INL/EXT-12-26585

HTR-Proteus Pebble Bed Experimental Program Cores 5, 6, 7, & 8: Columnar Hexagonal Point-on-Point Packing with a 1:2 Moderator-to-Fuel Pebble Ratio

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March 2013

The INL is a U.S. Department of Energy National Laboratory
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March 2013

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Prepared for the
U.S. Department of Energy
Office of Nuclear Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

NEA/NSC/DOC(2006)1

Gas Cooled (Thermal) Reactor – GCR

PROTEUS-GCR-EXP-003
CRIT

HTR-PROTEUS PEBBLE BED EXPERIMENTAL PROGRAM CORES 5, 6, 7, & 8: COLUMNAR HEXAGONAL POINT-ON-POINT PACKING WITH A 1:2 MODERATOR-TO-FUEL PEBBLE RATIO

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ACKNOWLEDGMENTS

The author would like to express gratitude for the initial efforts performed by Barbara H. Dolphin, William K. Terry, and Charles A. Wemple at the Idaho National Laboratory as well as Luka Snoj and Igor Lengar at the Jožef Stefan Institute.

This project was supported by the U.S. Department of Energy, Assistant Secretary for Nuclear Energy, under DOE Idaho Operations Office Contract DE-AC07-05ID14517.

The author would particularly like to acknowledge the indispensable work of Christine E. White in the preparation and deciphering of most of the drawings and graphics. IRPhEP working group provided much appreciated assistance, useful comments, and observations in the final preparation of this evaluation.

Gas Cooled (Thermal) Reactor – GCR

PROTEUS-GCR-EXP-003
CRIT

Status of Compilation / Evaluation / Peer Review

Section 1	**Compiled**	**Independent Review**	**Working Group Review**	**Approved**
1.0 DETAILED DESCRIPTION				
1.1 Description of the Critical and / or Subcritical Configuration	YES	YES	YES	YES
1.2 Description of Buckling and Extrapolation Length Measurements	NA	NA	NA	NA
1.3 Description of Spectral Characteristics Measurements	NA	NA	NA	NA
1.4 Description of Reactivity Effects Measurements	NA	NA	NA	NA
1.5 Description of Reactivity Coefficient Measurements	NA	NA	NA	NA
1.6 Description of Kinetics Measurements	NA	NA	NA	NA
1.7 Description of Reaction-Rate Distribution Measurements	NA	NA	NA	NA
1.8 Description of Power Distribution Measurements	NA	NA	NA	NA
1.9 Description of Isotopic Measurements	NA	NA	NA	NA
1.10 Description of Other Miscellaneous Types of Measurements	NA	NA	NA	NA
Section 2	**Evaluated**	**Independent Review**	**Working Group Review**	**Approved**
2.0 EVALUATION OF EXPERIMENTAL DATA				
2.1 Evaluation of Critical and / or Subcritical Configuration Data	YES	YES	YES	YES
2.2 Evaluation of Buckling and Extrapolation Length Data	NA	NA	NA	NA
2.3 Evaluation of Spectral Characteristics Data	NA	NA	NA	NA
2.4 Evaluation of Reactivity Effects Data	NA	NA	NA	NA
2.5 Evaluation of Reactivity Coefficient Data	NA	NA	NA	NA
2.6 Evaluation of Kinetics Measurements Data	NA	NA	NA	NA
2.7 Evaluation of Reaction Rate Distributions	NA	NA	NA	NA
2.8 Evaluation of Power Distribution Data	NA	NA	NA	NA
2.9 Evaluation of Isotopic Measurements	NA	NA	NA	NA
2.10 Evaluation of Other Miscellaneous Types of Measurements	NA	NA	NA	NA

