zhemicyl-y 2 1 .470                29.07   0.0
cuboid     0 1  2p1.1692  0 -1.35  29.07   0.0
hole       15   0           -1.35          0.0
hole       16   +1.1692     -0.675         0.0
hole       17   -1.1692     -0.675         0.0
unit  19
zhemicyl+y 7 1 .395                29.07   0.0
zhemicyl+y 0 1 .410                29.07   0.0
zhemicyl+y 2 1 .470                29.07   0.0
cuboid     0 1  2p1.1692 1.35   0  29.07   0.0
hole       16   +1.1692     +0.675         0.0
unit  20
zhemicyl+y 7 1 .395                29.07   0.0
zhemicyl+y 0 1 .410                29.07   0.0
zhemicyl+y 2 1 .470                29.07   0.0
cuboid     0 1  2p1.1692 1.35   0  29.07   0.0
hole       17   -1.1692     +0.675         0.0
unit  21
zhemicyl-y 7 1 .395                29.07   0.0
zhemicyl-y 0 1 .410                29.07   0.0
zhemicyl-y 2 1 .470                29.07   0.0
cuboid     0 1  2p1.1692  0 -1.35  29.07   0.0
hole       16   +1.1692     -0.675         0.0
unit  22
zhemicyl-y 7 1 .395                29.07   0.0
zhemicyl-y 0 1 .410                29.07   0.0
zhemicyl-y 2 1 .470                29.07   0.0
```

```
cuboid      0 1  2p1.1692  0 -1.35  29.07   0.0
hole       17     -1.1692      -0.675           0.0
unit  23
zhemicyl-y 7 1 .395                 29.07   0.0
zhemicyl-y 0 1 .410                 29.07   0.0
zhemicyl-y 2 1 .470                 29.07   0.0
cuboid      0 1  2p1.1692  0 -1.35  29.07   0.0
unit  24
zhemicyl+y 7 1 .395                 29.07   0.0
zhemicyl+y 0 1 .410                 29.07   0.0
zhemicyl+y 2 1 .470                 29.07   0.0
cuboid      0 1  2p1.1692 1.35  0   29.07   0.0
unit  25
cuboid      0 1  2p1.1692 1.35  0   29.07   0.0
hole       16     +1.1692      +0.675           0.0
unit  26
cuboid      0 1  2p1.1692 1.35  0  29.07    0.0
hole       17     -1.1692      +0.675           0.0
unit  27
cuboid      0 1  2p1.1692 1.35  0  29.07    0.0
unit 28
array 1 3*0.0
reflector  5 1 5r0    0.25 1
reflector  6 1 5r0    1.55 1
reflector  3 1 4r20 2r0    1
reflector  4 1 5r0     .8  1
reflector  3 1 5r0   20    1
unit 29
array 2 3*0.0
reflector  0 1 4r20 2r0    1
global unit  30
array 3 3*0.0
end geom

read array
ara=1 nux=15 nuy=28 nuz=1
fill 7r14 10 7r14  6r14 8 5 9 6r14  5r14 8 3r5 9 5r14
     4r14 8 5r5 9 4r14  3r14 8 7r5 9 3r14  2r14 8 9r5 9 2r14
     14 8 11r5 9 14  12 13r5 13 13q15
     14 6 11r5 7 14  2r14 6 9r5 7 2r14  3r14 6 7r5 7 3r14
     4r14 6 5r5 7 4r14  5r14 6 3r5 7 5r14  6r14 6 5 7 6r14
     7r14 11 7r14                    end fill
ara=2 nux=15 nuy=28 nuz=1
fill 7r27 23 7r27  6r27 21 18 22 6r27  5r27 21 3r18 22 5r27
     4r27 21 5r18 22 4r27  3r27 21 7r18 22 3r27  2r27 21 9r18 22 2r27
     27 21 11r18 22 27  25 13r18 26 13q15
     27 19 11r18 20 27  2r27 19 9r18 20 2r27  3r27 19 7r18 20 3r27
     4r27 19 5r18 20 4r27  5r27 19 3r18 20 5r27  6r27 19 18 20 6r27
     7r27 24 7r27                    end fill
ara=3 nux=1  nuy=1  nuz=2 fill 28 29 end fill
end array
```

```
end data
end
```

<u>nse71h2</u>

```
#csas25
nse71h2
44group  latticecell
uo2       1 den=10.38 1.0 293 92235 4.742 92238 95.258                 end
arbmag5   2.70 4 0 0 1 13027 98.85 12000 0.47  14000 0.43
          26000 0.22 2 1 293                                           end
h2o       3 1.0                                                        end
arbmstl   7.90 3 0 0 1 26304 71.40 24304 19.16 28304 9.44 4 1         end
al        5 0.437                                                      end
arbmstl   7.90 3 0 0 1 26304 71.40 24304 19.16 28304 9.44 5 .505  end
h2o       5 0.058                                                      end
al        6 0.62                                                       end
h2o       6 0.038                                                      end
uo2       7 0.946 293 92235 4.742 92238 95.258                         end
end comp
triangpitch  1.72  0.79   1 3 0.94  2 0.82  0                          end
more data res=7 cyl 0.395  dan(7)=.98899                               end
Core of 271 fuel rods in a hexagonal lattice, 68.06 cm water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit  2
zhemicyl+y 1 1 .395                   68.06   0.0
zhemicyl+y 0 1 .410                   68.06   0.0
zhemicyl+y 2 1 .470                   68.06   0.0
unit  3
zhemicyl-x 1 1 .395                   68.06   0.0
zhemicyl-x 0 1 .410                   68.06   0.0
zhemicyl-x 2 1 .470                   68.06   0.0
unit  4
zhemicyl+x 1 1 .395                   68.06   0.0
zhemicyl+x 0 1 .410                   68.06   0.0
zhemicyl+x 2 1 .470                   68.06   0.0
unit  5
zhemicyl-y 1 1 .395                   68.06   0.0
zhemicyl-y 0 1 .410                   68.06   0.0
zhemicyl-y 2 1 .470                   68.06   0.0
cuboid      3 1  2p1.4896  0 -1.72   68.06   0.0
hole        2    0            -1.72           0.0
hole        3    +1.4896      -0.860          0.0
hole        4    -1.4896      -0.860          0.0
unit  6
zhemicyl+y 1 1 .395                   68.06   0.0
zhemicyl+y 0 1 .410                   68.06   0.0
zhemicyl+y 2 1 .470                   68.06   0.0
cuboid      3 1  2p1.4896 1.72   0   68.06   0.0
```

```
hole        3    +1.4896     +0.860          0.0
unit  7
zhemicyl+y 1 1 .395                  68.06   0.0
zhemicyl+y 0 1 .410                  68.06   0.0
zhemicyl+y 2 1 .470                  68.06   0.0
cuboid     3 1  2p1.4896 1.72   0  68.06   0.0
hole        4    -1.4896     +0.860          0.0
unit  8
zhemicyl-y 1 1 .395                  68.06   0.0
zhemicyl-y 0 1 .410                  68.06   0.0
zhemicyl-y 2 1 .470                  68.06   0.0
cuboid     3 1  2p1.4896  0 -1.72  68.06   0.0
hole        3    +1.4896     -0.860          0.0
unit  9
zhemicyl-y 1 1 .395                  68.06   0.0
zhemicyl-y 0 1 .410                  68.06   0.0
zhemicyl-y 2 1 .470                  68.06   0.0
cuboid     3 1  2p1.4896  0 -1.72  68.06   0.0
hole        4    -1.4896     -0.860          0.0
unit  10
zhemicyl-y 1 1 .395                  68.06   0.0
zhemicyl-y 0 1 .410                  68.06   0.0
zhemicyl-y 2 1 .470                  68.06   0.0
cuboid     3 1  2p1.4896  0 -1.72  68.06   0.0
unit  11
zhemicyl+y 1 1 .395                  68.06   0.0
zhemicyl+y 0 1 .410                  68.06   0.0
zhemicyl+y 2 1 .470                  68.06   0.0
cuboid     3 1  2p1.4896 1.72  0   68.06   0.0
unit  12
cuboid     3 1  2p1.4896 1.72  0  68.06    0.0
hole        3    +1.4896     +0.860          0.0
unit  13
cuboid     3 1  2p1.4896 1.72  0  68.06    0.0
hole        4    -1.4896     +0.860          0.0
unit  14
cuboid     3 1  2p1.4896 1.72  0  68.06    0.0
unit  15
zhemicyl+y 7 1 .395                  90.00   68.06
zhemicyl+y 0 1 .410                  90.00   68.06
zhemicyl+y 2 1 .470                  90.00   68.06
unit  16
zhemicyl-x 7 1 .395                  90.00   68.06
zhemicyl-x 0 1 .410                  90.00   68.06
zhemicyl-x 2 1 .470                  90.00   68.06
unit  17
zhemicyl+x 7 1 .395                  90.00   68.06
zhemicyl+x 0 1 .410                  90.00   68.06
zhemicyl+x 2 1 .470                  90.00   68.06
unit  18
zhemicyl-y 7 1 .395                  90.00   68.06
zhemicyl-y 0 1 .410                  90.00   68.06
zhemicyl-y 2 1 .470                  90.00   68.06
cuboid     0 1  2p1.4896  0 -1.72  90.00   68.06
hole       15    0             -1.72          0.0
hole       16    +1.4896      -0.860          0.0
hole       17    -1.4896      -0.860          0.0
unit  19
zhemicyl+y 7 1 .395                  90.00   68.06
zhemicyl+y 0 1 .410                  90.00   68.06
zhemicyl+y 2 1 .470                  90.00   68.06
cuboid     0 1  2p1.4896 1.72  0   90.00   68.06
hole       16    +1.4896      +0.860          0.0
unit  20
zhemicyl+y 7 1 .395                  90.00   68.06
zhemicyl+y 0 1 .410                  90.00   68.06
zhemicyl+y 2 1 .470                  90.00   68.06
cuboid     0 1  2p1.4896 1.72  0   90.00   68.06
hole       17    -1.4896      +0.860          0.0
unit  21
zhemicyl-y 7 1 .395                  90.00   68.06
zhemicyl-y 0 1 .410                  90.00   68.06
zhemicyl-y 2 1 .470                  90.00   68.06
cuboid     0 1  2p1.4896  0 -1.72  90.00   68.06
hole       16    +1.4896      -0.860          0.0
unit  22
zhemicyl-y 7 1 .395                  90.00   68.06
zhemicyl-y 0 1 .410                  90.00   68.06
zhemicyl-y 2 1 .470                  90.00   68.06
cuboid     0 1  2p1.4896  0 -1.72  90.00   68.06
hole       17    -1.4896      -0.860          0.0
unit  23
zhemicyl-y 7 1 .395                  90.00   68.06
zhemicyl-y 0 1 .410                  90.00   68.06
zhemicyl-y 2 1 .470                  90.00   68.06
cuboid     0 1  2p1.4896  0 -1.72  90.00   68.06
unit  24
zhemicyl+y 7 1 .395                  90.00   68.06
zhemicyl+y 0 1 .410                  90.00   68.06
zhemicyl+y 2 1 .470                  90.00   68.06
cuboid     0 1  2p1.4896 1.72  0   90.00   68.06
unit  25
cuboid     0 1  2p1.4896 1.72  0   90.00   68.06
hole       16    +1.4896      +0.860          0.0
unit  26
cuboid     0 1  2p1.4896 1.72  0  90.00    68.06
hole       17    -1.4896      +0.860          0.0
unit  27
cuboid     0 1  2p1.4896 1.72  0  90.00    68.06
unit  28
array 1 3*0.0
reflector  5 1 5r0    0.25 1
```

```
reflector  6 1 5r0    1.55 1
reflector  3 1 4r20 2r0    1
reflector  4 1 5r0     .8  1
reflector  3 1 5r0   20    1
unit 29
array 2 3*0.0
reflector  0 1 4r20 2r0    1
global unit  30
array 3 3*0.0
end geom

read array
ara=1 nux=11 nuy=20 nuz=1
fill 5r14 10 5r14  4r14 8 5 9 4r14  3r14 8 3r5 9 3r14
     2r14 8 5r5 9 2r14  14 8 7r5 9 14  12 9r5 13
     9q11
     14 6 7r5 7 14  2r14 6 5r5 7 2r14  3r14 6 3r5 7 3r14
     4r14 6 5 7 4r14  5r14 11 5r14    end fill
ara=2 nux=11 nuy=20 nuz=1
fill 5r27 23 5r27  4r27 21 18 22 4r27  3r27 21 3r18 22 3r27
     2r27 21 5r18 22 2r27  27 21 7r18 22 27  25 9r18 26
     9q11
     27 19 7r18 20 27  2r27 19 5r18 20 2r27  3r27 19 3r18 20 3r27
     4r27 19 18 20 4r27  5r27 24 5r27 end fill
ara=3 nux=1  nuy=1  nuz=2 fill 28 29  end fill
end array
end data
end
```

<u>nse71h3</u>

```
#csas25
nse71h3
44group   latticecell
uo2       1 den=10.38 1.0 293 92235 4.742 92238 95.258               end
arbmag5   2.70 4 0 0 1 13027 98.85 12000 0.47  14000 0.43
          26000 0.22 2 1 293                                         end
h2o       3 1.0                                                      end
arbmstl   7.90 3 0 0 1 26304 71.40 24304 19.16 28304 9.44 4 1        end
al        5 0.437                                                    end
arbmstl   7.90 3 0 0 1 26304 71.40 24304 19.16 28304 9.44 5 .505     end
h2o       5 0.058                                                    end
al        6 0.62                                                     end
h2o       6 0.038                                                    end
uo2       7 0.946 293 92235 4.742 92238 95.258                       end
end comp
triangpitch  2.26  0.79   1 3 0.94  2 0.82  l                        end
more data res=7 cyl 0.395  dan(7)=.991675                            end
Core of 217 fuel rods in a hexagonal lattice, 79.50 cm water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm
```

```
read geom
unit  2
zhemicyl+y 1 1 .395                        79.50   0.0
zhemicyl+y 0 1 .410                        79.50   0.C
zhemicyl+y 2 1 .470                        79.50   0.0
unit  3
zhemicyl-x 1 1 .395                        79.50   0.0
zhemicyl-x 0 1 .410                        79.50   0.0
zhemicyl-x 2 1 .470                        79.50   0.0
unit  4
zhemicyl+x 1 1 .395                        79.50   0.0
zhemicyl+x 0 1 .410                        79.50   0.0
zhemicyl+x 2 1 .470                        79.50   0.0
unit  5
zhemicyl-y 1 1 .395                        79.50   0.0
zhemicyl-y 0 1 .410                        79.50   0.0
zhemicyl-y 2 1 .470                        79.50   0.0
cuboid     3 1  2p1.9572  0 -2.26          79.50   0.0
hole       2    0              -2.26               0.0
hole       3    +1.9572        -1.130              0.0
hole       4    -1.9572        -1.130              0.0
unit  6
zhemicyl+y 1 1 .395                        79.50   0.0
zhemicyl+y 0 1 .410                        79.50   0.0
zhemicyl+y 2 1 .470                        79.50   0.0
cuboid     3 1  2p1.9572 2.26    0         79.50   0.0
hole       3    +1.9572        +1.130              0.0
unit  7
zhemicyl+y 1 1 .395                        79.50   0.0
zhemicyl+y 0 1 .410                        79.50   0.0
zhemicyl+y 2 1 .470                        79.50   0.0
cuboid     3 1  2p1.9572 2.26    0         79.50   0.0
hole       4    -1.9572        +1.130              0.0
unit  8
zhemicyl-y 1 1 .395                        79.50   0.0
zhemicyl-y 0 1 .410                        79.50   0.0
zhemicyl-y 2 1 .470                        79.50   0.0
cuboid     3 1  2p1.9572  0 -2.26          79.50   0.0
hole       3    +1.9572        -1.130              0.0
unit  9
zhemicyl-y 1 1 .395                        79.50   0.0
zhemicyl-y 0 1 .410                        79.50   0.0
zhemicyl-y 2 1 .470                        79.50   0.0
cuboid     3 1  2p1.9572  0 -2.26          79.50   0.0
hole       4    -1.9572        -1.130              0.0
unit  10
zhemicyl-y 1 1 .395                        79.50   0.0
zhemicyl-y 0 1 .410                        79.50   0.0
zhemicyl-y 2 1 .470                        79.50   0.0
cuboid     3 1  2p1.9572  0 -2.26          79.50   0.0
unit  11
```

```
zhemicyl+y 1 1 .395                 79.50   0.0
zhemicyl+y 0 1 .410                 79.50   0.0
zhemicyl+y 2 1 .470                 79.50   0.0
cuboid     3 1  2p1.9572 2.26  0    79.50   0.0
unit  12
zhemicyl-y 1 1 .395                 79.50   0.0
zhemicyl-y 0 1 .410                 79.50   0.0
zhemicyl-y 2 1 .470                 79.50   0.0
cuboid     3 1  2p1.9572  0 -2.26   79.50   0.0
hole       2    0         -2.26             0.0
hole       3    +1.9572   -1.130            0.0
unit  13
zhemicyl-y 1 1 .395                 79.50   0.0
zhemicyl-y 0 1 .410                 79.50   0.0
zhemicyl-y 2 1 .470                 79.50   0.0
cuboid     3 1  2p1.9572  0 -2.26   79.50   0.0
hole       2    0         -2.26             0.0
hole       4    -1.9572   -1.130            0.0
unit  14
cuboid     3 1  2p1.9572 2.26  0    79.50   0.0
unit  15
zhemicyl+y 7 1 .395                 90.00   79.50
zhemicyl+y 0 1 .410                 90.00   79.50
zhemicyl+y 2 1 .470                 90.00   79.50
unit  16
zhemicyl-x 7 1 .395                 90.00   79.50
zhemicyl-x 0 1 .410                 90.00   79.50
zhemicyl-x 2 1 .470                 90.00   79.50
unit  17
zhemicyl+x 7 1 .395                 90.00   79.50
zhemicyl+x 0 1 .410                 90.00   79.50
zhemicyl+x 2 1 .470                 90.00   79.50
unit  18
zhemicyl-y 7 1 .395                 90.00   79.50
zhemicyl-y 0 1 .410                 90.00   79.50
zhemicyl-y 2 1 .470                 90.00   79.50
cuboid     0 1  2p1.9572  0 -2.26   90.00   79.50
hole      15    0         -2.26             0.0
hole      16    +1.9572   -1.130            0.0
hole      17    -1.9572   -1.130            0.0
unit  19
zhemicyl+y 7 1 .395                 90.00   79.50
zhemicyl+y 0 1 .410                 90.00   79.50
zhemicyl+y 2 1 .470                 90.00   79.50
cuboid     0 1  2p1.9572 2.26  0    90.00   79.50
hole      16    +1.9572   +1.130            0.0
unit  20
zhemicyl+y 7 1 .395                 90.00   79.50
zhemicyl+y 0 1 .410                 90.00   79.50
zhemicyl+y 2 1 .470                 90.00   79.50
cuboid     0 1  2p1.9572 2.26  0    90.00   79.50
hole      17    -1.9572   +1.130            0.0
unit  21
zhemicyl-y 7 1 .395                 90.00   79.50
zhemicyl-y 0 1 .410                 90.00   79.50
zhemicyl-y 2 1 .470                 90.00   79.50
cuboid     0 1  2p1.9572  0 -2.26   90.00   79.50
hole      16    +1.9572   -1.130            0.0
unit  22
zhemicyl-y 7 1 .395                 90.00   79.50
zhemicyl-y 0 1 .410                 90.00   79.50
zhemicyl-y 2 1 .470                 90.00   79.50
cuboid     0 1  2p1.9572  0 -2.26   90.00   79.50
hole      17    -1.9572   -1.130            0.0
unit  23
zhemicyl-y 7 1 .395                 90.00   79.50
zhemicyl-y 0 1 .410                 90.00   79.50
zhemicyl-y 2 1 .470                 90.00   79.50
cuboid     0 1  2p1.9572  0 -2.26   90.00   79.50
unit  24
zhemicyl+y 7 1 .395                 90.00   79.50
zhemicyl+y 0 1 .410                 90.00   79.50
zhemicyl+y 2 1 .470                 90.00   79.50
cuboid     0 1  2p1.9572 2.26  0    90.00   79.50
unit  25
zhemicyl-y 7 1 .395                 90.00   79.50
zhemicyl-y 0 1 .410                 90.00   79.50
zhemicyl-y 2 1 .470                 90.00   79.50
cuboid     0 1  2p1.9572  0 -2.26   90.00   79.50
hole      15    0         -2.26             0.0
hole      16    +1.9572   -1.130            0.0
unit  26
zhemicyl-y 7 1 .395                 90.00   79.50
zhemicyl-y 0 1 .410                 90.00   79.50
zhemicyl-y 2 1 .470                 90.00   79.50
cuboid     0 1  2p1.9572  0 -2.26   90.00   79.50
hole      15    0         -2.26             0.0
hole      17    -1.9572   -1.130            0.0
unit  27
cuboid     0 1  2p1.9572 2.26  0    90.00   79.50
unit 28
array 1 3*0.0
reflector  5 1 5r0    0.25 1
reflector  6 1 5r0    1.55 1
reflector  3 1 4r20 2r0    1
reflector  4 1 5r0      .8 1
reflector  3 1 5r0   20    1
unit 29
array 2 3*0.0
reflector  0 1 4r20 2r0    1
global unit  30
```

```
array 3 3*0.0
end geom

read array
ara=1 nux=9 nuy=18 nuz=1
fill 4r14 10 4r14  3r14 8 5 9 3r14  2r14 8 3r5 9 2r14
     14 8 5r5 9 14  8 7r5 9  12 7r5 13
     7q9
     6 7r5 7   14 6 5r5 7 14  2r14 6 3r5 7 2r14
     3r14 6 5 7 3r14  4r14 11 4r14    end fill
ara=2 nux=9 nuy=18 nuz=1
fill 4r27 23 4r27  3r27 21 18 22 3r27  2r27 21 3r18 22 2r27
     27 21 5r18 22 27  21 7r18 22  25 7r18 26
     7q9
     19 7r18 20  27 19 5r18 20 27  2r27 19 3r18 20 2r27
     3r27 19 18 20 3r27  4r27 24 4r27 end fill
ara=3 nux=1  nuy=1  nuz=2 fill 28 29  end fill
end array
end data
end
```

nse71sq

```
=csas25
nse71sq
44group latticecell
uo2       1 0.947 293 92235 4.742 92238 95.258                 end
arbmag5   2.70 4 0 0 1 13027 98.85 12000 0.47 14000 0.43
          26000 0.22 2 1 293                                   end
h2o       3 1.0                                                end
arbmss    7.90 3 0 0 1 24304 19.17 26304 71.40 28304 9.37 4    end
al        5 1.0                                                end
end comp
squarepitch 1.26 0.79 1 3 0.94 2 0.82 0                        end
Core of 22x22 fuel rods, 90.69 cm water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 1 1 0.395          90.00 0.0
cylinder 0 1 0.410          90.00 0.0
cylinder 2 1 0.470          90.00 0.0
cuboid   3 1 4p0.63         90.69 0.0
unit 2
cylinder 5 1 0.470          0.25  0.0
cylinder 3 1 0.500          0.25  0.0
cuboid   4 1 4p0.63         0.25  0.0
unit 3
cylinder 5 1 0.470          2.35  0.8
cuboid   3 1 4p0.63         2.35  0.8
cuboid   4 1 4p0.63         2.35  0.0
```

```
unit 4
array 1 3*0.0
global
unit 5
array 2 3*0.0
reflector 3 1 4r20.0 0.0 20.0 1
end geom

read array
ara=1 nux=1 nuy=1 nuz=3   fill 3 2 1 end fill
ara=2 nux=22 nuy=22 nuz=1 fill f4    end fill
end array
end data
end
```

nse71w1

```
=csas25
nse71w1
44group latticecell
uo2     1 0.947 293 92235 4.742 92238 95.258                   end
arbmag5 2.70 4 0 0 1 13027 98.85 12000 0.47 14000 0.43
        26000 0.22 2 1 293                                     end
h2o     3 1.0                                                  end
arbmss 7.90 3 0 0 1 24000 19.17 26000 71.40 28000 9.37 4       end
al      5 1.0                                                  end
end comp
squarepitch 1.26 0.79 1 3 0.94 2 0.82 0                        end
Core of 22x22 positions: 459 fuel rods, 25 water holes, 81.36 cm water
 height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 1 1 0.395          81.36 0.0
cylinder 0 1 0.410          81.36 0.0
cylinder 2 1 0.470          81.36 0.0
cuboid   3 1 4p0.63         81.36 0.0
unit 2
cylinder 5 1 0.470          0.25  0.0
cylinder 3 1 0.500          0.25  0.0
cuboid   4 1 4p0.63         0.25  0.0
unit 3
cylinder 5 1 0.470          2.35  0.8
cuboid   3 1 4p0.63         2.35  0.8
cuboid   4 1 4p0.63         2.35  0.0
unit 4
array 1 3*0.0
unit 5
cylinder 3 1 0.500          0.00  -0.25
cuboid   4 1 4p0.63         0.00  -0.25
```

```
cuboid   3 1 4p0.63        0.00  -1.80
cuboid   4 1 4p0.63        0.00  -2.60
cuboid   3 1 4p0.63        81.36 -2.60
global
unit 6
array 2 3*0.0
reflector 3 1 4r20.0 0.0 20.0 1
end geom

read array
ara=1 nux=1 nuy=1 nuz=3   fill 3 2 1                        end fill
ara=2 nux=22 nuy=22 nuz=1 fill 5 4r4 3q5 5 4 88r4 3q110 5 4r4
     3q5 5 4 22r4                                           end fill
end array
end data
end
```

nse71w2

```
=csas25
nse71w2
44group latticecell
uo2      1 0.947 293 92235 4.742 92238 95.258               end
arbmag5 2.70 4 0 0 1 13027 98.85 12000 0.47 14000 0.43
         26009 0.22 2 1 293                                 end
h2o      3 1.0                                              end
arbmss   7.90 3 0 0 1 24000 19.17 26000 71.40 28000 9.37 4 end
al       5 1.0                                              end
end comp
squarepitch 1.26 0.79 1 3 0.94 2 0.82 0                     end
Core of 22x22 positions: 420 fuel rods, 64 water holes, 73.05 cm water
`height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 1 1 0.395          73.05 0.0
cylinder 0 1 0.410          73.05 0.0
cylinder 2 1 0.470          73.05 0.0
cuboid   3 1 4p0.63         73.05 0.0
unit 2
cylinder 5 1 0.470          0.25  0.0
cylinder 3 1 0.500          0.25  0.0
cuboid   4 1 4p0.63         0.25  0.0
unit 3
cylinder 5 1 0.470          2.35  0.8
cuboid   3 1 4p0.63         2.35  0.8
cuboid   4 1 4p0.63         2.35  0.0
unit 4
array 1 3*0.0
unit 5
cylinder 3 1 0.500          0.00  -0.25
cuboid   4 1 4p0.63         0.00  -0.25
cuboid   3 1 4p0.63         0.00  -1.80
cuboid   4 1 4p0.63         0.00  -2.60
cuboid   3 1 4p0.63         73.05 -2.60
global
unit 6
array 2 3*0.0
reflector 3 1 4r20.0 0.0 20.0 1
end geom

read array
ara=1 nux=1 nuy=1 nuz=3   fill 3 2 1                            end fill
ara=2 nux=22 nuy=22 nuz=1 fill 5 2r4 6q3 5 44r4 6q66 5 2r4
6q3 5                                                       end fill
end array
end data
end
```

p49-194

```
=csas25          parm=size=300000
p49-194
44group                   latticecell
uo2         1  den=10.40 1.0 293 92234 .022 92235 4.306 92236
               .022 92238 95.65                              end
al          2  1.0 293                                       end
h           3  den=1.321 .065 293                            end
c           3  den=1.321 .58  293                            end
o           3  den=1.321 .221 293                            end
s           3  den=1.321 .017 293                            end
ca          3  den=1.321 .114 293                            end
si          3  den=1.321 .003 293                            end
h2o         4  1.0            293                            end
h           5  den=1.185 .08  293                            end
c           5  den=1.185 .60  293                            end
o           5  den=1.185 .32  293                            end
poly(h2o)   6  den=0.905 1.0  293                            end
end comp
triangpitch 1.598 1.265 1  4  1.415 2  1.283 0               end
Core of 1185 fuel rods in a hexagonal lattice
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit  1
com=!   0.0  to    2.54 cm 01 !
zhemicyl+x 3 1 .6415 2.54 0.0
zhemicyl+x 2 1 .7075 2.54 0.0
zhemicyl+x 4 1 .714  2.54 0.0
unit  2
com=!   0.0  to    2.54 cm 01 !
```

```
zhemicyl-y 3 1 .6415 2.54 0.0
zhemicyl-y 2 1 .7075 2.54 0.0
zhemicyl-y 4 1 .714  2.54 0.0
unit  3
com=!   0.0  to    2.54 cm 01 !
zhemicyl-x 3 1 .6415 2.54 0.0
zhemicyl-x 2 1 .7075 2.54 0.0
zhemicyl-x 4 1 .714  2.54 0.0
unit  4
com=!   0.0  to    2.54 cm 01 !
zhemicyl+y 3 1 .6415 2.54 0.0
zhemicyl+y 2 1 .7075 2.54 0.0
zhemicyl+y 4 1 .714  2.54 0.0
unit  5
com=!   0.0 to     35.48 cm 02 !
zhemicyl+x 1 1 .6325 35.48 0.0
zhemicyl+x 0 1 .6415 35.48 0.0
zhemicyl+x 2 1 .7075 35.48 0.0
unit  6
com=!   0.0 to     35.48 cm 02 !
zhemicyl-y 1 1 .6325 35.48 0.0
zhemicyl-y 0 1 .6415 35.48 0.0
zhemicyl-y 2 1 .7075 35.48 0.0
unit  7
com=!   0.0 to     35.48 cm 02 !
zhemicyl-x 1 1 .6325 35.48 0.0
zhemicyl-x 0 1 .6415 35.48 0.0
zhemicyl-x 2 1 .7075 35.48 0.0
unit  8
com=!   0.0 to     35.48 cm 02 !
zhemicyl+y 1 1 .6325 35.48 0.0
zhemicyl+y 0 1 .6415 35.48 0.0
zhemicyl+y 2 1 .7075 35.48 0.0
unit  9
com=!   0.0 to 1.35 cm 03 !
zhemicyl+x 1 1 .6325 1.35 0.0
zhemicyl+x 0 1 .6415 1.35 0.0
zhemicyl+x 2 1 .7075 1.35 0.0
zhemicyl+x 4 1 .714  1.35 0.0
unit 10
com=!   0.0 to 1.35 cm 03 !
zhemicyl-y 1 1 .6325 1.35 0.0
zhemicyl-y 0 1 .6415 1.35 0.0
zhemicyl-y 2 1 .7075 1.35 0.0
zhemicyl-y 4 1 .714  1.35 0.0
unit 11
com=!   0.0 to 1.35 cm 03 !
zhemicyl-x 1 1 .6325 1.35 0.0
zhemicyl-x 0 1 .6415 1.35 0.0
zhemicyl-x 2 1 .7075 1.35 0.0
zhemicyl-x 4 1 .714  1.35 0.0
unit 12
com=!   0.0 to 1.35 cm 03 !
zhemicyl+y 1 1 .6325 1.35 0.0
zhemicyl+y 0 1 .6415 1.35 0.0
zhemicyl+y 2 1 .7075 1.35 0.0
zhemicyl+y 4 1 .714  1.35 0.0
unit 13
com=!   0.0 to     47.291 cm 04 !
zhemicyl+x 1 1 .6325 47.291 0.0
zhemicyl+x 0 1 .6415 47.291 0.0
zhemicyl+x 2 1 .7075 47.291 0.0
unit 14
com=!   0.0 to     47.291 cm 04 !
zhemicyl-y 1 1 .6325 47.291 0.0
zhemicyl-y 0 1 .6415 47.291 0.0
zhemicyl-y 2 1 .7075 47.291 0.0
unit 15
com=!   0.0 to     47.291 cm 04 !
zhemicyl-x 1 1 .6325 47.291 0.0
zhemicyl-x 0 1 .6415 47.291 0.0
zhemicyl-x 2 1 .7075 47.291 0.0
unit 16
com=!   0.0 to     47.291 cm 04 !
zhemicyl+y 1 1 .6325 47.291 0.0
zhemicyl+y 0 1 .6415 47.291 0.0
zhemicyl+y 2 1 .7075 47.291 0.0
unit 17
com=!   0.0 to     5.969 cm 06 !
zhemicyl+x 1 1 .6325 5.969 0.0
zhemicyl+x 0 1 .6415 5.969 0.0
zhemicyl+x 2 1 .7075 5.969 0.0
unit 18
com=!   0.0 to     5.969 cm 06 !
zhemicyl-y 1 1 .6325 5.969 0.0
zhemicyl-y 0 1 .6415 5.969 0.0
zhemicyl-y 2 1 .7075 5.969 0.0
unit 19
com=!   0.0 to     5.969 cm 06 !
zhemicyl-x 1 1 .6325 5.969 0.0
zhemicyl-x 0 1 .6415 5.969 0.0
zhemicyl-x 2 1 .7075 5.969 0.0
unit 20
com=!   0.0 to     5.969 cm 06 !
zhemicyl+y 1 1 .6325 5.969 0.0
zhemicyl+y 0 1 .6415 5.969 0.0
zhemicyl+y 2 1 .7075 5.969 0.0
unit 21
com=!   0.0  to    .809 cm 01 !
zhemicyl+x 3 1 .6415 .809 0.0
zhemicyl+x 2 1 .7075 .809 0.0
unit 22
```

```
com=!   0.0  to    .809 cm 01 !
zhemicyl-y 3 1 .6415 .809 0.0
zhemicyl-y 2 1 .7075 .809 0.0
unit 23
com=!   0.0  to    .809 cm 01 !
zhemicyl-x 3 1 .6415 .809 0.0
zhemicyl-x 2 1 .7075 .809 0.0
unit 24
com=!   0.0  to    .809 cm 01 !
zhemicyl+y 3 1 .6415 .809 0.0
zhemicyl+y 2 1 .7075 .809 0.0
unit 25
com=!   0.0  to    1.35 cm 01 !
zhemicyl+x 3 1 .6415 1.35 0.0
zhemicyl+x 2 1 .7075 1.35 0.0
zhemicyl+x 4 1 .714  1.35 0.0
unit 26
com=!   0.0  to    1.35 cm 01 !
zhemicyl-y 3 1 .6415 1.35 0.0
zhemicyl-y 2 1 .7075 1.35 0.0
zhemicyl-y 4 1 .714  1.35 0.0
unit 27
com=!   0.0  to    1.35 cm 01 !
zhemicyl-x 3 1 .6415 1.35 0.0
zhemicyl-x 2 1 .7075 1.35 0.0
zhemicyl-x 4 1 .714  1.35 0.0
unit 28
com=!   0.0  to    1.35 cm 01 !
zhemicyl+y 3 1 .6415 1.35 0.0
zhemicyl+y 2 1 .7075 1.35 0.0
zhemicyl+y 4 1 .714  1.35 0.0
unit  31
com=!   0.0  to    0.381 cm 01 !
zhemicyl+x 3 1 .6415 0.381 0.0
zhemicyl+x 2 1 .7075 0.381 0.0
zhemicyl+x 4 1 .714  0.381 0.0
unit  32
com=!   0.0  to    0.381 cm 01 !
zhemicyl-y 3 1 .6415 0.381 0.0
zhemicyl-y 2 1 .7075 0.381 0.0
zhemicyl-y 4 1 .714  0.381 0.0
unit  33
com=!   0.0  to    0.381 cm 01 !
zhemicyl-x 3 1 .6415 0.381 0.0
zhemicyl-x 2 1 .7075 0.381 0.0
zhemicyl-x 4 1 .714  0.381 0.0
unit  34
com=!   0.0  to    0.381 cm 01 !
zhemicyl+y 3 1 .6415 0.381 0.0
zhemicyl+y 2 1 .7075 0.381 0.0
zhemicyl+y 4 1 .714  0.381 0.0
```

```
unit 101
com=!   0.0  to    1.35 cm 01 !
zhemicyl+x 3 1 .6415    1.35    0.0
zhemicyl+x 2 1 .7075    1.35    0.0
zhemicyl+x 4 1 .7140    1.35    0.0
cuboid 6 1 1.598   0      2p1.384  1.35    0.0
hole       26    .799      1.384  0.0
hole       27   1.598   0         0.0
hole       28    .799     -1.384  0.0
unit 102
com=!   0.0  to    1.35 cm 02 !
zhemicyl+x 3 1 .6415    1.35    0.0
zhemicyl+x 2 1 .7075    1.35    0.0
zhemicyl+x 4 1 .7140    1.35    0.0
cuboid 6 1 1.598   0      2p1.384  1.35    0.0
hole       26    .799      1.384  0.0
hole       27   1.598   0         0.0
unit 103
com=!   0.0  to    1 35 cm 03 !
zhemicyl+x 3 1 .6415    1.35    0.0
zhemicyl+x 2 1 .7075    1.35    0.0
zhemicyl+x 4 1 .7140    1.35    0.0
cuboid 6 1 1.598   0      2p1.384  1.35    0.0
hole       26    .799      1.384  0.0
hole       28    .799     -1.384  0.0
unit 104
com=!   0.0  to    1.35 cm 04 !
zhemicyl+x 3 1 .6415    1.35    0
zhemicyl+x 2 1 .7075    1.35    0
zhemicyl+x 4 1 .7140    1.35    0
cuboid 6 1 1.598   0.0    2p1.384  1.35    0.0
hole       27   1.598   0.0     0
hole       28    .799     -1.384  0
unit 105
com=!   0.0  to    1.35 cm 05 !
zhemicyl+x 3 1 .6415    1.35    0
zhemicyl+x 2 1 .7075    1.35    0
zhemicyl+x 4 1 .7140    1.35    0
cuboid 6 1 1.598   0.0    2p1.384  1.35    0.0
hole       26    .799      1.384  0
unit 106
com=!   0.0  to    1.35 cm 06 !
zhemicyl+x 3 1 .6415    1.35    0
zhemicyl+x 2 1 .7075    1.35    0
zhemicyl+x 4 1 .7140    1.35    0
cuboid 6 1 1.598   0.0    2p1.384  1.35    0.0
hole       27   1.598   0.0     0
unit 107
com=!   0.0  to    1.35 cm 07 !
zhemicyl+x 3 1 .6415    1.35    0
zhemicyl+x 2 1 .7075    1.35    0
```

```
zhemicyl+x 4 1 .7140   1.35   0
cuboid 6 1 1.598   0.0   2p1.384  1.35   0.0
hole       28   .799    -1.384  0
unit 108
com=!   0.0  to    1.35 cm 08 !
zhemicyl+x 3 1 .6415   1.35   0
zhemicyl+x 2 1 .7075   1.35   0
zhemicyl+x 4 1 .7140   1.35   0
cuboid 6 1 1.598   0.0   2p1.384  1.35   0.0
unit 109
com=!   0.0  to    1.35 cm 09 !
zhemicyl-y 3 1 .6415   1.35   0
zhemicyl-y 2 1 .7075   1.35   0
zhemicyl-y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  0.0 -2.768    1.35   0.0
hole       27    0.799 -1.384  0
hole       28    0.0   -2.768  0
unit 110
com=!   0.0  to    1.35 cm 10 !
zhemicyl-y 3 1 .6415   1.35   0
zhemicyl-y 2 1 .7075   1.35   0
zhemicyl-y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  0.0 -2.768    1.35   0.0
hole       27    0.799 -1.384  0
unit 111
com=!   0.0  to    1.35 cm 11 !
zhemicyl-y 3 1 .6415   1.35   0
zhemicyl-y 2 1 .7075   1.35   0
zhemicyl-y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  0.0 -2.768    1.35   0.0
hole       28    0.0   -2.768  0
unit 112
com=!   0.0  to    1.35 cm 12 !
zhemicyl-y 3 1 .6415   1.35   0
zhemicyl-y 2 1 .7075   1.35   0
zhemicyl-y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799 0    -2.768     1.35   0.0
unit 113
com=!   0.0  to    1.35 cm 13 !
zhemicyl-x 3 1 .6415   1.35   0
zhemicyl-x 2 1 .7075   1.35   0
zhemicyl-x 4 1 .7140   1.35   0
cuboid 6 1 0     -1.598  2p1.384    1.35   0.0
hole       28    -0.799  -1.384  0
unit 114
com=!   0.0  to    1.35 cm 14 !
zhemicyl-x 3 1 .6415   1.35   0
zhemicyl-x 2 1 .7075   1.35   0
zhemicyl-x 4 1 .7140   1.35   0
cuboid 6 1 0     -1.598  2p1.384    1.35   0.0
unit 115
com=!   0.0  to    1.35 cm 15 !
zhemicyl+y 3 1 .6415   1.35   0
zhemicyl+y 2 1 .7075   1.35   0
zhemicyl+y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  2.768     0   1.35   0.0
unit 116
com=!   0.0  to    1.35 cm 16 !
cuboid 6 1 2p0.799  2p1.384       1.35   0.0
unit 201
com=!   0.0  to    35.48 cm 01 !
zhemicyl+x 1 1 .6325   35.48 0.0
zhemicyl+x 0 1 .6415   35.48 0.0
zhemicyl+x 2 1 .7075   35.48 0.0
cuboid 4 1 1.598   0      2p1.384  35.48  0.0
hole       6   .799     1.384  0.0
hole       7   1.598    0       0.0
hole       8   .799    -1.384  0.0
unit 202
com=!   0.0  to    35.48 cm 02 !
zhemicyl+x 1 1 .6325   35.48 0.0
zhemicyl+x 0 1 .6415   35.48 0.0
zhemicyl+x 2 1 .7075   35.48 0.0
cuboid 4 1 1.598   0      2p1.384  35.48  0.0
hole       6   .799     1.384  0.0
hole       7   1.598    0       0.0
unit 203
com=!   0.0  to    35.48 cm 03 !
zhemicyl+x 1 1 .6325   35.48 0.0
zhemicyl+x 0 1 .6415   35.48 0.0
zhemicyl+x 2 1 .7075   35.48 0.0
cuboid 4 1 1.598   0      2p1.384  35.48  0.0
hole       6   .799     1.384  0.0
hole       8   .799    -1.384  0.0
unit 204
com=!   0.0  to    35.48 cm 04 !
zhemicyl+x 1 1 .6325   35.48 0
zhemicyl+x 0 1 .6415   35.48 0
zhemicyl+x 2 1 .7075   35.48 0
cuboid 4 1 1.598   0.0   2p1.384  35.48 0.0
hole       7   1.598   0.0    0
hole       8   .799    -1.384  0
unit 205
com=!   0.0  to    35.48 cm 05 !
zhemicyl+x 1 1 .6325   35.48 0
zhemicyl+x 0 1 .6415   35.48 0
zhemicyl+x 2 1 .7075   35.48 0
cuboid 4 1 1.598   0.0   2p1.384  35.43 0.0
hole       6   .799     1.384  0
unit 206
com=!   0.0  to    35.48 cm 06 !
zhemicyl+x 1 1 .6325   35.48 0
```

```
zhemicyl+x 0 1 .6415    35.48 0
zhemicyl+x 2 1 .7075    35.48 0
cuboid 4 1 1.598    0.0    2p1.384   35.48 0.0
hole        7    1.598    0.0     0
unit 207
com=!   0.0  to    35.48 cm 07 !
zhemicyl+x 1 1 .6325    35.48 0
zhemicyl+x 0 1 .6415    35.48 0
zhemicyl+x 2 1 .7075    35.48 0
cuboid 4 1 1.598    0.0    2p1.384   35.48 0.0
hole        8    .799    -1.384   0
unit 208
com=!   0.0  to    35.48 cm 08 !
zhemicyl+x 1 1 .6325    35.48 0
zhemicyl+x 0 1 .6415    35.48 0
zhemicyl+x 2 1 .7075    35.48 0
cuboid 4 1 1.598    0.0    2p1.384   35.48 0.0
unit 209
com=!   0.0  to    35.48 cm 09 !
zhemicyl-y 1 1 .6325    35.48 0
zhemicyl-y 0 1 .6415    35.48 0
zhemicyl-y 2 1 .7075    35.48 0
cuboid 4 1 2p0.799  0.0 -2.768     35.48 0.0
hole        7     0.799 -1.384   0
hole        8     0.0    -2.768   0
unit 210
com=!   0.0  to    35.48 cm 10 !
zhemicyl-y 1 1 .6325    35.48 0
zhemicyl-y 0 1 .6415    35.48 0
zhemicyl-y 2 1 .7075    35.48 0
cuboid 4 1 2p0.799  0.0 -2.768     35.48 0.0
hole        7     0.799 -1.384   0
unit 211
com=!   0.0  to    35.48 cm 11 !
zhemicyl-y 1 1 .6325    35.48 0
zhemicyl-y 0 1 .6415    35.48 0
zhemicyl-y 2 1 .7075    35.48 0
cuboid 4 1 2p0.799  0.0 -2.768     35.48 0.0
hole        8     0.0    -2.768   0
unit 212
com=!   0.0  to    35.48 cm 12 !
zhemicyl-y 1 1 .6325    35.48 0
zhemicyl-y 0 1 .6415    35.48 0
zhemicyl-y 2 1 .7075    35.48 0
cuboid 4 1 2p0.799  0.0 -2.768     35.48 0.0
unit 213
com=!   0.0  to    35.48 cm 13 !
zhemicyl-x 1 1 .6325    35.48 0
zhemicyl-x 0 1 .6415    35.48 0
zhemicyl-x 2 1 .7075    35.48 0
cuboid 4 1 0     -1.598  2p1.384    35.48 0.0
hole        8     -0.799  -1.384   0
unit 214
com=!   0.0  to    35.48 cm 14 !
zhemicyl-x 1 1 .6325    35.48 0
zhemicyl-x 0 1 .6415    35.48 0
zhemicyl-x 2 1 .7075    35.48 0
cuboid 4 1 0     -1.598  2p1.384    35.48 0.0
unit 215
com=!   0.0  to    35.48 cm 15 !
zhemicyl+y 1 1 .6325    35.48 0
zhemicyl+y 0 1 .6415    35.48 0
zhemicyl+y 2 1 .7075    35.48 0
cuboid 4 1 2p0.799  2.768    0.     35.48 0.0
unit 216
com=!   0.0  to    35.48 cm 16 !
cuboid 4 1 2p0.799  2p1.384          35.48 0.0
unit 301
com=!   0.0  to     1.35 cm  01 !
zhemicyl+x 1 1 .6325     1.35    0.0
zhemicyl+x 0 1 .6415     1.35    0.0
zhemicyl+x 2 1 .7075     1.35    0.0
zhemicyl+x 4 1 .7140     1.35    0.0
cuboid 6 1 1.598    0      2p1.384   1.35   0.0
hole       10    .799     1.384   0.0
hole       11   1.598    0        0.0
hole       12    .799    -1.384   0.0
unit 302
com=!   0.0  to     1.35 cm  02 !
zhemicyl+x 1 1 .6325     1.35    0.0
zhemicyl+x 0 1 .6415     1.35    0.0
zhemicyl+x 2 1 .7075     1.35    0.0
zhemicyl+x 4 1 .7140     1.35    0.0
cuboid 6 1 1.598    0      2p1.384   1.35   0.0
hole       10    .799     1.384   0.0
hole       11   1.598    0        0.0
unit 303
com=!   0.0  to     1.35 cm  03 !
zhemicyl+x 1 1 .6325     1.35    0.0
zhemicyl+x 0 1 .6415     1.35    0.0
zhemicyl+x 2 1 .7075     1.35    0.0
zhemicyl+x 4 1 .7140     1.35    0.0
cuboid 6 1 1.598    0      2p1.384   1.35   0.0
hole       10    .799     1.384   0.0
hole       12    .799    -1.384   0.0
unit 304
com=!   0.0  to     1.35 cm  04 !
zhemicyl+x 1 1 .6325     1.35    0
zhemicyl+x 0 1 .6415     1.35    0
zhemicyl+x 2 1 .7075     1.35    0
zhemicyl+x 4 1 .7140     1.35    0
cuboid 6 1 1.598    0.0    2p1.384   1.35   0.0
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hole      11   1.598   0.0    0
hole      12   .799   -1.384  0
unit 305
com=!   0.0  to    1.35 cm  05 !
zhemicyl+x 1 1 .6325   1.35   0
zhemicyl+x 0 1 .6415   1.35   0
zhemicyl+x 2 1 .7075   1.35   0
zhemicyl+x 4 1 .7140   1.35   0
cuboid 6 1 1.598   0.0   2p1.384  1.35  0.0
hole      10   .799    1.384  0
unit 306
com=!   0.0  to    1.35 cm  06 !
zhemicyl+x 1 1 .6325   1.35   0
zhemicyl+x 0 1 .6415   1.35   0
zhemicyl+x 2 1 .7075   1.35   0
zhemicyl+x 4 1 .7140   1.35   0
cuboid 6 1 1.598   0.0   2p1.384  1.35  0.0
hole      11   1.598   0.0    0
unit 307
com=!   0.0  to    1.35 cm  07 !
zhemicyl+x 1 1 .6325   1.35   0
zhemicyl+x 0 1 .6415   1.35   0
zhemicyl+x 2 1 .7075   1.35   0
zhemicyl+x 4 1 .7140   1.35   0
cuboid 6 1 1.598   0.0   2p1.384  1.35  0.0
hole      12   .799   -1.384  0
unit 308
com=!   0.0  to    1.35 cm  08 !
zhemicyl+x 1 1 .6325   1.35   0
zhemicyl+x 0 1 .6415   1.35   0
zhemicyl+x 2 1 .7075   1.35   0
zhemicyl+x 4 1 .7140   1.35   0
cuboid 6 1 1.598   0.0   2p1.384  1.35  0.0
unit 309
com=!   0.0  to    1.35 cm  09 !
zhemicyl-y 3 1 .6415   1.35   0
zhemicyl-y 2 1 .7075   1.35   0
zhemicyl-y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  0.0 -2.768    1.35  0.0
hole      11   0.799 -1.384  0
hole      12   0.0   -2.768  0
unit 310
com=!   0.0  to    1.35 cm  10 !
zhemicyl-y 1 1 .6325   1.35   0
zhemicyl-y 0 1 .6415   1.35   0
zhemicyl-y 2 1 .7075   1.35   0
zhemicyl-y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  0.0 -2.768    1.35  0.0
hole      11   0.799 -1.384  0
unit 311
com=!   0.0  to    1.35 cm  11 !
zhemicyl-y 1 1 .6325   1.35   0
zhemicyl-y 0 1 .6415   1.35   0
zhemicyl-y 2 1 .7075   1.35   0
zhemicyl-y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  0.0 -2.768    1.35  0.0
hole      12    0.0   -2.768  0
unit 312
com=!   0.0  to    1.35 cm  12 !
zhemicyl-y 1 1 .6325   1.35   0
zhemicyl-y 0 1 .6415   1.35   0
zhemicyl-y 2 1 .7075   1.35   0
zhemicyl-y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  0.0 -2.768    1.35  0.0
unit 313
com=!   0.0  to    1.35 cm  13 !
zhemicyl-x 1 1 .6325   1.35   0
zhemicyl-x 0 1 .6415   1.35   0
zhemicyl-x 2 1 .7075   1.35   0
zhemicyl-x 4 1 .7140   1.35   0
cuboid 6 1 0     -1.598  2p1.384   1.35  0.0
hole      12    -0.799  -1.384  0
unit 314
com=!   0.0  to    1.35 cm  14 !
zhemicyl-x 1 1 .6325   1.35   0
zhemicyl-x 0 1 .6415   1.35   0
zhemicyl-x 2 1 .7075   1.35   0
zhemicyl-x 4 1 .7140   1.35   0
cuboid 6 1 0     -1.598  2p1.384   1.35  0.0
unit 315
com=!   0.0  to    1.35 cm  15 !
zhemicyl+y 1 1 .6325   1.35   0
zhemicyl+y 0 1 .6415   1.35   0
zhemicyl+y 2 1 .7075   1.35   0
zhemicyl+y 4 1 .7140   1.35   0
cuboid 6 1 2p0.799  2.768      0   1.35  0.0
unit 316
com=!   0.0  to    1.35 cm  16 !
cuboid 6 1 2p0.799  2p1.384        1.35  0.0
unit 401
com=!   0.0  to    47.291 cm 01 !
zhemicyl+x 1 1 .6325   47.291 0.0
zhemicyl+x 0 1 .6415   47.291 0.0
zhemicyl+x 2 1 .7075   47.291 0.0
cuboid 4 1 1.598   0      2p1.384  47.291 0.0
hole      14   .799    1.384  0.0
hole      15   1.598   0      0.0
hole      16   .799   -1.384  0.0
unit 402
com=!   0.0  to    47.291 cm 02 !
zhemicyl+x 1 1 .6325   47.291 0.0
zhemicyl+x 0 1 .6415   47.291 0.0
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zhemicyl+x 2 1 .7075   47.291 0.0
cuboid 4 1 1.598   0      2p1.384  47.291 0.0
hole       14   .799      1.384  0.0
hole       15   1.598   0        0.0
unit 403
com=!   0.0  to    47.291 cm 03 !
zhemicyl+x 1 1 .6325   47.291 0.0
zhemicyl+x 0 1 .6415   47.291 0.0
zhemicyl+x 2 1 .7075   47.291 0.0
cuboid 4 1 1.598   0      2p1.384  47.291 0.0
hole       14   .799      1.384  0.0
hole       16   .799     -1.384  0.0
unit 404
com=!   0.0  to    47.291 cm 04 !
zhemicyl+x 1 1 .6325   47.291 0
zhemicyl+x 0 1 .6415   47.291 0
zhemicyl+x 2 1 .7075   47.291 0
cuboid 4 1 1.598   0.0   2p1.384  47.291 0.0
hole       15   1.598   0.0     0
hole       16   .799    -1.384  0
unit 405
com=!   0.0  to    47.291 cm 05 !
zhemicyl+x 1 1 .6325   47.291 0
zhemicyl+x 0 1 .6415   47.291 0
zhemicyl+x 2 1 .7075   47.291 0
cuboid 4 1 1.598   0.0   2p1.384  47.291 0.0
hole       14   .799     1.384  0
unit 406
com=!   0.0  to    47.291 cm 06 !
zhemicyl+x 1 1 .6325   47.291 0
zhemicyl+x 0 1 .6415   47.291 0
zhemicyl+x 2 1 .7075   47.291 0
cuboid 4 1 1.598   0.0   2p1.384  47.291 0.0
hole       15   1.598   0.0     0
unit 407
com=!   0.0  to    47.291 cm 07 !
zhemicyl+x 1 1 .6325   47.291 0
zhemicyl+x 0 1 .6415   47.291 0
zhemicyl+x 2 1 .7075   47.291 0
cuboid 4 1 1.598   0.0   2p1.384  47.291 0.0
hole       16   .799    -1.384  0
unit 408
com=!   0.0  to    47.291 cm 08 !
zhemicyl+x 1 1 .6325   47.291 0
zhemicyl+x 0 1 .6415   47.291 0
zhemicyl+x 2 1 .7075   47.291 0
cuboid 4 1 1.598   0.0   2p1.384  47.291 0.0
unit 409
com=!   0.0  to    47.291 cm 09 !
zhemicyl-y 1 1 .6325   47.291 0
zhemicyl-y 0 1 .6415   47.291 0
zhemicyl-y 2 1 .7075   47.291 0
cuboid 4 1 2p0.799  0.0 -2.768      47.291 0.0
hole       15    0.799 -1.384  0
hole       16    0.0   -2.768  0
unit 410
com=!   0.0  to    47.291 cm 10 !
zhemicyl-y 1 1 .6325    47.291 0
zhemicyl-y 0 1 .6415    47.291 0
zhemicyl-y 2 1 .7075    47.291 0
cuboid 4 1 2p0.799  0.0 -2.768      47.291 0.0
hole       15    0.799 -1.384  0
unit 411
com=!   0.0  to    47.291 cm 11 !
zhemicyl-y 1 1 .6325    47.291 0
zhemicyl-y 0 1 .6415    47.291 0
zhemicyl-y 2 1 .7075    47.291 0
cuboid 4 1 2p0.799  0.0 -2.768      47.291 0.0
hole       16    0.0   -2.768  0
unit 412
com=!   0.0  to    47.291 cm 12 !
zhemicyl-y 1 1 .6325    47.291 0
zhemicyl-y 0 1 .6415    47.291 0
zhemicyl-y 2 1 .7075    47.291 0
cuboid 4 1 2p0.799  0.0 -2.768      47.291 0.0
unit 413
com=!   0.0  to    47.291 cm 13 !
zhemicyl-x 1 1 .6325    47.291 0
zhemicyl-x 0 1 .6415    47.291 0
zhemicyl-x 2 1 .7075    47.291 0
cuboid 4 1 0     -1.598  2p1.384    47.291 0.0
hole       16    -0.799  -1.384   0
unit 414
com=!   0.0  to    47.291 cm 14 !
zhemicyl-x 1 1 .6325    47.291 0
zhemicyl-x 0 1 .6415    47.291 0
zhemicyl-x 2 1 .7075    47.291 0
cuboid 4 1 0     -1.598  2p1.384    47.291 0.0
unit 415
com=!   0.0  to    47.291 cm 15 !
zhemicyl+y 1 1 .6325    47.291 0
zhemicyl+y 0 1 .6415    47.291 0
zhemicyl+y 2 1 .7075    47.291 0
cuboid 4 1 2p0.799  2.768     0   47.291 0.0
unit 416
com=!   0.0  to    47.291 cm 16 !
cuboid 4 1 2p0.799  2p1.384         47.291 0.0
unit 501
com=!   0.0  to    5.969 cm 01 !
zhemicyl+x 1 1 .6325    5.969 0.0
zhemicyl+x 0 1 .6415    5.969 0.0
zhemicyl+x 2 1 .7075    5.969 0.0
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cuboid 4 1 1.598    0      2p1.384  5.969 0.0
hole      18   .799     1.384  0.0
hole      19   1.598   0        0.0
hole      20   .799    -1.384  0.0
unit 502
com=!   0.0  to    5.969 cm 02 !
zhemicyl+x 1 1 .6325    5.969 0.0
zhemicyl+x 0 1 .6415    5.969 0.0
zhemicyl+x 2 1 .7075    5.969 0.0
cuboid 4 1 1.598    0      2p1.384  5.969 0.0
hole      18   .799     1.384  0.0
hole      19   1.598   0        0.0
unit 503
com=!   0.0  to    5.969 cm 03 !
zhemicyl+x 1 1 .6325    5.969 0.0
zhemicyl+x 0 1 .6415    5.969 0.0
zhemicyl+x 2 1 .7075    5.969 0.0
cuboid 4 1 1.598    0      2p1.384  5.969 0.0
hole      18   .799     1.384  0.0
hole      20   .799    -1.384  0.0
unit 504
com=!   0.0  to    5.969 cm 04 !
zhemicyl+x 1 1 .6325    5.969 0
zhemicyl+x 0 1 .6415    5.969 0
zhemicyl+x 2 1 .7075    5.969 0
cuboid 4 1 1.598    0.0    2p1.384  5.969 0.0
hole      19   1.598    0.0     0
hole      20   .799    -1.384  0
unit 505
com=!   0.0  to    5.969 cm 05 !
zhemicyl+x 1 1 .6325    5.969 0
zhemicyl+x 0 1 .6415    5.969 0
zhemicyl+x 2 1 .7075    5.969 0
cuboid 4 1 1.598    0.0    2p1.384  5.969 0.0
hole      18   .799     1.384  0
unit 506
com=!   0.0  to    5.969 cm 06 !
zhemicyl+x 1 1 .6325    5.969 0
zhemicyl+x 0 1 .6415    5.969 0
zhemicyl+x 2 1 .7075    5.969 0
cuboid 4 1 1.598    0.0    2p1.384  5.969 0.0
hole      19   1.598    0.0     0
unit 507
com=!   0.0  to    5.969 cm 07 !
zhemicyl+x 1 1 .6325    5.969 0
zhemicyl+x 0 1 .6415    5.969 0
zhemicyl+x 2 1 .7075    5.969 0
cuboid 4 1 1.598    0.0    2p1.384  5.969 0.0
hole      20   .799    -1.384  0
unit 508
com=!   0.0  to    5.969 cm 08 !
zhemicyl+x 1 1 .6325    5.969 0
zhemicyl+x 0 1 .6415    5.969 0
zhemicyl+x 2 1 .7075    5.969 0
cuboid 4 1 1.598    0.0    2p1.384  5.969 0.0
unit 509
com=!   0.0  to    5.969 cm 09 !
zhemicyl-y 1 1 .6325    5.969 0
zhemicyl-y 0 1 .6415    5.969 0
zhemicyl-y 2 1 .7075    5.969 0
cuboid 4 1 2p0.799  0.0 -2.768     5.969 0.0
hole      19     0.799 -1.384  0
hole      20     0.0    -2.768  0
unit 510
com=!   0.0  to    5.969 cm 10 !
zhemicyl-y 1 1 .6325    5.969 0
zhemicyl-y 0 1 .6415    5.969 0
zhemicyl-y 2 1 .7075    5.969 0
cuboid 4 1 2p0.799  0.0 -2.768     5.969 0.0
hole      19     0.799 -1.384  0
unit 511
com=!   0.0  to    5.969 cm 11 !
zhemicyl-y 1 1 .6325    5.969 0
zhemicyl-y 0 1 .6415    5.969 0
zhemicyl-y 2 1 .7075    5.969 0
cuboid 4 1 2p0.799  0.0 -2.768     5.969 0.0
hole      20     0.0    -2.768  0
unit 512
com=!   0.0  to    5.969 cm 12 !
zhemicyl-y 1 1 .6325    5.969 0
zhemicyl-y 0 1 .6415    5.969 0
zhemicyl-y 2 1 .7075    5.969 0
cuboid 4 1 2p0.799  0.0 -2.768     5.969 0.0
unit 513
com=!   0.0  to    5.969 cm 13 !
zhemicyl-x 1 1 .6325    5.969 0
zhemicyl-x 0 1 .6415    5.969 0
zhemicyl-x 2 1 .7075    5.969 0
cuboid 4 1 0      -1.598  2p1.384   5.969 0.0
hole      20     -0.799  -1.384  0
unit 514
com=!   0.0  to    5.969 cm 14 !
zhemicyl-x 1 1 .6325    5.969 0
zhemicyl-x 0 1 .6415    5.969 0
zhemicyl-x 2 1 .7075    5.969 0
cuboid 4 1 0      -1.598  2p1.384   5.969 0.0
unit 515
com=!   0.0  to    5.969 cm 15 !
zhemicyl+y 1 1 .6325    5.969 0
zhemicyl+y 0 1 .6415    5.969 0
zhemicyl+y 2 1 .7075    5.969 0
cuboid 4 1 2p0.799  2.768     0      5.969 0.0
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unit 516
com=!   0.0  to    5.969 cm 16 !
cuboid 4 1 2p0.799  2p1.384         5.969 0.0
unit 601
com=!   0.0  to    2.54 cm 01 !
zhemicyl+x 3 1 .6415    2.54  0.0
zhemicyl+x 2 1 .7075    2.54  0.0
cuboid 4 1 1.598   0      2p1.384  2.54  0.0
hole        2   .799      1.384  0.0
hole        3   1.598   0        0.0
hole        4   .799     -1.384  0.0
unit 602
com=!   0.0  to    2.54 cm 02 !
zhemicyl+x 3 1 .6415    2.54  0.0
zhemicyl+x 2 1 .7075    2.54  0.0
cuboid 4 1 1.598   0      2p1.384  2.54  0.0
hole        2   .799      1.384  0.0
hole        3   1.598   0        0.0
unit 603
com=!   0.0  to    2.54 cm 03 !
zhemicyl+x 3 1 .6415    2.54  0.0
zhemicyl+x 2 1 .7075    2.54  0.0
cuboid 4 1 1.598   0      2p1.384  2.54  0.0
hole        2   .799      1.384  0.0
hole        4   .799     -1.384  0.0
unit 604
com=!   0.0  to    2.54 cm 04 !
zhemicyl+x 3 1 .6415    2.54  0
zhemicyl+x 2 1 .7075    2.54  0
cuboid 4 1 1.598   0.0   2p1.384  2.54  0.0
hole        3   1.598   0.0     0
hole        4   .799    -1.384  0
unit 605
com=!   0.0  to    2.54 cm 05 !
zhemicyl+x 3 1 .6415    2.54  0
zhemicyl+x 2 1 .7075    2.54  0
cuboid 4 1 1.598   0.0   2p1.384  2.54  0.0
hole        2   .799      1.384  0
unit 606
com=!   0.0  to    2.54 cm 06 !
zhemicyl+x 3 1 .6415    2.54  0
zhemicyl+x 2 1 .7075    2.54  0
cuboid 4 1 1.598   0.0   2p1.384  2.54  0.0
hole        3   1.598   0.0     0
unit 607
com=!   0.0  to    2.54 cm 07 !
zhemicyl+x 3 1 .6415    2.54  0
zhemicyl+x 2 1 .7075    2.54  0
cuboid 4 1 1.598   0.0   2p1.384  2.54  0.0
hole        4   .799    -1.384  0
unit 608
com=!   0.0  to    2.54 cm 08 !
zhemicyl+x 3 1 .6415    2.54  0
zhemicyl+x 2 1 .7075    2.54  0
cuboid 4 1 1.598   0.0   2p1.384  2.54  0.0
unit 609
com=!   0.0  to    2.54 cm 09 !
zhemicyl-y 3 1 .6415    2.54  0
zhemicyl-y 2 1 .7075    2.54  0
cuboid 4 1 2p0.799  0.0 -2.768    2.54  0.0
hole        3     0.799 -1.384  0
hole        4     0.0   -2.768  0
unit 610
com=!   0.0  to    2.54 cm 10 !
zhemicyl-y 3 1 .6415    2.54  0
zhemicyl-y 2 1 .7075    2.54  0
cuboid 4 1 2p0.799  0.0 -2.768    2.54  0.0
hole        3     0.799 -1.384  0
unit 611
com=!   0.0  to    2.54 cm 11 !
zhemicyl-y 3 1 .6415    2.54  0
zhemicyl-y 2 1 .7075    2.54  0
cuboid 4 1 2p0.799  0.0 -2.768    2.54  0.0
hole        4     0.0   -2.768  0
unit 612
com=!   0.0  to    2.54 cm 12 !
zhemicyl-y 3 1 .6415    2.54  0
zhemicyl-y 2 1 .7075    2.54  0
cuboid 4 1 2p0.799  0.0 -2.768    2.54  0.0
unit 613
com=!   0.0  to    2.54 cm 13 !
zhemicyl-x 3 1 .6415    2.54  0
zhemicyl-x 2 1 .7075    2.54  0
cuboid 4 1 0     -1.598  2p1.384   2.54  0.0
hole        4    -0.799  -1.384  0
unit 614
com=!   0.0  to    2.54 cm 14 !
zhemicyl-x 3 1 .6415    2.54  0
zhemicyl-x 2 1 .7075    2.54  0
cuboid 4 1 0     -1.598  2p1.384   2.54  0.0
unit 615
com=!   0.0  to    2.54 cm 15 !
zhemicyl+y 3 1 .6415    2.54  0
zhemicyl+y 2 1 .7075    2.54  0
cuboid 4 1 2p0.799  2.768      0   2.54  0.0
unit 616
com=!   0.0  to    2.54 cm 16 !
cuboid 4 1 2p0.799  2p1.384        2.54  0.0
unit 701
com=!   0.0  to    0.809 cm 01 !
zhemicyl+x 3 1 .6415    0.809  0.0
zhemicyl+x 2 1 .7075    0.809  0.0
```

```
cuboid 4 1 1.598   0      2p1.384  0.809 0.0
hole       22   .799     1.384  0.0
hole       23   1.598   0       0.0
hole       24   .799    -1.384  0.0
unit 702
com=!   0.0  to    0.809 cm 02 !
zhemicyl+x 3 1 .6415    0.809  0.0
zhemicyl+x 2 1 .7075    0.809  0.0
cuboid 4 1 1.598   0      2p1.384  0.809  0.0
hole       22   .799     1.334  0.0
hole       23   1.598   0       0.0
unit 703
com=!   0.0  to    0.809 cm 03 !
zhemicyl+x 3 1 .6415    0.809  0.0
zhemicyl+x 2 1 .7075    0.809  0.0
cuboid 4 1 1.598   0      2p1.384  0.809  0.0
hole       22   .799     1.384  0.0
hole       24   .799    -1.384  0.0
unit 704
com=!   0.0  to    0.809 cm 04 !
zhemicyl+x 3 1 .6415    0.809  0
zhemicyl+x 2 1 .7075    0.809  0
cuboid 4 1 1.598   0.0   2p1.384  0.809  0.0
hole       23   1.598   0.0     0
hole       24   .799    -1.384  0
unit 705
com=!   0.0  to    0.809 cm 05 !
zhemicyl+x 3 1 .6415    0.809  0
zhemicyl+x 2 1 .7075    0.809  0
cuboid 4 1 1.598   0.0   2p1.384  0.809  0.0
hole       22   .799     1.384  0
unit 706
com=!   0.0  to    0.809 cm 06 !
zhemicyl+x 3 1 .6415    0.809  0
zhemicyl+x 2 1 .7075    0.809  0
cuboid 4 1 1.598   0.0   2p1.384  0.809  0.0
hole       23   1.598   0.0     0
unit 707
com=!   0.0  to    0.809 cm 07 !
zhemicyl+x 3 1 .6415    0.809  0
zhemicyl+x 2 1 .7075    0.809  0
cuboid 4 1 1.598   0.0   2p1.384  0.809  0.0
hole       24   .799    -1.384  0
unit 708
com=!   0.0  to    0.809 cm 08 !
zhemicyl+x 3 1 .6415    0.809  0
zhemicyl+x 2 1 .7075    0.809  0
cuboid 4 1 1.598   0.0   2p1.384  0.809  0.0
unit 709
com=!   0.0  to    0.809 cm 09 !
zhemicyl-y 3 1 .6415    0.809  0
zhemicyl-y 2 1 .7075    0.809  0
cuboid 4 1 2p0.799  0.0 -2.768     0.809  0.0
hole       23    0.799 -1.384  0
hole       24    0.0   -2.768  0
unit 710
com=!   0.0  to    0.809 cm 10 !
zhemicyl-y 3 1 .6415    0.809  0
zhemicyl-y 2 1 .7075    0.809  0
cuboid 4 1 2p0.799  0.0 -2.768     0.809  0.0
hole       23    0.799 -1.384  0
unit 711
com=!   0.0  to    0.809 cm 11 !
zhemicyl-y 3 1 .6415    0.809  0
zhemicyl-y 2 1 .7075    0.809  0
cuboid 4 1 2p0.799  0.0 -2.768     0.809  0.0
hole       24    0.0   -2.768  0
unit 712
com=!   0.0  to    0.809 cm 12 !
zhemicyl-y 3 1 .6415    0.809  0
zhemicyl-y 2 1 .7075    0.809  0
cuboid 4 1 2p0.799  0.0 -2.768     0.809  0.0
unit 713
com=!   0.0  to    0.809 cm 13 !
zhemicyl-x 3 1 .6415    0.809  0
zhemicyl-x 2 1 .7075    0.809  0
cuboid 4 1 0     -1.598  2p1.384    0.809  0.0
hole       24    -0.799  -1.384  0
unit 714
com=!   0.0  to    0.809 cm 14 !
zhemicyl-x 3 1 .6415    0.809  0
zhemicyl-x 2 1 .7075    0.809  0
cuboid 4 1 0     -1.598  2p1.384    0.809  0.0
unit 715
com=!   0.0  to    0.809 cm 15 !
zhemicyl+y 3 1 .6415    0.809  0
zhemicyl+y 2 1 .7075    0.809  0
cuboid 4 1 2p0.799  2.768      0   0.809  0.0
unit 716
com=!   0.0  to    0.809 cm 16 !
cuboid 4 1 2p0.799  2p1.384        0.809  0.0
unit 801
com=!   0.0  to    0.381 cm 01 !
zhemicyl+x 3 1 .6415    0.381  0.0
zhemicyl+x 2 1 .7075    0.381  0.0
cuboid 4 1 1.598   0      2p1.384  0.381  0.0
hole       32   .799     1.384  0.0
hole       33   1.598   0       0.0
hole       34   .799    -1.384  0.0
unit 802
com=!   0.0  to    0.381 cm 02 !
zhemicyl+x 3 1 .6415    0.381  0.0
```

```
zhemicyl+x 2 1 .7075    0.381  0.0
cuboid 4 1 1.598    0      2p1.384  0.381  0.0
hole       32    .799      1.384  0.0
hole       33   1.598    0        0.0
unit 803
com=!   0.0  to    0.381 cm 03 !
zhemicyl+x 3 1 .6415    0.381  0.0
zhemicyl+x 2 1 .7075    0.381  0.0
cuboid 4 1 1.598    0      2p1.384  0.381  0.0
hole       32    .799      1.384  0.0
hole       34    .799     -1.384  0.0
unit 804
com=!   0.0  to    0.381 cm 04 !
zhemicyl+x 3 1 .6415    0.381  0
zhemicyl+x 2 1 .7075    0.381  0
cuboid 4 1 1.598    0.0    2p1.384  0.381  0.0
hole       33   1.598    0.0      0
hole       34    .799    -1.384   0
unit 805
com=!   0.0  to    0.381 cm 05 !
zhemicyl+x 3 1 .6415    0.381  0
zhemicyl+x 2 1 .7075    0.381  0
cuboid 4 1 1.598    0.0    2p1.384  0.381  0.0
hole       32    .799     1.384   0
unit 806
com=!   0.0  to    0.381 cm 06 !
zhemicyl+x 3 1 .6415    0.381  0
zhemicyl+x 2 1 .7075    0.381  0
cuboid 4 1 1.598    0.0    2p1.384  0.381  0.0
hole       33   1.598    0.0      0
unit 807
com=!   0.0  to    0.381 cm 07 !
zhemicyl+x 3 1 .6415    0.381  0
zhemicyl+x 2 1 .7075    0.381  0
cuboid 4 1 1.598    0.0    2p1.384  0.381  0.0
hole       34    .799    -1.384   0
unit 808
com=!   0.0  to    0.381 cm 08 !
zhemicyl+x 3 1 .6415    0.381  0
zhemicyl+x 2 1 .7075    0.381  0
cuboid 4 1 1.598    0.0    2p1.384  0.381  0.0
unit 809
com=!   0.0  to    0.381 cm 09 !
zhemicyl-y 3 1 .6415    0.381  0
zhemicyl-y 2 1 .7075    0.381  0
cuboid 4 1 2p0.799  0.0 -2.768     0.381  0.0
hole       33     0.799 -1.384  0
hole       34     0.0   -2.768  0
unit 810
com=!   0.0  to    0.381 cm 10 !
zhemicyl-y 3 1 .6415    0.381  0
zhemicyl-y 2 1 .7075    0.381  0
cuboid 4 1 2p0.799  0.0 -2.768     0.381  0.0
hole       33     0.799 -1.384  0
unit 811
com=!   0.0  to    0.381 cm 11 !
zhemicyl-y 3 1 .6415    0.381  0
zhemicyl-y 2 1 .7075    0.381  0
cuboid 4 1 2p0.799  0.0 -2.768     0.381  0.0
hole       34     0.0   -2.768  0
unit 812
com=!   0.0  to    0.381 cm 12 !
zhemicyl-y 3 1 .6415    0.381  0
zhemicyl-y 2 1 .7075    0.381  0
cuboid 4 1 2p0.799  0.0 -2.768     0.381  0.0
unit 813
com=!   0.0  to    0.381 cm 13 !
zhemicyl-x 3 1 .6415    0.381  0
zhemicyl-x 2 1 .7075    0.381  0
cuboid 4 1 0     -1.598  2p1.384   0.381  0.0
hole       34    -0.799  -1.384  0
unit 814
com=!   0.0  to    0.381 cm 14 !
zhemicyl-x 3 1 .6415    0.381  0
zhemicyl-x 2 1 .7075    0.381  0
cuboid 4 1 0     -1.598  2p1.384   0.381  0.0
unit 815
com=!   0.0  to    0.381 cm 15 !
zhemicyl+y 3 1 .6415    0.381  0
zhemicyl+y 2 1 .7075    0.381  0
cuboid 4 1 2p0.799  2.768        0   0.381  0.0
unit 816
com=!   0.0  to    0.381 cm 16 !
cuboid 4 1 2p0.799  2p1.384          0.381  0.0
global unit 900
com=! reflector region!
array   1   -30.362 -29.064  0.0
reflector 5 1 0 0 0 0 0 2.54   1
zcylinder 4 1 76.0 109.14 -22.86
end geom

read array
ara=1 nux=38 nuy=21 nuz=9
com=!full array of fuel pins!
fill
  11r716  3r712    710           9r702   705  2r712  11r716
   8r716    712    710      702 16r701   702    705     712  8r716
   6r716    712    710          22r701   705  7r716
   5r716    710                 25r701   702    705  5r716
   4r716    710                 28r701   705  4r716
   3r716    710                 30r701   705  3r716
   2r716    710                 32r701   705  2r716
```

716	714			34r701	705	716		
716	710			34r701	703	716		
	714			36r701	708		2q38	
716	709			34r701	707	716		
716	713			34r701	708	716		
2r716	713			32r701	707	2r716		
2r716	714	704		30r701	703	3r716		
4r716	713			28r701	707	715	3r716	
5r716	713	704		25r701	707	5r716		
7r716	713			22r701	707	715	6r716	
8r716	715	713	704	16r701	704	707	715	8r716
11r716	2r715	713		9r704	707	3r715	11r716	
11r116	3r112	110		9r102	105	2r112	11r116	
8r116	112	110	102	16r101	102	105	112	8r116
6r116	112	110		22r101	105	7r116		
5r116	110			25r101	102	105	5r116	
4r116	110			28r101	105	4r116		
3r116	110			30r101	105	3r116		
2r116	110			32r101	105	2r116		
116	114			34r101	105	116		
116	110			34r101	103	116		
	114			36r101	108		2q38	
116	109			34r101	107	116		
116	113			34r101	108	116		
2r116	113			32r101	107	2r116		
2r116	114	104		30r101	103	3r116		
4r116	113			28r101	107	115	3r116	
5r116	113	104		25r101	107	5r116		
7r116	113			22r101	107	115	6r116	
8r116	115	113	104	16r101	104	107	115	8r116
11r116	2r115	113		9r104	107	3r115	11r116	
11r816	3r812	810		9r802	805	2r812	11r816	
8r816	812	810	802	16r801	802	805	812	8r816
6r816	812	810		22r801	805	7r816		
5r816	810			25r801	802	805	5r816	
4r816	810			28r801	805	4r816		
3r816	810			30r801	805	3r816		
2r816	810			32r801	805	2r816		
816	814			34r801	805	816		
816	810			34r801	803	816		
	814			36r801	808		2q38	
816	809			34r801	807	816		
816	813			34r801	808	816		
2r816	813			32r801	807	2r816		
2r816	814	804		30r801	803	3r816		
4r816	813			28r801	807	815	3r816	
5r816	813	804		25r801	807	5r816		
7r816	813			22r801	807	815	6r816	
8r816	815	813	804	16r801	804	807	815	8r816
11r816	2r815	813		9r804	807	3r815	11r816	
11r216	3r212	210		9r202	205	2r212	11r216	

8r216	212	210	202	16r201	202	205	212	8r216
6r216	212	210		22r201	205	7r216		
5r216	210			25r201	202	205	5r216	
4r216	210			28r201	205	4r216		
3r216	210			30r201	205	3r216		
2r216	210			32r201	205	2r216		
216	214			34r201	205	216		
216	210			34r201	203	216		
	214			36r201	208		2q38	
216	209			34r201	207	216		
216	213			34r201	208	216		
2r216	213			32r201	207	2r216		
2r216	214	204		30r201	203	3r216		
4r216	213			28r201	207	215	3r216	
5r216	213	204		25r201	207	5r216		
7r216	213			22r201	207	215	6r216	
8r216	215	213	204	16r201	204	207	215	8r216
11r216	2r215	213		9r204	207	3r215	11r216	
11r316	3r312	310		9r302	305	2r312	11r316	
8r316	312	310	302	16r301	302	305	312	8r316
6r316	312	310		22r301	305	7r316		
5r316	310			25r301	302	305	5r316	
4r316	310			28r301	305	4r316		
3r316	310			30r301	305	3r316		
2r316	310			32r301	305	2r316		
316	314			34r301	305	316		
316	310			34r301	303	316		
	314			36r301	308		2q38	
316	309			34r301	307	316		
316	313			34r301	308	316		
2r316	313			32r301	307	2r316		
2r316	314	304		30r301	303	3r316		
4r316	313			28r301	307	315	3r316	
5r316	313	304		25r301	307	5r316		
7r316	313			22r301	307	315	6r316	
8r316	315	313	304	16r301	304	307	315	8r316
11r316	2r315	313		9r304	307	3r315	11r316	
11r416	3r412	410		9r402	405	2r412	11r416	
8r416	412	410	402	16r401	402	405	412	8r416
6r416	412	410		22r401	405	7r416		
5r416	410			25r401	402	405	5r416	
4r416	410			28r401	405	4r416		
3r416	410			30r401	405	3r416		
2r416	410			32r401	405	2r416		
416	414			34r401	405	416		
416	410			34r401	403	416		
	414			36r401	408		2q38	
416	409			34r401	407	416		
416	413			34r401	408	416		
2r416	413			32r401	407	2r416		
2r416	414	404		30r401	403	3r416		

```
  4r416   413               28r401  407   415  3r416
  5r416   413   404         25r401  407  5r416
  7r416   413               22r401  407   415  6r416
  8r416   415   413   404  16r401  404   407   415  8r416
 11r416  2r415  413          9r404  407  3r415 11r416
 11r316  3r312  310          9r302  305  2r312 11r316
  8r316   312   310   302  16r301  302   305   312  8r316
  6r316   312   310         22r301  305  7r316
  5r316   310               25r301  302   305  5r316
  4r316   310               28r301  305  4r316
  3r316   310               30r301  305  3r316
  2r316   310               32r301  305  2r316
    316   314               34r301  305   316
    316   310               34r301  303   316
          314               36r301  308              2q38
    316   309               34r301  307   316
    316   313               34r301  308   316
  2r316   313               32r301  307  2r316
  2r316   314   304         30r301  303  3r316
  4r316   313               28r301  307   315  3r316
  5r316   313   304         25r301  307  5r316
  7r316   313               22r301  307   315  6r316
  8r316   315   313   304  16r301  304   307   315  8r316
 11r316  2r315  313          9r304  307  3r315 11r316
 11r516  3r512  510          9r502  505  2r512 11r516
  8r516   512   510   502  16r501  502   505   512  8r516
  6r516   512   510         22r501  505  7r516
  5r516   510               25r501  502   505  5r516
  4r516   510               28r501  505  4r516
  3r516   510               30r501  505  3r516
  2r516   510               32r501  505  2r516
    516   514               34r501  505   516
    516   510               34r501  503   516
          514               36r501  508              2q38
    516   509               34r501  507   516
    516   513               34r501  508   516
  2r516   513               32r501  507  2r516
  2r516   514   504         30r501  503  3r516
  4r516   513               28r501  507   515  3r516
  5r516   513   504         25r501  507  5r516
  7r516   513               22r501  507   515  6r516
  8r516   515   513   504  16r501  504   507   515  8r516
 11r516  2r515  513          9r504  507  3r515 11r516
 11r616  3r612  610          9r602  605  2r612 11r616
  8r616   612   610   602  16r601  602   605   612  8r616
  6r616   612   610         22r601  605  7r616
  5r616   610               25r601  602   605  5r616
  4r616   610               28r601  605  4r616
  3r616   610               30r601  605  3r616
  2r616   610               32r601  605  2r616
    616   614               34r601  605   616
    616   610               34r601  603   616
          614               36r601  608              2q38
    616   609               34r601  607   616
    616   613               34r601  608   616
  2r616   613               32r601  607  2r616
  2r616   614   604         30r601  603  3r616
  4r616   613               28r601  607   615  3r616
  5r616   613   604         25r601  607  5r616
  7r616   613               22r601  607   615  6r616
  8r616   615   613   604  16r601  604   607   615  8r616
 11r616  2r615  613          9r604  607  3r615 11r616
end fill
end array
end data
end
```

p2438al

```
=csas25
p2438al
44group latticecell
uo2        1 0.84 293 92235 2.35 92238 97.65                  end
al         2 1.0                                              end
h2o        3 1.0                                              end
plexiglas  4 1.0                                              end
arbmal     2.692 8 0 0 1 13027 97.15 24000 .21 29000 .12
           26000 .82 25055 .21 14000 .82 16000 .06 22000
           .61 5                                              end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2                          end
3-20x16 assemblies separated by 0.625-cm-thick aluminum plates and
`8.045 cm of water, plate-to-assembly distance of 0.645 cm
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  1 1 0.5588                       91.44   0.0
cylinder  2 1 0.635                        96.52  -1.27
cuboid    3 1 4p1.016                      96.52  -1.27
unit 2
array  1 3*0.0
reflector 3 1 2r0.0 2r1.544 2r0.0 1
unit 3
cuboid    3 1 7.400  0.0  35.6   0.0  91.5   0.0
cuboid    5 1 8.025  0.0  35.6   0.0  91.5   0.0
cuboid    3 1 8.67   0.0  35.6   0.0  96.52  -1.27
unit 4
cuboid    3 1 0.645  0.0  35.6   0.0  91.5   0.0
cuboid    5 1 1.27   0.0  35.6   0.0  91.5   0.0
cuboid    3 1 8.67   0.0  35.6   0.0  96.52  -1.27
global unit 5
```

```
array 2  3*0.0
reflector   4 1 5r0 2.54    1
reflector   3 1 2r30.5 2r28.96 2r15.3 1
end geometry

read array
ara=1 nux=20 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 4 2 end fill
end array
end data
end
```

p2438ba

```
=csas25
p2438ba
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65              end
al           2 1.0                                          end
h2o          3 1.0                                          end
plexiglas  4 1.0                                            end
arbmboral    2.49  5 1 0 1 5000 28.7 13027 62.8
             6012 7.97 26000 .33 14000 .2  5 1 293          end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2                        end
2-22x16 and 1-20x16 (center) assemblies separated by 0.713-cm-thick
`Boral-A plates and 4.337 cm of water, plate-to-assembly distance of
`0.645 cm
read parm  run=yes  gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  1 1 0.5588                       91.44   0.0
cylinder  2 1 0.635                        96.52  -1.27
cuboid    3 1 4p1.016                      96.52  -1.27
unit 2
array  1 3*0.0
reflector 3 1 2r0.0 2r1.994 2r0.0  1
unit 3
cuboid    5 1 4.303 3.794 36.5    0.0   91.5     0.0
cuboid    2 1 4.405 3.692 36.5    0.0   91.5     0.0
cuboid    3 1 5.05  0.0   36.5    0.0   96.52   -1.27
unit 4
cuboid    5 1 1.256 0.747 36.5    0.0   91.5     0.0
cuboid    2 1 1.358 0.645 36.5    0.0   91.5     0.0
cuboid    3 1 5.05  0.0   36.5    0.0   96.52   -1.27
unit 5
array 2  3*0.0
reflector 3 1 2r0.0 2r1.994 2r0.0  1
global
unit 6
array 3  3*0.0
reflector   4 1 5r0  2.54    1
reflector   3 1 2r30.5 2r26.51 2r15.3 1
end geometry

read array
ara=1 nux=22 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=20 nuy=16 nuz=1 fill f1         end fill
ara=3 nux=5  nuy=1  nuz=1 fill 2 3 5 4 2 end fill
end array
end data
end
```

p2438cu

```
=csas25
p2438cu
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65              end
al           2 1.0                                          end
h2o          3 1.0                                          end
plexiglas  4 1.0                                            end
cu           5  den=8.913                                   end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2                        end
3-20x16 assemblies separated by 0.646-cm-thick copper plates and
`5.974 cm of water, plate-to-assembly distance of 0.645 cm
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  1 1 0.5588                       91.44   0.0
cylinder  2 1 0.635                        96.52  -1.27
cuboid    3 1 4p1.016                      96.52  -1.27
unit 2
array  1 3*0.0
reflector 3 1 2r0.0 2r1.544 2r0.0 1
unit 3
cuboid    3 1 5.329  0.0  35.6    0.0   91.5     0.0
cuboid    5 1 5.975  0.0  35.6    0.0   91.5     0.0
cuboid    3 1 6.62   0.0  35.6    0.0   97.79    0.0
unit 4
cuboid    3 1 0.645  0.0  35.6    0.0   91.5     0.0
cuboid    5 1 1.291  0.0  35.6    0.0   91.5     0.0
cuboid    3 1 6.62   0.0  35.6    0.0   97.79    0.0
global unit 5
array  2 3*0.0
reflector   4 1 5r0 2.54     1
reflector   3 1 2r30.5 2r28.96 2r15.3 1
end geometry
```

```
read array
ara=1 nux=20 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 4 2 end fill
end array
end data
end
```

p2438slg

```
=csas25
p2438slg
44group latticecell
uo2         1 0.84 293 92235 2.35 92238 97.65            end
al          2 1.0                                        end
h2o         3 1.0                                        end
plexiglas  4 1.0                                         end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2                     end
3-20x16 assemblies separated by 8.39 cm of water
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  1 1 0.5588                      91.44   0.0
cylinder  2 1 0.635                       96.52  -1.27
cuboid    3 1 4p1.016                     96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    3 1 8.39   0.0  32.512  0.0    96.52  -1.27
global unit 4
array 2  3*0.0
reflector   4 1 5r0 2.54      1
reflector   3 1 4r30.5 2r15.3 1
end geometry

read array
ara=1 nux=20 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p2438ss

```
=csas25
p2438ss
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65           end
al           2 1.0                                       end
h2o          3 1.0                                       end
plexiglas  4 1.0                                         end
arbmss      7.93 6 0 0 1 24304 18.56 29000 0.27 26304
            68.24 25000 1.58 42000 0.26 28304 11.09 5     end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2                     end
3-20x16 assemblies separated by 0.485-cm-thick 304L stainless steel
`plates and 6.395 cm of water, plate-to-assembly distance of 0.645 cm
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  1 1 0.5588                       92.72   1.27
cylinder  2 1 0.635                        97.79   0.00
cuboid    3 1 4p1.016                      97.79   0.00
unit 2
array  1 3*0.0
cuboid    3 1 40.64  0.0  34.056 -1.544 97.79    0.0
unit 3
cuboid    3 1 5.750  0.0  35.6    0.0   91.5     0.0
cuboid    5 1 6.235  0.0  35.6    0.0   91.5     0.0
cuboid    3 1 6.88   0.0  35.6    0.0   97.79    0.0
unit 4
cuboid    3 1 0.645  0.0  35.6    0.0   91.5     0.0
cuboid    5 1 1.130  0.0  35.6    0.0   91.5     0.0
cuboid    3 1 6.88   0.0  35.6    0.0   97.79    0.0
global unit 5
array 2  3*0.0
reflector   4 1 5r0          2.54 1
reflector   3 1 4r30.5 15.2 15.3  1
end geometry

read array
ara=1 nux=20 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 4 2 end fill
end array
end data
end
```

p2438zr

```
=csas25
p2438zr
44group latticecell
uo2         1 0.84 293 92235 2.35 92238 97.65            end
al          2 1.0                                        end
h2o         3 1.0                                        end
plexiglas 4 1.0                                          end
arbmzr4     6.32 4 0 0 1 40000 98.16 50000 1.5
            24000 .13 26000 .21 5                        end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2                     end
```

```
3-20x16 assemblies separated by 0.652-cm-thick Zircaloy-4 plates and
`8.138 cm of water, plate-to-assembly distance of 0.645 cm
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  1 1 0.5588                        91.44   0.0
cylinder  2 1 0.635                         96.52  -1.27
cuboid    3 1 4p1.016                       96.52  -1.27
unit 2
array  1 3*0.0
reflector 3 1 2r0.0  2r1.544 2r0.0 1
unit 3
cuboid    3 1 7.493  0.0  35.6    0.0  91.5    0.0
cuboid    5 1 8.145  0.0  35.6    0.0  91.5    0.0
cuboid    3 1 8.79   0.0  35.6    0.0  97.79   0.0
unit 4
cuboid    3 1 0.645  0.0  35.6    0.0  91.5    0.0
cuboid    5 1 1.297  0.0  35.6    0.0  91.5    0.0
cuboid    3 1 8.79   0.0  35.6    0.0  97.79   0.0
global unit 5
array 2  3*0.0
reflector   4 1 5r0 2.54    1
reflector   3 1 2r30.5 2r28.96 2r15.3 1
end geometry

read array
ara=1 nux=20 nuy=16 nuz=1 fill f1        end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 4 2 enu fill
end array
end data
end
```

p2615al

```
=csas25
p2615al
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69              end
al           2 1.0                                           end
h2o          3 1.0                                           end
plexiglas  4 1.0                                             end
arbmal       2.692 8 0 0 1 13027 97.15 24000 .21 29000 .12
             26000 .82 25055 .21 14000 .82 16000 .06 22000
             .61 5                                           end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 6                 end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0            end
3-15x8 assemblies separated by 0.625-cm-thick aluminum plates and
`10.095 cm of water, plate-to-assembly distance of 0.105 cm
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  1 1 0.63245                        91.44   0.0
cylinder  0 1 0.64135                        91.44   0.0
cylinder  6 1 0.64135                        93.98  -2.54
cylinder  2 1 0.70735                        93.98  -2.54
cuboid    3 1 4p1.270                        93.98  -2.54
unit 2
array  1 3*0.0
reflector   3 1 2r0  2r7.64 2r0  1
unit 3
cuboid    5 1  0.0  -0.625  2p17.8      88.96  -2.54
cuboid    3 1  .105 -10.615 2p17.8      93.98  -2.54
unit 4
cuboid    5 1  0.625  0.0  2p17.8       88.96  -2.54
cuboid    3 1  10.615 -.105 2p17.8      93.98  -2.54
global unit 5
array 2  -67.87   -17.8    0.
reflector   4 1 5r0.0   2.54 1
reflector   3 1 2r30.5 2r22.86 2r15.3 1
end geometry

read array
ara=1 nux=15 nuy=8 nuz=1 fill f1        end fill
ara=2 nux=5  nuy=1 nuz=1 fill 2 3 2 4 2 end fill
end array
end data
end
```

p2615ba

```
=csas25
p2615ba
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69              end
al           2 1.0                                           end
h2o          3 1.0                                           end
plexiglas  4 1.0                                             end
arbmboral    2.49  4 1 0 1 5000 28.7 13027 63.0
             6012 7.97  26000 0.33   5   1   293             end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 6                 end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0            end
3-15x8 assemblies separated by 0.713-cm-thick Boral-A plates and
`6.007 cm of water, plate-to-assembly distance of 3.277 cm
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm
```

```
read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  6 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p1.270                    93.98  -2.54
unit 2
array  1 3*0.0
reflector   3 1 2r0  2r8.09 2r0  1
unit 3
cuboid    5 1 -0.102 -0.611 2p18.25      88.96  -2.54
cuboid    2 1  0.0   -0.713 2p18.25      88.96  -2.54
cuboid    3 1 3.277  -3.443 2p18.25      93.98  -2.54
unit 4
cuboid    5 1  0.611 0.102  2p18.25      88.96  -2.54
cuboid    2 1  0.713 0.0    2p18.25      88.96  -2.54
cuboid    3 1  3.443 -3.277 2p18.25      93.98  -2.54
global unit 5
array 2  -63.87   -18.25   0.
reflector   4 1 5r0.0   2.54 1
reflector   3 1 2r30.5 2r22.41 2r15.3 1
end geometry

read array
ara=1 nux=15 nuy=8 nuz=1 fill f1          end fill
ara=2 nux=5  nuy=1 nuz=1 fill 2 3 2 4 2 end fill
end array
end data
end
```

<u>p2615cd1</u>

```
=csas25
p2615cd1
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69                 end
al           2 1.0                                              end
h2o          3 1.0                                              end
plexiglas  4 1.0                                                end
cd           5 0.997                                            end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 6                    end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0                end
3-15x8 assemblies separated by 0.2006-cm-thick cadmium plates and
`7.0794 cm of water, plate-to-assembly distance of 3.277 cm
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  6 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p1.270                    93.98  -2.54
unit 2
array  1 3*0.0
reflector   3 1 2r0  2r7.64 2r0  1
unit 3
cuboid    5 1 0.0    -0.2006 2p17.8      88.96  -2.54
cuboid    3 1 3.277 -4.003  2p17.8       93.98  -2.54
unit 4
cuboid    5 1 0.2006 0.0    2p17.8       88.96  -2.54
cuboid    3 1 4.003 -3.277  2p17.8       93.98  -2.54
global unit 5
array 2  -64.43   -17.8    0.
reflector   4 1 5r0.0   2.54 1
reflector   3 1 2r30.5 2r22.86 2r15.3 1
end geometry
read array
ara=1 nux=15 nuy=8 nuz=1 fill f1          end fill
ara=2 nux=5  nuy=1 nuz=1 fill 2 3 2 4 2 end fill
end array
end data
end
```

<u>p2615cd2</u>

```
=csas25
p2615cd2
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69                 end
al           2 1.0                                              end
h2o          3 1.0                                              end
plexiglas  4 1.0                                                end
cd           5 0.997                                            end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 6                    end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0                end
3-15x8 assemblies separated by 0.2006-cm-thick cadmium plates and
`3.674 cm of water, plate-to-assembly distance of 0.529 cm
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  6 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p1.270                    93.98  -2.54
```

```
unit 2
array  1 3*0.0
reflector   3 1 2r0  2r7.64 2r0  1
unit 3
cuboid    5 1  0.0   -0.2006 2p17.8      88.96  -2.54
cuboid    3 1  0.529 -5.151  2p17.8      93.98  -2.54
unit 4
cuboid    5 1  0.2006 0.0    2p17.8      88.96  -2.54
cuboid    3 1  5.151 -0.529  2p17.8      93.98  -2.54
global unit 5
array 2  -62.83   -17.8    0.
reflector   4 1 5r0.0   2.54 1
reflector   3 1 2r30.5 2r22.86 2r15.3 1
end geometry

read array
ara=1 nux=15 nuy=8 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1 nuz=1 fill 2 3 2 4 2 end fill
end array
end data
end
```

<u>p2615cu</u>

```
=csas25
p2615cu
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69            end
al           2 1.0                                         end
h2o          3 1.0                                         end
plexiglas  4 1.0                                           end
cu           5 den=8.913                                   end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 6               end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0           end
3-15x8 assemblies separated by 0.646-cm-thick copper plates and 7.504
`cm of water, plate-to-assembly distance of 0.084 cm
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  6 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p1.270                    93.98  -2.54
unit 2
array  1 3*0.0
reflector   3 1 2r0  2r7.64 2r0  1
unit 3
cuboid    5 1  0.0   -0.646 2p17.8      88.96  -2.54
cuboid    3 1  0.084 -8.066 2p17.8      93.98  -2.54
unit 4
cuboid    5 1  0.646  0.0   2p17.8      88.96  -2.54
cuboid    3 1  8.066 -0.084 2p17.8      93.98  -2.54
global unit 5
array 2  -65.3    -17.8    0.
reflector   4 1 5r0.0   2.54 1
reflector   3 1 2r30.5 2r22.86 2r15.3 1
end geometry

read array
ara=1 nux=15 nuy=8 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1 nuz=1 fill 2 3 2 4 2 end fill
end array
end data
end
```

<u>p2615ss</u>

```
=csas25
p2615ss
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69            end
al           2 1.0                                         end
h2o          3 1.0                                         end
plexiglas  4 1.0                                           end
ss304        5 1.0                                         end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 6               end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0           end
3-15x8 assemblies separated by 0.485-cm-thick 304L stainless steel
`plates and 8.095 cm of water, plate-to-assembly distance of 0.245 cm
read parm  run=yes gen=405 npg=600 nsk=5  nub=yes end parm

read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  6 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p1.270                    93.98  -2.54
unit 2
array  1 3*0.0
reflector   3 1 2r0  2r7.64 2r0  1
unit 3
cuboid    5 1  0.0   -0.485 2p17.8      88.96  -2.54
cuboid    3 1  0.245 -8.335 2p17.8      93.98  -2.54
unit 4
cuboid    5 1  0.485  0.0   2p17.8      88.96  -2.54
```

```
cuboid    3 1  8.335 -0.245 2p17.8       93.98  -2.54
global unit 5
array 2  -65.73   -17.8     0.
reflector   4 1 5r0.0    2.54 1
reflector   3 1 2r30.5 2r22.86 2r15.3 1
end geometry

read array
ara=1 nux=15 nuy=8 nuz=1 fill f1          end fill
ara=2 nux=5  nuy=1 nuz=1 fill 2 3 2 4 2 end fill
end array
end data
end
```

p2615zr

```
=csas25
p2615zr
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69              end
al           2 1.0                                           end
h2o          3 1.0                                           end
plexiglas  4 1.0                                             end
arbmzr4      6.32  4 0 0 1 40000 .9816 50000 .015
             24000 .0013 26000 .0021 5                       end
arbmrubber  1.321 6 0 0 0 6012  58.    1001  6.5  20000 11.4
             16000 1.7 8016 22.1 14000 0.3 6                 end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0            end
3-15x8 assemblies separated by 0.652-cm-thick Zircaloy-4 plates and
`10.268 cm of water, plate-to-assembly distance of 0.078 cm
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  1 1 0.63245                     91.44    0.0
cylinder  0 1 0.64135                     91.44    0.0
cylinder  6 1 0.64135                     93.98   -2.54
cylinder  2 1 0.70735                     93.98   -2.54
cuboid    3 1 4p1.270                     93.98   -2.54
unit 2
array  1 3*0.0
reflector 3 1  2r0  2r7.64  2r0   1
unit 3
cuboid     5 1  0.0     -0.652  2p17.8    88.96   -2.54
cuboid     3 1  0.078 -10.842  2p17.8     93.98   -2.54
unit 4
cuboid     5 1  0.652   0.0     2p17.8    88.96   -2.54
cuboid     3 1  10.842 -0.078  2p17.8     93.98   -2.54
global unit 5
array 2  -68.07    -17.8     0.
reflector   4 1 5r0.0    2.54 1
reflector   3 1 2r30.5 2r22.86 2r15.3 1
end geometry

read array
ara=1 nux=15 nuy=8 nuz=1 fill f1          end fill
ara=2 nux=5  nuy=1 nuz=1 fill 2 3 2 4 2 end fill
end array
end data
end
```

p2827l1

```
=csas25
p2827l1
44group  latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65               end
al           2 1.0                                           end
h2o          3 1.0                                           end
plexiglas  4 1.0                                             end
h2o          5 1.0                                           end
pb           6 .9758                                         end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2                         end
3-19x16 assemblies separated by 13.27 cm of water, assemblies
'separated from lead reflecting walls by 0.66 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                      91.44   0.0
cylinder  2 1 0.635                       96.52  -1.27
cuboid    3 1 4p1.016                     96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 12.958 0.0  32.512  0.0   96.52  -1.27
global unit 4
array 2  -70.87    -16.256  0.
reflector  4 1  5r0.0     2.54                  1
cuboid     5 1  2p82.0    2p16.916 104.29 -19.11
reflector  6 1  2r0.0     2r10.2    2r0.0        1
reflector  5 1  2r30.5 2r19.64 7.43 0           1
end geometry

read array
ara=1 nux=19 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p282712

```
=csas25
p282712
44group  latticecell
uo2         1 0.84 293 92235 2.35 92238 97.65             end
al          2 1.0                                         end
h2o         3 1.0                                         end
plexiglas  4 1.0                                          end
h2o         5 1.0                                         end
pb          6 .9758                                       end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2                      end
3-19x16 assemblies separated by 11.25 cm of water, assemblies
'separated from lead reflecting walls by 2.616 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                      91.44   0.0
cylinder  2 1 0.635                       96.52  -1.27
cuboid    3 1 4p1.016                     96.52  -1.27
unit 2
array 1 3*0.0
unit 3
cuboid     5 1 10.488 0.0 32.512 0.0   96.52  -1.27
global unit 4
array 2  -68.4  -16.256  0.
reflector   4 1  5r0.0    2.54                   1
cuboid      5 1  2p82.0   2p18.872 104.29 -19.11
reflector   6 1  2r0.0    2r10.2   2r0.0         1
reflector   5 1  2r30.5   2r17.684 7.43      0   1
end geometry

read array
ara=1 nux=19 nuy=16 nuz=1 fill f1          end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p282713

```
=csas25
p282713
44group latticecell
uo2         1 0.949 293 92235 4.31 92238 95.69            end
al          2 1.0                                         end
h2o         3 1.0                                         end
plexiglas  4 1.0                                          end
pb          5 .9758                                       end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7               end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0          end
3-13x8 assemblies separated by 20.78 cm of water, assemblies separated
`from lead reflecting walls by 0.66 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                     91.44   0.0
cylinder  0 1 0.64135                     91.44   0.0
cylinder  7 1 0.64135                     93.98  -2.54
cylinder  2 1 0.70735                     93.98  -2.54
cuboid    3 1 4p1.270                     93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    3 1 19.6547 0.0 20.32   0.0   93.98  -2.54
global unit 4
array 2  -69.1847 -10.16   0.
reflector   4 1 5r0.0   2.54              1
cuboid      3 1 2p82.0  2p10.82   103.02 -20.38
reflector   5 1 2r0.0   2r10.2    2r0.0  1
reflector   3 1 2r30.5  2r19.64   6.16 0 1
end geometry

read array
ara=1 nux=13 nuy=8  nuz=1 fill f1          end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2  end fill
end array
end data
end
```

p282714

```
=csas25
p282714
44group latticecell
uo2         1 0.949 293 92235 4.31 92238 95.69            end
al          2 1.0                                         end
h2o         3 1.0                                         end
plexiglas  4 1.0                                          end
h2o         5 1.0                                         end
pb          6 .9758                                       end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7               end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0          end
3-13x8 assemblies separated by 19.04 cm of water, assemblies separated
`from lead reflecting walls by 1.321 cm of water
```

```
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                   91.44   0.0
cylinder  0 1 0.64135                   91.44   0.0
cylinder  7 1 0.64135                   93.98  -2.54
cylinder  2 1 0.70735                   93.98  -2.54
cuboid    3 1 4p1.270                   93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 17.9147 0.0 20.32   0.0   93.98  -2.54
global unit 4
array 2  -67.4447 -10.16   0.
reflector   4 1 5r0.0   2.54              1
cuboid      5 1 2p82.0  2p11.481  103.02 -20.38
reflector   6 1 2r0.0   2r10.2    2r0.0  1
reflector   5 1 2r30.5  2r18.979  2r6.16 1
end geometry

read array
ara=1 nux=13 nuy=8  nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2  end fill
end array
end data
end
```

p2827slg

```
=csas25
p2827slg
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65              end
al           2 1.0                                          end
h2o          3 1.0                                          end
plexiglas  4 1.0                                            end
h2o          5 1.0                                          end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2                        end
3-19x16 assemblies separated by 8.31 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                    91.44   0.0
cylinder  2 1 0.635                     96.52  -1.27
cuboid    3 1 4p1.016                   96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 7.548  0.0  32.512  0.0   96.52  -1.27
global unit 4
array 2  -65.460  -16.256  0.
reflector   4 1 5r0.0         2.54 1
reflector   5 1 4r30.5 15.2 15.3  1
end geometry

read array
ara=1 nux=19 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p2827u1

```
=csas25
p2827u1
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65              end
al           2 1.0                                          end
h2o          3 1.0                                          end
plexiglas  4 1.0                                            end
h2o          5 1.0                                          end
uranium      6 .98163 293 92235 .199 92238 99.801           end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2                        end
3-19x16 assemblies separated by 11.83 cm of water, assemblies
separated from depleted uranium reflecting walls by 0.0 cm of water
read parm  run=yes gen=405 npg=600 nsk=5  nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                    91.44   0.0
cylinder  2 1 0.635                     96.52  -1.27
cuboid    3 1 4p1.016                   96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 11.068 0.0  32.512  0.0   96.52  -1.27
global unit 4
array 2  -68.98   -16.256  0.
reflector   4 1  5r0.0    2.54                  1
cuboid      5 1  2p76.15  2p16.256  102.79  -19.11
reflector   6 1  2r0.0    2r7.65    2r0.0       1
reflector   5 1  2r30.5   2r22.85   8.93 0      1
end geometry


read array
ara=1 nux=19 nuy=16 nuz=1 fill f1         end fill
```

```
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p2827u2

```
=csas25
p2827u2
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65                end
al           2 1.0                                            end
h2o          3 1.0                                            end
plexiglas  4 1.0                                              end
h2o          5 1.0                                            end
uranium      6 .98163 293 92235 .199 92238 99.801             end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2                          end
3-19x16 assemblies separated by 14.11 cm of water, assemblies
'separated from depleted uranium reflecting walls by 1.956 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                     91.44   0.0
cylinder  2 1 0.635                      96.52  -1.27
cuboid    3 1 4p1.016                    96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 13.348 0.0  32.512  0.0   96.52  -1.27
global unit 4
array 2  -71.26   -16.256  0.
reflector   4 1  5r0.0    2.54                       1
cuboid      5 1  2p76.15  2p18.212  102.79  -19.11
reflector   6 1  2r0.0    2r7.65    2r0.0            1
reflector   5 1  2r30.5   2r20.894  8.93 0           1
end geometry

read array
ara=1 nux=19 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p2827u3

```
=csas25
p2827u3
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69               end
al           2 1.0                                            end
h2o          3 1.0                                            end
plexiglas  4 1.0                                              end
h2o          5 1.0                                            end
uranium      6 .98163  293  92235  .199  92238  99.801        end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 7                  end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0              end
3-13x8 assemblies separated by 15.38 cm of water, assemblies separated
'from depleted uranium reflecting walls by 0.0 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                     91.44   0.0
cylinder  0 1 0.64135                     91.44   0.0
cylinder  7 1 0.64135                     93.98  -2.54
cylinder  2 1 0.70735                     93.98  -2.54
cuboid    3 1 4p1.270                     93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 14.2547 0.0 20.32   0.0   93.98  -2.54
global unit 4
array 2  -63.7847 -10.16   0.
reflector   4 1 5r0.0    2.54                  1
cuboid      5 1 2p76.15  2p10.16  101.52 -20.38
reflector   6 1 2r0.0    2r7.65   2r0.0        1
reflector   5 1 2r30.5   2r22.85  7.66 0       1
end geometry

read array
ara=1 nux=13 nuy=8 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1 nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p2827u4

```
=csas25
p2827u4
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69               end
al           2 1.0                                            end
h2o          3 1.0                                            end
plexiglas  4 1.0                                              end
h2o          5 1.0                                            end
```

```
uranium     6 .98163  293  92235  .199  92238  99.801       end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7                 end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0            end
3-19x16 assemblies separated by 15.32 cm of water, assemblies
'separated from depleted uranium reflecting walls by 1.956 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                   91.44   0.0
cylinder  0 1 0.64135                   91.44   0.0
cylinder  7 1 0.64135                   93.98  -2.54
cylinder  2 1 0.70735                   93.98  -2.54
cuboid    3 1 4p1.270                   93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 14.1947 0.0 20.32   0.0   93.98  -2.54
global unit 4
array 2  -59.9147 -10.16   0.
reflector   4 1 5r0.0   2.54              1
cuboid      5 1 2p76.15 2p12.116  101.52 -20.38
reflector   6 1 2r0.0   2r7.65    2r0.0  1
reflector   5 1 2r30.5  2r20.894  7.66 0 1
end geometry

read array
ara=1 nux=12 nuy=8 nuz=1 fill f1        end fill
ara=2 nux=5  nuy=1 nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p3314al

```
=csas25
p3314al
44group latticecell
uo2         1 0.949 293 92235 4.31 92238 95.69              end
al          2 1.0                                           end
h2o         3 1.0                                           end
plexiglas  4 1.0                                            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 5                 end
al   6 den=2.692 .9715                                      end
cr   6 den=2.692 .0021                                      end
cu   6 den=2.692 .0012                                      end
fe   6 den=2.692 .0082                                      end
mn   6 den=2.692 .0021                                      end
si   6 den=2.692 .0082                                      end
s    6 den=2.692 .0006                                      end
ti   6 den=2.692 .0061                                      end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0            end
2-9x12 and 2-9x1 assemblies separated by 0.625-cm-thick aluminum
'plates and 2.205- and 8.415-cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                   91.44   0.0
cylinder  0 1 0.64135                   91.44   0.0
cylinder  5 1 0.64135                   93.98  -2.54
cylinder  2 1 0.70735                   93.98  -2.54
cuboid    3 1 4p.9460                   93.98  -2.54
unit 2
cuboid    3 1 17.157 0.0 22.704  0.0    93.98  -2.54
unit 3
array 1 3*0.0
unit 4
cuboid    6 1 2.83  2.205 22.704 0.0    88.96  -2.54
cuboid    3 1 2.83  0.0   22.704 0.0    93.98  -2.54
unit 5
cuboid    6 1 71.2  0.0    0.625 0.0    88.96  -2.54
cuboid    3 1 71.2  0.0    0.625 0.0    93.98  -2.54
unit 6
cuboid    3 1 36.39   0.0  8.415 0.0    88.96  -2.54
cuboid    6 1 37.015  0.0  8.415 0.0    88.96  -2.54
cuboid    3 1 71.2    0.0  8.415 0.0    93.98  -2.54
unit 7
cuboid    3 1 17.157  0.0  1.892 0.0    93.98  -2.54
unit 8
cuboid    6 1 2.83  2.205  1.892 0.0    88.96  -2.54
cuboid    3 1 2.83  0.0    1.892 0.0    93.98  -2.54
unit 9
array 2 3*0.0
unit 10
cuboid    3 1 36.39   0.0  37.564 0.0  88.96  -2.54
cuboid    6 1 37.015  0.0  37.564 0.0  88.96  -2.54
cuboid    3 1 71.2    0.0  37.564 0.0  93.98  -2.54
unit 11
array 3 3*0.0
unit 12
array 4 3*0.0
global unit 13
array 5  3*0.0
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry
```

```
read array
ara=1 nux=9  nuy=12 nuz=1 fill f1           end fill
ara=2 nux=9  nuy=1  nuz=1 fill f1           end fill
ara=3 nux=5  nuy=1  nuz=1 fill 2 3 4 3 2    end fill
ara=4 nux=5  nuy=1  nuz=1 fill 7 9 8 9 7    end fill
ara=5 nux=1  nuy=5  nuz=1 fill 11 5 6 12 10 end fill
end array
end data
end
```

p3314ba

```
=csas25
p3314ba
44group latticecell
uo2         1 0.949 293 92235 4.31 92238 95.69              end
al          2 1.0                                           end
h2o         3 1.0                                           end
plexiglas  4 1.0                                            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 5                 end
b           6 den=2.49  .287                                end
c           6 den=2.49  .0797                               end
al          6 den=2.49  .6249                               end
cr          6 den=2.49  .0005                               end
cu          6 den=2.49  .0009                               end
fe          6 den=2.49  .0033                               end
mg          6 den=2.49  .0005                               end
mn          6 den=2.49  .0005                               end
na          6 den=2.49  .0002                               end
ni          6 den=2.49  .0002                               end
si          6 den=2.49  .0020                               end
s           6 den=2.49  .0003                               end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0            end
2-11x14 and 2-11x16 assemblies separated by 0.713-cm-thick Boral-A
plates and 2.117- and 4.087-cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                     91.44   0.0
cylinder  0 1 0.64135                     91.44   0.0
cylinder  5 1 0.64135                     93.98  -2.54
cylinder  2 1 0.70735                     93.98  -2.54
cuboid    3 1 4p.9460                     93.98  -2.54
unit 2
cuboid    3 1 13.373 0.0 26.488  0.0      93.98  -2.54
unit 3
array 1 3*0.0
unit 4
cuboid    6 1 2.728  2.219 26.488 0.0   88.96  -2.54
cuboid    2 1 2.83   2.117 26.488 0.0   88.96  -2.54
cuboid    3 1 2.83   0.0   26.488 0.0   93.98  -2.54
unit 5
cuboid    2 1 71.2   0.0    0.102 0.0   88.96  -2.54
cuboid    6 1 71.2   0.0    0.611 0.0   88.96  -2.54
cuboid    2 1 71.2   0.0    0.713 0.0   88.96  -2.54
cuboid    3 1 71.2   0.0    0.713 0.0   93.98  -2.54
unit 6
cuboid    3 1 36.302 0.0    4.087 0.0   88.96  -2.54
cuboid    2 1 36.404 0.0    4.087 0.0   88.96  -2.54
cuboid    6 1 36.913 0.0    4.087 0.0   88.96  -2.54
cuboid    2 1 37.015 0.0    4.087 0.0   88.96  -2.54
cuboid    3 1 71.2   0.0    4.087 0.0   93.98  -2.54
unit 7
cuboid    3 1 13.373 0.0   30.272 0.0   93.98  -2.54
unit 8
cuboid    6 1 2.728 2.219  30.272 0.0   88.96  -2.54
cuboid    2 1 2.83  2.117  30.272 0.0   88.96  -2.54
cuboid    3 1 2.83  0.0    30.272 0.0   93.98  -2.54
unit 9
array 2 3*0.0
unit 10
cuboid    3 1 36.302 0.0    9.64  0.0   88.96  -2.54
cuboid    2 1 36.404 0.0    9.64  0.0   88.96  -2.54
cuboid    6 1 36.913 0.0    9.64  0.0   88.96  -2.54
cuboid    2 1 37.015 0.0    9.64  0.0   88.96  -2.54
cuboid    3 1 71.2   0.0    9.64  0.0   93.98  -2.54
unit 11
array 3 3*0.0
unit 12
array 4 3*0.0
global unit 13
array 5  3*0.0
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=11 nuy=14 nuz=1 fill f1           end fill
ara=2 nux=11 nuy=16 nuz=1 fill f1           end fill
ara=3 nux=5  nuy=1  nuz=1 fill 2 3 4 3 2    end fill
ara=4 nux=5  nuy=1  nuz=1 fill 7 9 8 9 7    end fill
ara=5 nux=1  nuy=5  nuz=1 fill 11 5 6 12 10 end fill
end array
end data
end
```

p3314bc

```
=csas25
p3314bc
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69          end
al           2 1.0                                       end
h2o          3 1.0                                       end
plexiglas  4 1.0                                         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 5              end
b            6 den=2.47  .3188                           end
c            6 den=2.47  .0886                           end
al           6 den=2.47  .5926                           end
fe           6 den=2.47  .0005                           end
mg           6 den=2.47  .0001                           end
na           6 den=2.47  .0002                           end
si           6 den=2.47  .0006                           end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0         end
2-11x14 and 2-11x14 assemblies separated by 0.231-cm-thick Boral-C
`plates and 2.599- and 3.299-cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  5 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p.9460                    93.98  -2.54
unit 2
cuboid    3 1 13.373 0.0  26.488  0.0    93.98  -2.54
unit 3
array 1 3*0.0
unit 4
cuboid    6 1 2.805 2.624 26.488 0.0     88.96  -2.54
cuboid    2 1 2.83  2.599 26.488 0.0     88.96  -2.54
cuboid    3 1 2.83  0.0   26.488 0.0     93.98  -2.54
unit 5
cuboid    6 1 71.2  0.0    0.206 0.025   88.96  -2.54
cuboid    2 1 71.2  0.0    0.231 0.0     88.96  -2.54
cuboid    3 1 71.2  0.0    0.231 0.0     93.98  -2.54
unit 6
cuboid    3 1 36.784 0.0    3.299 0.0    88.96  -2.54
cuboid    2 1 36.809 0.0    3.299 0.0    88.96  -2.54
cuboid    6 1 36.99  0.0    3.299 0.0    88.96  -2.54
cuboid    2 1 37.015 0.0    3.299 0.0    88.96  -2.54
cuboid    3 1 71.2   0.0    3.299 0.0    93.98  -2.54
unit 7
array 2 3*0.0
unit 8
cuboid    3 1 36.784 0.0    14.694 0.0    88.96  -2.54
cuboid    2 1 36.809 0.0    14.694 0.0    88.96  -2.54
cuboid    6 1 36.99  0.0    14.694 0.0    88.96  -2.54
cuboid    2 1 37.015 0.0    14.694 0.0    88.96  -2.54
cuboid    3 1 71.2   0.0    14.694 0.0    93.98  -2.54
global unit 9
array 3  3*0.0
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=11 nuy=14 nuz=1 fill f1        end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 4 3 2 end fill
ara=3 nux=1  nuy=5  nuz=1 fill 7 5 6 7 8 end fill
end array
end data
end
```

p3314bf1

```
=csas25
p3314bf1
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69          end
al           2 1.0                                       end
h2o          3 1.0                                       end
plexiglas  4 1.0                                         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 5              end
boron        6 den=1.731 .3274                           end
c            6 den=1.731 .2113                           end
h            6 den=1.731 .0265                           end
cr           6 den=1.731 .0003                           end
fe           6 den=1.731 .0005                           end
o            6 den=1.731 .2101                           end
si           6 den=1.731 .2239                           end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0         end
2-11x14 and 2-11x14 assemblies separated by 0.546-cm-thick Boroflex
`plates and 2.284- and 3.054-cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  5 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p.9460                    93.98  -2.54
```

```
unit 2
array  1 3*0.0
unit 3
cuboid    3 1 26.488  0.0 13.373   0.0    93.98  -2.54
unit 4
cuboid    6 1 26.488  0.0  2.67  2.444   88.96  -2.54
cuboid    4 1 26.488  0.0  2.83  2.284   88.96  -2.54
cuboid    3 1 26.488  0.0  2.83  0.0     93.98  -2.54
unit 5
cuboid    6 1 0.386   0.16    2p35.6     88.96  -2.54
cuboid    4 1 0.546   0.0     2p35.6     88.96  -2.54
cuboid    3 1 0.546   0.0     2p35.6     93.98  -2.54
unit 6
cuboid    6 1 3.054   0.0  0.386   0.16  88.96  -2.54
cuboid    4 1 3.054   0.0  0.546   0.0   88.96  -2.54
cuboid    3 1 3.054   0.0 34.731 -36.469 93.98  -2.54
unit 7
cuboid    6 1 14.624  0.0  0.386   0.16  88.96  -2.54
cuboid    4 1 14.624  0.0  0.546   0.0   88.96  -2.54
cuboid    3 1 14.624  0.0 34.731 -36.469 93.98  -2.54
unit 8
array  2 3*0.0
global unit 9
array 3  3*0.0
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=14 nuy=11 nuz=1 fill f1        end fill
ara=2 nux=1  nuy=5  nuz=1 fill 3 2 4 2 3 end fill
ara=3 nux=5  nuy=1  nuz=1 fill 8 5 6 8 7 end fill
end array
end data
end
```

<u>p3314bf2</u>

```
=csas25
p3314bf2
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69            end
al           2 1.0                                         end
h2o          3 1.0                                         end
plexiglas  4 1.0                                           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 5               end
boron        6 den=1.731 .3274                             end
c            6 den=1.731 .2113                             end
h            6 den=1.731 .0265                             end
cr           6 den=1.731 .0003                             end
fe           6 den=1.731 .0005                             end
o            6 den=1.731 .2101                             end
si           6 den=1.731 .2239                             end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0          end
2-11x14 and 2-11x16 assemblies separated by 0.772-cm-thick Boroflex
`plates and 2.058- and 4.168-cm of water
read parm  run=yes  gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  5 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p.9460                    93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    3 1 26.488  0.0 13.373   0.0    93.98  -2.54
unit 4
cuboid    6 1 26.488  0.0  2.67  2.218   88.96  -2.54
cuboid    4 1 26.488  0.0  2.83  2.058   88.96  -2.54
cuboid    3 1 26.488  0.0  2.83  0.0     93.98  -2.54
unit 5
array  2 3*0.0
unit 6
cuboid    3 1 30.272  0.0 13.373   0.0    93.98  -2.54
unit 7
cuboid    6 1 30.272  0.0  2.67  2.218   88.96  -2.54
cuboid    4 1 30.272  0.0  2.83  2.058   88.96  -2.54
cuboid    3 1 30.272  0.0  2.83  0.0     93.98  -2.54
unit 8
cuboid    6 1 0.612   0.16    2p35.6     88.96  -2.54
cuboid    4 1 0.772   0.0     2p35.6     88.96  -2.54
cuboid    3 1 0.772   0.0     2p35.6     93.98  -2.54
unit 9
cuboid    6 1 4.168   0.0  0.612   0.16  88.96  -2.54
cuboid    4 1 4.168   0.0  0.772   0.0   88.96  -2.54
cuboid    3 1 4.168   0.0 34.957 -36.243 93.98  -2.54
unit 10
cuboid    6 1 9.500   0.0  0.612   0.16  88.96  -2.54
cuboid    4 1 9.500   0.0  0.772   0.0   88.96  -2.54
cuboid    3 1 9.500   0.0 34.957 -36.243 93.98  -2.54
unit 11
array  3 3*0.0
unit 12
array  4 3*0.0
global unit 13
array 5  3*0.0
reflector   4 1 5r0.0   2.54   1
```

```
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=14 nuy=11 nuz=1 fill f1           end fill
ara=2 nux=16 nuy=11 nuz=1 fill f1           end fill
ara=3 nux=1  nuy=5  nuz=1 fill 3 2 4 2 3    end fill
ara=4 nux=1  nuy=5  nuz=1 fill 6 5 7 5 6    end fill
ara=5 nux=5  nuy=1  nuz=1 fill 11 8 9 12 10 end fill
end array
end data
end
```

p3314bs1

```
=csas25
p3314bs1
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65              end
al           2 1.0                                          end
h2o          3 1.0                                          end
plexiglas  4 1.0                                            end
cr           5 den=7.90 .1903                               end
b            5 den=7.90 .0105                               end
fe           5 den=7.90 .6804                               end
ni           5 den=7.90 .0953                               end
mn           5 den=7.90 .0158                               end
cu           5 den=7.90 .0028                               end
mo           5 den=7.90 .0049                               end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2  end geometry
2-17x20 and 1-25x20 (center) assemblies separated by 0.298-cm-thick
`1.1 wt% B stainless steel plates and 3.562 cm of water
read parm  run=yes  gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                       91.44   0.0
cylinder  2 1 0.635                        96.52  -1.27
cuboid    3 1 4p0.842                      96.52  -1.27
unit 2
array  1 3*0.0
reflector   3 1 2r0  1.92 0.0 2r0  1
unit 3
array  2 3*0.0
reflector   3 1 2r0  1.92 0.0 2r0  1
unit 4
cuboid    5 1  0.0  -0.298  35.6 0.0     90.23  -1.27
cuboid    3 1  0.0  -3.86   35.6 0.0     96.52  -1.27
unit 5
cuboid    5 1  0.298  0.0   35.6 0.0     90.23  -1.27
```



```
cuboid    3 1   3.86  0.0   35.6 0.0     96.52  -1.27
global unit 9
array 3  -53.538  -17.8    0.
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=25 nuy=20 nuz=1 fill f1         end fill
ara=2 nux=17 nuy=20 nuz=1 fill f1         end fill
ara=3 nux=5  nuy=1  nuz=1 fill 3 4 2 5 3 end fill
end array
end data
end
```

p3314bs2

```
=csas25
p3314bs2
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65              end
al           2 1.0                                          end
h2o          3 1.0                                          end
plexiglas  4 1.0                                            end
cr           5 den=7.77 .1960                               end
b            5 den=7.77 .0162                               end
fe           5 den=7.77 .6640                               end
ni           5 den=7.77 .1012                               end
mn           5 den=7.77 .0169                               end
cu           5 den=7.77 .0026                               end
mo           5 den=7.77 .0031                               end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2  end geometry
2-17x20 and 1-25x20 (center) assemblies separated by 0.298-cm-thick
`1.1 wt% B stainless steel plates and 3.162 cm of water
read parm  run=yes  gen=405 npg=600 nsk=5  nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                       91.44   0.0
cylinder  2 1 0.635                        96.52  -1.27
cuboid    3 1 4p0.842                      96.52  -1.27
unit 2
array  1 3*0.0
reflector   3 1 2r0  1.92 0.0 2r0  1
unit 3
array  2 3*0.0
reflector   3 1 2r0  1.92 0.0 2r0  1
unit 4
cuboid    5 1  0.0  -0.298  35.6 0.0     90.23  -1.27
cuboid    3 1  0.0  -3.46   35.6 0.0     96.52  -1.27
```

```
unit 5
cuboid    5 1  0.298  0.0   35.6 0.0    90.23  -1.27
cuboid    3 1   3.46  0.0   35.6 0.0    96.52  -1.27
global unit 9
array 3  -53.138  -17.8    0.
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=25 nuy=20 nuz=1 fill f1        end fill
ara=2 nux=17 nuy=20 nuz=1 fill f1        end fill
ara=3 nux=5  nuy=1  nuz=1 fill 3 4 2 5 3 end fill
end array
end data
end
```

<u>p3314bs3</u>

```
=csas25
p3314bs3
44group latticecell
uo2         1 0.949 293 92235 4.31 92238 95.69              end
al          2 1.0                                            end
h2o         3 1.0                                            end
plexiglas  4 1.0                                             end
cr          5 den=7.90 .1903                                 end
b           5 den=7.90 .0105                                 end
fe          5 den=7.90 .6804                                 end
ni          5 den=7.90 .0953                                 end
mn          5 den=7.90 .0158                                 end
cu          5 den=7.90 .0028                                 end
mo          5 den=7.90 .0049                                 end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 6                  end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0             end
3-12x16 assemblies separated by 0.298-cm-thick 1.1 wt% B stainless
`steel plates and 6.932 cm of water
read parm  run=yes  gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                   91.44   0.0
cylinder  0 1 0.64135                   91.44   0.0
cylinder  6 1 0.64135                   93.98  -2.54
cylinder  2 1 0.70735                   93.98  -2.54
cuboid    3 1 4p0.946                   93.98  -2.54
unit 2
array  1 3*0.0
reflector   3 1 2r0  2r2.664 2r0  1
unit 3
cuboid    5 1  0.0  -0.298  2p17.8       88.96  -2.54
cuboid    3 1  0.0  -07.23  2p17.8       93.98  -2.54
unit 4
cuboid    5 1  0.298  0.0   2p17.8       88.96  -2.54
cuboid    3 1  07.23  0.0   2p17.8       93.98  -2.54
global unit 5
array 2  -41.286  -17.8    0.
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1        end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 4 2 end fill
end array
end data
end
```

<u>p3314bs4</u>

```
=csas25
p3314bs4
44group latticecell
uo2         1 0.949 293 92235 4.31 92238 95.69              end
al          2 1.0                                            end
h2o         3 1.0                                            end
plexiglas  4 1.0                                             end
cr          5 den=7.77 .1960                                 end
b           5 den=7.77 .0162                                 end
fe          5 den=7.77 .6640                                 end
ni          5 den=7.77 .1012                                 end
mn          5 den=7.77 .0169                                 end
cu          5 den=7.77 .0026                                 end
mo          5 den=7.77 .0031                                 end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 6                  end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0             end
3-12x16 assemblies separated by 0.298-cm-thick 1.6 wt% B stainless
`steel plates and 6.332 cm of water
read parm  run=yes  gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                   91.44   0.0
cylinder  0 1 0.64135                   91.44   0.0
cylinder  6 1 0.64135                   93.98  -2.54
cylinder  2 1 0.70735                   93.98  -2.54
cuboid    3 1 4p0.946                   93.98  -2.54
unit 2
```

```
array  1 3*0.0
reflector    3 1 2r0  2r2.664 2r0  1
unit 3
cuboid     5 1  0.0  -0.298  2p17.8       88.96  -2.54
cuboid     3 1  0.0  -06.63  2p17.8       93.98  -2.54
unit 4
cuboid     5 1  0.298  0.0   2p17.8       88.96  -2.54
cuboid     3 1  06.63  0.0   2p17.8       93.98  -2.54
global unit 5
array 2  -40.686  -17.8    0.
reflector    4 1 5r0.0   2.54   1
reflector    3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 4 2 end fill
end array
end data
end
```

p3314cd1

```
=csas25
p3314cd1
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69             end
al           2 1.0                                          end
h2o          3 1.0                                          end
plexiglas  4 1.0                                            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 5                end
cd           6 den=8.65                                     end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0            end
2-11x14 and 2-11x13 assemblies separated by 0.061546-cm-thick cadmium
`plates and 2.769- and 5.239-cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                        91.44   0.0
cylinder  0 1 0.64135                        91.44   0.0
cylinder  5 1 0.64135                        93.98  -2.54
cylinder  2 1 0.70735                        93.98  -2.54
cuboid    3 1 4p.9460                        93.98  -2.54
unit 2
cuboid    3 1 13.373 0.0 26.488     0.0     93.98  -2.54
unit 3
array 1 3*0.0
unit 4
cuboid     6 1 2.83    2.769 26.488  0.0    88.96  -2.54
cuboid     3 1 2.83    0.0   26.488  0.0    93.98  -2.54
unit 5
cuboid     6 1 71.2    0.0    0.061  0.0    88.96  -2.54
cuboid     3 1 71.2    0.0    0.061  0.0    93.98  -2.54
unit 6
cuboid     3 1 36.954 0.0    5.2939 0.0    88.96  -2.54
cuboid     6 1 37.105 0.0    5.2939 0.0    88.96  -2.54
cuboid     3 1 71.2    0.0    5.2939 0.0    93.98  -2.54
unit 7
cuboid     3 1 13.373 0.0    24.596 0.0    93.98  -2.54
unit 8
cuboid     6 1 2.83  2.769   24.596 0.0    88.96  -2.54
cuboid     3 1 2.83  0.0     24.596 0.0    93.98  -2.54
unit 9
array 2 3*0.0
unit 10
cuboid     3 1 36.954 0.0    14.843 0.0    88.96  -2.54
cuboid     6 1 37.015 0.0    14.843 0.0    88.96  -2.54
cuboid     3 1 71.2    0.0    14.843 0.0    93.98  -2.54
unit 11
array 3 3*0.0
unit 12
array 4 3*0.0
global unit 13
array 5  3*0.0
reflector    4 1 5r0.0   2.54   1
reflector    3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=11 nuy=14 nuz=1 fill f1            end fill
ara=2 nux=11 nuy=13 nuz=1 fill f1            end fill
ara=3 nux=5  nuy=1  nuz=1 fill 2 3 4 3 2     end fill
ara=4 nux=5  nuy=1  nuz=1 fill 7 9 8 9 7     end fill
ara=5 nux=1  nuy=5  nuz=1 fill 11 5 6 12 10 end fill
end array
end data
end
```

p3314cd2

```
=csas25
p3314cd2
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65              end
al           2 1.0                                          end
h2o          3 1.0                                          end
plexiglas  4 1.0                                            end
cd           5 den=8.65                                     end
end comp
```

```
squarepitch  1.684 1.1176 1 3 1.27 2  end geometry
2-17x20 and 1-25x20 (center) assemblies separated by 0.061-cm-thick
`cadmium plates and 2.979 cm of water
read parm  run=yes  gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                         91.44    0.0
cylinder  2 1 0.635                          96.52   -1.27
cuboid    3 1 4p0.842                        96.52   -1.27
unit 2
array  1 3*0.0
reflector   3 1 2r0  1.92 0.0 2r0  1
unit 3
array  2 3*0.0
reflector   3 1 2r0  1.92 0.0 2r0  1
unit 4
cuboid    5 1  0.0  -0.061  35.6 0.0    90.23  -1.27
cuboid    3 1  0.0  -3.04   35.6 0.0    96.52  -1.27
unit 5
cuboid    5 1  0.061  0.0   35.6 0.0    90.23  -1.27
cuboid    3 1   3.04  0.0   35.6 0.0    96.52  -1.27
global unit 9
array 3  -52.718  -17.8    0.
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=25 nuy=20 nuz=1 fill f1         end fill
ara=2 nux=17 nuy=20 nuz=1 fill f1         end fill
ara=3 nux=5  nuy=1  nuz=1 fill 3 4 2 5 3 end fill
end array
end data
end
```

p3314cu1

```
=csas25
p3314cu1
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69                 end
al           2 1.0                                              end
h2o          3 1.0                                              end
plexiglas  4 1.0                                                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 5                    end
cu          6 den=8.913                                         end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0                end
2-9x12 and 2-9x7 assemblies separated by 0.337-cm-thick copper
`plates and 2.493- and 5.603-cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                              91.44   0.0
cylinder  0 1 0.64135                              91.44   0.0
cylinder  5 1 0.64135                              93.98  -2.54
cylinder  2 1 0.70735                              93.98  -2.54
cuboid    3 1 4p.9460                              93.98  -2.54
unit 2
cuboid    3 1 12.157 0.0 22.704  0.0    93.98  -2.54
unit 3
array 1 3*0.0
unit 4
cuboid    6 1  2.83   2.493 22.704 0.0  88.96  -2.54
cuboid    3 1  2.83   0.0   22.704 0.0  93.98  -2.54
unit 5
cuboid    6 1 61.2    0.0    0.337 0.0  88.96  -2.54
cuboid    3 1 61.2    0.0    0.337 0.0  93.98  -2.54
unit 6
cuboid    3 1 31.6[illegible]  [illegible]    5.603 0.0  88.96  -2.54
cuboid    6 1 32.0[illegible]  [illegible]    5.603 0.0  88.96  -2.54
cuboid    3 1 61.2    0.0    5.603 0.0  93.98  -2.54
unit 7
cuboid    3 1 12.157  0.0   13.244 0.0  93.98  -2.54
unit 8
cuboid    6 1  2.83   2.493 13.244 0.0  88.96  -2.54
cuboid    3 1  2.83   0.0   13.244 0.0  93.98  -2.54
unit 9
array 2 3*0.0
unit 10
cuboid    3 1 31.678  0.0   19.312 0.0  88.96  -2.54
cuboid    6 1 32.015  0.0   19.312 0.0  88.96  -2.54
cuboid    3 1 61.2    0.0  19.312 0.0   93.98  -2.54
unit 11
array 3 3*0.0
unit 12
array 4 3*0.0
global unit 13
array 5  3*0.0
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=9  nuy=12 nuz=1 fill f1            end fill
ara=2 nux=9  nuy=7  nuz=1 fill f1            end fill
ara=3 nux=5  nuy=1  nuz=1 fill 2 3 4 3 2     end fill
ara=4 nux=5  nuy=1  nuz=1 fill 7 9 8 9 7     end fill
ara=5 nux=1  nuy=5  nuz=1 fill 11 5 6 12 10 end fill
```

```
end array
end data
end
```

p3314cu2

```
=csas25
p3314cu2
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69           end
al           2 1.0                                        end
h2o          3 1.0                                        end
plexiglas  4 1.0                                          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 5               end
cu          6 den=8.913                                   end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0          end
2-9x12 and 2-9x5 assemblies separated by 0.646-cm-thick copper
`plates and 2.184- and 2.024-cm of water
read parm   run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                   91.44   0.0
cylinder  0 1 0.64135                   91.44   0.0
cylinder  5 1 0.64135                   93.98  -2.54
cylinder  2 1 0.70735                   93.98  -2.54
cuboid    3 1 4p.9460                   93.98  -2.54
unit 2
cuboid    3 1 17.157 0.0 22.704  0.0    93.98  -2.54
unit 3
array 1 3*0.0
unit 4
cuboid    6 1 2.83  2.184 22.704 0.0    88.96  -2.54
cuboid    3 1 2.83  0.0   22.704 0.0    93.98  -2.54
unit 5
cuboid    6 1 71.2  0.0    0.646 0.0    88.96  -2.54
cuboid    3 1 71.2  0.0    0.646 0.0    93.98  -2.54
unit 6
cuboid    3 1 36.369  0.0  2.024 0.0    88.96  -2.54
cuboid    6 1 37.015  0.0  2.024 0.0    88.96  -2.54
cuboid    3 1 71.2    0.0  2.024 0.0    93.98  -2.54
unit 7
cuboid    3 1 17.157  0.0  9.46  0.0    93.98  -2.54
unit 8
cuboid    6 1 2.83  2.184  9.46  0.0    88.96  -2.54
cuboid    3 1 2.83    0.0  9.46  0.0    93.98  -2.54
unit 9
array 2 3*0.0
unit 10
cuboid    3 1 36.369  0.0 36.366 0.0    88.96  -2.54
cuboid    6 1 37.015  0.0 36.366 0.0    88.96  -2.54
cuboid    3 1 71.2    0.0 36.366 0.0    93.98  -2.54
unit 11
array 3 3*0.0
unit 12
array 4 3*0.0
global unit 13
array 5  3*0.0
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=9  nuy=12 nuz=1 fill f1            end fill
ara=2 nux=9  nuy=5  nuz=1 fill f1            end fill
ara=3 nux=5  nuy=1  nuz=1 fill 2 3 4 3 2     end fill
ara=4 nux=5  nuy=1  nuz=1 fill 7 9 8 9 7     end fill
ara=5 nux=1  nuy=5  nuz=1 fill 11 5 6 12 10 end fill
end array
end data
end
```

p3314cu3

```
=csas25
p3314cu3
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69           end
al           2 1.0                                        end
h2o          3 1.0                                        end
plexiglas  4 1.0                                          end
cu           5 den=8.913                                  end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 6               end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0          end
3-12x16 assemblies separated by 0.337-cm-thick copper plates and
`10.023 cm of water
read parm  run=yes  gen=405 npg=600 nsk=5 nub=yes  end parm
read geom
unit 1
cylinder  1 1 0.63245                   91.44   0.0
cylinder  0 1 0.64135                   91.44   0.0
cylinder  6 1 0.64135                   93.98  -2.54
cylinder  2 1 0.70735                   93.98  -2.54
cuboid    3 1 4p.946                    93.98  -2.54
unit 2
array  1 3*0.0
reflector   3 1 2r0  2r0.164 2r0  1
unit 3
```

```
cuboid    5 1  0.0  -0.337  2p15.3      88.96  -2.54
cuboid    3 1  0.0  -10.36  2p15.3      93.98  -2.54
unit 4
cuboid    5 1  0.337  0.0   2p15.3      88.96  -2.54
cuboid    3 1  10.36  0.0   2p15.3      93.98  -2.54
global unit 5
array 2  -44.416  -15.3    0.
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1        end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 4 2 end fill
end array
end data
end
```

p3314cu4

```
=csas25
p3314cu4
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69            end
al           2 1.0                                         end
h2o          3 1.0                                         end
plexiglas  4 1.0                                           end
cu           5 den=8.913 .99                               end
cd           5 den=8.913 .01                               end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 6               end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0           end
3-12x16 assemblies separated by 0.357-cm-thick copper plates and
7.253 cm of water
read parm  run=yes  gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                   91.44   0.0
cylinder  0 1 0.64135                   91.44   0.0
cylinder  6 1 0.64135                   93.98  -2.54
cylinder  2 1 0.70735                   93.98  -2.54
cuboid    3 1 4p0.946                   93.98  -2.54
unit 2
array  1 3*0.0
reflector   3 1 2r0  2r2.664 2r0  1
unit 3
cuboid    5 1  0.0  -0.357  2p17.8      88.96  -2.54
cuboid    3 1  0.0  -07.61  2p17.8      93.98  -2.54
unit 4
cuboid    5 1  0.357  0.0   2p17.8      88.96  -2.54
cuboid    3 1  07.61  0.0   2p17.8      93.98  -2.54
global unit 5
array 2  -41.666  -17.8    0.
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1        end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 4 2 end fill
end array
end data
end
```

p3314cu5

```
=csas25
p3314cu5
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65             end
al           2 1.0                                         end
h2o          3 1.0                                         end
plexiglas  4 1.0                                           end
cu           5 den=8.913                                   end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2  end geometry
2-20x18 and 1-25x18 (center) assemblies separated by  .337-cm-thick
copper plates and 4.903 cm of water
read parm   run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                    91.44   0.0
cylinder  2 1 0.635                     96.52  -1.27
cuboid    3 1 4p0.842                   96.52  -1.27
unit 2
array  1 3*0.0
reflector   3 1 2r0  0.288 0.0 2r0  1
unit 3
array  2 3*0.0
reflector   3 1 2r0  0.288 0.0 2r0  1
unit 4
cuboid    5 1  0.0  -0.337  30.6 0.0    90.23  -1.27
cuboid    3 1  0.0  -5.24   30.6 0.0    96.52  -1.27
unit 5
cuboid    5 1  0.337  0.0   30.6 0.0    90.23  -1.27
cuboid    3 1  5.24   0.0   30.6 0.0    96.52  -1.27
global unit 9
array 3  -59.97   -15.3    0.
reflector   4 1 5r0.0   2.54   1
```

```
reflector   3 1 4r30.0  2r15.0 1
end geometry
read array
ara=1 nux=25 nuy=18 nuz=1 fill f1         end fill
ara=2 nux=20 nuy=18 nuz=1 fill f1         end fill
ara=3 nux=5  nuy=1  nuz=1 fill 3 4 2 5 3 end fill
end array
end data
end
```

p3314cu6

```
=csas25
p3314cu6
44group latticecell
uo2         1 0.84 293 92235 2.35 92238 97.65            end
al          2 1.0                                        end
h2o         3 1.0                                        end
plexiglas  4 1.0                                         end
cu          5 den=8.91 .99                               end
cd          5 den=8.91 .01                               end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2  end geometry
2-20x18 and 1-25x18 (center) assemblies separated by 0.357-cm-thick
`1 wt% cadmium copper plates and 2.243 cm of water
read parm  run=yes  gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                    91.44   0.0
cylinder  2 1 0.635                     96.52  -1.27
cuboid    3 1 4p0.842                   96.52  -1.27
unit 2
array  1 3*0.0
reflector   3 1 2r0  5.288 0.0 2r0  1
unit 3
array  2 3*0.0
reflector   3 1 2r0  5.288 0.0 2r0  1
unit 4
cuboid    5 1  0.0  -0.357  35.6 0.0    90.23  -1.27
cuboid    3 1  0.0  -2.60   35.6 0.0    96.52  -1.27
unit 5
cuboid    5 1  0.357  0.0   35.6 0.0    90.23  -1.27
cuboid    3 1  2.60   0.0   35.6 0.0    96.52  -1.27
global unit 9
array 3  -57.33   -17.8    0.
reflector   4 1 5r0.0   2.54    1
reflector   3 1 4r30.0  2r15.0 1
end geometry
```



```
read array
ara=1 nux=25 nuy=18 nuz=1 fill f1         end fill
ara=2 nux=20 nuy=18 nuz=1 fill f1         end fill
ara=3 nux=5  nuy=1  nuz=1 fill 3 4 2 5 3 end fill
end array
end data
end
```

p3314slg

```
=csas25
p3314slg
44group latticecell
uo2         1 0.949 293 92235 4.31 92238 95.69              end
al          2 1.0                                           end
h2o         3 1.0                                           end
plexiglas  4 1.0                                            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 5                 end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0            end
2-9x12 and 2-9x1 assemblies separated by 2.83- and 10.86-cm of water
read parm  run=yes  gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                       91.44   0.0
cylinder  0 1 0.64135                       91.44   0.0
cylinder  5 1 0.64135                       93.98  -2.54
cylinder  2 1 0.70735                       93.98  -2.54
cuboid    3 1 4p.9460                       93.98  -2.54
unit 2
cuboid    3 1 17.157 0.0  22.704  0.0   93.98  -2.54
unit 3
array 1 3*0.0
unit 4
cuboid    3 1 2.83    0.0  22.704  0.0   93.98  -2.54
unit 5
cuboid    3 1 71.2    0.0  10.86   0.0   93.98  -2.54
unit 6
cuboid    3 1 17.157 0.0  1.892   0.0   93.98  -2.54
unit 7
cuboid    3 1 2.83    0.0  1.892   0.0   93.98  -2.54
unit 8
array 2 3*0.0
unit 9
cuboid    3 1 71.2    0.0  25.744  0.0   93.98  -2.54
unit 10
array 3 3*0.0
unit 11
array 4 3*0.0
```

```
global unit 12
array 5  3*0.0
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=9  nuy=12 nuz=1 fill f1          end fill
ara=2 nux=9  nuy=1  nuz=1 fill f1          end fill
ara=3 nux=5  nuy=1  nuz=1 fill 2 3 4 3 2 end fill
ara=4 nux=5  nuy=1  nuz=1 fill 6 8 7 8 6 end fill
ara=5 nux=1  nuy=4  nuz=1 fill 10 5 11 9 end fill
end array
end data
end
```

p3314ss1

```
=csas25
p3314ss1
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69              end
al           2 1.0                                           end
h2o          3 1.0                                           end
plexiglas  4 1.0                                             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 5                 end
cr           6 den=7.93 .1856                                end
cu           6 den=7.93 .0027                                end
fe           6 den=7.93 .6824                                end
mn           6 den=7.93 .0158                                end
mo           6 den=7.93 .0026                                end
ni           6 den=7.93 .1109                                end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0             end
2-9x12 and 2-9x2 assemblies separated by 0.302-cm-thick 0.0 wt% B
`stainless steel plates and 2.528- and 3.078-cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                        91.44   0.0
cylinder  0 1 0.64135                        91.44   0.0
cylinder  5 1 0.64135                        93.98  -2.54
cylinder  2 1 0.70735                        93.98  -2.54
cuboid    3 1 4p.9460                        93.98  -2.54
unit 2
cuboid    3 1 17 157 0.0   22.704 0.0        93.98  -2.54
unit 3
array 1 3*0.0
unit 4
cuboid    6 1 2.83   2.528   22.704 0.0    88.96    .54
cuboid    3 1 2.83   0.0     22.704 0.0    93.98    .54
unit 5
cuboid    6 1 71.2   0.0      0.302 0.0    88.96   -2.54
cuboid    3 1 71.2   0.0      0.302 0.0    93.98   -2.54
unit 6
cuboid    3 1 36.713  0.0    3.078 0.0     88.96   -2.54
cuboid    6 1 37.015  0.0    3.078 0.0     88.96   -2.54
cuboid    3 1 71.2    0.0    3.078 0.0     93.98   -2.54
unit 7
cuboid    3 1 17.157  0.0    3.784 0.0     93.98   -2.54
unit 8
cuboid    6 1 2.83    2.528 3.784 0.0      88.96   -2.54
cuboid    3 1 2.83    0.0   3.784 0.0      93.98   -2.54
unit 9
array 2 3*0.0
unit 10
cuboid    3 1 36.713  0.0  41.332 0.0      88.96   -2.54
cuboid    6 1 37.015  0.0  41.332 0.0      88.96   -2.54
cuboid    3 1 71.2    0.0  41.332 0.0      93.98   -2.54
unit 11
array 3 3*0.0
unit 12
array 4 3*0.0
global unit 13
array 5  3*0.0
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=9  nuy=12 nuz=1 fill f1              end fill
ara=2 nux=9  nuy=2  nuz=1 fill f1              end fill
ara=3 nux=5  nuy=1  nuz=1 fill 2 3 4 3 2       end fill
ara=4 nux=5  nuy=1  nuz=1 fill 7 9 8 9 7       end fill
ara=5 nux=1  nuy=5  nuz=1 fill 11 5 6 12 10 end fill
end array
end data
end
```

p3314ss2

```
=csas25
p3314ss2
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69              end
al           2 1.0                                           end
h2o          3 1.0                                           end
plexiglas  4 1.0                                             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 5              end
cr          6 den=7.93 .1856                             end
cu          6 den=7.93 .0027                             end
fe          6 den=7.93 .6824                             end
mn          6 den=7.93 .0158                             end
mo          6 den=7.93 .0026                             end
ni          6 den=7.93 .1109                             end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0         end
2-9x12 and 2-9x13 assemblies separated by 0.302-cm-thick 0.0 wt% B
`stainless steel plates and 2.528- and 11.248-cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                     91.44   0.0
cylinder  0 1 0.64135                     91.44   0.0
cylinder  5 1 0.64135                     93.98  -2.54
cylinder  2 1 0.70735                     93.98  -2.54
cuboid    3 1 4p.9460                     93.98  -2.54
unit 2
cuboid    3 1 17.157   0.0   22.704 0.0   93.98  -2.54
unit 3
array 1 3*0.0
unit 4
cuboid    6 1 2.83     2.528 22.704 0.0   88.96  -2.54
cuboid    3 1 2.83     0.0   22.704 0.0   93.98  -2.54
unit 5
cuboid    6 1 71.2     0.0    0.302 0.0   88.96  -2.54
cuboid    3 1 71.2     0.0    0.302 0.0   93.98  -2.54
unit 6
cuboid    3 1 36.713   0.0   11.248 0.0   88.96  -2.54
cuboid    6 1 37.015   0.0   11.248 0.0   88.96  -2.54
cuboid    3 1 71.2     0.0   11.248 0.0   93.98  -2.54
unit 7
cuboid    3 1 17.157   0.0   24.596 0.0   93.98  -2.54
unit 8
cuboid    6 1 2.83     2.528 24.596 0.0   88.96  -2.54
cuboid    3 1 2.83     0.0   24.596 0.0   93.98  -2.54
unit 9
array 2 3*0.0
unit 10
cuboid    3 1 36.713   0.0   12.35  0.0   88.96  -2.54
cuboid    6 1 37.015   0.0   12.35  0.0   88.96  -2.54
cuboid    3 1 71.2     0.0   12.35  0.0   93.98  -2.54
unit 11
array 3 3*0.0
unit 12
array 4 3*0.0
global unit 13
array 5  3*0.0
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=9  nuy=12 nuz=1 fill f1             end fill
ara=2 nux=9  nuy=13 nuz=1 fill f1             end fill
ara=3 nux=5  nuy=1  nuz=1 fill 2 3 4 3 2      end fill
ara=4 nux=5  nuy=1  nuz=1 fill 7 9 8 9 7      end fill
ara=5 nux=1  nuy=5  nuz=1 fill 11 5 6 12 10 end fill
end array
end data
end
```

<u>p3314ss3</u>

```
=csas25
p3314ss3
44group latticecell
uo2         1 0.949 293 92235 4.31 92238 95.69              end
al          2 1.0                                           end
h2o         3 1.0                                           end
plexiglas  4 1.0                                            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 5                 end
cr          6 den=7.93 .1856                                end
cu          6 den=7.93 .0027                                end
fe          6 den=7.93 .6824                                end
mn          6 den=7.93 .0158                                end
mo          6 den=7.93 .0026                                end
ni          6 den=7.93 .1109                                end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0            end
2-9x12 and 2-9x5 assemblies separated by 0.485-cm-thick 0.0 wt% B
`stainless steel plates and 2.83- and 4.47-cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                       91.44   0.0
cylinder  0 1 0.64135                       91.44   0.0
cylinder  5 1 0.64135                       93.98  -2.54
cylinder  2 1 0.70735                       93.98  -2.54
cuboid    3 1 4p.9460                       93.98  -2.54
unit 2
cuboid    3 1 17.157 0.0 22.704  0.0        93.98  -2.54
unit 3
array 1 3*0.0
unit 4
cuboid    6 1 2.83  2.345 22.704 0.0        88.96  -2.54
cuboid    3 1 2.83  0.0   22.704 0.0        93.98  -2.54
```

```
unit 5
cuboid    6 1 71.2  0.0    0.485 0.0    88.96  -2.54
cuboid    3 1 71.2  0.0    0.485 0.0    93.98  -2.54
unit 6
cuboid    3 1 36.53   0.0  3.985 0.0    88.96  -2.54
cuboid    6 1 37.015  0.0  3.985 0.0    88.96  -2.54
cuboid    3 1 71.2    0.0  3.985 0.0    93.98  -2.54
unit 7
cuboid    3 1 17.157 0.0   9.46 0.0     93.98  -2.54
unit 8
cuboid    6 1 2.83  2.528  9.46  0.0    88.96  -2.54
cuboid    3 1 2.83  0.0    9.46  0.0    93.98  -2.54
unit 9
array 2 3*0.0
unit 10
cuboid    3 1 36.53   0.0  34.566 0.0   88.96  -2.54
cuboid    6 1 37.015  0.0  34.566 0.0   88.96  -2.54
cuboid    3 1 71.2    0.0  34.566 0.0   93.98  -2.54
unit 11
array 3 3*0.0
unit 12
array 4 3*0.0
global unit 13
array 5  3*0.0
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=9  nuy=12 nuz=1 fill f1            end fill
ara=2 nux=9  nuy=5  nuz=1 fill f1            end fill
ara=3 nux=5  nuy=1  nuz=1 fill 2 3 4 3 2     end fill
ara=4 nux=5  nuy=1  nuz=1 fill 7 9 8 9 7     end fill
ara=5 nux=1  nuy=5  nuz=1 fill 11 5 6 12 10 end fill
end array
end data
end
```

<u>p3314ss4</u>

```
=csas25
p3314ss4
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69                 end
al           2 1.0                                              end
h2o          3 1.0                                              end
plexiglas  4 1.0                                                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 5                    end
cr           6 den=7.93 .1856                                   end
cu           6 den=7.93 .0027                                   end
fe           6 den=7.93 .6824                                   end
mn           6 den=7.93 .0158                                   end
mo           6 den=7.93 .0026                                   end
ni           6 den=7.93 .1109                                   end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0                end
2-9x12 and 2-9x12 assemblies separated by 0.485-cm-thick 0.0 wt% B
`stainless steel plates and 2.83- and 8.36-cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                       91.44   0.0
cylinder  0 1 0.64135                       91.44   0.0
cylinder  5 1 0.64135                       93.98  -2.54
cylinder  2 1 0.70735                       93.98  -2.54
cuboid    3 1 4p.9460                       93.98  -2.54
unit 2
cuboid    3 1 17.157 0.0 22.704  0.0        93.98  -2.54
unit 3
array 1 3*0.0
unit 4
cuboid    6 1 2.83  2.345 22.704 0.0        88.96  -2.54
cuboid    3 1 2.83  0.0   22.704 0.0        93.98  -2.54
unit 5
cuboid    6 1 71.2  0.0    0.485 0.0        88.96  -2.54
cuboid    3 1 71.2  0.0    0.485 0.0        93.98  -2.54
unit 6
cuboid    3 1 36.53   0.0  7.875 0.0        88.96  -2.54
cuboid    6 1 37.015  0.0  7.875 0.0        88.96  -2.54
cuboid    3 1 71.2    0.0  7.875 0.0        93.98  -2.54
unit 7
cuboid    3 1 17.157 0.0  22.704 0.0        93.98  -2.54
unit 8
cuboid    6 1 2.83  2.345 22.704 0.0        88.96  -2.54
cuboid    3 1 2.83  0.0   22.704 0.0        93.98  -2.54
unit 9
array 2 3*0.0
unit 10
cuboid    3 1 36.53   0.0  17.432 0.0       88.96  -2.54
cuboid    6 1 37.015  0.0  17.432 0.0       88.96  -2.54
cuboid    3 1 71.2    0.0  17.432 0.0       93.98  -2.54
unit 11
array 3 3*0.0
unit 12
array 4 3*0.0
global unit 13
array 5  3*0.0
reflector   4 1 5r0.0   2.54   1
```

```
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=9  nuy=12 nuz=1 fill f1            end fill
ara=2 nux=9  nuy=12 nuz=1 fill f1            end fill
ara=3 nux=5  nuy=1  nuz=1 fill 2 3 4 3 2     end fill
ara=4 nux=5  nuy=1  nuz=1 fill 7 9 8 9 7     end fill
ara=5 nux=1  nuy=5  nuz=1 fill 11 5 6 12 10 end fill
end array
end data
end
```

p3314ss5

```
=csas25
p3314ss5
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65              end
al           2 1.0                                          end
h2o          3 1.0                                          end
plexiglas  4 1.0                                            end
cr           5 den=7.93 .1856                               end
cu           5 den=7.93 .0027                               end
fe           5 den=7.93 .6824                               end
mn           5 den=7.93 .0158                               end
mo           5 den=7.93 .0026                               end
ni           5 den=7.93 .1109                               end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2  end geometry
2-17x10 and 1-25x20 (center) assemblies separated by 0.302-cm-thick
'0.0 wt % B stainless steel plates and 7.80 cm of water
read parm  run=yes  gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                       91.44   0.0
cylinder  2 1 0.635                        96.52  -1.27
cuboid    3 1 4p0.842                      96.52  -1.27
unit 2
array  1 3*0.0
reflector   3 1 2r0  1.92 0.0 2r0  1
unit 3
array  2 3*0.0
reflector   3 1 2r0  1.92 0.0 2r0  1
unit 4
cuboid     5 1  0.0  -0.302  35.6 0.0     90.23  -1.27
cuboid     3 1  0.0  -7.80   35.6 0.0     96.52  -1.27
unit 5
cuboid     5 1  0.302  0.0   35.6 0.0     90.23  -1.27
cuboid     3 1   7.80  0.0   35.6 0.0     96.52  -1.27
global unit 9
array 3  -57.478  -17.8    0.
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=25 nuy=20 nuz=1 fill f1          end fill
ara=2 nux=17 nuy=20 nuz=1 fill f1          end fill
ara=3 nux=5  nuy=1  nuz=1 fill 3 4 2 5 3 end fill
end array
end data
end
```

p3314ss6

```
=csas25
p3314ss6
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69             end
al           2 1.0                                          end
h2o          3 1.0                                          end
plexiglas  4 1.0                                            end
cr           5 den=7.93 .1856                               end
cu           5 den=7.93 .0027                               end
fe           5 den=7.93 .6824                               end
mn           5 den=7.93 .0158                               end
mo           5 den=7.93 .0026                               end
ni           5 den=7.93 .1109                               end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 6                end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0            end
3-12x16 assemblies separated by 0.302-cm-thick 0.0 wt% B stainless
`steel plates and 10.218 cm of water
read parm  run=yes  gen=405 npg=600 nsk=5  nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                      91.44   0.0
cylinder  0 1 0.64135                      91.44   0.0
cylinder  6 1 0.64135                      93.98  -2.54
cylinder  2 1 0.70735                      93.98  -2.54
cuboid    3 1 4p0.946                      93.98  -2.54
unit 2
array  1 3*0.0
reflector   3 1 2r0  2r2.664 2r0  1
unit 3
cuboid     5 1  0.0  -0.302  2p17.8      88.96  -2.54
cuboid     3 1  0.0  -10.52  2p17.8      93.98  -2.54
unit 4
cuboid     5 1  0.302  0.0   2p17.8      88.96  -2.54
cuboid     3 1  10.52  0.0   2p17.8      93.98  -2.54
```

```
global unit 5
array 2  -44.576  -17.8    0.
reflector   4 1 5r0.0   2.54   1
reflector   3 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1        end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 4 2 end fill
end array
end data
end
```

p3314w1

```
=csas25
p3314w1
44group latticecell
uo2         1 0.949 293 92235 4.31 92238 95.69            end
al          2 1.0                                         end
h2o         3 1.0                                         end
plexiglas  4 1.0                                          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 5               end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2 1.2827 0 end geometry
Core of 14x14 positions: 168 fuel rods and 25 water holes
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                   91.44   0.0
cylinder  0 1 0.64135                   91.44   0.0
cylinder  5 1 0.64135                   93.98  -2.54
cylinder  2 1 0.70735                   93.98  -2.54
cuboid    3 1 4p.9460                   93.98  -2.54
unit 2
cuboid    3 1 4p.9460                   93.98  -2.54
unit 3
array 1 3*0.0
unit 4
array 2 3*0.0
unit 5
array 3 3*0.0
global unit 6
array 4  3*0.0
reflector   4 1 5r0.0      2.54 1
reflector   3 1 4r30. 15.2 15.3 1
end geometry

read array
ara=1 nux=14 nuy=1  nuz=1 fill f1               end fill
ara=2 nux=14 nuy=1  nuz=1 fill 2r1 1 2 4q2 2r1 end fill
ara=3 nux=14 nuy=1  nuz=1 fill 11r1 3r2         end fill
ara=4 nux=1  nuy=14 nuz=1 fill 2r3 4 3 4q2 3 5 end fill
end array
end data
end
```

p3314w2

```
=csas25
p3314w2
44group latticecell
uo2         1 0.840 293 92235 2.35 92238 97.65            end
al          2 1.0                                         end
h2o         3 1.0                                         end
plexiglas  4 1.0                                          end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2 end geometry
Core of 23x23 positions: 486 fuel rods and 25 water holes
read parm  run=yes  gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                    91.44   0.0
cylinder  2 1 0.635                     96.52  -1.27
cuboid    3 1 4p0.842                   96.52  -1.27
unit 2
cuboid    3 1 4p.842                    96.52  -1.27
unit 3
array 1 3*0.0
unit 4
array 2 3*0.0
unit 5
array 3 3*0.0
global unit 6
array 4  3*0.0
reflector   4 1 5r0.0      2.54 1
reflector   3 1 4r30. 15.2 15.3 1
end geometry

read array
ara=1 nux=23 nuy=1  nuz=1 fill f1               end fill
ara=2 nux=23 nuy=1  nuz=1 fill 5r1 1 2 4q2 8r1  end fill
ara=3 nux=23 nuy=1  nuz=1 fill 5r1 18r2         end fill
ara=4 nux=1  nuy=23 nuz=1 fill 7r3 4 3 4q2 5r3 5 end fill
end array
end data
end
```

<u>p3314zr</u>

```
=csas25
p3314zr
44group latticecell
uo2         1 0.949 293 92235 4.31 92238 95.69            end
al          2 1.0                                         end
h2o         3 1.0                                         end
plexiglas 4 1.0                                           end
h2o         5                                             end
arbmrubber 1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 6               end
arbmzr4     6.32 4 0 0 1 40000 .9816 50000 .015
            24000 .0013 26000 .0021 7                     end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0          end
2-9x12 and 2-9x1 assemblies separated by 0.652-cm-thick Zircaloy-4
`plates and 2.178- and 10.388-cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  6 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p.9460                    93.98  -2.54
unit 2
cuboid    5 1 17.157 0.0 22.704  0.0     93.98  -2.54
unit 3
array 1 3*0.0
unit 4
cuboid    7 1 2.83  2.178 22.704 0.0     88.96  -2.54
cuboid    5 1 2.83  0.0   22.704 0.0     93.98  -2.54
unit 5
cuboid    7 1 71.2  0.0    0.652 0.0     93.98  -2.54
unit 6
cuboid    5 1 36.363  0.0 10.388 0.0     88.96  -2.54
cuboid    7 1 37.015  0.0 10.388 0.0     88.96  -2.54
cuboid    5 1 71.2    0.0 10.388 0.0     93.98  -2.54
unit 7
cuboid    5 1 17.157  0.0  3.784 0.0     93.98  -2.54
unit 8
cuboid    7 1 2.83  2.178  3.784 0.0     88.96  -2.54
cuboid    5 1 2.83  0.0    3.784 0.0     93.98  -2.54
unit 9
array 2 3*0.0
unit 10
cuboid    5 1 36.363  0.0  33.672 0.0    88.96  -2.54
cuboid    7 1 37.015  0.0  33.672 0.0    88.96  -2.54
cuboid    5 1 71.2    0.0  33.672 0.0    93.98  -2.54
unit 11
array 3 3*0.0
unit 12
array 4 3*0.0
global unit 13
array 5  3*0.0
reflector   4 1 5r0.0   2.54  1
reflector   5 1 4r30.0  2r15.0 1
end geometry

read array
ara=1 nux=9  nuy=12 nuz=1 fill f1            end fill
ara=2 nux=9  nuy=2  nuz=1 fill f1            end fill
ara=3 nux=5  nuy=1  nuz=1 fill 2 3 4 3 2     end fill
ara=4 nux=5  nuy=1  nuz=1 fill 7 9 8 9 7     end fill
ara=5 nux=1  nuy=5  nuz=1 fill 11 5 6 12 10 end fill
end array
end data
end
```

<u>p3602bb</u>

```
=csas25
p3602bb
44group latticecell
uo2         1 0.949 293 92235 4.31 92238 95.69            end
al          2 1.0                                         end
h2o         3 1.0                                         end
plexiglas  4 1.0                                          end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055
            1.28 14000 .22 28304 .79 42000 .49  24304 .12
            29000 .13  5                                  end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 6               end
al          7 den=2.50 .6121                              end
boron       7 den=2.50 .3036                              end
c           7 den=2.50 .0843                              end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0          end
3-12x16 assemblies separated by 0.292-cm-thick Boral-B plates and
`8.008 cm of water, assemblies separated from stainless steel
`reflecting walls by 1.956 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  6 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p.9460                    93.98  -2.54
```

```
unit 2
array  1 3*0.0
unit 3
cuboid    3 1  7.5307 0.0 30.272  0.0   93.98  -2.54
unit 4
cuboid    7 1  0.292  0.0  2p15.1       88.96  -2.54
cuboid    3 1  0.292  0.0  2p15.136     93.98  -2.54
global unit 5
array 2  -41.8787 -15.136  0.
reflector   4 1 5r0.0              2.54   1
cuboid      3 1 2p73.65 2p17.0924 101.52 -20.38
reflector   5 1 2r0.0   2r17.85   2r0.0  1
reflector   3 1 2r30.5  2r10.694  7.54 0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1              end fill
ara=2 nux=7  nuy=1  nuz=1 fill  2 3 4 2 4 3 2 end fill
end array
end data
end
```

p3602bs1

```
=csas25
p3602bs1
44group latticecell
uo2         1 0.84 293 92235 2.35 92238 97.65                    end
al          2 1.0                                                 end
h2o         3 1.0                                                 end
plexiglas  4 1.0                                                  end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
            14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 5 end
boron       6 den=7.9 .0105                                       end
crss        6 den=7.9 .1903                                       end
cu          6 den=7.9 .0028                                       end
fess        6 den=7.9 .6804                                       end
mn          6 den=7.9 .0158                                       end
mo          6 den=7.9 .0049                                       end
niss        6 den=7.9 .0953                                       end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2                              end
2-18x20 and 1-25x18 (center) assemblies separated by 0.298-cm-thick
`1.1 wt% B 304L stainless steel plates and 4.502 cm of water,
`assemblies separated from stainless steel reflecting walls by 1.321
`cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                     91.44   0.0
cylinder  2 1 0.635                      96.52  -1.27
cuboid    3 1 4p0.842                    96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    3 1  4.088  0.0 30.312  0.0   96.52  -1.27
unit 4
cuboid    6 1  0.298  0.0  2p15.1       90.23  -1.27
cuboid    3 1  0.298  0.0  2p15.156     96.52  -1.27
unit 5
array  2 3*0.0
global unit 6
array 3  -59.116  -15.156  0.
reflector   4 1 5r0.0               2.54 1
cuboid      3 1 2p73.65 2p16.477 102.79 -19.11
reflector   5 1 2r0.0   2r17.85  2r0.0    1
reflector   3 1 2r30.5  2r11.329 8.93 0   1
end geometry

read array
ara=1 nux=20 nuy=18 nuz=1 fill f1            end fill
ara=2 nux=25 nuy=18 nuz=1 fill f1            end fill
ara=3 nux=7  nuy=1  nuz=1 fill 2 3 4 5 4 3 2 end fill
end array
end data
end
```

p3602bs2

```
=csas25
p3602bs2
44group  latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69                   end
al           2 1.0                                                end
h2o          3 1.0                                                end
plexiglas  4 1.0                                                  end
arbmsteel    7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
             14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 5 end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 6                      end
boron        7 den=7.9 .0105                                      end
crss         7 den=7.9 .1903                                      end
cu           7 den=7.9 .0028                                      end
fess         7 den=7.9 .6804                                      end
mn           7 den=7.9 .0158                                      end
mo           7 den=7.9 .0049                                      end
niss         7 den=7.9 .0953                                      end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0                  end
2-20x18 and 1-25x18 (center) assemblies separated by 0.061-cm-thick
`cadmium plates and 3.799 cm of water, assemblies separated from
```

```
`stainless steel reflecting walls by 1.321 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                      91.44   0.0
cylinder  0 1 0.64135                      91.44   0.0
cylinder  6 1 0.64135                      93.98  -2.54
cylinder  2 1 0.70735                      93.98  -2.54
cuboid    3 1 4p.9460                      93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    3 1  9.0547 0.0 30.272  0.0     93.98  -2.54
unit 4
cuboid    7 1  0.298  0.0  2p15.1          88.96  -2.54
cuboid    3 1  0.298  0.0  2p15.136        93.98  -2.54
global unit 5
array 2  -43.4087 -15.136  0.
reflector   4 1 5r0.0             2.54   1
cuboid      3 1 2p73.65 2p17.092 101.52 -20.38
reflector   5 1 2r0.0    2r17.85  2r0.0  1
reflector   3 1 2r30.5   2r10.694 7.54 0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1              end fill
ara=2 nux=7  nuy=1  nuz=1 fill 2 3 4 2 4 3 2 end fill
end array
end data
end
```

<u>p3602cd1</u>

```
=csas25
p3602cd1
44group latticecell
uo2         1 0.84 293 92235 2.35 92238 97.65                       end
al          2 1.0                                                   end
h2o         3 1.0                                                   end
plexiglas  4 1.0                                                    end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
            14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 5 end
cd          6 den=8.65                                              end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2                                end
2-20x18 and 1-25x18(center)assemblies separated by 0.061-cm-thick
`cadmium plates and 3.799 cm of water, assemblies separated from
`stainless steel reflecting walls by 1.321 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm
```

```
read geom
unit 1
cylinder  1 1 0.5588                        91.44   0.0
cylinder  2 1 0.635                         96.52  -1.27
cuboid    3 1 4p0.842                       96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    3 1  3.385 0.0 30.312  0.0      96.52  -1.27
unit 4
cuboid    6 1  0.061 0.0 2p15.1            90.23  -1.27
cuboid    3 1  0.061 0.0 2p15.156          96.52  -1.27
unit 5
array  2 3*0.0
global unit 6
array 3  -58.115 -15.156  0.
reflector   4 1 5r0.0              2.54    1
cuboid      3 1 2p73.65 2p16.477 102.79 -19.11
reflector   5 1 2r0.0   2r17.85  2r0.0   1
reflector   3 1 2r30.5  2r11.329 8.93 0  1
end geometry

read array
ara=1 nux=20 nuy=18 nuz=1 fill f1              end fill
ara=2 nux=25 nuy=18 nuz=1 fill f1              end fill
ara=3 nux=7  nuy=1  nuz=1 fill 2 3 4 5 4 3 2 end fill
end array
end data
end
```

<u>p3602cd2</u>

```
=csas25
p3602cd2
44group latticecell
uo2         1 0.949 293 92235 4.31 92238 95.69                 end
al          2 1.0                                              end
h2o         3 1.0                                              end
plexiglas  4 1.0                                               end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055
            1.28 14000 .22 28304 .79 42000 .49  24304 .12
            29000 .13  5                                       end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 6                    end
cd          7 den=8.65                                         end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0               end
3-12X16 assemblies separated by 0.061-cm-thick cadmium plates and
`8.799 cm of water, assemblies separated from stainless steel
`reflecting walls by 1.956 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm
```

```
read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  6 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p.9460                    93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    3 1  8.4017 0.0 30.272  0.0    93.98  -2.54
unit 4
cuboid    7 1  0.061  0.0  2p15.1        88.96  -2.54
cuboid    3 1  0.061  0.0  2p15.136      93.98  -2.54
global unit 5
array 2  -42.5187 -15.136  0.
reflector   4 1 5r0.0               2.54   1
cuboid      3 1 2p73.65 2p17.092  101.52 -20.38
reflector   5 1 2r0.0   2r17.85   2r0.0  1
reflector   3 1 2r30.5  2r10.694  7.54 0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1             end fill
ara=2 nux=7  nuy=1  nuz=1 fill 2 3 4 2 4 3 2 end fill
end array
end data
end
```

p3602cu1

```
=csas25
p3602cu1
44group latticecell
uo2         1 0.84 293 92235 2.35 92238 97.65                      end
al          2 1.0                                                  end
h2o         3 1.0                                                  end
plexiglas  4 1.0                                                   end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
            14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 5   end
cu          6 den=8.913                                            end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2                               end
2-20x18 and 1-25x18 (center) assemblies separated by 0.337-cm-thick
`copper plates and 7.453 cm of water, assemblies separated from
`stainless steel reflecting walls by 1.321 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                     91.44   0.0
cylinder  2 1 0.635                      96.52  -1.27
cuboid    3 1 4p0.842                    96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    3 1  7.039 0.0 30.312  0.0     96.52  -1.27
unit 4
cuboid    6 1  0.337  0.0  2p15.1        90.23  -1.27
cuboid    3 1  0.337  0.0  2p15.156      96.52  -1.27
unit 5
array  2 3*0.0
global unit 6
array 3  -62.106 -15.156  0.
reflector   4 1 5r0.0               2.54   1
cuboid      3 1 2p73.65 2p16.477 102.79 -19.11
reflector   5 1 2r0.0   2r17.85  2r0.0  1
reflector   3 1 2r30.5  2r11.329 8.93 0 1
end geometry

read array
ara=1 nux=20 nuy=1[illegible] nuz=1 fill f1             end fill
ara=2 nux=25 nuy=18 nuz=1 fill f1             end fill
ara=3 nux=7  nuy=1  nuz=1 fill 2 3 4 5 4 3 2 end fill
end array
end data
end
```

p3602cu2

```
=csas25
p3602cu2
44group latticecell
uo2         1 0.84 293 92235 2.35 92238 97.65                      end
al          2 1.0                                                  end
h2o         3 1.0                                                  end
plexiglas  4 1.0                                                   end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
            14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 5   end
cu          6 den=8.910 .99                                        end
cd          6 den=8.910 .01                                        end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2                               end
2-20x18 and 1-25x18 (center) assemblies separated by 0.357-cm-thick 1
`wt% cadmium copper plates and 5.073 cm of water, assemblies separated
`from stainless steel reflecting walls by 1.321 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                     91.44   0.0
cylinder  2 1 0.635                      96.52  -1.27
```

```
cuboid     3 1 4p0.842                   96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid     3 1  4.659 0.0 30.312  0.0    96.52  -1.27
unit 4
cuboid     6 1  0.357  0.0  2p15.1       90.23  -1.27
cuboid     3 1  0.357  0.0  2p15.156     96.52  -1.27
unit 5
array  2 3*0.0
global unit 6
array 3  -59.746 -15.156  0.
reflector   4 1 5r0.0             2.54   1
cuboid      3 1 2p73.65 2p16.477 102.79 -19.11
reflector   5 1 2r0.0   2r17.85  2r0.0  1
reflector   3 1 2r30.5  2r11.329 8.93 0 1
end geometry

read array
ara=1 nux=20 nuy=18 nuz=1 fill f1             end fill
ara=2 nux=25 nuy=18 nuz=1 fill f1             end fill
ara=3 nux=7  nuy=1   nuz=1 fill 2 3 4 5 4 3 2 end fill
end array
end data
end
```

<u>p3602cu3</u>

```
=csas25
p3602cu3
44group latticecell
uo2           1 0.949 293 92235 4.31 92238 95.69                     end
al            2 1.0                                                  end
h2o           3 1.0                                                  end
plexiglas   4 1.0                                                    end
arbmsteel    7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
              14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 5 end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
              16000 1.7 8016 22.1 14000 0.3 6                        end
cu            7 den=8.913                                            end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0                     end
3-12x16 assemblies separated by 0.337-cm-thick copper plates and
`13.133 cm of water, assemblies separated from stainless steel
`reflecting walls by 1.956 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

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



```
cylinder  6 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p.9460                    93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    3 1  12.6557 0.0 30.272  0.0  93.98  -2.54
unit 4
cuboid    7 1  0.337  0.0  2p15.1       88.96  -2.54
cuboid    3 1  0.337  0.0  2p15.136     93.98  -2.54
global unit 5
array 2  -47.0487 -15.136  0.
reflector   4 1 5r0.0             2.54   1
cuboid      3 1 2p73.65 2p17.092  101.52 -20.38
reflector   5 1 2r0.0   2r17.85   2r0.0  1
reflector   3 1 2r30.5 2r10.694   7.54 0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1             end fill
ara=2 nux=7  nuy=1   nuz=1 fill 2 3 4 2 4 3 2 end fill
end array
end data
end
```

<u>p3602cu4</u>

```
=csas25
p3602cu4
44group latticecell
uo2           1 0.949 293 92235 4.31 92238 95.69                     end
al            2 1.0                                                  end
h2o           3 1.0                                                  end
plexiglas   4 1.0                                                    end
arbmsteel    7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
              14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 5 end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
              16000 1.7 8016 22.1 14000 0.3 6                        end
cu            7 den=8.910 .99                                        end
cd            7 den=8.910 .01                                        end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0                     end
3-12x16 assemblies separated by 0.357-cm-thick 1 wt% cadmium copper
`plates and 10.213 cm of water, assemblies separated from stainless
`steel reflecting walls by 1.956 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

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

```
cylinder  6 1 0.64135                        93.98  -2.54
cylinder  2 1 0.70735                        93.98  -2.54
cuboid    3 1 4p.9460                        93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    3 1  9 7357 0.0 30.272  0.0    93.98  -2.54
unit 4
cuboid    7 1  0.357  0.0  2p15.1        88.96  -2.54
cuboid    3 1  0.357  0.0  2p15.136      93.98  -2.54
global unit 5
array 2  -44.1487 -15.136  0.
reflector   4 1 5r0.0            2.54    1
cuboid      3 1 2p73.65 2p17.092 101.52 -20.38
reflector   5 1 2r0.0    2r17.85  2r0.0   1
reflector   3 1 2r30.5   2r10.694 7.54 0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1               end fill
ara=2 nux=7  nuy=1  nuz=1 fill 2 3 4 2 4 3 2 end fill
end array
end data
end
```

p3602n11

```
=csas25
p3602n11
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65
al           2 1.0                                             end
h2o          3 1.0                                             end
plexiglas  4 1.0                                               end
h2o          5 1.0                                             end
                                                               end
arbmsteel    7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
             14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 6 end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2                           end
2-20x18 and 1-25x18 (center) assemblies separated by 8.98 cm of water,
`assemblies separated from stainless steel reflecting walls by 0.0 cm
`of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                        91.44   0.0
cylinder  2 1 0.635                         96.52  -1.27
cuboid    3 1 4p.842                        96.52  -1.27
unit 2
```

```
array  1 3*0.0
unit 3
array  2 3*0.0
unit 4
cuboid    5 1 8.566 0.0  30.312  0.0     96.52  -1.27
global unit 5
array 3  -63.296  -15.156  0.
reflector 4 1  5r0.0     2.54                          1
cuboid    5 1  2p73.65  2p15.156  102.79  -19.11
reflector 6 1  2r0.0     2r17.85    2r0.0              1
reflector 5 1  5r9.0     0                             1
reflector 5 1  2r21.0    4r0                           1
end geometry

read array
ara=1 nux=25 nuy=18 nuz=1 fill f1          end fill
ara=2 nux=20 nuy=18 nuz=1 fill f1          end fill
ara=3 nux=5  nuy=1  nuz=1 fill 3 4 2 4 3 end fill
end array
end data
end
```

p3602n12

```
=csas25
p3602n12
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65
al           2 1.0                                             end
h2o          3 1.0                                             end
plexiglas  4 1.0                                               end
h2o          5 1.0                                             end
arbmsteel    7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28  end
             14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 6 end
end comp

squarepitch  1.684 1.1176 1 3 1.27 2                           end
2-20x18 and 1-25x18 (center) assemblies separated by [illegible] of water,
`assemblies separated from stainless steel reflectir[illegible]s by 0.66 cm
`of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                      91.44   0.0
cylinder  2 1 0.635                       96.52  -1.27
cuboid    3 1 4p.842                      96.52  -1.27
unit 2
array  1 3*0.0
unit 3
array  2 3*0.0
```

```
unit 4
cuboid    5 1 9.166 0.0  30.312  0.0    96.52  -1.27
global unit 5
array 3  -63.896  -15.156  0.
reflector 4 1  5r0.0    2.54              1
cuboid    5 1  2p73.65  2p15.816  102.79  -19.11
reflector 6 1  2r0.0    2r17.85    2r0.0    1
reflector 5 1  5r9.0    0                 1
reflector 5 1  2r21.0   4r0               1
end geometry

read array
ara=1 nux=25 nuy=18 nuz=1 fill f1        end fill
ara=2 nux=20 nuy=18 nuz=1 fill f1        end fill
ara=3 nux=5  nuy=1  nuz=1 fill 3 4 2 4 3 end fill
end array
end data
end
```

p3602n13

```
=csas25
p3602n13
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65                end
al           2 1.0                                            end
h2o          3 1.0                                            end
plexiglas  4 1.0                                              end
h2o          5 1.0                                            end
arbmsteel    7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
             14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 6 end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2                          end
2-20x18 and 1-25x18 (center) assemblies separated by 9.66 cm of water,
`assemblies separated from stainless steel reflecting walls by 1.684
`cm of water
read parm  run=yes gen=405 npg=600 nsk=5  nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                     91.44   0.0
cylinder  2 1 0.635                      96.52  -1.27
cuboid    3 1 4p.842                     96.52  -1.27
unit 2
array  1 3*0.0
unit 3
array  2 3*0.0
unit 4
cuboid    5 1 9.246 0.0  30.312  0.0    96.52  -1.27
global unit 5
array 3  -63.976  -15.156  0.
reflector 4 1  5r0.0    2.54              1
cuboid    5 1  2p73.65  2p16.84  102.79  -19.11
reflector 6 1  2r0.0    2r17.85    2r0.0    1
reflector 5 1  5r9.0    0                 1
reflector 5 1  2r21.0   4r0               1
end geometry

read array
ara=1 nux=25 nuy=18 nuz=1 fill f1        end fill
ara=2 nux=20 nuy=18 nuz=1 fill f1        end fill
ara=3 nux=5  nuy=1  nuz=1 fill 3 4 2 4 3 end fill
end array
end data
end
```

p3602n14

```
=csas25
p3602n14
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65                end
al           2 1.0                                            end
h2o          3 1.0                                            end
plexiglas  4 1.0                                              end
h2o          5 1.0                                            end
arbmsteel    7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28 14000 .22
             28304 .79 42000 .49  24304 .12  29000 .13  6  end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2                          end
2-20x18 and 1-25x18 (center) assemblies separated by 8.54 cm of water,
`assemblies separated from stainless steel reflecting walls by 3.912
`cm of water
read parm  run=yes gen=405 npg=600 nsk=5  nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                     91.44   0.0
cylinder  2 1 0.635                      96.52  -1.27
cuboid    3 1 4p.842                     96.52  -1.27
unit 2
array  1 3*0.0
unit 3
array  2 3*0.0
unit 4
cuboid    5 1 8.126 0.0  30.312  0.0    96.52  -1.27
global unit 5
array 3  -62.856  -15.156  0.
reflector 4 1  5r0.0    2.54              1
cuboid    5 1  2p73.65  2p19.068  102.79  -19.11
reflector 6 1  2r0.0    2r17.85    2r0.0    1
reflector 5 1  5r9.0    0                 1
```

```
reflector 5 1  2r21.0   4r0                    1
end geometry

read array
ara=1 nux=25 nuy=18 nuz=1 fill f1         end fill
ara=2 nux=20 nuy=18 nuz=1 fill f1         end fill
ara=3 nux=5  nuy=1  nuz=1 fill 3 4 2 4 3 end fill
end array
end data
end
```

p3602n21

```
=csas25
p3602n21
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65                    end
al           2 1.0                                                end
h2o          3 1.0                                                end
plexiglas  4 1.0                                                  end
h2o          5 1.0                                                end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
             14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 6 end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2                              end
3-19x16 assemblies separated by 11.20 cm of water, assemblies
`separated from stainless steel reflecting walls by 0.66 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                      91.44   0.0
cylinder  2 1 0.635                       96.52  -1.27
cuboid    3 1 4p1.016                     96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 9.598 0.0  32.512  0.0     96.52  -1.27
global unit 4
array 2  -67.51   -16.256  0.
reflector 4 1  5r0.0    2.54                           1
cuboid    5 1  2p73.65  2p18.872  102.79  -19.11
reflector 6 1  2r0.0    2r17.85    2r0.0               1
reflector 5 1  5r9.0    0                              1
reflector 5 1  2r21.0   4r0                            1
end geometry

read array
ara=1 nux=19 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p3602n22

```
=csas25
p3602n22
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65                    end
al           2 1.0                                                end
h2o          3 1.0                                                end
plexiglas  4 1.0                                                  end
h2o          5 1.0                                                end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
             14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 6 end
end comp
squarepitch  2.032 1.1176 1 3 1.27 2                              end
3-19x16 assemblies separated by 10.36 cm of water, assemblies
`separated from stainless steel reflecting walls by 2.616 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                      91.44   0.0
cylinder  2 1 0.635                       96.52  -1.27
cuboid    3 1 4p1.016                     96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 10.438 0.0  32.512  0.0    96.52  -1.27
global unit 4
array 2  -68.35   -16.256  0.
reflector 4 1  5r0.0    2.54                           1
cuboid    5 1  2p73.65  2p16.916  102.79  -19.11
reflector 6 1  2r0.0    2r17.85    2r0.0               1
reflector 5 1  5r9.0    0                              1
reflector 5 1  2r21.0   4r0                            1
end geometry

read array
ara=1 nux=19 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p3602n31

```
=csas25
p3602n31
44group  latticecell
```

```
uo2          1 0.949 293 92235 4.31 92238 95.69                    end
al           2 1.0                                                 end
h2o          3 1.0                                                 end
plexiglas  4 1.0                                                   end
h2o          5 1.0                                                 end
arbmsteel    7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
              14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 6 end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7                        end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0                   end
3-12x16 assemblies separated by 14.87 cm of water, assemblies
`separated from stainless steel reflecting walls by 0.0 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  7 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p.9460                    93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 14.3927 0.0 30.272  0.0   93.98  -2.54
global unit 5
array 2  -46.4487 -15.136  0.
reflector   4 1 5r0.0   2.54 1
cuboid      5 1 2p73.65 2p15.136  101.52 -20.38
reflector   6 1 2r0.0 2r17.85 2r0.0  1
reflector   5 1 5r8.0      0  1
reflector   5 1 4r3.0   2r0  1
reflector   5 1 2r20.0  4r0  1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p3602n32

```
=csas25
p3602n32
44group  latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69                    end
al           2 1.0                                                 end
h2o          3 1.0                                                 end
plexiglas  4 1.0                                                   end
h2o          5 1.0                                                 end
arbmsteel    7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
              14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 6 end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7                        end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0                   end
3-12x16 assemblies separated by 15.74 cm of water, assemblies
`separated from stainless steel reflecting walls by 0.66 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  7 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p.9460                    93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 15.2627 0.0 30.272  0.0   93.98  -2.54
global unit 5
array 2  -49.3187 -15.136  0.
reflector   4 1 5r0.0   2.54 1
cuboid      5 1 2p73.45 2p15.796  101.52 -20.38
reflector   6 1 2r0.0 2r17.85 2r0.0  1
reflector   5 1 5r8.0      0  1
reflector   5 1 4r3.0   2r0  1
reflector   5 1 2r20.0  4r0  1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p3602n33

```
=csas25
p3602n33
44group  latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69                    end
al           2 1.0                                                 end
h2o          3 1.0                                                 end
plexiglas  4 1.0                                                   end
h2o          5 1.0                                                 end
```

```
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
            14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 6 end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7                     end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0          end
3-12x16 assemblies separated by 15.87 cm of water, assemblies
`separated from stainless steel reflecting walls by 1.321 cm of water
read parm  run=yes gen=405 npg=600 nsk=5  nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                     91.44   0.0
cylinder  0 1 0.64135                     91.44   0.0
cylinder  7 1 0.64135                     93.98  -2.54
cylinder  2 1 0.70735                     93.98  -2.54
cuboid    3 1 4p.9460                     93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid     5 1 15.3927 0.0 30.272  0.0   93.98  -2.54
global unit 5
array 2  -49.4487 -15.136  0.
reflector   4 1 5r0.0   2.54 1
cuboid      5 1 2p73.65 2p16.457  101.52 -20.38
reflector   6 1 2r0.0 2r17.85 2r0.0   1
reflector   5 1 2r30.5 2r11.329 7.76 0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p3602n34

```
=csas25
p3602n34
44group  latticecell
uo2         1 0.949 293 92235 4.31 92238 95.69                  end
al          2 1.0                                               end
h2o         3 1.0                                               end
plexiglas  4 1.0                                                end
h2o         5 1.0                                               end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
            14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 6 end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7                     end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0                 end
3-12x16 assemblies separated by 15.84 cm of water, assemblies
`separated from stainless steel reflecting walls by 1.956 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                     91.44   0.0
cylinder  0 1 0.64135                     91.44   0.0
cylinder  7 1 0.64135                     93.98  -2.54
cylinder  2 1 0.70735                     93.98  -2.54
cuboid    3 1 4p.9460                     93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid     5 1 15.3627 0.0 30.272  0.0   93.98  -2.54
global unit 5
array 2  -49.4187 -15.136  0.
reflector   4 1 5r0.0   2.54 1
cuboid      5 1 2p73.65 2p17.092  101.52 -20.38
reflector   6 1 2r0.0 2r17.85 2r0.0  1
reflector   5 1 5r8.0     0  1
reflector   5 1 4r3.0   2r0  1
reflector   5 1 2r20.0  4r0  1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p3602n35

```
=csas25
p3602n35
44group  latticecell
uo2         1 0.949 293 92235 4.31 92238 95.69            end
al          2 1.0                                         end
h2o         3 1.0                                         end
plexiglas  4 1.0                                          end
h2o         5 1.0                                         end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28 14000 .22
            28304 .79 42000 .49  24304 .12  29000 .13  6  end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7               end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0          end
3-12x16 assemblies separated by 15.45 cm of water, assemblies
```

```
 separated from stainless steel reflecting walls by 2.616 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                      91.44   0.0
cylinder  0 1 0.64135                      91.44   0.0
cylinder  7 1 0.64135                      93.98  -2.54
cylinder  2 1 0.70735                      93.98  -2.54
cuboid    3 1 4p.9460                      93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 14.9727 0.0 30.272  0.0   93.98  -2.54
global unit 5
array 2  -49.0287 -15.136  0.
reflector   4 1 5r0.0   2.54 1
cuboid      5 1 2p73.65 2p17.752  101.52 -20.38
reflector   6 1 2r0.0 2r17.85 2r0.0  1
reflector   5 1 5r8.0      0  1
reflector   5 1 4r3.0   2r0  1
reflector   5 1 2r20.0  4r0  1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

<u>p3602n36</u>

```
=csas25
p3602n36
44group  latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69                    end
al           2 1.0                                                 end
h2o          3 1.0                                                 end
plexiglas  4 1.0                                                   end
h2o          5 1.0                                                 end
arbmsteel    7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
             14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 6 end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 7                       end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0                   end
3-12x16 assemblies separated by 13.82 cm of water, assemblies
`separated from stainless steel reflecting walls by 5.405 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                      91.44   0.0
cylinder  0 1 0.64135                      91.44   0.0
cylinder  7 1 0.64135                      93.98  -2.54
cylinder  2 1 0.70735                      93.98  -2.54
cuboid    3 1 4p.9460                      93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 13.3427 0.0 30.272  0.0   93.98  -2.54
global unit 5
array 2  -47.3987 -15.136  0.
reflector   4 1 5r0.0   2.54 1
cuboid      5 1 2p73.65 2p20.541  101.52 -20.38
reflector   6 1 2r0.0 2r17.85 2r0.0  1
reflector   5 1 5r8.0      0  1
reflector   5 1 4r3.0   2r0  1
reflector   5 1 2r20.0  4r0  1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

<u>p3602n41</u>

```
=csas25
p3602n41
44group  latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69                    end
al           2 1.0                                                 end
h2o          3 1.0                                                 end
plexiglas  4 1.0                                                   end
h2o          5 1.0                                                 end
arbmsteel    7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
             14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 6 end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 7                       end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0                   end
3-13x8 assemblies separated by 12.89 cm of water, assemblies
`separated from stainless steel reflecting walls by 0.0 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

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

```
cylinder  0 1 0.64135                    91.44   0.0
cylinder  7 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p1.270                    93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 11.7647 0.0 20.32  0.0     93.98  -2.54
global unit 5
array 2  -61.2947 -10.16  0.
reflector   4 1 5r0.0   2.54 1
cuboid      5 1 2p73.65 2p10.16  101.52 -20.38
reflector   6 1 2r0.0 2r17.85 2r0.0  1
reflector   5 1 5r8.0      0  1
reflector   5 1 4r3.0   2r0  1
reflector   5 1 2r20.0  4r0  1
end geometry

read array
ara=1 nux=13 nuy=8 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1 nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p3602n42

```
=csas25
p3602n42
44group  latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69                       end
al           2 1.0                                                    end
h2o          3 1.0                                                    end
plexiglas  4 1.0                                                      end
h2o          5 1.0                                                    end
arbmsteel   7.84 8 0 0 1 26304 96.78 6012 0.19 25055 1.28 14000
             .22 28304 .79 42000 .49  24304 .12  29000 .13  6         end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7                           end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0                      end
3-13x8 assemblies separated by 14.12 cm of water, assemblies
`separated from stainless steel reflecting walls by 1.321 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  7 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p1.270                    93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 12.9947 0.0 20.32   0.0    93.98  -2.54
global unit 5
array 2  -62.5247 -10.16  0.
reflector   4 1 5r0.0   2.54 1
cuboid      5 1 2p73.65 2p11.481 101.52 -20.38
reflector   6 1 2r0.0 2r17.85 2r0.0 1
reflector   5 1 5r8.0      0  1
reflector   5 1 4r3.0   2r0  1
reflector   5 1 2r20.0  4r0  1
end geometry

read array
ara=1 nux=13 nuy=8 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1 nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p3602n43

```
=csas25
p3602n43
44group  latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69                       end
al           2 1.0                                                    end
h2o          3 1.0                                                    end
plexiglas  4 1.0                                                      end
h2o          5 1.0                                                    end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
            14000 .22 28304 .79 42000 .49 24304 .12 29000 .13 6       end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 7                           end
end comp
squarepitch  2.540 1.2649 1 3 1.4147 2  1.2827 0                      end
3-13x8 assemblies separated by 12.44 cm of water, assemblies
`separated from stainless steel reflecting walls by 2.616 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  7 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p1.270                    93.98  -2.54
unit 2
array  1 3*0.0
```

```
unit 3
cuboid    5 1 11.3147 0.0 20.32   0.0   93.98  -2.54
global unit 5
array 2  -60.8447 -10.16  0.
reflector   4 1 5r0.0   2.54 1
cuboid    5 1 2p73.65 2p12.776  101.52 -20.38
reflector   6 1 2r0.0 2r17.85 2r0.0  1
reflector   5 1 5r8.0     0  1
reflector   5 1 4r3.0   2r0  1
reflector   5 1 2r20.0  4r0  1
end geometry

read array
ara=1 nux=13 nuy=8 nuz=1 fill f1        end fill
ara=2 nux=5  nuy=1 nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p3602ss1

```
=csas25
p3602ss1
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65                    end
al           2 1.0                                                end
h2o          3 1.0                                                end
plexiglas  4 1.0                                                  end
arbmsteel    7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
             14000 .22 28304 .79 42000 .49  24304 .12 29000 .13 5 end
crss         6 den=7.93 .1856                                     end
cu           6 den=7.93 .0027                                     end
fess         6 den=7.93 .6824                                     end
mn           6 den=7.93 .0158                                     end
mo           6 den=7.93 .0026                                     end
niss         6 den=7.93 .1109                                     end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2                              end
2-20x18 and 1-25x18 (center) assemblies separated by 0.302-cm-thick
`304L stainless steel plates and 7.978 cm of water, assemblies
`separated from stainless steel reflecting walls by 1.321 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                          91.44   0.0
cylinder  2 1 0.635                           96.52  -1.27
cuboid    3 1 0.842 -0.842 0.842 -0.842 96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    3 1  7.564  0.0 30.312  0.0    96.52  -1.27
unit 4
cuboid    6 1  0.302  0.0  2p15.1        90.23  -1.27
cuboid    3 1  0.302  0.0  2p15.156      96.52  -1.27
unit 5
array  2 3*0.0
global unit 6
array 3  -62.596 -15.156  0.
reflector   4 1 5r0.0              2.54   1
cuboid      3 1 2p73.65 2p16.477 102.79 -19.11
reflector   5 1 2r0.0   2r17.85  2r0.0  1
reflector   3 1 2r30.5  2r11.329 8.93 0 1
end geometry

read array
ara=1 nux=20 nuy=18 nuz=1   fill f1                  end fill
ara=2 nux=25 nuy=18 nuz=1   fill f1                  end fill
ara=3 nux=7  nuy=1  nuz=1   fill  2 3 4 5 4 3 2      end fill
end array
end data
end
```

p3602ss2

```
=csas25
p3602ss2
44group  latticecell
uo2  1 0.949 293 92235 4.31 92238 95.69                              end
al   2 1.0                                                           end
h2o  3 1.0                                                           end
plexiglas  4 1.0                                                     end
arbmsteel   7.84  8 0 0 1 26304 96.78  6012 0.19  25055 1.28
            14000 .22 28304 .79 42000 .49 24304 .12 29000 .13 5  end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 6                          end
crss        7 den=7.93 .1856                                         end
cu          7 den=7.93 .0027                                         end
fess        7 den=7.93 .6824                                         end
mn          7 den=7.93 .0158                                         end
mo          7 den=7.93 .0026                                         end
niss        7 den=7.93 .1109                                         end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0                     end
3-12x16 assemblies separated by 0.302-cm-thick 304L stainless steel
`plates and 13.448 cm of water, assemblies separated from stainless
`steel reflecting walls by 1.956 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

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

```
cylinder  0 1 0.64135                    91.44   0.0
cylinder  6 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p.9460                    93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    3 1 12.9707 0.0 30.272  0.0    93.98  -2.54
unit 4
cuboid    7 1  0.302  0.0  2p15.1        88.96  -2.54
cuboid    3 1  0.302  0.0  2p15.136      93.98  -2.54
global unit 5
array 2  -47.3287 -15.136  0.
reflector   4 1 5r0.0             2.54    1
cuboid      3 1 2p73.65 2p17.092  101.52 -20.38
reflector   5 1 2r0.0    2r17.85   2r0.0  1
reflector   3 1 2r30.5   2r10.694  7.54 0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1   fill f1                    end fill
ara=2 nux=7  nuy=1  nuz=1   fill  2 3 4 2 4 3 2        end fill
end array
end data
end
```

p3926l1

```
=csas25
p3926l1
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65              end

al           2 1.0                                          end
h2o          3 1.0                                          end
plexiglas  4 1.0                                            end
h2o          5 1.0                                          end
pb           6 .9758                                        end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2                        end
2-20x18 and 1-23x18 (center) assemblies separated by 10.06 cm of
`water, assemblies separated from lead reflecting walls by 0.0 cm of
`water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                     91.44   0.0
cylinder  2 1 0.635                      96.52  -1.27
cuboid    3 1 4p0.842                    96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid     5 1 9.646  0.0  30.312  0.0   96.52  -1.27
unit 4
array  2 3*0.0
global unit 5
array 3  -62.692  -15.156  0.
reflector   4 1  5r0.0  2.54                 1
cuboid      5 1  2p82.0 2p15.156 104.29 -19.11
reflector   6 1  2r0.0  2r10.2    2r0.0      1
reflector   5 1  2r30.5 2r20.3    7.43 0     1
end geometry

read array
ara=1 nux=23 nuy=18 nuz=1 fill f1        end fill
ara=2 nux=20 nuy=18 nuz=1 fill f1        end fill
ara=3 nux=5  nuy=1  nuz=1 fill 4 3 2 3 4 end fill
end array
end data
end
```

p3926l2

```
=csas25
p3926l2
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65              end
al           2 1.0                                          end
h2o          3 1.0                                          end
plexiglas  4 1.0                                            end
h2o          5 1.0                                          end
pb           6 .9758                                        end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2                        end
2-20x18 and 1-23x18 (center) assemblies separated by 10.11 cm of
`water, assemblies separated from lead reflecting walls by 0.66 cm of
`water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                     91.44   0.0
cylinder  2 1 0.635                      96.52  -1.27
cuboid    3 1 4p0.842                    96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid     5 1 9.696  0.0  30.312  0.0   96.52  -1.27
unit 4
array  2 3*0.0
global unit 5
```

```
array 3  -62.742  -15.156  0.
reflector   4 1  5r0.0    2.54                  1
cuboid      5 1  2p82.0   2p15.816 104.29 -19.11
reflector   6 1  2r0.0    2r10.2   2r0.0        1
reflector   5 1  2r30.5   2r19.64  7.43 0       1
end geometry

read array
ara=1 nux=23 nuy=18 nuz=1 fill f1         end fill
ara=2 nux=20 nuy=18 nuz=1 fill f1         end fill
ara=3 nux=5  nuy=1  nuz=1 fill 4 3 2 3 4 end fill
end array
end data
end
```

p392613

```
=csas25
p392613
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65              end
al           2 1.0                                          end
h2o          3 1.0                                          end
plexiglas  4 1.0                                            end
h2o          5 1.0                                          end
pb           6 .9758                                        end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2                        end
2-20x18 and 1-23x18 (center) assemblies separated by 8.50 cm of
`water, assemblies separated from lead reflecting walls by 3.276 cm of
`water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                       91.44   0.0
cylinder  2 1 0.635                        96.52  -1.27
cuboid    3 1 4p0.842                      96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid     5 1 8.086  0.0  30.312  0.0   96.52  -1.27
unit 4
array  2 3*0.0
global unit 5
array 3  -61.132  -15.156  0.
reflector   4 1  5r0.0   2.54                   1
cuboid      5 1  2p82.0  2p18.432 104.29 -19.11
reflector   6 1  2r0.0   2r10.2    2r0.0        1
reflector   5 1  2r30.5  2r17.024  7.43 0       1
end geometry
```

```
read array
ara=1 nux=23 nuy=18 nuz=1 fill f1         end fill
ara=2 nux=20 nuy=18 nuz=1 fill f1         end fill
ara=3 nux=5  nuy=1  nuz=1 fill 4 3 2 3 4 end fill
end array
end data
end
```

p392614

```
=csas25
p392614
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69             end
al           2 1.0                                          end
h2o          3 1.0                                          end
plexiglas  4 1.0                                            end
h2o          5 1.0                                          end
pb           6 .9758                                        end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 7                end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0 end
3-12x16 assemblies separated by 17.74 cm of water, assemblies
`separated from lead reflecting walls by 0.0 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  7 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p0.946                    93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 17.2627 0.0 30.272  0.0    93.98  -2.54
global unit 4
array 2  -51.3187 -15.136  0.
reflector   4 1 5r0.0   2.54             1
cuboid      5 1 2p82.0  2p15.136  103.02 -20.38
reflector   6 1 2r0.0   2r10.2    2r0.0  1
reflector   5 1 2r30.5  2r20.3    6.16 0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
```

```
end data
end
```

p3926l5

```
=csas25
p3926l5
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69             end
al           2 1.0                                          end
h2o          3 1.0                                          end
plexiglas  4 1.0                                            end
h2o          5 1.0                                          end
pb           6 .9758                                        end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 7                end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0            end
3-12x16 assemblies separated by 18.18 cm of water, assemblies
`separated from lead reflecting walls by 0.66 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  7 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p0.946                    93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 17.7027 0.0 30.272  0.0    93.98  -2.54
global unit 4
array 2  -51.7587 -15.136  0.
reflector   4 1 5r0.0    2.54              1
cuboid      5 1 2p82.0   2p15.796   103.02 -20.38
reflector   6 1 2r0.0    2r10.2     2r0.0  1
reflector   5 1 2r30.5   2r19.64    6.16 0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p3926l6

```
=csas25
p3926l6
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69             end
al           2 1.0                                          end
h2o          3 1.0                                          end
plexiglas  4 1.0                                            end
h2o          5 1.0                                          end
pb           6 .9758                                        end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 7                end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0            end
3-12x16 assemblies separated by 17.43 cm of water, assemblies
`separated from lead reflecting walls by 1.956 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  7 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p0.946                    93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 16.9527 0.0 30.272  0.0    93.98  -2.54
global unit 4
array 2  -51.0087 -15.136  0.
reflector   4 1 5r0.0    2.54              1
cuboid      5 1 2p82.0   2p17.092   103.02 -20.38
reflector   6 1 2r0.0    2r10.2     2r0.0  1
reflector   5 1 2r30.5   2r18.344 6.16 0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p3926sl1

```
=csas25
p3926sl1
44group latticecell
uo2          1 0.84 293 92235 2.35 92238 97.65              end
```

```
al          2 1.0                                              end
h2o         3 1.0                                              end
plexiglas  4 1.0                                               end
h2o         5 1.0                                              end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2                           end
2-20x18 and 1-23x18 (center) assemblies separated by 6.59 of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                  91.44   0.0
cylinder  2 1 0.635                   96.52  -1.27
cuboid    3 1 4p0.842                 96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 6.176  0.0  30.312  0.0   96.52  -1.27
unit 4
array  2 3*0.0
global unit 5
array 3  -59.222  -15.156  0.
reflector   4 1 5r0            2.54 1
reflector   5 1 4r30.5 15.2 15.3  1
end geometry

read array
ara=1 nux=23 nuy=13 nuz=1 fill f1          end fill
ara=2 nux=20 nuy=18 nuz=1 fill f1          end fill
ara=3 nux=5  nuy=1  nuz=1 fill 4 3 2 3 4 end fill
end array
end data
end
```

p3926sl2

```
=csas25
p3926sl2
44group  latticecell
uo2         1 0.949 293 92235 4.31 92238 95.69              end
al          2 1.0                                            end
h2o         3 1.0                                            end
plexiglas  4 1.0                                             end
h2o         5 1.0                                            end
arbmrubber  1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
            16000 1.7 8016 22.1 14000 0.3 6                  end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0             end
3-12x16 assemblies separated by 12.79 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm
```

```
read geom
unit 1
cylinder  1 1 0.63245                    91.44   0.0
cylinder  0 1 0.64135                    91.44   0.0
cylinder  6 1 0.64135                    93.98  -2.54
cylinder  2 1 0.70735                    93.98  -2.54
cuboid    3 1 4p.9460                    93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 12.4927 0.0 30.272  0.0    93.98  -2.54
global unit 5
array 2  -46.5487 -15.136  0.
reflector   4 1 5r0.0         2.54 1
reflector   5 1 4r30.4 15.2 15.3 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1        end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p3926u1

```
=csas25
p3926u1
44group latticecell
uo2         1 0.84 293 92235 2.35 92238 97.65              end
al          2 1.0                                           end
h2o         3 1.0                                           end
plexiglas  4 1.0                                            end

h2o         5 1.0                                           end
uranium     6 .98163 293 92235 .199 92238 99.801            end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2                        end
2-20x18 and 1-23x18 (center) assemblies separated by 8.06 cm of water,
`assemblies separated from depleted uranium reflecting walls by 0.0 cm
`of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                  91.44   0.0
cylinder  2 1 0.635                   96.52  -1.27
cuboid    3 1 4p0.842                 96.52  -1.27
unit 2
array  1 3*0.0
unit 3
```

```
cuboid     5 1 7.646  0.0  30.312  0.0   96.52  -1.27
unit 4
array  2 3*0.0
global unit 5
array 3  -60.692  -15.156  0.
reflector   4 1  5r0.0     2.54                    1
cuboid      5 1  2p76.15   2p15.156   102.79  -19.11
reflector   6 1  2r0.0     2r7.65     2r0.0        1
reflector   5 1  2r30.5    2r22.85    8.93 0       1
end geometry

read array
ara=1 nux=23 nuy=18 nuz=1 fill f1         end fill
ara=2 nux=20 nuy=18 nuz=1 fill f1         end fill
ara=3 nux=5  nuy=1  nuz=1 fill 4 3 2 3 4 end fill
end array
end data
end
```

p3926u2

```
=csas25
p3926u2
44group latticecell
uo2         1 0.84 293 92235 2.35 92238 97.65                  end
al          2 1.0                                              end
h2o         3 1.0                                              end
plexiglas  4 1.0                                               end
h2o         5 1.0                                              end
uranium     6 .98163 293 92235 .199 92238 99.801               end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2                           end
2-20x18 and 1-23x18 (center) assemblies separated by 9.50 cm of water,
`assemblies separated from depleted uranium reflecting walls by 1.321
`cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                      91.44    0.0
cylinder  2 1 0.635                       96.52  -1.27
cuboid    3 1 4p0.842                     96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid     5 1 9.086  0.0  30.312  0.0   96.52  -1.27
unit 4
array  2 3*0.0
global unit 5
array 3  -62.132  -15.156  0.
reflector   4 1 5r0.0     2.54                    1
```

```
cuboid      5 1 2p76.15   2p16.477   102.79  -19.11
reflector   6 1 2r0.0     2r7.65     2r0.0        1
reflector   5 1 2r30.5    2r21.529   8.93 0       1
end geometry

read array
ara=1 nux=23 nuy=18 nuz=1 fill f1         end fill
ara=2 nux=20 nuy=18 nuz=1 fill f1         end fill
ara=3 nux=5  nuy=1  nuz=1 fill 4 3 2 3 4 end fill
end array
end data
end
```

p3926u3

```
=csas25
p3926u3
44group latticecell
uo2         1 0.84 293 92235 2.35 92238 97.65                  end
al          2 1.0                                              end
h2o         3 1.0                                              end
plexiglas  4 1.0                                               end
h2o         5 1.0                                              end
uranium     6 .98163 293 92235 .199 92238 99.801               end
end comp
squarepitch  1.684 1.1176 1 3 1.27 2                           end
2-20x18 and 1-23x18 (center) assemblies separated by 9.19 cm of water,
`assemblies separated from depleted uranium reflecting walls by 3.912
`cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.5588                      91.44    0.0
cylinder  2 1 0.635                       96.52  -1.27
cuboid    3 1 4p0.842                     96.52  -1.27
unit 2
array  1 3*0.0
unit 3
cuboid     5 1 8.776  0.0  30.312  0.0   96.52  -1.27
unit 4
array  2 3*0.0
global unit 5
array 3  -61.822 -15.156  0.
reflector   4 1 5r0.0     2.54                    1
cuboid      5 1 2p76.15   2p19.068   102.79  -19.11
reflector   6 1 2r0.0     2r7.65     2r0.0        1
reflector   5 1 2r30.5    2r18.938   8.93 0       1
end geometry
```

```
read array
ara=1 nux=23 nuy=18 nuz=1 fill f1         end fill
ara=2 nux=20 nuy=18 nuz=1 fill f1         end fill
ara=3 nux=5  nuy=1  nuz=1 fill 4 3 2 3 4 end fill
end array
end data
end
```

p3926u4

```
=csas25
p3926u4
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69              end
al           2 1.0                                           end
h2o          3 1.0                                           end
plexiglas  4 1.0                                             end
h2o          5 1.0                                           end
uranium      6 .98163  293  92235  .199  92238  99.801       end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 7                 end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0             end
3-12x16 assemblies separated by 15.33 cm of water, assemblies
`separated from depleted uranium reflecting walls by 0.0 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                        91.44   0.0
cylinder  0 1 0.64135                        91.44   0.0
cylinder  7 1 0.64135                        93.98  -2.54
cylinder  2 1 0.70735                        93.98  -2.54
cuboid    3 1 4p0.946                        93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 14.8527 0.0 30.272  0.0   93.98  -2.54
global unit 4
array 2  -48.9087 -15.136  0.
reflector   4 1 5r0.0   2.54          1
cuboid    5 1 2p76.15  2p15.136  101.57 -20.38
reflector   6 1 2r0.0  2r7.65    2r0.0  1
reflector   5 1 2r30.5 2r22.85   7.66 0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p3926u5

```
=csas25
p3926u5
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69              end
al           2 1.0                                           end
h2o          3 1.0                                           end
plexiglas  4 1.0                                             end
h2o          5 1.0                                           end
uranium      6 .98163  293  92235  .199  92238  99.801       end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 7                 end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0             end
3-12x16 assemblies separated by 19.24 cm of water, assemblies
`separated from depleted uranium reflecting walls by 1.956 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                        91.44   0.0
cylinder  0 1 0.64135                        91.44   0.0
cylinder  7 1 0.64135                        93.98  -2.54
cylinder  2 1 0.70735                        93.98  -2.54
cuboid    3 1 4p0.946                        93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 18.7627 0.0 30.272  0.0   93.98  -2.54
global unit 4
array 2  -52.8187 -15.136  0.
reflector   4 1 5r0.0   2.54          1
cuboid    5 1 2p76.15  2p17.092  101.57 -20.38
reflector   6 1 2r0.0   2r7.65    2r0.0  1
reflector   5 1 2r30.5  2r20.894  7.66 0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1         end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

p3926u6

```
=csas25
```

```
p3926u6
44group latticecell
uo2          1 0.949 293 92235 4.31 92238 95.69            end
al           2 1.0                                         end
h2o          3 1.0                                         end
plexiglas  4 1.0                                           end
h2o          5 1.0                                         end
uranium      6 .98163  293  92235  .199  92238  99.801     end
arbmrubber   1.321 6 0 0 0 6012 58. 1001 6.5 20000 11.4
             16000 1.7 8016 22.1 14000 0.3 7               end
end comp
squarepitch  1.892 1.2649 1 3 1.4147 2  1.2827 0           end
3-12x16 assemblies separated by 18.78 cm of water, assemblies
`separated from depleted uranium reflecting walls by 3.276 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  1 1 0.63245                      91.44   0.0
cylinder  0 1 0.64135                      91.44   0.0
cylinder  7 1 0.64135                      93.98  -2.54
cylinder  2 1 0.70735                      93.98  -2.54
cuboid    3 1 4p0.946                      93.98  -2.54
unit 2
array  1 3*0.0
unit 3
cuboid    5 1 18.3027 0.0 30.272  0.0   93.98  -2.54
global unit 4
array 2  -52.3587 -15.136  0.
reflector   4 1 5r0.0   2.54              1
cuboid      5 1 2p76.15 2p18.412  101.57 -20.38
reflector   6 1 2r0.0   2r7.65     2r0.0  1
reflector   5 1 2r30.5  2r19.574  7.66 0 1
end geometry

read array
ara=1 nux=12 nuy=16 nuz=1 fill f1        end fill
ara=2 nux=5  nuy=1  nuz=1 fill 2 3 2 3 2 end fill
end array
end data
end
```

<u>p4267b1</u>

```
=csas25
p4267b1
44group latticecell
uo2          1 den=10.40 1.0 293 92234 .022 92235 4.306 92236
             .022 92238  95.65                                        end
al           2 1.0                                                    end
boron        3 den=.00215 1.0                                         end
h2o          3              1.0                                       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
arbmprop     0.904 2 0 1 0 6312 6 1901 3 5 1                          end
plexiglas  6 1.0                                                      end
h2o          7 1.0                                                    end
end comp
squarepitch  1.890 1.2649 1 3 1.4147 2 1.2827 0                       end
Core of 923 fuel rods, 111.7 water height with 2150 ppm boron
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  4 1 0.63880                           2.54   0.0
cylinder  2 1 0.70735                           2.54   0.0
cuboid    5 1 4p0.945                           2.54   0.0
unit 2
cylinder  1 1 0.63245                          67.31   0.0
cylinder  0 1 0.64135                          67.31   0.0
cylinder  2 1 0.70735                          67.31   0.0
cuboid    3 1 4p0.945                          67.31   0.0
unit 3
cylinder  1 1 0.63245                           1.27   0.0
cylinder  0 1 0.64135                           1.27   0.0
cylinder  2 1 0.70735                           1.27   0.0
cuboid    5 1 4p0.945                           1.27   0.0
unit 4
cylinder  1 1 0.63245                          22.86   0.0
cylinder  0 1 0.64135                          22.86   0.0
cylinder  2 1 0.70735                          22.86   0.0
cuboid    3 1 4p0.945                          22.86   0.0
unit 5
cylinder  4 1 0.63880                           2.54   0.0
cylinder  2 1 0.70735                           2.54   0.0
cuboid    3 1 4p0.945                           2.54   0.0
unit 6
array  1 3*0.0
unit 7
cuboid    6 1 4p0.945                           2.54   0.0
cuboid    3 1 4p0.945                          69.85   0.0
cuboid    6 1 4p0.945                          71.12   0.0
cuboid    3 1 4p0.945                          96.52   0.0
global
unit 8
array  2 -22.68 -37.80  0.0
cuboid    3 1 22.68  -56.92  2p37.8     111.7  0.0
cuboid    6 1 24.585 -58.825 2p39.705   111.7  -17.105
reflector 7 1 4r30 2r0 1
end geometry
```

```
read array
ara=1 nux=1  nuy=1  nuz=5 fill 1 2 3 4 5         end fill
ara=2 nux=24 nuy=40 nuz=1 fill 72r6 7 23r6 36q24 end fill
end array
end data
end
```

p4267b2

```
=csas25
p4267b2
44group latticecell
uo2          1 den=10.40 1.0 293 92234 .022 92235 4.306 92236
             .022 92238 95.65                                   end
al           2 1.0                                              end
boron        3 den=.00255 1.0                                   end
h2o          3            1.0                                   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
arbmprop     0.904 2 0 1 0 6312 6 1901 3 5 1                    end
plexiglas  6 1.0                                                end
h2o          7 1.0                                              end
end comp
squarepitch  1.890 1.2649 1 3 1.4147 2 1.2827 0                 end
Core of 1237 fuel rods, 111.7 water height with 2550 ppm boron
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  4 1 0.63880                          2.54    0.0
cylinder  2 1 0.70735                          2.54    0.0
cuboid    5 1 4p0.945                          2.54    0.0
unit 2
cylinder  1 1 0.63245                         67.31    0.0
cylinder  0 1 0.64135                         67.31    0.0
cylinder  2 1 0.70735                         67.31    0.0
cuboid    3 1 4p0.945                         67.31    0.0
unit 3
cylinder  1 1 0.63245                          1.27    0.0
cylinder  0 1 0.64135                          1.27    0.0
cylinder  2 1 0.70735                          1.27    0.0
cuboid    5 1 4p0.945                          1.27    0.0
unit 4
cylinder  1 1 0.63245                         22.86    0.0
cylinder  0 1 0.64135                         22.86    0.0
cylinder  2 1 0.70735                         22.86    0.0
cuboid    3 1 4p0.945                         22.86    0.0
unit 5
cylinder  4 1 0.63880                          2.54    0.0
cylinder  2 1 0.70735                          2.54    0.0
cuboid    3 1 4p0.945                          2.54    0.0
unit 6
array  1 3*0.0
unit 7
cuboid    6 1 4p0.945                          2.54    0.0
cuboid    3 1 4p0.945                         69.85    0.0
cuboid    6 1 4p0.945                         71.12    0.0
cuboid    3 1 4p0.945                         96.52    0.0
global
unit 8
array  2 -29.295 -37.80  0.0
cuboid    3 1 29.295 -50.305  2p37.8     111.7  0.0
cuboid    6 1 31.2    -52.21   2p39.705  111.7  -17.105
reflector 7 1 4r30 2r0 1
end geometry

read array
ara=1 nux=1  nuy=1  nuz=5 fill 1 2 3 4 5         end fill
ara=2 nux=31 nuy=40 nuz=1 fill 1147r6 7 30r6 2q31 end fill
end array
end data
end
```

p4267b3

```
=csas25
p4267b3
44group latticecell
uo2          1 den=10.40 1.0 293 92234 .022 92235 4.306 92236
             .022 92238 95.65                                   end
al           2 1.0                                              end
boron        3 den=.00103 1.0                                   end
h2o          3            1.0                                   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
arbmprop     0.904 2 0 1 0 6312 6 1901 3 5 1                    end
plexiglas  6 1.0                                                end
h2o          7 1.0                                              end
end comp
squarepitch  1.715 1.2649 1 3 1.4147 2 1.2827 0                 end
Core of 737 fuel rods, 111.7 water height with 1030 ppm boron
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  4 1 0.63880                          2.54    0.0
cylinder  2 1 0.70735                          2.54    0.0
cuboid    5 1 4p0.8575                         2.54    0.0
unit 2
cylinder  1 1 0.63245                         67.31    0.0
cylinder  0 1 0.64135                         67.31    0.0
cylinder  2 1 0.70735                         67.31    0.0
```

```
cuboid    3 1 4p0.8575                          67.31    0.0
unit 3
cylinder  1 1 0.63245                            1.27    0.0
cylinder  0 1 0.64135                            1.27    0.0
cylinder  2 1 0.70735                            1.27    0.0
cuboid    5 1 4p0.8575                           1.27    0.0
unit 4
cylinder  1 1 0.6324⁵                           22.86    0.0
cylinder  0 1 0.64135                           22.86    0.0
cylinder  2 1 0.70735                           22.86    0.0
cuboid    3 1 4p0.8575                          22.86    0.0
unit 5
cylinder  4 1 0.63880                            2.54    0.0
cylinder  2 1 0.70735                            2.54    0.0
cuboid    3 1 4p0.8575                           2.54    0.0
unit 6
array 1  3*0.0
unit 7
cuboid    6 1 4p0.8575                           2.54    0.0
cuboid    3 1 4p0.8575                          69.85    0.0
cuboid    6 1 4p0.8575                          71.12    0.0
cuboid    3 1 4p0.8575                          96.52    0.0
global
unit 8
array  2 -14.5775  -37.73  0.0
cuboid    3 1 14.5775 -65.0225 2p37.73   111.7  0.0
cuboid    6 1 16.4825 -66.9275 2p39.635  111.7  -17.105
reflector 7 1 4r30 2r0 1
end geometry

read array
ara-1 nux=1  nuy=1  nuz=5 fill 1 2 3 4 5          end fill
ara=2 nux=17 nuy=44 nuz=1 fill 561r6 7 16r6 10q17 end fill
end array
end data
end
```

<u>p4267b4</u>

```
=csas25
p4267b4
44group latticecell
uo2          1 den=10.40 1.0 293 92234 .022 92235 4.306 92236
             .022 92238 95.65                                    end
al           2 1.0                                               end
boron        3 den=.00182 1.0                                    end
h2o          3            1.0                                    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
arbmprop     0.904 2 0 1 0 6312 6 1901 3 5 1                     end
plexiglas  6 1.0                                                 end
h2o          7 1.0                                               end
end comp
squarepitch  1.715 1.2649 1 3 1.4147 2 1.2827 0                  end
Core of 917 fuel rods, 111.7 water height with 1820 ppm boron
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  4 1 0.63880                            2.54    0.0
cylinder  2 1 0.70735                            2.54    0.0
cuboid    5 1 4p0.8575                           2.54    0.0
unit 2
cylinder  1 1 0.63245                           67.31    0.0
cylinder  0 1 0.64135                           67.31    0.0
cylinder  2 1 0.70735                           67.31    0.0
cuboid    3 1 4p0.8575                          67.31    0.0
unit 3
cylinder  1 1 0.63245                            1.27    0.0
cy  der   0 1 0.64135                            1.27    0.0
cylinder  2 1 0.70735                            1.27    0.0
cuboid    5 1 4p0.8575                           1.27    0.0
unit 4
cylinder  1 1 0.63245                           22.86    0.0
cylinder  0 1 0.64135                           22.86    0.0
cylinder  2 1 0.70735                           22.86    0.0
cuboid    3 1 4p0.8575                          22.86    0.0
unit 5
cylinder  4 1 0.63880                            2.54    0.0
cylinder  2 1 0.70735                            2.54    0.0
cuboid    3 1 4p0.8575                           2.54    0.0
unit 6
array 1  3*0.0
unit 7
cuboid    6 1 4p0.8575                           2.54    0.0
cuboid    3 1 4p0.8575                          69.85    0.0
cuboid    6 1 4p0.8575                          71.12    0.0
cuboid    3 1 4p0.8575                          96.52    0.0
global
unit 8
arra   2 -18.0075  -37.73  0.0
cub       3 1 18.0075 -61.5925 2p37.73   111.7  0.0
cubo      6 1 19.9125 -63.4975 2p39.635  111.7  -17.105
refle     7 1 4r30 2r0 1
end g  etry

read array
ara=1 nux=1  nuy=1  nuz=5 fill 1 2 3 4 5          end fill
ara=2 nux=21 nuy=44 nuz=1 fill 777r6 7 20r6 6q21 end fill
end array
end data
end
```

<u>p4267b5</u>

```
=csas25
p4267b5
44group latticecell
uo2         1 den=10.40 1.0 293 92234 .022 92235 4.306 92236
            .022 92238 95.65                                   end
al          2 1.0                                              end
boron       3 den=.00255 1.0                                   end
h2o         3            1.0                                   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
arbmprop    0.904 2 0 1 0 6312 6 1901 3 5 1                    end
plexiglas  6 1.0                                               end
h2o         7 1.0                                              end
end comp
squarepitch  1.715 1.2649 1 3 1.4147 2 1.2827 0                end
Core of 1192 fuel rods, 111.7 water height with 2550 ppm boron
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  4 1 0.63880                        2.54   0.0
cylinder  2 1 0.70735                        2.54   0.0
cuboid    5 1 4p0.8575                       2.54   0.0
unit 2
cylinder  1 1 0.63245                       67.31   0.0
cylinder  0 1 0.64135                       67.31   0.0
cylinder  2 1 0.70735                       67.31   0.0
cuboid    3 1 4p0.8575                      67.31   0.0
unit 3
cylinder  1 1 0.63245                        1.27   0.0
cylinder  0 1 0.64135                        1.27   0.0
cylinder  2 1 0.70735                        1.27   0.0
cuboid    5 1 4p0.8575                       1.27   0.0
unit 4
cylinder  1 1 0.63245                       22.86   0.0
cylinder  0 1 0.64135                       22.86   0.0
cylinder  2 1 0.70735                       22.86   0.0
cuboid    3 1 4p0.8575                      22.86   0.0
unit 5
cylinder  4 1 0.63880                        2.54   0.0
cylinder  2 1 0.70735                        2.54   0.0
cuboid    3 1 4p0.8575                       2.54   0.0
unit 6
array 1  3*0.0
unit 7
cuboid    6 1 4p0.8575                       2.54   0.0
cuboid    3 1 4p0.8575                      69.85   0.0
cuboid    6 1 4p0.8575                      71.12   0.0
cuboid    3 1 4p0.8575                      96.52   0.0
global
unit 8
array  2 -24.01 -37.73  0.0
cuboid    3 1 24.01  -55.59  2p37.73   111.7  0.0
cuboid    6 1 25.915 -57.495 2p39.635  111.7  -17.105
reflector 7 1 4r30 2r0 1
end geometry

read array
ara=1 nux=1  nuy=1  nuz=5 fill 1 2 3 4 5          end fill
ara=2 nux=28 nuy=44 nuz=1 fill 112r6 7 27r6 39q28 end fill
end array
end data
end
```

<u>p4267sl1</u>

```
=csas25
p4267sl1
44group latticecell
uo2         1 den=10.40 1.0 293 92234 .022 92235 4.306 92236
            .022 92238 95.65                                   end
al          2 1.0                                              end
h2o         3 1.0                                              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
arbmprop    0.904 2 0 1 0 6312 6 1901 3 5 1                    end
plexiglas  6 1.0                                               end
end comp
squarepitch  1.890 1.2649 1 3 1.4147 2 1.2827 0                end
Core of 357 fuel rods, 111.7 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geom
unit 1
cylinder  4 1 0.63880                        2.54   0.0
cylinder  2 1 0.70735                        2.54   0.0
cuboid    5 1 4p0.945                        2.54   0.0
unit 2
cylinder  1 1 0.63245                       67.31   0.0
cylinder  0 1 0.64135                       67.31   0.0
cylinder  2 1 0.70735                       67.31   0.0
cuboid    3 1 4p0.945                       67.31   0.0
unit 3
cylinder  1 1 0.63245                        1.27   0.0
cylinder  0 1 0.64135                        1.27   0.0
cylinder  2 1 0.70735                        1.27   0.0
cuboid    5 1 4p0.945                        1.27   0.0
unit 4
cylinder  1 1 0.63245                       22.86   0.0
cylinder  0 1 0.64135                       22.86   0.0
```

```
cylinder  2 1 0.70735                              22.86   0.0
cuboid    3 1 4p0.945                              22.86   0.0
unit 5
cylinder  4 1 0.63880                               2.54   0.0
cylinder  2 1 0.70735                               2.54   0.0
cuboid    3 1 4p0.945                               2.54   0.0
unit 6
array  1 3*0.0
unit 7
cuboid    6 1 4p0.945                               2.54   0.0
cuboid    3 1 4p0.945                              69.85   0.0
cuboid    6 1 4p0.945                              71.12   0.0
cuboid    3 1 4p0.945                              96.52   0.0
global
unit 8
array  2 -8.505 -37.80  0.0
cuboid    3 1 8.505  -71.095 2p37.8    111.7  0.0
cuboid    6 1 10.41  -73.000 2p39.705  111.7  -17.105
reflector 3 1 4r30 2r0 1
end geometry

read array
ara=1 nux=1 nuy=1  nuz=5 fill 1 2 3 4 5        end fill
ara=2 nux=9 nuy=40 nuz=1 fill 333r6 7 8r6 2q9 end fill
end array
end data
end
```

p4267sl2

```
=csas25
p4267sl2
44group latticecell
uo2          1 den=10.40 1.0 293 92234 .022 92235 4.306 92236
             .022 92238 95.65                                     end
al           2 1.0                                                end
h2o          3 1.0                                                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
arbmprop     0.904 2 0 1 0 6312 6 1901 3 5 1                      end
plexiglas  6 1.0                                                  end
end comp
squarepitch  1.715 1.2649 1 3 1.4147 2 1.2827 0                   end
Core of 509 fuel rods, 111.7 cm water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  4 1 0.63880                               2.54   0.0
cylinder  2 1 0.70735                               2.54   0.0
cuboid    5 1 4p0.8575                              2.54   0.0
unit 2
cylinder  1 1 0.63245                              67.31   0.0
cylinder  0 1 0.64135                              67.31   0.0
cylinder  2 1 0.70735                              67.31   0.0
cuboid    3 1 4p0.8575                             67.31   0.0
unit 3
cylinder  1 1 0.63245                               1.27   0.0
cylinder  0 1 0.64135                               1.27   0.0
cylinder  2 1 0.70735                               1.27   0.0
cuboid    5 1 4p0.8575                              1.27   0.0
unit 4
cylinder  1 1 0.63245                              22.86   0.0
cylinder  0 1 0.64135                              22.86   0.0
cylinder  2 1 0.70735                              22.86   0.0
cuboid    3 1 4p0.8575                             22.86   0.0
unit 5
cylinder  4 1 0.63880                               2.54   0.0
cylinder  2 1 0.70735                               2.54   0.0
cuboid    3 1 4p0.8575                              2.54   0.0
unit 6
array  1 3*0.0
unit 7
cuboid    6 1 4p0.8575                              2.54   0.0
cuboid    3 1 4p0.8575                             69.85   0.0
cuboid    6 1 4p0.8575                             71.12   0.0
cuboid    3 1 4p0.8575                             96.52   0.0
global
unit 8
array  2 -10.29 -37.73  0.0
cuboid    3 1 10.29  -69.31  2p37.73   111.7  0.0
cuboid    6 1 12.195 -71.215 2p39.635  111.7  -17.105
reflector 3 1 4r30 2r0 1
end geometry

read array
ara=1 nux=1  nuy=1  nuz=5 fill 1 2 3 4 5           end fill
ara=2 nux=12 nuy=44 nuz=1 fill 300r6 7 11r6 18q12 end fill
end array
end data
end
```

p62ft231

```
=csas25
p62ft231
44group latticecell
uo2          1 0.9489 293 92234 0.022 92235 4.306 92236 0.022
             92238 95.65                                          end
al           2 1.0                                                end
h2o          3 1.0                                                end
```

```
arbmboral     2.64 5 1 0 1 5000 35.63 6012 9.95 13027 54.33
              8016 0.07 26000 0.02 4                                    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 5                           end
plexiglas     6 1.0                                                     end
end comp
squarepitch 1.891 1.265 1 3 1.415 2 1.283 0                             end
3-15x16 and 1-12x16 plus 3x17 assemblies separated by 0.683-cm-thick
`Boral plates and 3.824 cm of water
read parm    run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geometry
unit 1
cylinder 1 1 .6325                                     93.98  2.54
cylinder 0 1 .6415                                     93.98  2.54
cylinder 5 1 .6415                                     96.00  0.0
cylinder 2 1 .7075                                     96.00  0.0
cuboid   3 1 4p.9455                                   96.00  0.0
unit 2
array  2 3*0.0
cuboid   3 1 32.4220 -11.8750   44.0220 -0.2950    96.00  0.0
cuboid   2 1 32.5435 -11.8750   44.0220 -0.3965    96.00  0.0
cuboid   4 1 33.0235 -11.8750   44.0220 -0.8765    96.00  0.0
cuboid   2 1 33.1250 -11.8750   44.0220 -0.9780    96.00  0.0
unit 3
array  1 3*0.0
cuboid   3 1 44.0220 -0.2950    44.0220 -0.2950    96.00  0.0
cuboid   2 1 44.0220 -0.3965    44.0220 -0.3965    96.00  0.0
cuboid   4 1 44.0220 -0.8765    44.0220 -0.8765    96.00  0.0
cuboid   2 1 44.0220 -0.9780    44.0220 -0.9780    96.00  0.0
unit 4
array  2 3*0.0
cuboid   3 1 32.4220 -11.8750   28.6600 -15.6570   96.00  0.0
cuboid   2 1 32.5435 -11.8750   28.7615 -15.6570   96.00  0.0
cuboid   4 1 33.0235 -11.8750   29.2415 -15.6570   96.00  0.0
cuboid   2 1 33.1250 -11.8750   29.3430 -15.6570   96.00  0.0
unit 5
array  3 3*0.0
cuboid   3 1   44.0220 -0.2955  28.6600 -15.657    96.00  0.0
cuboid   2 1   44.0220 -0.3965  28.7615 -15.657    96.00  0.0
cuboid   4 1   44.0220 -0.8765  29.2415 -15.657    96.00  0.0
cuboid   2 1   44.0220 -0.9780  29.3430 -15.657    96.00  0.0
unit 6
cuboid   3 1  3.71     0.0       45.0      0.0      96.00  0.0
unit 7
cuboid   3 1 45.0      0.0        3.71     0.0      96.00  0.0
unit 8
cuboid   3 1  3.71     0.0        3.71     0.0      96.00  0.0
unit 9
cuboid   3 1 4p.9455                                   96.00  0.0
global unit 10
array 4 3*0.0
reflector 6 1 5r0        5.08 1
reflector 3 1 4r15 15. 15.88 1
end geom

read array
ara=1 nux=17 nuy=15 fill 16r1 9 14q17       end fill
ara=2 nux=17 nuy=15 fill 9 16r1 14q17       end fill
ara=3 nux=17 nuy=15 fill 51r1 16r1 9 11q17 end fill
ara=4 nux=3  nuy=3  fill 4 6 5 7 8 7 2 6 3 end fill
end array
end data
end
```

<u>p71f14f3</u>

```
=csas25
p71f14f3
44group latticecell
uo2           1 0.9489 293 92234 0.022 92235 4.306 92236 0.022
              92238 95.650                                              end
al            2 1.0                                                     end
h2o           3 1.0                                                     end
arbmboral     2.64 5 1 0 1 5000 29.22 6012 8.16 13027 62.54
              8016 0.06 26000 0.02 4                                    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 5                           end
plexiglas     6 1.0                                                     end
end comp
squarepitch 1.891 1.265 1 3 1.415 2 1.283 0                             end
2-15x14 and 1-15x15 and 1-12x14 plus 3x15 assemblies separated by
`0.673-cm thick Boral plates, 14 fuel rods, and 3.844 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geometry
unit 1
cylinder 1 1 .6325                                         93.98  2.54
cylinder 0 1 .6415                                         93.98  2.54
cylinder 5 1 .6415                                         96.00  0.0
cylinder 2 1 .7075                                         96.00  0.0
cuboid   3 1 4p.9455                                       96.00  0.0
unit 2
array  1 3*0.0
cuboid   3 1 28.4220  -15.9050  44.2700  -.0570    96.00  0.0
cuboid   2 1 28.5235  -15.9050  44.2700  -.1585    96.00  0.0
cuboid   4 1 28.9935  -15.9050  44.2700  -.6285    96.00  0.0
cuboid   2 1 29.0950  -15.9050  44.2700  -.7300    96.00  0.0
unit 3
array  3 3*0.0
cuboid   3 1 44.2700  -0.0570   44.2700  -0.0570   96.00  0.0
cuboid   2 1 44.2700  -0.1585   44.2700  -0.1585   96.00  0.0
```

```
cuboid   4 1 44.2700  -0.6285   44.2700  -0.6285  96.00  0.0
cuboid   2 1 44.2700  -0.7300   44.2700  -0.7300  96.00  0.0
unit 4
array  2 3*0.0
cuboid   3 1 28.4220  -15.9050  28.4220  -15.9050 96.00  0.0
cuboid   2 1 28.5235  -15.9050  28.5235  -15.9050 96.00  0.0
cuboid   4 1 28.9935  -15.9050  28.9935  -15.9050 96.00  0.0
cuboid   2 1 29.0950  -15.9050  29.0950  -15.9050 96.00  0.0
unit 5
array  3 3*0.0
cuboid   3 1 44.2700  -0.0570   28.4220  -15.9050 96.00  0.0
cuboid   2 1 44.2700  -0.1585   28.5235  -15.9050 96.00  0.0
cuboid   4 1 44.2700  -0.6285   28.9935  -15.9050 96.00  0.0
cuboid   2 1 44.2700  -0.7300   29.0950  -15.9050 96.00  0.0
unit 6
array 4 -.9455 .968 0.0
cuboid   3 1 1.865    -1.865     45.00     0.0      96.00  0.0
unit 7
array 5 .968 -.9455 0.0
cuboid   3 1 45.00     0.0        1.865   -1.865    96.00  0.0
unit 8
cuboid   3 1 4p1.865                                96.00  0.0
unit 9
cuboid   3 1 4p.9455                                96.00  0.0
unit 10
array 6 -.9455 15.9050 0.0
cuboid   3 1 1.865    -1.865     45.00     0.0      96.00  0.0
unit 11
array 7 15.9050 -.9455 0.0
cuboid   3 1 45.00     0.0        1.865   -1.865    96.00  0.0
global unit 12
array 8 3*0.0
reflector 6 1 5r0    5.08 1
reflector 3 1 5r15. 15.88 1
end geom

read array
ara=1 nux=15 nuy=15 fill 45r1 9 14r1 11q15    end fill
ara=2 nux=15 nuy=15 fill f1                   end fill
ara=3 nux=15 nuy=15 fill 14r1 9 14q15         end fill
ara=4 nux=1  nuy=15 fill 14r1 9               end fill
ara=5 nux=15 nuy=1  fill 14r1 9               end fill
ara=6 nux=1  nuy=15 fill 9 14r1               end fill
ara=7 nux=15 nuy=1  fill 9 14r1               end fill
ara=8 nux=3  nuy=3  fill 4 10 5 11 8 7 2 6 3 end fill
end array
end data
end
```

<u>p71f14v3</u>

```
=csas25
p71f14v3
44group latticecell
uo2          1 0.9489 293 92234 0.022 92235 4.306 92236 0.022
             92238 95.650                                        end
al           2 1.0                                               end
h2o          3 1.0                                               end
arbmboral    2.64 5 1 0 1 5000 29.22 6012 8.16 13027 62.54
             8016 0.06 26000 0.02 4                              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 5                     end
plexiglas    6 1.0                                               end
end comp
squarepitch 1.891 1.265 1 3 1.415 2 1.283 0                      end
2-15x14 and 1-15x15 and 1-8x14 plus 7x15 assemblies separated by
 0.673-cm thick Boral plates, 0.62-cm-thick aluminum plates, and 3.844
 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geometry
unit 1
cylinder 1 1 .6325                              93.98  2.54
cylinder 0 1 .6415                              93.98  2.54
cylinder 5 1 .6415                              96.00  0.0
cylinder 2 1 .7075                              96.00  0.0
cuboid   3 1 4p.9455                            96.00  0.0
unit 2
array  1 3*0.0
cuboid   3 1 26.5310  -17.7960   44.2700  -.0570 96.00  0.0
cuboid   2 1 26.6325  -17.7960   44.2700  -.1585   96.00  0.0
cuboid   4 1 27.1025  -17.7960   44.2700  -.6285   96.00  0.0
cuboid   2 1 27.2040  -17.7960   44.2700  -.7300   96.00  0.0
unit 3
array  2 3*0.0
cuboid   3 1 44.2700  -0.0570    44.2700  -.0570   96.00  0.0
cuboid   2 1 44.2700  -0.1585    44.2700  -.1585   96.00  0.0
cuboid   4 1 44.2700  -0.6285    44.2700  -.6285   96.00  0.0
cuboid   2 1 44.2700  -0.7300    44.2700  -.7300   96.00  0.0
unit 4
array  1 3*0.0
cuboid   3 1 26.5310  -17.7960   28.4220  -15.9050  96.00  0.0
cuboid   2 1 26.6325  -17.7960   28.5235  -15.9050  96.00  0.0
cuboid   4 1 27.1025  -17.7960   28.9935  -15.9050  96.00  0.0
cuboid   2 1 27.2040  -17.7960   29.0950  -15.9050  96.00  0.0
unit 5
array  3 3*0.0
cuboid   3 1 44.2700  -0.0570    28.4220  -15.9050  96.00  0.0
```

```
cuboid   2 1 44.2700  -0.1585      28.5235  -15.9050  96.00  0.0
cuboid   4 1 44.2700  -0.6285      28.9935  -15.9050  96.00  0.0
cuboid   2 1 44.2700  -0.7300      29.0950  -15.9050  96.00  0.0
unit 6
cuboid   3 1  0.46     0.0         45.0       0.0     96.00  0.0
cuboid   2 1  1.09     0.0         45.0       0.0     96.00  0.0
cuboid   3 1  1.55     0.0         45.0       0.0     96.00  0.0
cuboid   2 1  2.18     0.0         45.0       0.0     96.00  0.0
cuboid   3 1  2.64     0.0         45.0       0.0     96.00  0.0
cuboid   2 1  3.27     0.0         45.0       0.0     96.00  0.0
cuboid   3 1  3.73     0.0         45.0       0.0     96.00  0.0
unit 7
cuboid   3 1  45.0     0.0          0.46      0.0     96.00  0.0
cuboid   2 1  45.0     0.0          1.09      0.0     96.00  0.0
cuboid   3 1  45.0     0.0          1.55      0.0     96.00  0.0
cuboid   2 1  45.0     0.0          2.18      0.0     96.00  0.0
cuboid   3 1  45.0     0.0          2.64      0.0     96.00  0.0
cuboid   2 1  45.0     0.0          3.27      0.0     96.00  0.0
cuboid   3 1  45.0     0.0          3.73      0.0     96.00  0.0
unit 8
cuboid   3 1 4p1.865                                  96.00  0.0
unit 9
cuboid   3 1 4p.9455                                  96.00  0.0
global
unit 10
array 4 3*0.0
reflector 6 1 5r0    5.08 1
reflector 3 1 5r15. 15.88 1
end geom

read array
ara=1 nux=14 nuy=15 fill f1                end fill
ara=2 nux=15 nuy=15 fill f1                end fill
ara=3 nux=15 nuy=15 fill 105r1 14r1 9 7q15 end fill
ara=4 nux=3  nuy=3  fill 4 6 5 7 8 7 2 6 3 end fill
end array
end data
end
```

p71f14v5

```
=csas25
p71f14v5
44group latticecell
uo2          1 0.9489 293 92234 0.022 92235 4.306 92236 0.022
             92238 95.650                                            end
al           2 1.0                                                   end
h2o          3 1.0                                                   end
arbmboral    2.64 5 1 0 1 5000 29.22 6012 8.16 13027 62.54
             8016 0.06 26000 0.02 4                                  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 5                         end
plexiglas    6 1.0                                                   end
end comp
squarepitch  1.891 1.265 1 3 1.415 2 1.283 0                         end
2-15x15 and 1-16x15 and 1-15x15 plus 1x10 assemblies separated by
0.673-cm thick Boral plates, 14 aluminum rods, and 3.844 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geometry
unit 1
cylinder 1 1 .6325                                       93.98  2.54
cylinder 0 1 .6415                                       93.98  2.54
cylinder 5 1 .6415                                       96.00  0.0
cylinder 2 1 .7075                                       96.00  0.0
cuboid   3 1 4p.9455                                     96.00  0.0
unit 2
array  3 3*0.0
cuboid   3 1 28.4220 -15.9050   44.2700 -.0570           96.00  0.0
cuboid   2 1 28.5235 -15.9050   44 2700 -.1585           96.00  0.0
cuboid   4 1 28.9935 -15.9050   44.2700 -.6285           96.00  0.0
cuboid   2 1 29.0950 -15.9050   44.2700 -.7300           96.00  0.0
unit 3
array  2 3*0.0
cuboid   3 1 44.2700 -.0570     44.2700 -.0570           96.00  0.0
cuboid   2 1 44.2700 -.1585     44.2700 -.1585           96.00  0.0
cuboid   4 1 44.2700 -.6285     44.2700 -.6285           96.00  0.0
cuboid   2 1 44.2700 -.7300     44.2700 -.7300           96.00  0.0
unit 4
array  1 3*0.0
cuboid   3 1 28.4220 -15.9050   28.4220 -15.9050         96.00  0.0
cuboid   2 1 28.5235 -15.9050   28.5235 -15.9050         96.00  0.0
cuboid   4 1 28.9935 -15.9050   28.9935 -15.9050         96.00  0.0
cuboid   2 1 29.0950 -15.9050   29.0950 -15.9050         96.00  0.0
unit 5
array  1 3*0.0
cuboid   3 1 44.2700 -.0570     28.4220 -15.9050         96.00  0.0
cuboid   2 1 44.2700 -.1585     28.5235 -15.9050         96.00  0.0
cuboid   4 1 44.2700 -.6285     28.9935 -15.9050         96.00  0.0
cuboid   2 1 44.2700 -.7300     29.0950 -15.9050         96.00  0.0
unit 6
array 4 -0.9455 2r0.0
cuboid   3 1  1.865 -1.865      44.2700  -0.7300         96.00  0.0
unit 7
array 5 0.0 -0.9455 0.0
cuboid   3 1 44.27    -0.73      1.865    -1.865         96.00  0.0
unit 8
cuboid   3 1 4p1.865                                     96.00  0.0
unit 9
cuboid   3 1 4p.9455                                     96.00  0.0
unit 10
```

```
array 6 -0.9455 2r0.0
cuboid   3 1  1.865 -1.865     29.0950  -15.9050  96.00  0.0
unit 11
array 7  0.0 -0.9455 0.0
cuboid   3 1 29.0950 -15.9050   1.865   -1.865    96.00  0.0
unit 12
cylinder 2 1 .635                                 96.00  0.0
cuboid   3 1 4p.9455                              96.00  0.0
global unit 13
array 8 3*0.0
reflector 6 1 5r0    5.08 1
reflector 3 1 5r15. 15.88 1
end geom

read array
ara=1 nux=15 nuy=15 fill f1                   end fill
ara=2 nux=15 nuy=16 fill f1                   end fill
ara=3 nux=15 nuy=16 fill 225r1 5r9 10r1       end fill
ara=4 nux=1  nuy=16 fill 14r12 2r9            end fill
ara=5 nux=15 nuy=1  fill 14r12 9              end fill
ara=6 nux=1  nuy=15 fill 9 14r12              end fill
ara=7 nux=15 nuy=1  fill 9 14r12              end fill
ara=8 nux=3  nuy=3  fill 4 10 5 11 8 7 2 6 3 end fill
end array
end data
end
```

<u>p71f214r</u>

```
=csas25
p71f214r
44group latticecell
uo2          1 0.9489 293 92234 0.022 92235 4.306 92236 0.022
               92238 95.650                                        end
al           2 1.0                                                 end
h2o          3 1.0                                                 end

arbmboral    2.64 5 1 0 1 5000 29.22 6012 8.16 13027 62.54
             8016 0.06 26000 0.02 4                                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 5                       end
plexiglas    6 1.0                                                 end
end comp
squarepitch  1.891 1.265 1 3 1.415 2 1.283 0                       end
3-15x16 and 1-8x15 and plus 7x16 assemblies separated by 0.673-cm
`thick Boral plates and 3.844 cm of water
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes  end parm

read geometry
unit 1
cylinder 1 1 .6325                                               93.98  2.54
cylinder 0 1 .6415                                               93.98  2.54
cylinder 5 1 .6415                                               96.00  0.0
cylinder 2 1 .7075                                               96.00  0.0
cuboid   3 1 4p.9455                                             96.00  0.0
unit 2
array  1 3*0.0
cuboid   3 1 30.313  -14.0140   44.270  -.0570     96.00  0.0
cuboid   2 1 30.4145 -14.0140   44.270  -.1585     96.00  0.0
cuboid   4 1 30.8845 -14.0140   44.270  -.6285     96.00  0.0
cuboid   2 1 30.9860 -14.0140   44.270  -.7300     96.00  0.0
unit 3
array  1 3*0.0
cuboid   3 1 44.270  -0.0570    44.270  -0.0570    96.00  0.0
cuboid   2 1 44.270  -0.1585    44.270  -0.1585    96.00  0.0
cuboid   4 1 44.270  -0.6285    44.270  -0.6285    96.00  0.0
cuboid   2 1 44.270  -0.7300    44.270  -0.7300    96.00  0.0
unit 4
array  1 3*0.0
cuboid   3 1 30.3130 -14.0140   28.4220 -15.9050   96.00  0.0
cuboid   2 1 30.4145 -14.0140   28.5235 -15.9050   96.00  0.0
cuboid   4 1 30.8845 -14.0140   28.9935 -15.9050   96.00  0.0
cuboid   2 1 30.9860 -14.0140   29.0950 -15.9050   96.00  0.0
unit 5
array  2 3*0.0
cuboid   3 1 44.270  -0.0570    28.4220 -15.9050   96.00  0.0
cuboid   2 1 44.270  -0.1585    28.5235 -15.9050   96.00  0.0
cuboid   4 1 44.270  -0.6285    28.9935 -15.9050   96.00  0.0
cuboid   2 1 44.270  -0.7300    29.0950 -15.9050   96.00  0.0
unit 6
cuboid   3 1 2p1.865            45.0     0.0       96.00  0.0
unit 7
cuboid   3 1 45.0     0.0       2p1.865            96.00  0.0
unit 8
cuboid   3 1 4p1.865                               96.00  0.0
unit 9
cuboid   3 1 4p.9455                               96.00  0.0
global unit 10
array 3 3*0.0
reflector 6 1 5r0.   5.08 1
reflector 3 1 5r15. 15.88 1
end geom

read array
ara=1 nux=16 nuy=15 fill f1                   end fill
ara=2 nux=16 nuy=15 fill 15r1 9 7q16 112r1 end fill
ara=3 nux=3  nuy=3  fill 4 6 5 7 8 7 2 6 3 end fill
end array
end data
end
```

pat80l1

```
=csas25
pat80l1
44group latticecell
uo2        1 den=10.38 1.0 293 92235 4.742 92238 95.258          end
arbmag5    2.70 4 0 0 1 13027 98.85 12000 0.47 14000 0.43 26000
           0.22 2 1 293                                          end
h2o        3 1.0                                                 end
pb         4 den=11.34                                           end
arbmss     7.90   3 0 0 1 26000 72.00 24000 18.00 28000 10.0 5  end
arbmboral  2.6189 3 1 0 0 5000  22.20 13027 71.64 6012  6.17 6  end
uo2        7 den=10.38 1.0 293 92235 4.742 92238 95.258          end
al         8 den=2.651                                           end
al         9 1.0                                                 end
end comp
squarepitch 1.6 0.79 1 3 0.94 2 0.82 0 end
more data res=7 cylinder 0.395 dan(7)=0.991436 end more
4-18x18 assemblies separated by 0.65-cm-thick Boral plates and 3.6 cm
'of water, plate-to-assembly distance of 0.8 cm, assemblies separated
'from lead reflecting walls by 1.68 cm of water, 53.98 cm water height
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 7 1 0.395          36.02 0.0
cylinder 0 1 0.410          36.02 0.0
cylinder 2 1 0.470          36.02 0.0
cuboid   0 1 4p0.800        36.02 0.0
unit 2
cylinder 1 1 0.395          53.98 0.0
cylinder 0 1 0.410          53.98 0.0
cylinder 2 1 0.470          53.98 0.0
cuboid   3 1 4p0.800        53.98 0.0
unit 3
cylinder 9 1 0.470          0.25  0.0
cylinder 3 1 0.500          0.25  0.0
cuboid   5 1 4p0.800        0.25  0.0
unit 4
cylinder 9 1 0.470          1.95  0.4
cuboid   3 1 4p0.800        1.95  0.4
cuboid   5 1 4p0.800        1.95  0.0
unit 5
array 1 3*0.0
unit 6
cylinder 5 1 0.500          56.18 0.4
cuboid   3 1 4p0.800        56.18 0.4
cuboid   5 1 4p0.800        56.18 0.0
unit 7
array 2 3*0.0
reflector 8 1 4r0.11 2r0 1
reflector 6 1 4r0.43 2r0 1
reflector 8 1 4r0.11 2r0 1
unit 8
cuboid    3 1 2.0 0.0 30.1 0.0 56.18 0.4
cuboid    5 1 2.0 0.0 30.1 0.0 56.18 0.0
unit 9
array 3 3*0.0
unit 10
cuboid    3 1 62.2 0.0 2.0 0.0 56.18 0.4
cuboid    5 1 62.2 0.0 2.0 0.0 56.18 0.0
unit 11
array 4 3*0.0
reflector 3 1 4r0.23 2r0.0     1
reflector 4 1 4r10.0 2r0.0     1
reflector 3 1 4r18.7 2r0.0     1
reflector 5 1 5r0.0  0.8       1
reflector 3 1 5r0.0  20.0      1
unit 12
cylinder 5 1 0.500          36.02 0.0
cuboid   0 1 4p0.800        36.02 0.0
unit 13
array 5 3*0.0
reflector 8 1 4r0.11 2r0 1
reflector 6 1 4r0.43 2r0 1
reflector 8 1 4r0.11 2r0 1
unit 14
cuboid    0 1 2.0 0.0 30.1 0.0 36.02 0.0
unit 15
array 6 3*0.0
unit 16
cuboid    0 1 62.2 0.0 2.0 0.0 36.02 0.0
unit 17
array 7 3*0.0
reflector 0 1 4r0.23 2r0.0     1
reflector 4 1 4r10.0 2r0.0     1
reflector 0 1 4r18.7 2r0.0     1
global unit 18
array 8 3*0.0
end geom

read array
ara=1 nux=1  nuy=1  nuz=3 fill 4 3 2                                   end
fill
ara=2 nux=18 nuy=18 nuz=1 fill 6 16r5 6 18r5 15q18 6 16r5 6           end
fill
ara=3 nux=3  nuy=1  nuz=1 fill 7 8 7                                   end
fill
ara=4 nux=1  nuy=3  nuz=1 fill 9 10 9                                  end
fill
ara=5 nux=18 nuy=18 nuz=1 fill 12 16r1 12 18r1 15q18 12 16r1 12 end
fill
```

```
ara=6 nux=3  nuy=1  nuz=1 fill 13 14 13                          end
fill
ara=7 nux=1  nuy=3  nuz=1 fill 15 16 15                          end
fill
ara=8 nux=1  nuy=1  nuz=2 fill 11 17                             end
fill
end array
end data
end
```

pat80l2

```
=csas25
pat80l2
44group latticecell
uo2        1 den=10.38 1.0 293 92235 4.742 92238 95.258          end
arbmag5    2.70 4 0 0 1 13027 98.85 12000 0.47 14000 0.43 26000
           0.22 2 1 293                                          end
h2o        3 1.0                                                 end
pb         4 den=11.34                                           end
arbmss     7.90   3 0 0 1 26000 72.00 24000 18.00 28000 10.0 5 end
arbmboral  2.6189 3 1 0 0 5000  22.20 13027 71.64 6012  6.17 6 end
uo2        7 den=10.38 1.0 293 92235 4.742 92238 95.258          end
al         8 den=2.6[illegible]1                                 end
al         9 1.0                                                 end
end comp
squarepitch 1.6 0.79 1 3 0.94 2 0.82 0 end
more data res=7 cylinder 0.395 dan(7)=0.991436 end more
4-18x18 assemblies separated by 0.65-cm-thick Boral plates and 3.6 cm
'of water, plate-to-assembly distance of 0.8 cm, assemblies separated
'from lead reflecting walls by 3.95 cm of water, 63.85 cm water height
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm
read geom
unit 1
cylinder 7 1 0.395          26.15 0.0
cylinder 0 1 0.410          26.15 0.0
cylinder 2 1 0.470          26.15 0.0
cuboid   0 1 4p0.800        26.15 0.0
unit 2
cylinder 1 1 0.395          63.85 0.0
cylinder 0 1 0.410          63.85 0.0
cylinder 2 1 0.470          63.85 0.0
cuboid   3 1 4p0.800        63.85 0.0
unit 3
cylinder 9 1 0.470          0.25  0.0
cylinder 3 1 0.500          0.25  0.0
cuboid   5 1 4p0.800        0.25  0.0
unit 4
cylinder 9 1 0.470          1.95  0.4
cuboid   3 1 4p0.800        1.95  0.4
cuboid   5 1 4p0.800        1.95  0.0
unit 5
array 1 3*0.0
unit 6
cylinder 5 1 0.500          66.05 0.4
cuboid   3 1 4p0.800        66.05 0.4
cuboid   5 1 4p0.800        66.05 0.0
unit 7
array 2 3*0.0
reflector 8 1 4r0.11 2r0 1
reflector 6 1 4r0.43 2r0 1
reflector 8 1 4r0.11 2r0 1
unit 8
cuboid    3 1 2.0 0.0 30.1 0.0 66.05 0.4
cuboid    5 1 2.0 0.0 30.1 0.0 66.05 0.0
unit 9
array 3 3*0.0
unit 10
cuboid    3 1 62.2 0.0 2.0 0.0 66.05 0.4
cuboid    5 1 62.2 0.0 2.0 0.0 66.05 0.0
unit 11
array 4 3*0.0
reflector 3 1 4r2.50 2r0.0     1
reflector 4 1 4r10.0 2r0.0     1
reflector 3 1 4r18.7 2r0.0     1
reflector 5 1 5r0.0  0.8       1
reflector 3 1 5r0.0  20.0      1
unit 12
cylinder 5 1 0.500          26.15 0.0
cuboid   0 1 4p0.800        26.15 0.0
unit 13
array 5 3*0.0
reflector 8 1 4r0.11 2r0 1
reflector 6 1 4r0.43 2r0 1
reflector 8 1 4r0.11 2r0 1
unit 14
cuboid    0 1 2.0 0.0 30.1 0.0 26.15 0.0
unit 15
array 6 3*0.0
unit 16
cuboid    0 1 62.2 0.0 2.0 0.0 26.15 0.0
unit 17
array 7 3*0.0
reflector 0 1 4r2.50 2r0.0     1
reflector 4 1 4r10.0 2r0.0     1
reflector 0 1 4r18.7 2r0.0     1
global unit 18
array 8 3*0.0
end geom

read array
ara=1 nux=1  nuy=1  nuz=3 fill 4 3 2                             end
```

```
fill
ara=2 nux=18 nuy=18 nuz=1 fill 6 16r5 6 18r5 15q18 6 16r5 6      end
fill
ara=3 nux=3  nuy=1  nuz=1 fill 7 8 7                              end
fill
ara=4 nux=1  nuy=3  nuz=1 fill 9 10 9                             end
fill
ara=5 nux=18 nuy=18 nuz=1 fill 12 16r1 12 18r1 15q18 12 16r1 12 end
fill
ara=6 nux=3  nuy=1  nuz=1 fill 13 14 13                           end
fill
ara=7 nux=1  nuy=3  nuz=1 fill 15 16 15                           end
fill
ara=8 nux=1  nuy=1  nuz=2 fill 11 17                              end
fill
end array
end data
end
```

pat80ss1

```
=csas25
pat80ss1
44group latticecell
uo2        1 den=10.38 1.0 293 92235 4.742 92238 95.258              end
arbmag5    2.70 4 0 0 1 13027 98.85 12000 0.47 14000 0.43 26000
           0.22 2 1 293                                              end
h2o        3 1.0                                                     end
arbmst     7.80   3 0 0 1 26000 99.66 6012  0.14  14000 .20  4       end
arbmss     7.90   3 0 0 1 26000 72.00 24000 18.00 28000 10.0 5       end
arbmboral  2.6189 3 1 0 0 5000  22.20 13027 71.64 6012  6.17 6       end
uo2        7 den=10.38 1.0 293 92235 4.742 92238 95.258              end
al         8 den=2.651                                               end
al         9 1.0                                                     end
end comp
squarepitch 1.6 0.79 1 3 0.94 2 0.82 0                               end
more data res=7 cylinder 0.395 dan(7)=0.991436 end more
4-18x18 assemblies separated by 0.65-cm-thick Boral plates and 3.6 cm
'of water, plate-to-assembly distance of 0.8 cm, assemblies separated
'from stainless steel reflecting walls by 1.68 cm of water, 51.55 cm
'water height
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 7 1 0.395          38.45 0.0
cylinder 0 1 0.410          38.45 0.0
cylinder 2 1 0.470          38.45 0.0
cuboid   0 1 4p0.800        38.45 0.0
unit 2
cylinder 1 1 0.395          51.55 0.0
cylinder 0 1 0.410          51.55 0.0
cylinder 2 1 0.470          51.55 0.0
cuboid   3 1 4p0.800        51.55 0.0
unit 3
cylinder 9 1 0.470          0.25  0.0
cylinder 3 1 0.500          0.25  0.0
cuboid   5 1 4p0.800        0.25  0.0
unit 4
cylinder 9 1 0.470          1.95  0.4
cuboid   3 1 4p0.800        1.95  0.4
cuboid   5 1 4p0.800        1.95  0.0
unit 5
array 1 3*0.0
unit 6
cylinder 5 1 0.500          53.75 0.4
cuboid   3 1 4p0.800        53.75 0.4
cuboid   5 1 4p0.800        53.75 0.0
unit 7
array 2 3*0.0
reflector 8 1 4r0.11 2r0 1
reflector 6 1 4r0.43 2r0 1
reflector 8 1 4r0.11 2r0 1
unit 8
cuboid    3 1 2.0 0.0 30.1 0.0 53.75 0.4
cuboid    5 1 2.0 0.0 30.1 0.0 53.75 0.0
unit 9
array 3 3*0.0
unit 10
cuboid    3 1 62.2 0.0 2.0 0.0 53.75 0.4
cuboid    5 1 62.2 0.0 2.0 0.0 53.75 0.0
unit 11
array 4 3*0.0
reflector 3 1 4r0.23 2r0.0    1
reflector 4 1 4r15.0 2r0.0    1
reflector 3 1 4r13.7 2r0.0    1
reflector 5 1 5r0.0  0.8      1
reflector 3 1 5r0.0  20.0     1
unit 12
cylinder 5 1 0.500          38.45 0.0
cuboid   0 1 4p0.800        38.45 0.0
unit 13
array 5 3*0.0
reflector 8 1 4r0.11 2r0 1
reflector 6 1 4r0.43 2r0 1
reflector 8 1 4r0.11 2r0 1
unit 14
cuboid    0 1 2.0 0.0 30.1 0.0 38.45 0.0
unit 15
array 6 3*0.0
unit 16
cuboid    0 1 62.2 0.0 2.0 0.0 38.45 0.0
```

```
unit 17
array 7 3*0.0
reflector 0 1 4r0.23 2r0.0     1
reflector 4 1 4r15.0 2r0.0     1
reflector 0 1 4r13.7  2r0.0     1
global unit 18
array 8 3*0.0
end geom

read array
ara=1 nux=1  nuy=1  nuz=3 fill 4 3 2                                  end
fill
ara=2 nux=18 nuy=18 nuz=1 fill 6 16r5 6 18r5 15q18 6 16r5 6          end
fill
ara=3 nux=3  nuy=1  nuz=1 fill 7 8 7                                  end
fill
ara=4 nux=1  nuy=3  nuz=1 fill 9 10 9                                 end
fill
ara=5 nux=18 nuy=18 nuz=1 fill 12 16r1 12 18r1 15q18 12 16r1 12 end
fill
ara=6 nux=3  nuy=1  nuz=1 fill 13 14 13                               end
fill
ara=7 nux=1  nuy=3  nuz=1 fill 15 16 15                               end
fill
ara=8 nux=1  nuy=1  nuz=2 fill 11 17                                  end
fill
end array
end data
end
```

pat80ss2

```
=csas25
pat80ss2
44group latticecell
uo2        1 den=10.38 1.0 293 92235 4.742 92238 95.258           end

arbmag5    2.70 4 0 0 1 13027 98.85 12000 0.47 14000 0.43 26000
           0.22 2 1 293                                            end
h2o        3 1.0                                                   end
arbmst     7.80    3 0 0 1 26000 99.64 6012   0.14   14000 .20   4 end
arbmss     7.90    3 0 0 1 26000 72.00 24000 18.00 28000 10.0 5 end
arbmboral 2.6189 3 1 0 0 5000   22.20 13027 71.64 6012   6.17 6 end
uo2        7 den=10.38 1.0 293 92235 4.742 92238 95.258           end
al         8 den=2.651                                             end
al         9 1.0                                                   end
end comp
squarepitch 1.6 0.79 1 3 0.94 2 0.82 0                             end
more data res=7 cylinder 0.395 dan(7)=0.991436 end more
4-18x18 assemblies separated by 0.65-cm-thick Boral plates and 3.6 cm
'of water, plate-to-assembly distance of 0.8 cm, assemblies separated
'from stainless steel reflecting walls by 3.95 cm of water, 61.84 cm
'water height
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 7 1 0.395          28.16 0.0
cylinder 0 1 0.410          28.16 0.0
cylinder 2 1 0.470          28.16 0.0
cuboid   0 1 4p0.800        28.16 0.0
unit 2
cylinder 1 1 0.395          61.84 0.0
cylinder 0 1 0.410          61.84 0.0
cylinder 2 1 0.470          61.84 0.0
cuboid   3 1 4p0.800        61.84 0.0
unit 3
cylinder 9 1 0.470          0.25  0.0
cylinder 3 1 0.500          0.25  0.0
cuboid   5 1 4p0.800        0.25  0.0
unit 4
cylinder 9 1 0.470          1.95  0.4
cuboid   3 1 4p0.800        1.95  0.4
cuboid   5 1 4p0.800        1.95  0.0
unit 5
array 1 3*0.0
unit 6
cylinder 5 1 0.500          64.04 0.4
cuboid   3 1 4p0.800        64.04 0.4
cuboid   5 1 4p0.800        64.04 0.0
unit 7
array 2 3*0.0
reflector 8 1 4r0.11 2r0 1
reflector 6 1 4r0.43 2r0 1
reflector 8 1 4r0.11 2r0 1
unit 8
cuboid    3 1 2.0 0.0 30.1 0.0 64.04 0.4
cuboid    5 1 2.0 0.0 30.1 0.0 64.04 0.0
unit 9
array 3 3*0.0
unit 10
cuboid    3 1 62.2 0.0 2.0 0.0 64.04 0.4
cuboid    5 1 62.2 0.0 2.0 0.0 64.04 0.0
unit 11
array 4 3*0.0
reflector 3 1 4r2.50 2r0.0     1
reflector 4 1 4r15.0 2r0.0     1
reflector 3 1 4r13.7 2r0.0     1
reflector 5 1 5r0.0  0.8       1
reflector 3 1 5r0.0  20.0      1
unit 12
cylinder 5 1 0.500          28.16 0.0
```

```
cuboid   0 1 4p0.800       28.16 0.0
unit 13
array 5 3*0.0
reflector 8 1 4r0.11 2r0 1
reflector 6 1 4r0.43 2r0 1
reflector 8 1 4r0.11 2r0 1
unit 14
cuboid    0 1 2.0 0.0 30.1 0.0 28.16 0.0
unit 15
array 6 3*0.0
unit 16
cuboid    0 1 62.2 0.0 2.0 0.0 28.16 0.0
unit 17
array 7 3*0.0
reflector 0 1 4r2.50 2r0.0    1
reflector 4 1 4r15.0 2r0.0    1
reflector 0 1 4r13.7 2r0.0    1
global unit 18
array 8 3*0.0
end geom

read array
ara=1 nux=1  nuy=1  nuz=3 fill 4 3 2                          end
fill
ara=2 nux=18 nuy=18 nuz=1 fill 6 16r5 6 18r5 15q18 6 16r5 6   end
fill
ara=3 nux=3  nuy=1  nuz=1 fill 7 8 7                          end
fill
ara=4 nux=1  nuy=3  nuz=1 fill 9 10 9                         end
fill
ara=5 nux=18 nuy=18 nuz=1 fill 12 16r1 12 18r1 15q18 12 16r1 12 end
fill
ara=6 nux=3  nuy=1  nuz=1 fill 13 14 13                       end
fill
ara=7 nux=1  nuy=3  nuz=1 fill 15 16 15                       end
fill
ara=8 nux=1  nuy=1  nuz=2 fill 11 17                          end
fill
end array
end data
end
```

<u>w3269a</u>

```
=csas25
w3269a
44group        latticecell
uo2    1 0.930 293 92235 5.70 92238 94.30                     end
ss304  2 1.0                                                  end
h2o    3 1.0                                                  end
al     4 1.0                                                  end
```



```
uo2    5 0.930 293 92235 5.70 92238 94.30                     end
arbmagincd 9.91 3 0 0 1 47000 79.60 49000 15.17 48000 5.08 6  end
end comp
squarepitch  1.4224 0.9068 1 3 0.9931 2 0.9169 0              end
more data dan(5)=.927954 res=5 cyl .4534 end more
Core of 453 fuel rods, 6-1.024-cm-diam Ag-In-Cd rods, 88.27 cm water
`height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 1 1 .4534        45.72   0.0
cylinder 0 1 .4585        45.72   0.0
cylinder 2 1 .4966        45.72  -1.27
cuboid   3 1 4p.7112      45.72  -1.27
unit 2
cylinder 1 1 .4534         0.635  0.0
cylinder 0 1 .4585         0.635  0.0
cylinder 2 1 .4966         0.635  0.0
cuboid   4 1 4p.7112       0.635  0.0
unit 3
cylinder 1 1 .4534        36.34   0.0
cylinder 0 1 .4585        36.34   0.0
cylinder 2 1 .4966        36.34   0.0
cuboid   3 1 4p.7112      36.34   0.0
unit 4
cylinder 5 1 .4534        92.964 88.27
cylinder 0 1 .4585        92.964 88.27
cylinder 2 1 .4966        93.979 88.27
cuboid   0 1 4p.7112      93.979 88.27
unit 5
cylinder 6 1   .5118      45.72 -1.27
cuboid   3 1 4p.7112      45.72 -1.27
unit 6
cylinder 6 1   .5118       0.635  0.0
cuboid   4 1 4p.7112       0.635  0.0
unit 7
cylinder 6 1   .5118      36.34   0.0
cuboid   3 1 4p.7112      36.34   0.0
unit 8
cylinder 6 1   .5118      93.979 88.27
cuboid   0 1 4p.7112      93.979 88.27
unit 9
array 1 3*0.0
reflector 3 1 2r11.2776 2r18.3896 2r0 1
reflector 4 1 5r0 3.175               1
reflector 3 1 2r3.7224 3r0 6.35       1
reflector 4 1 5r0 5.08                1
unit 10
array 2 3*0.0
reflector 4 1 2r11.2776 2r18.3896 2r0 1
```

```
reflector 3 1 2r3.7224            4r0 1
unit 11
array 3 3*0.0
reflector 3 1 2r15. 2r18.3896 2r0 1
unit 12
array 4 3*0.0
reflector 0 1 2r15. 2r18.3896 2r0 1
reflector 4 1 4r0 1.27 0          1
global
unit 13
array 5 3*0.0
end geom

read array
ara=1 nux=27 nuy=17 nuz=1 fill
113r1 5 7r1 5 7r1 5 199r1 5 7r1 5 7r1 5 113r1 end fill
ara=2 nux=27 nuy=17 nuz=1 fill
113r2 6 7r2 6 7r2 6 199r2 6 7r2 6 7r2 6 113r2 end fill
ara=3 nux=27 nuy=17 nuz=1 fill
113r3 7 7r3 7 7r3 7 199r3 7 7r3 7 7r3 7 113r3 end fill
ara=4 nux=27 nuy=17 nuz=1 fill
113r4 8 7r4 8 7r4 8 199r4 8 7r4 8 7r4 8 113r4 end fill
ara=5 nux=1  nuy=1  nuz=4
fill 9 10 11 12                              end fill
end array
end data
end
```

<u>w3269b1</u>

```
=csas2x
w3269b1
44group      latticecell
uo2          1 0.950 293 92235 3.70 92238 96.30                end
ss304        2  1.0                                            end
h2o          3  1.0                                            end
arbmegincd   9.91 3 0 0 1 47000 79.60 49000 15.17 48000 5.08 4  end
al           5                                                 end
h2o          6                                                 end
uo2          7  0.950 293 92235 3.70 92238 96.30               end
ss304 8      1.0                                               end
uo2          9  0.950 293 92235 3.70 92238 96.30               end
end comp
squarepitch 1.1049 0.754  1 3 0.8555 2  0.7788 0               end
more data dan(7)=.301909  res=7  cyl .3772
          dan(9)=.924574  res=10 cyl .3772 end more
Core of 2221 fuel rods, 12-0.838-cm-diam Ag-In-Cd rods, 55.41 cm water
`height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm
read geom
unit 1
cylinder  7 1 0.3772              35.88   0.00
cylinder  0 1 0.3894              35.88   0.00
cylinder  8 1 0.4300              35.88   0.00
cuboid    6 1 4p.5525             35.88   0.00
unit 2
cuboid  500 1 4p.5525             35.88   0.00
unit 3
cylinder  4 1 0.4191              35.88   0.00
cuboid    6 1 4p.5525             35.88   0.00
unit 4
cuboid    6 1 4p.5525             35.88   0.00
unit 5
cylinder  7 1 0.3772               1.27   0.00
cylinder  0 1 0.3894               1.27   0.00
cylinder  8 1 0.4300               1.27   0.00
cuboid    5 1 4p.5525              1.27   0.00
unit 6
cuboid  500 1 4p.5525              1.27   0.00
unit 7
cylinder  4 1 0.4191               1.27   0.00
cuboid    5 1 4p.5525              1.27   0.00
unit 8
cuboid    5 1 4p.5525              1.27   0.00
unit 9
cylinder  7 1 0.3772              18.26   0.00
cylinder  0 1 0.3894              18.26   0.00
cylinder  8 1 0.4300              18.26   0.00
cuboid    6 1 4p.5525             18.26   0.00
unit 10
cuboid  500 1 4p.5525             18.26   0.00
unit 11
cylinder  4 1 0.4191              18.26   0.00
cuboid    6 1 4p.5525             18.26   0.00
unit 12
cuboid    6 1 4p.5525             18.26   0.00
unit 13
cylinder  9 1 0.377              121.92  55.41
cylinder  0 1 0.389              121.92  55.41
cylinder  8 1 0.430              121.92  55.41
cuboid    0 1 4p.5525            121.92  55.41
unit 14
cuboid   500 1 4p.5525           121.92  55.41
unit 15
cylinder   4 1 0.4191            121.92  55.41
cuboid     0 1 4p.5525           121.92  55.41
unit 16
cuboid     0 1 4p.5525           121.92  55.41
unit 17
array 1  3*0.0
```

```
reflector 6 1 2r19.8882 2r26.5176 0 10.16  1
reflector 5 1 5r0.0              2.54   1
unit 18
array 2  3*0.0
reflector 5 1 4r2.1303           2r0.0   1
reflector 6 1 2r17.7579 2r24.3873 2r0.0   1
unit 19
array 3  3*0.0
reflector 6 1 2r19.8882 2r26.5176 2r0.0   1
unit 20
array 4  3*0.0
reflector 0 1 2r19.8882 2r26.5176 10.16 0  1
reflector 5 1 4r0.               2.54 0.0 1
global unit 21
array 5  3*0.0
end geometry

read array
ara=1 nux=53 nuy=53 nuz=1   fill
9r4  2   33r4  2    9r4  2q53
 3r4  6r1  2    33r1  2    6r1   3r4   5q53
 19r2 15r1 19r2
 3r4  6r1  2    33r1  2    6r1   3r4 8q53
 3r4  47r1 3r4   3q53
 3r4  20r1 3     1     3q2  19r1  3r4
 3r4  47r1 3r4
 3r4  20r1 3     5r1   3    20r1  3r4
 3r4  47r1 3r4
 53b1378 end fill
ara=2 nux=53 nuy=53 nuz=1   fill
 9r8      6  33r8     6  9r8  2q53
 3r8   6r5     6  33r5    6   6r5   3r8   5q53
19r6  15r5  19r6
 3r8   6r5     6  33r5    6   6r5   3r8   8q53
 3r8  47r5   3r8  3q53
 3r8  20r5     7     5  3q2  19r5   3r8
 3r8  47r5   3r8
 3r8  20r5     7   5r5    7  20r5   3r8
 3r8  47r5   3r8
53b1378 end fill
ara=3 nux=53 nuy=53 nuz=1   fill
 9r12     10 33r12    10 9r10 2q53
 3r12  6r9     10 33r9    10  6r9   3r12  5q53
19r10 15r9  19r10
 3r12  6r9     10 33r9    10  6r9   3r12  8q53
 3r12 47r9   3r12 3q53
 3r12 20r9     11     9   3q2  19r9   3r12
 3r12 47r9   3r12
 3r12 20r9     11  5r9    11  20r9   3r12
 3r12 47r9   3r12
53b1378 end fill
ara=4 nux=53 nuy=53 nuz=1   fill
 9r16     14 33r16    14 9r14 2q53
  3r16  6r13     14 33r13   14  6r13  3r16  5q53
 19r14 15r13 19r14
  3r16  6r13     14 33r13   14  6r13  3r16  8q53
  3r16 47r13  3r16 3q53
  3r16 20r13     15     13  3q2  19r13  3r16
  3r16 47r13  3r16
  3r16 20r13     15  5r13    15  20r13  3r16
  3r16 47r13  3r16
 53b1378 end fill
ara=5 nux=1 nuy=1 nuz=4
fill 17 18 19 20 end fill
end array
end data
end
```

<u>w3269b2</u>

```
=csas2x
w3269b2
44group       latticecell
uo2          1 0.950 293 92235 3.70 92238 96.30                     end
ss304        2  1.0                                                 end
h2o          3  1.0                                                 end
arbmagincd 9.91 3 0 0 1 47000 79.60 49000 15.17 48000 5.08 4        end
al           5  1.0                                                 end
h2o          6  1.0                                                 end
uo2          7  0.950 293 92235 3.70 92238 96.30                    end
ss304        8  1.0                                                 end
uo2          9  0.950 293 92235 3.70 92238 96.30                    end
end comp
squarepitch  1.1049 0.754  1 3 0.8555 2  0.7788 0                   end
more data dan(7)=.301909  res=7  cyl .3772
          dan(9)=.924574  res=10 cyl .3772 end more
Core of 2209 fuel rods, 24-0.838-cm-diam Ag-In-Cd rods, 64.56 cm water
`height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  7 1 0.3772                     35.88   0.00
cylinder  0 1 0.3894                     35.88   0.00
cylinder  8 1 0.4300                     35.88   0.00
cuboid    6 1 4p.5525                    35.88   0.00
unit 2
cuboid  500 1 4p.5525                    35.88   0.00
unit 3
cylinder  4 1 0.4191                     35.88   0.00
cuboid    6 1 4p.5525                    35.88   0.00
unit 4
```

```
cuboid    6 1 4p.5525                35.88  0.00
unit 5
cylinder  7 1 0.3772                  1.27  0.00
cylinder  0 1 0.3894                  1.27  0.00
cylinder  8 1 0.4300                  1.27  0.00
cuboid    5 1 4p.5525                 1.27  0.00
unit 6
cuboid  500 1 4p.5525                 1.27  0.00
unit 7
cylinder  4 1 0.4191                  1.27  0.00
cuboid    5 1 4p.5525                 1.27  0.00
unit 8
cuboid    5 1 4p.5525                 1.27  0.00
unit 9
cylinder  7 1 0.3772                 27.41  0.00
cylinder  0 1 0.3894                 27.41  0.00
cylinder  8 1 0.4300                 27.41  0.00
cuboid    6 1 4p.5525                27.41  0.00
unit 10
cuboid  500 1 4p.5525                27.41  0.00
unit 11
cylinder  4 1 0.4191                 27.41  0.00
cuboid    6 1 4p.5525                27.41  0.00
unit 12
cuboid    6 1 4p.5525                27.41  0.00
unit 13
cylinder  9 1 0.377                 121.92  64.56
cylinder  0 1 0.389                 121.92  64.56
cylinder  8 1 0.430                 121.92  64.56
cuboid    0 1 4p.5525               121.92  64.56
unit 14
cuboid   500 1 4p.5525              121.92  64.56
unit 15
cylinder   4 1 0.4191               121.92  64.56
cuboid     0 1 4p.5525              121.92  64.56
unit 16
cuboid     0 1 4p.5525              121.92  64.56
unit 17
array 1  3*0.0
reflector 6 1 2r19.8882 2r26.5176 0 10.16  1
reflector 5 1 5r0.0                   2.54  1
unit 18
array 2  3*0.0
reflector 5 1 4r2.1303           2r0.0     1
reflector 6 1 2r17.7579 2r24.3873 2r0.0    1
unit 19
array 3  3*0.0
reflector 6 1 2r19.8882 2r26.5176 2r0.0    1
unit 20
array 4  3*0.0
reflector 0 1 2r19.8882 2r26.5176 10.16 0  1

reflector 5 1 4r0.                   2.54 0.0 1
global unit 21
array 5  3*0.0
end geometry

read array
ara=1 nux=53 nuy=53 nuz=1 fill
 9r4    2 33r4     2  9r4  2q53
 3r4  6r1    2  33r1    2  6r1 3r4 5q53
19r2 15r1 19r2
 3r4  6r1    2  33r1    2  6r1 3r4 8q53
 3r4 47r1  3r4  3q53
 3r4 20r1    3     1  3q2 19r1 3r4
 3r4 47r1  3r4
 3r4 20r1    3   5r1    3 20r1 3r4
 3r4 47r1  3r4                            53b424
 3r4  6r1    2     1    3    1 3q2 24r1  2 6r1 3r4
 3r4  6r1    2  33r1    2  6r1 3r4
 3r4  6r1    2     1    3  5r1    3 25r1  2 6r1 3r4
 3r4  6r1    2  33r1    2  6r1 3r4
 3r4  6r1    2     1    3  5r1    3 25r1  2 6r1 3r4
 3r4  6r1    2  33r1    2  6r1 3r4
 3r4  6r1    2     1    3    1 3q2 24r1  2 6r1 3r4
 3r4  6r1    2  33r1    2  6r1 3r4
19r2 15r1 19r2
 3r4  6r1    2  33r1    2  6r1 3r4 5q53
 9r4    2 33r4     2  9r4  2q53
 end fill
ara=2 nux=53 nuy=53 nuz=1 fill
 9r8    6 33r8     6  9r8  2q53
 3r8  6r5    6  33r5    6  6r5 3r8 5q53
19r6 15r5 19r6
 3r8  6r5    6  33r5    6  6r5 3r8 8q53
 3r8 47r5  3r8  3q53
 3r8 20r5    7     5  3q2 19r5 3r8
 3r8 47r5  3r8
 3r8 20r5    7   5r5    7 20r5 3r8
 3r8 47r5  3r8                            53b424
 3r8  6r5    6     5    7    5 3q2 24r5  6 6r5 3r8
 3r8  6r5    6  33r5    6  6r5 3r8
 3r8  6r5    6     5    7  5r5    7 25r5  6 6r5 3r8
 3r8  6r5    6  33r5    6  6r5 3r8
 3r8  6r5    6     5    7  5r5    7 25r5  6 6r5 3r3
 3r8  6r5    6  33r5    6  6r5 3r8
 3r8  6r5    6     5    7    5 3q2 24r5  6 6r5 3r8
 3r8  6r5    6  33r5    6  6r5 3r8
19r6 15r5 19r6
 3r8  6r5    6  33r5    6  6r5 3r8 5q53
 9r8    6 33r8     6  9r8  2q53
 end fill
ara=3 nux=53 nuy=53 nuz=1 fill
```

```
 9r12    10 33r12    10 9r12   2q53
 3r12  6r9     10 33r9     10  6r9  3r12 5q53
19r10 15r9  19r10
 3r12  6r9     10 33r9     10  6r9  3r12 8q53
 3r12 47r9   3r12 3q53
 3r12 20r9     11     9  3q2  19r9  3r12
 3r12 47r9   3r12
 3r12 20r9     11   5r9    11 20r9  3r12
 3r12 47r9   3r12                          53b424
 3r12  6r9     10     9    11     9  3q2  24r9  10 6r9 3r12
 3r12  6r9     10 33r9     10   6r9  3r12
 3r12  6r9     10     9    11   5r9    11 25r9  10 6r9 3r12
 3r12  6r9     10 33r9     10   6r9  3r12
 3r12  6r9     10     9    11   5r9    11 25r9  10 6r9 3r12
 3r12  6r9     10 33r9     10   6r9  3r12
 3r12  6r9     10     9    11     9  3q2  24r9  10 6r9 3r12
 3r12  6r9     10 33r9     10   6r9  3r12
19r10 15r9  19r10
 3r12  6r9     10 33r9     10   6r9  3r12 5q53
 9r12    10 33r12    10 9r12   2q53
 end fill
ara=4 nux=53 nuy=53 nuz=1 fill
 9r16    14 33r16    14 9r16   2q53
 3r16  6r13    14 33r13   14   6r13 3r16 5q53
19r14 15r13 19r14
 3r16  6r13    14 33r13   14   6r13 3r16 8q53
 3r16 47r13  3r16 3q53
 3r16 20r13    15     13 3q2  19r13 3r16
 3r16 47r13  3r16
 3r16 20r13    15   5r13   15 20r13 3r16
 3r16 47r13  3r16                          53b424
 3r16  6r13    14     13   15     13 3q2  24r13 14 6r13 3r16
 3r16  6r13    14 33r13   14   6r13 3r16
 3r16  6r13    14     13   15   5r13   15 25r13 14 6r13 3r16
 3r16  6r13    14 33r13   14   6r13 3r16
 3r16  6r13    14     13   15   5r13   15 25r13 14 6r13 3r16
 3r16  6r13    14 33r13   14   6r13 3r16
 3r16  6r13    14     13   15     13 3q2  24r13 14 6r13 3r16
 3r16  6r13    14 33r13   14   6r13 3r16
19r14 15r13 19r14
 3r16  6r13    14 33r13   14   6r13 3r16 5q53
 9r16    14 33r16    14 9r16   2q53
 end fill
ara=5 nux=1 nuy=1 nuz=4 fill 17 18 19 20 end fill
end array
end data
end
```

<u>w3269b3</u>

```
=csas2x
w3269b3
44group        latticecell
uo2         1 0.950 293 92235 3.70 92238 96.30                         end
ss304       2  1.0                                                     end
h2o         3  1.0                                                     end
arbmagincd 9.91 3 0 0 1 47000 79.60 49000 15.17 48000 5.08 4           end
al          5  1.0                                                     end
h2o         6  1.0                                                     end
uo2         7  0.950 293 92235 3.70 92238 96.30                        end
ss304       8  1.0                                                     end
uo2         9  0.950 293 92235 3.70 92238 96.30                        end
end comp
squarepitch  1.1049 0.754  1 3 0.8555 2  0.7788 0                      end
more data dan(7)=.30[illegible]9  res=7  cyl .3772
          dan(9)=.92[illegible]4  res=10 cyl .3772
end more
Core of 2185 fuel rods, 48-0.838-cm-diam Ag-In-Cd rods, 57.00 cm water
height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  7 1 0.3772                    35.88   0.00
cylinder  0 1 0.3894                    35.88   0.00
cylinder  8 1 0.4300                    35.88   0.00
cuboid    6 1 4p.5525                   35.88   0.00
unit 2
cuboid  500 1 4p.5525                   35.88   0.00
unit 3
cylinder  4 1 0.4191                    35.88   0.00
cuboid    6 1 4p.5525                   35.88   0.00
unit 4
cuboid    6 1 4p.5525                   35.88   0.00
unit 5
cylinder  7 1 0.3772                     1.27   0.00
cylinder  0 1 0.3894                     1.27   0.00
cylinder  8 1 0.4300                     1.27   0.00
cuboid    5 1 4p.5525                    1.27   0.00
unit 6
cuboid  500 1 4p.5525                    1.27   0.00
unit 7
cylinder  4 1 0.4191                     1.27   0.00
cuboid    5 1 4p.5525                    1.27   0.00
unit 8
cuboid    5 1 4p.5525                    1.27   0.00
unit 9
cylinder  7 1 0.3772                    19.85   0.00
cylinder  0 1 0.3894                    19.85   0.00
cylinder  8 1 0.4300                    19.85   0.00
cuboid    6 1 4p.5525                   19.85   0.00
unit 10
```

```
cuboid  500 1 4p.5525                  19.85   0.00
unit 11
cylinder  4 1 0.4191                   19.85   0.00
cuboid    6 1 4p.5525                  19.85   0.00
unit 12
cuboid    6 1 4p.5525                  19.85   [illegible]
unit 13
cylinder  9 1 0.377                    121.92  [illegible].00
cylinder  0 1 0.389                    121.92  [illegible].00
cylinder  8 1 0.430                    121.9[illegible] [illegible]7.00
cuboid    0 1 4p.5525                  121.[illegible] [illegible]7.00
unit 14
cuboid   500 1 4p.5525                 121.92 57.00
unit 15
cylinder   4 1 0.4191                  121.92 57.00
cuboid     0 1 4p.5525                 121.92 57.[illegible]
unit 16
cuboid     0 1 4p.5525                 121.92 57.[illegible]
unit 17
array 1  3*0.0
reflector 6 1 2r19.8882 2r26.5176 0 10.16  1
reflector 5 1 5r0.0                 2.54  1
unit 18
array 2  3*0.0
reflector 5 1 4r2.1303            2r0.0    1
reflector 6 1 2r17.7579 2r24.3873 2r0.0    1
unit 19
array 3  3*0.0
reflector 6 1 2r19.8882 2r26.5176 2r0.0    1
unit 20
array 4  3*0.0
reflector 0 1 2r19.8882 2r26.5176 10.16 0  1
reflector 5 1 4r0.                2.54 0.0 1
global unit 2[illegible]
array 5  3*0.0
end geometry

read array
ara=1 nux=53 nuy=[illegible] nuz=1 fill
 9r4    2       33r4    2 9r4   2q53
 3r4  6r1    2 33r1    2 6r1  3r4  4q53
 3r4  5r1    3    2    3   1   2q2 21r1    1 3 2q2  2   3 5r1 3r4
19r2 15r1 19r2
 3r4  5r1    3    2  4r1   3 23r1     3  4r1 2  3 5r1 3r4
 3r4  6r1    2 33r1    2 6r1  3r4  1q106
 3r4  5r1    3    2    3   1   2q2 21r1    1 3 2q2  2   3 5r1 3r4
 3r4  6r1    2 33r1    2 6r1  3r4    3q53
 3r4 47r1  3r4  14q53
 3r4  6r1    2 33r1    2 6r1  3r4    3q53
 3r4  5r1    3    2    3   1   2q2 21r1    1 3 2q2  2   3 5r1 3r4
 3r4  6r1    2 33r1    2 6r1  3r4
 3r4  5r1    3    2  4r1   3 23r1     3  4r1 2  3 5r1 3r4  1q106
19r2 15r1 19r2
 3r4  5r1    3    2    3   1   2q2 21r1    1 3 2q2  2   3 5r1 3r4
 3r4  6r1    2 33r1    2 6r1  3r4    4q53
 9r4    2 33r4    2  9r4 2q53   end fill
ara=2 nux=53 nuy=53 nuz=1 fill
 9r8    6       33r8    6 9r8   2q53
 3r8  6r5    6 33r5    6 6r5  3r8    4q53
 3r8  5r5    7    6    7   5   2q2 21r5    5 7 2q2  6   7 5r5 3r8
19r6 15r5 19r6
 3r8  5r5    7    6 4r5    7 23r5     7  4r5 6  7 5r5 3r8
 3r8  6r5    6 33r5    6 6r5  3r8    1q106
 3r8  5r5    7    6    7   5   2q2 21r5    5 7 2q2  6   7 5r5 3r8
 3r8  6r5    6 33r5    6 6r5  3r8    3q53
 3r8 47r5  3r8  14q53
 3r8  6r5    6 33r5    6 6r5  3r8    3q53
 3r8  5r5    7    6    7   5   2q2 21r5    5 7 2q2  6   7 5r5 3r8
 3r8  6r5    6 33r5    6 6r5  3r8
 3r8  5r5    7    6 4r5    7 23r5     7  4r5 6  7 5r5 3r8  1q106
19r6 15r5 19r6
 3r8  5r5    7    6    7   5   2q2 21r5    5 7 2q2  6   7 5r5 3r8
 3r8  6r5    6 33r5    6  6r5   3r8    4q53
 9r8    6 33r8    6  9r8   2q53   end fill
ara=3 nux=53 nuy=53 nuz=1 fill
 9r12   10       33r12  10 9r12 2q53
 3r12  6r9    10 33r9    10 6r9  3r12  4q53
 3r12  5r9    11    10   11    9  2q2 21r9  9 11  2q2 10  11 5r9 3r12
19r10 15r9 19r10
 3r12  5r9    11    10 4r9  11  23r9     11 4r9 10  11 5r9 3r12
 3r12  6r9    10 33r9    10 6r9  3r12  1q106
 3r12  5r9    11    10   11    9  2q2 21r9  9 11  2q2 10  11 5r9 3r12
 3r12  6r9    10 33r9    10 6r9  3r12  3q53
 3r12 47r9  3r12 14q53
 3r12  6r9    10 33r9    10 6r9  3r12  3q53
 3r12  5r9    11    10   11    9  2q2 21r9  9 11  2q2 10  11 5r9 3r12
 3r12  6r9    10 33r9    10 6r9  3r12
 3r12  5r9    11    10 4r9  11  23r9     11 4r9 10  11 5r9 3r12 1q106
19r10 15r9 19r10
 3r12  5r9    11    10   11    9  2q2 21r9  9 11  2q2 10  11 5r9 3r12
 3r12  6r9    10 33r9    10 6r9  3r12  4q53
 9r12    10 33r12    10  9r12   2q53   end fill
ara=4 nux=53 nuy=53 nuz=1 fill
 9r16    14       33r16   14 9r16  2q53
 3r16  6r13    14 33r13   14 6r13  3r16  4q53
 3r16  5r13    15    14    15    13   2q2 21r13 13 15 2q2 14 15 5r13 3r16
19r14 15r13 19r14
 3r16  5r13    15    14 4r13    15 23r13 15 4r13 14 15 5r13 3r16
 3r16  6r13    14 33r13   14 6r13  3r16 1q106
 3r16  5r13    15    14    15    13   2q2 21r13 13 15 2q2 14 15 5r13 3r16
 3r16  6r13    14 33r13   14 6r13  3r16 3q53
 3r16 47r13  3r16 14q53
```

```
 3r16  6r13     14 33r13    14 6r13   3r16 3q53
 3r16  5r13     15     14    15    13    2q2 21r13 13 15 2q2 14 15 5r13 3r16
 3r16  6r13     14 33r13    14 6r13   3r16
 3r16  5r13     15     14 4r13    15 23r13 15 4r13 14   15 5r13 3r16 1q106
19r14 15r13 19r14
 3r16  5r13     15     14    15    13    2q2 21r13 13 15 2q2 14 15 5r13 3r16
 3r16  6r13     14 33r13    14 6r13   3r16 4q53
 9r16     14 33r16     14 9r16 2q53                    end fill
ara=5 nux=1 nuy=1 nuz=4
fill 17 18 19 20                                       end fill
end array
end data
end
```

w3269c

```
=csas25
w3269c
44group       latticecell
uo2           1 0.950 293 92235 2.72 92238 97.28                         end
arbmzir2      6.50 4 0 0 1 40000 98.20 26000 0.21 50000 1.4 24000
               0.10 2                                                    end
h2o           3 1.0                                                      end
arbmagincd    9.91 3 0 0 1 47000 79.60 49000 15.17 48000 5.08 4          end
al            5 1.0                                                      end
uo2           6 0.950 293 92235 2.72 92238 97.28                         end
end comp
squarepitch 1.524  1.016  1 3 1.189  2  1.0297 0                         end
more data res=6 cyl .508 dan(6)=.948580 end more
Core of 945 fuel rods, 16-1.024-cm-diam Ag-In-Cd rods, 89.75 cm water
`height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  1 1 0.5080                    72.93    0.00
cylinder  0 1 0.5149                    72.93    0.00
cylinder  2 1 0.5947                    72.93   -2.07
cuboid    3 1 4p.762                    72.93   -2.07
unit 2
cylinder  1 1 0.5080                     0.63    0.00
cylinder  0 1 0.5149                     0.63    0.00
cylinder  2 1 0.5947                     0.63    0.00
cuboid    5 1 4p.762                     0.63    0.00
unit 3
cylinder  1 1 0.5080                    16.19    0.00
cylinder  0 1 0.5149                    16.19    0.00
cylinder  2 1 0.5947                    16.19    0.00
cuboid    3 1 4p.762                    16.19    0.00
unit 4
cylinder  6 1 0.5080                    32.17    0.00
cylinder  0 1 0.5149                    32.17    0.00
cylinder  2 1 0.5947                    47.17    0.00
cuboid    0 1 4p.762                    47.17    0.00
unit 5
cylinder  4 1 0.5118                    72.93   -2.07
cuboid    3 1 4p.762                    72.93   -2.07
unit 6
cylinder  4 1 0.5118                     0.63    0.00
cuboid    5 1 4p.762                     0.63    0.00
unit 7
cylinder  4 1 0.5118                    16.19    0.00
cuboid    3 1 4p.762                    16.19    0.00
unit 8
cylinder  4 1 0.5118                    32.17    0.00
cuboid    0 1 4p.762                    47.17    0.00
unit 9
array 1 3*0.0
reflector 3 1 4r6.858    2r0 1
reflector 5 1 5r0       1.27 1
reflector 3 1 4r8.142 0 .48 1
reflector 5 1 5r0       5.08 1
unit 10
array 2 3*0.0
reflector 5 1 4r6.858    2r0 1
reflector 3 1 4r8.142    2r0 1
unit 11
array 3 3*0.0
reflector 3 1 4r15.0     2r0 1
unit 12
array 4 3*0.0
reflector 0 1 4r15.0     2r0 1
global
unit 13
array 5 3*0.0
end geom

read array
ara=1 nux=31 nuy=31 nuz=1 fill
31r1 9q31  10r1 5 2r1 3q3 9r1  31r1  12r1 5 4r1 5 13r1  10r1 5 8r1 5
11r1
31r1  1b464  32r1 end fill
ara=2 nux=31 nuy=31 nuz=1 fill
31r2 9q31  10r2 6 2r2 3q3 9r2  31r2  12r2 6 4r2 6 13r2  10r2 6 8r2 6
11r2
31r2  1b464  32r2 end fill
ara=3 nux=31 nuy=31 nuz=1 fill
31r3 9q31  10r3 7 2r3 3q3 9r3  31r3  12r3 7 4r3 7 13r3  10r3 7 8r3 7
11r3
31r3  1b464  32r3 end fill
ara=4 nux=31 nuy=31 nuz=1 fill
31r4 9q31  10r4 8 2r4 3q3 9r4  31r4  12r4 8 4r4 8 13r4  10r4 8 8r4 8
```

```
11r4
31r4  1b464  32r4 end fill
ara=5 nux=1  nuy=1  nuz=4
fill 9 10 11 12 end fill
end array
end data
end
```

<u>w3269sl1</u>

```
=csas25
w3269sl1
44group      latticecell
uo2        1 0.950 293 92235 2.72 92238 97.28                      end
arbmzir2   6.50 4 0 0 1 40000 98.20 26000 0.21 50000 1.4 24000
           0.10 2                                                  end
h2o        3 1.0                                                   end
al         4 1.0                                                   end
uo2        5 0.950 293 92235 2.72 92238 97.28                      end
end comp
squarepitch 1.524  1.016  1 3 1.189  2  1.030  0                   end
more data res=5 cyl .508 dan(5)=.948684 end more
Core of 31x31 fuel rods, 38.58 cm water height
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  1 1 0.508                      38.58    0.00
cylinder  0 1 0.515                      38.58    0.00
cylinder  2 1 0.5945                     38.58   -2.07
cuboid    3 1 4p.762                     38.58   -2.07
unit 2
cylinder  5 1 0.508                      121.92  38.58
cylinder  0 1 0.515                      121.92  38.58
cylinder  2 1 0.5945                     121.92  38.58
cuboid    0 1 4p.762                     121.92  38.58
unit 3
array 1 3*0.0
unit 4
array 2 3*0.0
global unit 5
array 3  3*0.0
reflector   3 1 4r13.72 2r0  1
reflector   4 1 5r0.0   1.27 1
reflector   3 1 4r15 0  0.48 1
reflector   4 1 5r0.0   5.08 1
end geometry

read array
ara=1 nux=31 nuy=31 nuz=1   fill 31r1 30q31 end fill
ara=2 nux=31 nuy=31 nuz=1   fill 31r2 30q31 end fill
ara=3 nux=1  nuy=1  nuz=2   fill 3 4       end fill
end array
end data
end
```

<u>w3269sl2</u>

```
=csas25
w3269sl2
44group      latticecell
uo2     1 0.930 293 92235 5.70 92238 94.30                        end
ss304   2 1.0                                                     end
h2o     3 1.0                                                     end
al      4 1.0                                                     end
uo2     5 0.930 293 92235 5.70 92238 94.30                        end
end comp
squarepitch  1.4224 0.9068 1 3 0.9931 2 0.9169 0                  end
more data dan(5)=.927954 res=5 cyl .4534 end more
Core of 27x17 fuel rods, 52.97 cm water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder 1 1 .4534          45.72   0.0
cylinder 0 1 .4585          45.72   0.0
cylinder 2 1 .4966          45.72  -1.27
cuboid   3 1 4p.7112        45.72  -1.27
unit 2
array 1 3*0.0
reflector 3 1 4r15.0 2r0. 1
reflector 4 1 5r0.0 3.175 1
reflector 3 1 5r0.0 6.350 1
reflector 4 1 5r0.0 5.080 1
unit 3
cylinder 1 1 .4534          0.653  0.0
cylinder 0 1 .4585          0.653  0.0
cylinder 2 1 .4966          0.653  0.0
cuboid   4 1 4p.7112        0.653  0.0
unit 4
array 2 3*0.0
reflector 4 1 4r15.0 2r0. 1
unit 5
cylinder 1 1 .4534          6.597   0.0
cuboid   3 1 4p.7112        6.597   0.0
unit 6
array 3 3*0.0
reflector 3 1 4r15.0 2r0. 1
unit 7
cylinder 5 1 .4534          39.994  0.0
cylinder 0 1 .4585          39.994  0.0
cylinder 2 1 .4966          41.009  0.0
```

```
cuboid   0 1 4p.7112        41.009  0.0
unit 8
array 4 3*0.0
reflector 0 1 4r15.0 2r0. 1
reflector 4 1 4r0  1.27 0 1
global
unit 9
array 5 3*0.0
end geom

read array
ara=1 nux=27 nuy=17 nuz=1 fill 459r1 end fill
ara=2 nux=27 nuy=17 nuz=1 fill 459r3 end fill
ara=3 nux=27 nuy=17 nuz=1 fill 459r5 end fill
ara=4 nux=27 nuy=17 nuz=1 fill 459r7 end fill
ara=5 nux=1 nuy=1 nuz=4 fill 2 4 6 8 end fill
end array
end data
end
```

<u>w3269w1</u>

```
=csas25
w3269w1
44group      latticecell
uo2        1 0.950 293 92235 2.72 92238 97.28                           end
artbmzir2  6.50 4 0 0 1 40000 98.20 26000 0.21 50000 1.4 24000
            0.10 2                                                      end
h2o        3 1.0                                                        end
al         4 1.0                                                        end
uo2        5 0.950 293 92235 2.72 92238 97.28                           end
end comp
squarepitch  1.524  1.016  1 3 1.189  2  1.030  0                       end
more data res=5 cyl .508 dan(5)=.948684 end more
Core of 945 fuel rods, 16 water holes, 37.21 cm water height
read parm run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
cylinder  1 1 0.508                    37.21     0.00
cylinder  0 1 0.515                    37.21     0.00
cylinder  2 1 0.5945                   37.21    -2.07
cuboid    3 1 4p.762                   37.21    -2.07
unit 2
cylinder  5 1 0.508                    121.92  37.21
cylinder  0 1 0.515                    121.92  37.21
cylinder  2 1 0.5945                   121.92  37.21
cuboid    0 1 4p.762                   121.92  37.21
unit 3
cuboid    3 1 4p.762                   37.21    -2.07
unit 4
array 1 3*0.0
unit 5
array 2 3*0.0
global unit 6
array 3 3*0.0
reflector   3 1 4r13.72 2r0  1
reflector   4 1 5r0.0   1.27 1
reflector   3 1 4r15 0  0.48 1
reflector   4 1 5r0.0   5.08 1
end geometry

read array
ara=1 nux=31 nuy=31 nuz=1 fill
310r1
10r1 3 2r1 3q3 9r1
31r1
12r1 3 4r1 3 13r1
10r1 3 8r1 3 11r1
62r1
10r1 3 8r1 3 11r1
12r1 3 4r1 3 13r1
31r1
10r1 3 2r1 3q3 9r1
341r1
end fill
ara=2 nux=31 nuy=31 nuz=1 fill 31r2 30q31 end fill
ara=3 nux=1  nuy=1  nuz=2 fill 4 5 end fill
end array
end data
end
```

<u>w3269w2</u>

```
=csas25
w3269w2
44group      latticecell
uo2    1 0.930 293 92235 5.70 92238 94.30                        end
ss304  2 1.0                                                     end
h2o    3 1.0                                                     end
al     4 1.0                                                     end
uo2    5 0.930 293 92235 5.70 92238 94.30                        end
end comp
squarepitch  1.4224 0.9068 1 3 0.9931 2 0.9169 0                 end
more data dan(5)=.927954 res=5 cyl .4534 end more
Core of 27x17 positions: 453 fuel rods and 6 water holes, 37.21 cm
`water height
read parm  run=yes gen=405 npg=600 nsk=5 nub=yes end parm

read geom
unit 1
```

```
cylinder 1 1 .4534         45.72   0.0
cylinder 0 1 .4585         45.72   0.0
cylinder 2 1 .4966         45.72  -1.27
cuboid   3 1 4p.7112       45.72  -1.27
unit 2
cylinder 1 1 .4534          0.635  0.0
cylinder 0 1 .4585          0.635  0.0
cylinder 2 1 .4966          0.635  0.0
cuboid   4 1 4p.7112        0.635  0.0
unit 3
cylinder     .4534          5.575  0.0
cylinder 0 1 .4585          5.575  0.0
cylinder 2 1 .4966          5.575  0.0
cuboid   3 1 4p.7112        5.575  0.0
unit 4
cylinder 5 1 .4534         92.964 51.93
cylinder 0 1 .4585         92.964 51.93
cylinder 2 1 .4966         93.979 51.93
cuboid   0 1 4p.7112       93.979 51.93
unit 5
cuboid   3 1 4p.7112       45.72 -1.27
unit 6
cuboid   4 1 4p.7112        0.635  0.0
unit 7
cuboid   3 1 4p.7112        5.575  0.0
unit 8
cuboid   0 1 4p.7112       93.979 51.93
unit 9
array 1 3*0.0
reflector 3 1 2r11.2776 2r18.3896 2r0 1
reflector 4 1 5r0 3.175               1
reflector 3 1 2r3.7224 3r0 6.35       1
reflector 4 1 5r0 5.08                1
unit 10
array 2 3*0.0
reflector 4 1 2r11.2776 2r18.3896 2r0 1
reflector 3 1 2r3.7224            4r0 1
unit 11
array 3 3*0.0
reflector 3 1 2r15. 2r18.3896 2r0 1
unit 12
array 4 3*0.0
reflector 0 1 2r15. 2r18.3896 2r0 1
reflector 4 1 4r0 1.27 0              1
global
unit 13
array 5 3*0.0
end geom

read array
ara=1 nux=27 nuy=17 nuz=1 fill
113r1 5 7r1 5 7r1 5 199r1 5 7r1 5 7r1 5 113r1 end fill
ara=2 nux=27 nuy=17 nuz=1 fill
113r2 6 7r2 6 7r2 6 199r2 6 7r2 6 7r2 6 113r2 end fill
ara=3 nux=27 nuy=17 nuz=1 fill
113r3 7 7r3 7 7r3 7 199r3 7 7r3 7 7r3 7 113r3 end fill
ara=4 nux=27 nuy=17 nuz=1 fill
113r4 8 7r4 8 7r4 8 199r4 8 7r4 8 7r4 8 113r4 end fill
ara=5 nux=1  nuy=1  nuz=4 fill 9 10 11 12     end fill
end array
end data
end
```

w3385sl1

```
#csas25
w3385sl1
44group                  latticecell
uo2        1  den=10.1928 1.0 291.0  92235 5.742  92238 94.258  end
ss304      2  1.0 291.0                                         end
h2o        3  1.0 291.0                                         end
al         4  1.0 291.0                                         end
uo2        5  den=10.1928 1.0 291.0  92235 5.742  92238 94.258  end
al         6  .85 293                                           end
h2o        6  .15 293                                           end
end comp
squarepitch 1.4224 .9068 1 3  .9931 2  .9169 0                  end
more data res=5 cyl .4534   dan(5)=.922095 end more
Core of 19x19 fuel rods, 83.71 cm water height
read parm gen=405 npg=600 nsk=5 nub=yes run=yes end parm

read geom
unit  1
cylinder   2 1 .4966 .635 0
cylinder   3 1 .5042 .635 0
cuboid     4 1     .7112 -.7112 .7112 -.7112 .635 0
unit  2
cylinder   1 1 .4534 47.625 1.905
cylinder   0 1 .4585 47.625 1.905
cylinder   2 1 .4966 47.625 .635
cuboid     3 1     .7112 -.7112 .7112 -.7112 47.625 .635
unit  3
cylinder   1 1 .4534 48.26 47.625
cylinder   0 1 .4585 48.26 47.625
cylinder   2 1 .4966 48.26 47.625
cylinder   3 1 .5042 48.26 47.625
cuboid     6 1     .7112 -.7112 .7112 -.7112 48.26 47.625
unit  4
cylinder   1 1 .4534 83.955 48.26
cylinder   0 1 .4585 83.955 48.26
cylinder   2 1 .4966 83.955 48.26
cuboid     3 1     .7112 -.7112 .7112 -.7112 83.955 48.26
```

```
unit  5
cylinder   5 1 .4534 94.869 83.955
cylinder   0 1 .4585 94.869 83.955
cylinder   2 1 .4966 94.869 83.955
cuboid     0 1     .7112 -.7112 .7112 -.7112 94.869 83.955
unit  6
cylinder   2 1 .4966 95.885 94.869
cuboid     0 1     .7112 -.7112 .7112 -.7112 95.885 94.869
unit  7
cylinder   2 1 .4966 97.155 95.885
cylinder   0 1 .5042 97.155 95.885
cuboid     4 1     .7112 -.7112 .7112 -.7112 97.155 95.885
unit  8
array      1   0 0 0
reflector  3 1 30 30 30 30 0 0 1
reflector  4 1 0 0 0 0 0 2.54  1
reflector  3 1 0 0 0 0 0 6.35  1
reflector  4 1 0 0 0 0 0 5.08  1
unit  9
array      2   0 0 0
reflector  0 1 30 30 30 30 0 0  1
end geom

read array
ara=1 nux=19 nuy=19 nuz=4      fill 361r1 361r2 361r3 361r4 end fill
ara=2 nux=19 nuy=19 nuz=3      fill 361r5 361r6 361r7       end fill
ara=3 gbl=3 nux=1 nuy=1 nuz=2 fill 8 9                      end fill
end array
end data
end
```

<u>w3385sl2</u>

```
#csas25
w3385sl2
44group                    latticecell
uo2        1  den=10.1928 1.0 290.3  92235 5.742  92238 94.258    end
ss304      2  1.0 290.3                                           end
h2o        3  1.0 290.3                                           end
al         4  1.0 290.3                                           end
uo2        5  den=10.1928 1.0 290.3  92235 5.742  92238 94.258    end
al         6  .94 293                                             end
h2o        6  .06 293                                             end
end comp
squarepitch 2.01168 .9068 1 3  .9931 2  .9169 0                   end
more data res=5 cyl .4534  dan(5)=.945902  end more
Core of 13x14 fuel rods, 90.60 cm water height
read parm gen=405 npg=600 nsk=5 nub=yes run=yes end parm
read geom
unit  1
cylinder   2 1 .4966 .635 0
cylinder   3 1 .5042 .635 0
cuboid     4 1     1.00584 -1.00584 1.00584 -1.00584 .635 0
unit  2
cylinder   1 1 .4534 47.625 1.905
cylinder   0 1 .4585 47.625 1.905
cylinder   2 1 .4966 47.625 .635
cuboid     3 1     1.00584 -1.00584 1.00584 -1.00584 47.625 .635
unit  3
cylinder   1 1 .4534 48.26 47.625
cylinder   0 1 .4585 48.26 47.625
cylinder   2 1 .4966 48.26 47.625
cylinder   3 1 .5042 48.26 47.625
cuboid     6 1     1.00584 -1.00584 1.00584 -1.00584 48.26 47.625
unit  4
cylinder   1 1 .4534 90.865 48.26
cylinder   0 1 .4585 90.865 48.26
cylinder   2 1 .4966 90.865 48.26
cuboid     3 1     1.00584 -1.00584 1.00584 -1.00584 90.865 48.26
unit  5
cylinder   5 1 .4534 94.869 90.865
cylinder   0 1 .4585 94.869 90.865
cylinder   2 1 .4966 94.869 90.865
cuboid     0 1     1.00584 -1.00584 1.00584 -1.00584 94.869 90.865
unit  6
cylinder   2 1 .4966 95.885 94.869
cuboid     0 1     1.00584 -1.00584 1.00584 -1.00584 95.885 94.869
unit  7
cylinder   2 1 .4966 97.155 95.885
cylinder   0 1 .5042 97.155 95.885
cuboid     4 1     1.00584 -1.00584 1.00584 -1.00584 97.155 95.885
unit  8
array      1   0 0 0
reflector  3 1 30 30 30 30 0 0 1
reflector  4 1 0 0 0 0 0 2.54  1
reflector  3 1 0 0 0 0 0 6.35  1
reflector  4 1 0 0 0 0 0 5.08  1
unit  9
array      2   0 0 0
reflector  0 1 30 30 30 30 0 0  1
end geom

read array
ara=1 nux=13 nuy=14 nuz=4      fill 182r1 182r2 182r3 182r4 end fill
ara=2 nux=13 nuy=14 nuz=3      fill 182r5 182r6 182r7       end fill
ara=3 gbl=3 nux=1 nuy=1 nuz=2 fill 8 9                      end fill
end array
end data
end
```

ydr14pl2

```
#csas25
ydr14pl2
44group       infhommedium
u-235         1 0 1.1191e-4                              end
u-238         1 0 5.4152e-3                              end
h             1 0 4.5472e-2                              end
c             1 0 2.1861e-2                              end
f             1 0 2.2109e-2                              end
para(h2o)     2 1.0                                      end
plexiglas  3 0.918                                       end
al            3 0.062                                    end
end comp
2.00 wt% 235U UF4-paraffin parallelpiped, paraffin reflected
read param run=yes gen=405 npg=600 nsk=5 nub=yes fdn=yes end param

read geom
unit  1
cuboid      1 1 4p26.835 2p27.145
reflector  2 1 5*15.2 0.0 1
unit  2
cuboid      3 1 4p42.035 15.2 0.0
end geom
read array
nux=1  nuy=1  nuz=2 fill 2 1 end fill
end array
end data
end
```

ydr14pl3

```
#csas25
ydr14pl3
44group       infhommedium
u-235        1 0 2.3494e-4                               end
u-238        1 0 7.4999e-3                               end
h            1 0 3.1341e-2                               end
c            1 0 1.5067e-2                               end
f            1 0 3.0939e-2                               end
para(h2o)  2 1.0                                         end
plexiglas 3 0.918                                        end
al           3 0.062                                     end
end comp
3.00 wt% 235U UF4-paraffin parallelpiped,paraffin reflected
read param gen=405 npg=600 nsk=5 run=yes nub=yes end param

read geom
unit  1
cuboid      1 1 2p21.735 2p21.735 2p43.1950
reflector  2 1 5*15.2 0.0  1
unit  2
cuboid      3 1 2p36.935 2p36.935 15.2 0.
end geom
read array
gbl=1 ara=1 nux=1 nuy=1 nuz=2 fill 2 1 end fill
end array
end data
end
```

ydr14un2

```
=csas25
ydr14un2
44group       infhommedium
u-235  1 0 1.3303e-4      end
u-238  1 0 6.4370e-3      end
h      1 0 3.9097e-2      end
c      1 0 1.8797e-2      end
f      1 0 2.6280e-2      end
end comp
2.00 wt% 235U UF4-paraffin parallelpiped, unreflected
read param gen=405 npg=600 nsk=5 nub=yes fdn=yes run=yes end param

read geom
cuboid  1 1 28.11 -28.11 28.11 -28.11 61.235 -61.235
end geom
end data
end
```

ydr14un3

```
=csas25
ydr14un3
44group       infhommedium
u-235  1 0 2.3494e-4                              end
u-238  1 0 7.4999e-3                              end
h      1 0 3.1341e-2                              end
c      1 0 1.5067e-2                              end
f      1 0 3.0939e-2                              end
end comp
3.00 wt% 235U UF4-paraffin parallelpiped, unreflected
read param gen=405 npg=600 nsk=5 nub=yes fdn=yes run=yes end param

read geom
cuboid  1 1 28.235 -28.235 28.235 -28.235 43.32 -43.32
end geom
end data
end
```

APPENDIX B

Comparison of 44- and 238-Group Results

To address the effectiveness of the broad-group structure in the 44GROUPNDF5 library, the benchmark calculations were repeated using SCALE-4.3 and the 238GROUPNDF5 library. The calculated k_{eff} values obtained with the two libraries are compared in Table B.1. These results indicate that, on average, the fine-group library underpredicts the critical condition by 0.35% while the broad-group library predicts the critical condition almost exactly. Note, however, that the additional group structure in the 238-group library enables it to more accurately predict most of the homogeneous uranium critical experiments.

Table B.1 Comparison of 44- and 238-group results

Case No.	Case designation	44-Group k_{eff}	238-Group k_{eff}	Δk_{eff} (%)	Case No.	Case designation	44-Group k_{eff}	238-Group k_{eff}	Δk_{eff} (%)
1	ANS33AL1	1.0027	1.0036	-0.09	48	EPRU65	0.9977	0.9900	0.77
2	ANS33AL2	1.0129	1.0092	0.37	49	EPRU65B	0.9985	0.9965	0.20
3	ANS33AL3	1.0035	0.9991	0.44	50	EPRU75	0.9974	0.9941	0.33
4	ANS33EB1	0.9979	0.9906	0.73	51	EPRU75B	1.0023	1.0004	0.19
5	ANS33EB2	1.0096	1.0073	0.23	52	EPRU87	0.9986	0.9974	0.12
6	ANS33EP1	0.9964	0.9941	0.23	53	EPRU87B	0.9985	0.9968	0.17
7	ANS33EP2	1.0020	0.9984	0.36	54	NSE71H1	0.9982	0.9939	0.43
8	ANS33SLG	0.9964	0.9960	0.04	55	NSE71H2	1.0009	0.9973	0.36
9	ANS33STY	0.9909	0.9876	0.33	56	NSE71H3	1.0036	0.9979	0.57
10	B1645SO1	0.9976	0.9947	0.29	57	NSE71SQ	1.0014	0.9959	0.55
11	B1645SO2	1.0007	0.9983	0.24	58	NSE71W1	0.9993	0.9919	0.74
12	BW1231B1	0.9969	0.9936	0.33	59	NSE71W2	0.9976	0.9957	0.19
13	BW1231B2	0.9985	0.9947	0.38	60	P2438AL	0.9951	0.9943	0.08
14	BW1273M	0.9947	0.9943	0.04	61	P2438BA	0.9972	0.9958	0.14
15	BW1484A1	0.9965	0.9948	0.17	62	P2438CU	0.9957	0.9958	-0.01
16	BW1484A2	0.9954	0.9888	0.66	63	P2438SLG	0.9997	0.9954	0.43
17	BW1484B1	0.9973	0.9964	0.09	64	P2438SS	0.9978	0.9987	-0.09
18	BW1484B2	0.9973	0.9940	0.33	65	P2438ZR	0.9956	0.9937	0.19
19	BW1484B3	0.9992	0.9955	0.37	66	P2615AL	1.0004	0.9940	0.64
20	BW1484C1	0.9937	0.9914	0.23	67	P2615BA	0.9970	0.9961	0.09
21	BW1484C2	0.9936	0.9937	-0.01	68	P2615CD1	0.9985	0.9986	-0.01
22	BW1484S1	0.9981	0.9947	0.34	69	P2615CD2	0.9990	0.9930	0.60
23	BW1484S2	0.9989	0.9980	0.09	70	P2615CU	1.0003	0.9968	0.35
24	BW1484SL	0.9966	0.9911	0.55	71	P2615SS	0.9998	0.9969	0.29
25	BW1645S1	1.0010	0.9906	1.04	72	P2615ZR	0.9980	0.9940	0.40
26	BW1645S2	1.0035	0.9940	0.95	73	P2827L1	1.0023	1.0006	0.17
27	BW1645T1	1.0062	0.9951	1.11	74	P2827L2	0.9997	0.9964	0.33
28	BW1645T2	1.0068	0.9965	1.03	75	P2827L3	1.0081	1.0088	-0.07
29	BW1645T3	1.0007	0.9924	0.83	76	P2827L4	1.0073	1.0044	0.29
30	BW1645T4	0.9986	0.9888	0.98	77	P2827SLG	0.9948	0.9939	0.09
31	BW1810A	0.9971	0.9945	0.26	78	P2827U1	1.0004	0.9955	0.49
32	BW1810B	0.9980	0.9969	0.11	79	P2827U2	0.9998	0.9979	0.19
33	BW1810C	1.0005	0.9984	0.21	80	P2827U3	1.0018	0.9999	0.19
34	BW1810D	0.9999	0.9962	0.37	81	P2827U4	1.0042	1.0011	0.31
35	BW1810E	0.9976	0.9940	0.36	82	P3314AL	0.9973	0.9944	0.29
36	BW1810F	1.0032	0.9983	0.49	83	P3314BA	1.0002	1.0075	-0.73
37	BW1810G	0.9971	0.9949	0.22	84	P3314BC	1.0008	1.0072	-0.64
38	BW1810H	0.9973	0.9939	0.34	85	P3314BF1	1.0022	1.0055	-0.33
39	BW1810I	1.0022	0.9953	0.69	86	P3314BF2	0.9981	0.9985	-0.04
40	BW1810J	0.9980	0.9970	0.10	87	P3314BS1	0.9970	0.9965	0.05
41	CR1071AS	1.0207	1.0125	0.82	88	P3314BS2	0.9959	0.9926	0.33
42	CR1653AS	1.0169	1.0097	0.72	89	P3314BS3	0.9972	0.9936	0.36
43	CR2500S	1.0194	1.0129	0.65	90	P3314BS4	1.0005	0.9941	0.64
44	DSN399-1	1.0056	0.9973	0.83	91	P3314CD1	1.0001	0.9939	0.62
45	DSN399-2	1.0010	0.9948	0.62	92	P3314CD2	0.9929	0.9910	0.19
46	DSN399-3	1.0024	0.9977	0.47	93	P3314CU1	0.9941	0.9877	0.64
47	DSN399-4	0.9965	0.9910	0.55	94	P3314CU2	1.0005	0.9953	0.52

Table B.1 (continued)

Case No.	Case designation	44-Group k_{eff}	238-Group k_{eff}	Δk_{eff} (%)	Case No.	Case designation	44-Group k_{eff}	238-Group k_{eff}	Δk_{eff} (%)
95	P3314CU3	0.9972	0.9989	-0.17	141	P3926SL1	0.9942	0.9926	0.16
96	P3314CU4	0.9992	0.9950	0.42	142	P3926SL2	0.9990	0.9928	0.62
97	P3314CU5	0.9938	0.9926	0.12	143	P3926U1	0.9979	0.9939	0.40
98	P3314CU6	0.9958	0.9910	0.48	144	P3926U2	0.9980	0.9931	0.49
99	P3314SLG	0.9982	0.9942	0.40	145	P3926U3	1.0001	0.9959	0.42
100	P3314SS1	0.9969	0.9946	0.23	146	P3926U4	1.0026	0.9974	0.52
101	P3314SS2	1.0011	0.9960	0.51	147	P3926U5	0.9999	0.9998	0.01
102	P3314SS3	0.9990	0.9926	0.64	148	P3926U6	1.0024	0.9970	0.54
103	P3314SS4	0.9957	0.9957	0.00	149	P4267B1	0.9969	0.9981	-0.12
104	P3314SS5	0.9944	0.9875	0.69	150	P4267B2	1.0035	1.0010	0.25
105	P3314SS6	1.0003	0.9935	0.68	151	P4267B3	1.0025	1.0053	-0.28
106	P3314W1	1.0015	0.9992	0.23	152	P4267B4	0.9993	0.9977	0.16
107	P3314W2	0.9958	0.9927	0.31	153	P4267B5	1.0031	1.0007	0.24
108	P3314ZR	0.9978	0.9957	0.21	154	P4267SL1	0.9974	0.9940	0.34
109	P3602BB	0.9988	0.9947	0.41	155	P4267SL2	0.9993	0.9958	0.35
110	P3602BS1	1.0000	0.9928	0.72	156	P49-194	1.0081	0.9981	1.00
111	P3602BS2	1.0001	0.9977	0.24	157	P62FT231	1.0005	0.9958	0.47
112	P3602CD1	0.9988	0.9943	0.45	158	P71F14F3	1.0029	0.9944	0.85
113	P3602CD2	1.0002	0.9931	0.71	159	P71F14V3	0.9973	0.9929	0.44
114	P3602CU1	0.9964	0.9945	0.19	160	P71F14V5	0.9977	0.9959	0.18
115	P3602CU2	0.9980	0.9926	0.54	161	P71F214R	1.0010	0.9949	0.61
116	P3602CU3	1.0039	0.9938	1.010	162	PAT80L1	1.0031	0.9987	0.44
117	P3602CU4	1.0040	0.9944	0.96	163	PAT80L2	0.9920	0.9954	-0.34
118	P3602N11	1.0003	0.9918	0.85	164	PAT80SS1	1.0004	1.0003	0.01
119	P3602N12	0.9963	0.9943	0.20	165	PAT80SS2	0.9926	0.9946	-0.20
120	P3602N13	0.9957	0.9939	0.18	166	W3269A	0.9934	0.9920	0.14
121	P3602N14	0.9984	0.9951	0.33	167	W3269B1	0.9963	0.9900	0.63
122	P3602N21	0.9995	0.9972	0.23	168	W3269B2	0.9964	0.9898	0.66
123	P3602N22	0.9967	0.9972	-0.05	169	W3269B3	0.9948	0.9878	0.70
124	P3602N31	1.0010	0.9966	0.44	170	W3269C	0.9986	0.9946	0.40
125	P3602N32	1.0015	0.9967	0.48	171	W3269SL1	0.9952	0.9919	0.33
126	P3602N33	1.0045	0.9976	0.69	172	W3269SL2	1.0040	0.9947	0.93
127	P3602N34	1.0027	0.9961	0.66	173	W3269W1	0.9957	0.9938	0.19
128	P3602N35	1.0036	0.9960	0.76	174	W3269W2	1.0009	0.9995	0.14
129	P3602N36	1.0009	0.9964	0.45	175	W3385SL1	0.9964	0.9918	0.46
130	P3602N41	1.0002	0.9948	0.54	176	W3385SL2	1.0005	0.9995	0.10
131	P3602N42	1.0019	0.9995	0.24	177	YDR14PL2	1.0011	1.0011	0.00
132	P3602N43	0.9994	0.9967	0.27	178	YDR14PL3	1.0115	1.0089	0.26
133	P3602SS1	0.9978	0.9904	0.74	179	YDR14UN2	1.0047	1.0024	0.23
134	P3602SS2	1.0012	0.9962	0.50	180	YDR14UN3	1.0163	1.0128	0.35
135	P3926L1	0.9996	0.9966	0.30					
136	P3926L2	1.0028	0.9994	0.34		**MEAN**	0.9999	0.9964	
137	P3926L3	1.0017	0.9959	0.58		**MEDIAN**	0.9993	0.9957	
138	P3926L4	1.0055	1.0114	-0.59		**STD. DEV.**	0.0045	0.0064	
139	P3926L5	1.0070	1.0032	0.38		**MIN.**	0.9909	0.9875	
140	P3926L6	1.0026	0.9994	0.32		**MAX.**	1.0207	1.0129	

APPENDIX C

USER'S MANUAL FOR *USLSTATS* V1.0

C.1 Introduction

The ANS/ANSI-8.1 Standard[39] recommends that calculational methods used in determining criticality safety limits for applications outside reactors be validated by comparison with appropriate critical experiments. An upper safety limit (USL) provides a high degree of confidence that a given system is subcritical if a criticality calculation based on the system yields a multiplication factor (k_{eff}) below the USL. Section 4 describes two different methods for the determination of a USL for criticality based on any set of calculations based on criticality experiments.

The *USLSTATS* computer program uses these two methods [i.e., (1) confidence band with administrative margin and (2) single-sided uniform-width closed-interval] to calculate and print USL correlations based on a set of user-supplied k_{eff} values and corresponding values of a single associated parameter X [e.g., lattice pitch, fuel enrichment, average energy group causing fission (AEG), etc.], for a set of criticality benchmark calculations. In addition, other statistical parameters computed as a part of the USL calculation are included in the output. The user is referred to Sect. 4 for the definition of these factors and for additional details relative to the theory and application of upper safety limit calculations.

C.2 Background

The *USLSTATS* program is derived from the V_STATS program,[45] originally developed to calculate and plot the USL based on a single-sided, uniform-width, closed-interval approach[40,41] (method 2). Because USL method 1 is essentially a simplification of method 2, the calculation of USLs via the results of a method 2 calculation are straightforward. In creating *USLSTATS*, the input was simplified somewhat, and the output was completely redesigned, in order to print only the information required for USL calculations using the nomenclature given in Sect. 4.

C.3 Input Description

The input required by the *USLSTATS* program is very minimal. The input consists of three sections, all read in a free-format fashion. The first line contains a title, up to 80 characters. The second line contains problem-specification parameters: P, $(1 - \gamma)$, α, x_{min}, x_{max}, σ_{sample}, and Δk_m, where

- P = proportion of population falling above lower tolerance level,
- $1 - \gamma$ = confidence on fit,
- α = confidence on proportion P,
- x_{min} = minimum value of parameter X for which USL correlations are computed,
- x_{max} = maximum value of parameter X for which USL correlations are computed,
- σ_{sample} = estimate in average standard deviation of all input values of k_{eff},
- Δk_m = administrative margin used to ensure subcriticality.

The final section of input read is the set of values (parameter X, k_{eff}, and, if $\sigma_{sample} < 0.0$, the value of σ corresponding to k_{eff}) for each of up to 1000 benchmark critical experiments. A minimum of 25 experiments is recommended to have a sufficient number of data points to determine the statistical normality of the data. *USLSTATS* reads X, k_{eff}

pairs (or X, k_{eff}, σ triplets) until the end-of-file marker is reached. Again, X is the value of an independent parameter for which a trend in k_{eff} is known or suspected to exist.

The value of P is typically selected as 0.995. This statistical parameter is used only in the computation of USL by method 2, and represents the proportion of the population of criticality experiments that will lie above the line representing one tolerance level below the linear regression fit to k_{eff}. The value $1 - \gamma$, used in the Student-t calculation of USL methods 1 and 2, is typically assigned a value of 0.95 and represents the desired confidence level to be assigned the linear regression fit of k_{eff} values. (It is also used in a χ^2 test for normality of input data. USL methods 1 and 2 are valid only for normally distributed data.) The third statistical parameter, α, represents the confidence on the proportion P, and is also typically assigned a value of 0.95.

The parameters x_{min} and x_{max} represent the lower and upper limits, respectively, for parameter X in the USL correlations of methods 1 and 2. These limit the range in which the USL correlation is valid, but a smaller range will raise the USL. Typically, values of 0.0 are entered for both x_{min} and x_{max}; this instructs the code to use the minimum and maximum values of X found in the user-supplied data.

The parameter σ_{sample} is the average standard deviation estimated for the supplied values of k_{eff}. For the results of a set of deterministic calculations, an average standard deviation of 0.0 may be specified; a positive value may be supplied to account for modeling and numerical uncertainties associated with the set of values. However, if an estimate of the standard deviation associated with each value of k_{eff} is available (such as is computed for Monte Carlo criticality calculations), *USLSTATS* may be instructed to read this value for each value of k_{eff} by supplying any negative value for σ_{sample}.

The final parameter supplied in line 2 of the input file is the administrative margin that is to be included in calculation of the USL by method 1. Based on general experience, a value of 0.05 is most often used in criticality calculations as the value for the administrative subcritical margin. A statistically based margin is computed and used in the method 2 approach, and is supplied in output as the "minimum margin of subcriticality." Typically, this statistical margin is found to be less than the arbitrary 5% margin; for this reason, the method 2 USL is generally less restrictive.

A sample input case is given on the following page. In this case, entitled "34 fresh fuel LWR-type criticals," typical values for P, $1 - \gamma$, and α of 0.995, 0.95, and 0.95, respectively, are given. A value of 0.0 is assigned to both x_{min} and x_{max}, indicating that the minimum and maximum limits of the USL correlations are to be set as the minimum and maximum values of X from the list supplied by the user. A value of −1.0 is given for σ_{sample}, indicating that individual uncertainties are to be read for each value of k_{eff}. Finally, 34 sets of X, k_{eff}, and σ are supplied. (In this case, parameter X is the AEG computed by KENO V.a based on the SCALE 27-group library group structure.)

Sample input for a *USLSTATS* calculation

```
34.fresh fuel LWR-type criticals
 0.995 0.95 0.95 0.0 0.0 -1.0 0.05
  2.26322E+01      .9912  .0010
  2.16825E+01      .9953  .0011
  2.17734E+01      .9919  .0010
  2.18186E+01      .9949  .0010
  2.22143E+01      .9904  .0014
  2.37713E+01      .9946  .0013
  2.06628E+01      .9955  .0014
  2.10962E+01      .9956  .0013
  2.20739E+01     1.0071  .0012
  2.26189E+01     1.0037  .0010
  2.26746E+01     1.0072  .0009
  2.30862E+01     1.0077  .0015
  2.16605E+01      .9971  .0016
  2.16390E+01      .9924  .0011
  2.35796E+01      .9912  .0014
  2.35464E+01      .9927  .0010
  2.35761E+01       9924  .0013
  2.35623E+01      .9921  .0014
  2.19304E+01      .9970  .0016
  2.19636E+01     1.0000  .0015
  2.13056E+01      .9994  .0014
  2.20520E+01      .9952  .0011
  2.09066E+01      .9991  .0012
  2.11516E+01      .9940  .0011
  1.99756E+01      .9904  .0013
  1.82077E+01      .9869  .0012
  2.34646E+01     1.0057  .0022
  2.07944E+01     1.0027  .0015
  2.25639E+01     1.0031  .0017
  2.28514E+01     1.0040  .0018
  2.03398E+01     1.0015  .0012
  2.10385E+01     1.0014  .0018
  2.18995E+01      .9861  .0016
  2.34236E+01      .9972  .0011
```

C.4 Output Description

The output generated by *USLSTATS* (corresponding to the sample input supplied earlier) is given at the end of this appendix. The first section lists the filename corresponding to the input file and supplies all input in a descriptive format. The value of χ from the χ^2 test is printed and compared to the value required for normal data. A message is printed indicating whether or not the supplied data is normal. Note that if fewer than 25 data points are supplied, a warning message is also printed indicating that too few points are available for an accurate assessment of normality. The final section of the output supplies the two USLs, together with important input and intermediate parameters used in the calculation of the USL correlations.

C.5 How to Run *USLSTATS*

The *USLSTATS* program has an interactive interface to allow the user to specify the location of an input file and to select the name of the output file. Below is an example of typical *USLSTATS* usage. Input and output file names are limited to 20 characters. Note that text supplied by the user is shown in boldface in the following example.

```
$ uslstats

 Enter filename containing input data.
 (Enter "test" to generate test case input.)
list34_uslstats.in

 Enter output filename (will overwrite existing file):
list34_uslstats.out
$
```

Note that *USLSTATS* will create a sample input file and will then run using the information in the sample file if the word "test" is given as the name for the input file. This is illustrated in the sample interactive session below.

```
$ uslstats

 Enter filename containing input data.
 (Enter "test" to generate test case input.)
test

 Input file named "usl_test.in" will be created.

 Enter output filename (will overwrite existing file):
usl_test.out
$
```

USLSTATS does not require significant computing space or time. It will typically execute in less than 1 second once the interactive input is completed.

C.6 How to Obtain *USLSTATS*

The *USLSTATS* program may be downloaded from the World Wide Web (WWW) by accessing the SCALE home page. A pointer for the SCALE home page may be found at http://www.cad.ornl.gov

Sample output from a *USLSTATS* calculation

```
          uslstats: a utility to calculate upper subcritical
                    limits for criticality safety applications

  ****************************************************************************
                    Version 1.2, December 9, 1996
                    Oak Ridge National Laboratory
  ****************************************************************************


   Input to statistical treatment from file:usl_test.in

 Title: 34 Fresh-fuel UO2 criticals

   Proportion of the population = .999
   Confidence of fit            = .950
   Confidence on proportion     = .950
   Number of observations       =   29
   Minimum value of closed band =     .00
   Maximum value of closed band =     .00
   Administrative margin        =     .05


   independent      dependent       deviation
   variable - x     variable - y      in y

    1.48200E+01      9.96470E-01     3.37000E-03
    1.48100E+01      9.97760E-01     3.26000E-03
    1.48300E+01      1.00764E+00     3.11000E-03
    1.44400E+01      9.95870E-01     3.65000E-03
    1.42800E+01      9.97440E-01     3.27000E-03
    1.48400E+01      1.00337E+00     3.95000E-03
    1.47300E+01      9.96090E-01     3.95000E-03
    1.50800E+01      1.00108E+00     3.78000E-03
    1.52000E+01      9.97370E-01     3.25000E-03
    1.53100E+01      9.84080E-01     3.42000E-03
    1.52600E+01      9.88710E-01     3.61000E-03
    1.55000E+01      9.95270E-01     2.92000E-03
    1.54900E+01      9.88040E-01     2.73000E-03
    1.43600E+01      1.01363E+00     4.01000E-03
    1.43600E+01      1.01660E+00     4.45000E-03
    1.43600E+01      1.00874E+00     4.85000E-03
    1.43800E+01      1.01190E+00     4.79000E-03
    1.43500E+01      1.00980E+00     4.98000E-03
    1.41000E+01      1.00565E+00     3.97000E-03
    1.41200E+01      1.01929E+00     4.07000E-03
    1.41000E+01      1.00860E+00     4.11000E-03
    1.50400E+01      9.94870E-01     4.62000E-03
    1.49000E+01      9.92570E-01     3.82000E-03
    1.49000E+01      1.00132E+00     4.50000E-03
    1.49000E+01      9.91540E-01     4.20000E-03
    1.54300E+01      1.00028E+00     3.74000E-03
    1.54400E+01      9.95650E-01     4.13000E-03
    1.54300E+01      9.85740E-01     4.15000E-03
    1.54300E+01      9.87330E-01     4.16000E-03
```

```
WARNING *** the test for normal may be unreliable due to insufficient data.

chi =  4.2759 (upper bound = 9.49). The data tests normal.


     Output from statistical treatment

34 Fresh-fuel UO2 criticals

 Number of data points (n)                      29
 Linear regression, k(X)                        1.2267 + (-1.5296E-02)*X
 Confidence on fit (1-gamma) [input]            95.0%
 Confidence on proportion (alpha) [input]       95.0%
 Proportion of population falling above
 lower tolerance interval (rho) [input]         99.9%
 Minimum value of X                             14.1000
 Maximum value of X                             15.5000
 Average value of X                             14.83414
 Average value of k                              .99975
 Minimum value of k                              .98408
 Variance of fit, s(k,X)^2                      3.8263E-05
 Within variance, s(w)^2                        1.5455E-05
 Pooled variance, s(p)^2                        5.3718E-05
 Pooled std. deviation, s(p)                    7.3293E-03
 C(alpha,rho)*s(p)                              3.6627E-02
 student-t @ (n-2,1-gamma)                      1.70300E+00
 Confidence band width, W                       1.3223E-02
 Minimum margin of subcriticality, C*s(p)-W     2.3404E-02

 Upper subcritical limits: ( 14.10000 <= X <=  15.50000)
 ***** *********** *******

 USL Method 1 (Confidence Band with
 Administrative Margin)              1.1634 + (-1.5296E-02)*X (X >   14.818)
                                      .9368                   (X <=  14.818)

 USL Method 2 (Single-Sided Uniform
 Width Closed Interval Approach)     1.1900 + (-1.5296E-02)*X (X >   14.818)
                                      .9634                   (X <=  14.818)


 USLs Evaluated Over Range of Parameter X:
 **** ********* **** ***** ** ********* **

 X:  14.10  14.30  14.50  14.70  14.90  15.10  15.30  15.50
     -----------------------------------------------------
USL-1:  .9368  .9368  .9368  .9368  .9355  .9325  .9294  .9263
USL-2:  .9634  .9634  .9634  .9634  .9621  .9591  .9560  .9529
     -----------------------------------------------------

******************************************************************************
```

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11. ABSTRACT *(200 words or less)*

This report is designed as a guide for performing criticality benchmark calculations for light-water-reactor (LWR) fuel applications. The guide provides documentation of 180 criticality experiments with geometries, materials, and neutron interaction characteristics representative of transportation packages containing LWR fuel or uranium oxide pellets or powder. These experiments should benefit the U.S. Nuclear Regulatory Commission (NRC) staff and licensees in validation of computational methods used in LWR fuel storage and transportation concerns. The experiments are classified by key parameters such as enrichment, water/fuel volume, hydrogen-to-fissile ratio (H/X), and lattice pitch. Groups of experiments with common features such as separator plates, shielding walls, and soluble boron are also identified. In addition, a sample validation using these experiments and a statistical analysis of the results are provided. Recommendations for selecting suitable experiments and determination of calculational bias and uncertainty are presented as part of this benchmark guide.

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