Section 3	Compiled	Independent Review	Working Group Review	Approved
3.0 BENCHMARK SPECIFICATIONS				
3.1 Benchmark-Model Specifications for Critical and / or Subcritical Measurements	YES	YES	YES	YES
3.2 Benchmark-Model Specifications for Buckling and Extrapolation Length Measurements	NA	NA	NA	NA
3.3 Benchmark-Model Specifications for Spectral Characteristics Measurements	NA	NA	NA	NA
3.4 Benchmark-Model Specifications for Reactivity Effects Measurements	NA	NA	NA	NA
3.5 Benchmark-Model Specifications for Reactivity Coefficient Measurements	NA	NA	NA	NA
3.6 Benchmark-Model Specifications for Kinetics Measurements	NA	NA	NA	NA
3.7 Benchmark-Model Specifications for Reaction-Rate Distribution Measurements	NA	NA	NA	NA
3.8 Benchmark-Model Specifications for Power Distribution Measurements	NA	NA	NA	NA
3.9 Benchmark-Model Specifications for Isotopic Measurements	NA	NA	NA	NA
3.10 Benchmark-Model Specifications of Other Miscellaneous Types of Measurements	NA	NA	NA	NA
Section 4	**Compiled**	**Independent Review**	**Working Group Review**	**Approved**
4.0 RESULTS OF SAMPLE CALCULATIONS				
4.1 Results of Calculations of the Critical or Subcritical Configurations	YES	YES	YES	YES
4.2 Results of Buckling and Extrapolation Length Calculations	NA	NA	NA	NA
4.3 Results of Spectral Characteristics Calculations	NA	NA	NA	NA
4.4 Results of Reactivity Effect Calculations	NA	NA	NA	NA
4.5 Results of Reactivity Coefficient Calculations	NA	NA	NA	NA
4.6 Results of Kinetics Parameter Calculations	NA	NA	NA	NA
4.7 Results of Reaction-Rate Distribution Calculations	NA	NA	NA	NA
4.8 Results of Power Distribution Calculations	NA	NA	NA	NA
4.9 Results of Isotopic Calculations	NA	NA	NA	NA
4.10 Results of Calculations of Other Miscellaneous Types of Measurements	NA	NA	NA	NA
Section 5	**Compiled**	**Independent Review**	**Working Group Review**	**Approved**
5.0 REFERENCES	YES	YES	YES	YES
Appendix A: Computer Codes, Cross Sections, and Typical Input Listings	YES	YES	YES	YES

HTR-PROTEUS PEBBLE BED EXPERIMENTAL PROGRAM CORES 5, 6, 7, & 8: COLUMNAR HEXAGONAL POINT-ON-POINT PACKING WITH A 1:2 MODERATOR-TO-FUEL PEBBLE RATIO

IDENTIFICATION NUMBER: PROTEUS-GCR-EXP-003
CRIT

KEY WORDS: critical facility, graphite-moderated, graphite-reflected, intermediate enriched uranium dioxide, Paul Scherrer Institut, pebble bed arrangement, PROTEUS, TRISO, zero-power experiment

SUMMARY

1.0 DETAILED DESCRIPTION

PROTEUS is a zero-power research reactor based on a cylindrical graphite annulus with a central cylindrical cavity; it is a part of the Paul Scherrer Institute (formerly EIR) and is situated near Würenlingen in the canton of Aargau in northern Switzerland. The graphite annulus remains basically the same for all experimental programs, but the contents of the central cavity are changed according to the type of reactor being investigated. Through most of its service history, PROTEUS has represented light-water reactors, but from 1992 to 1996 PROTEUS was configured as a pebble-bed reactor (PBR) critical facility and designated as HTR-PROTEUS. The nomenclature was used to indicate that this series consisted of High Temperature Reactor experiments performed in the PROTEUS assembly. During this period, seventeen critical configurations were assembled and various reactor physics experiments were conducted. These experiments included measurements of criticality, differential and integral control rod and safety rod worths, kinetics, reaction rates, water ingress effects, and small sample reactivity effects (Ref. 3).

HTR-PROTEUS was constructed, and the experimental program was conducted, for the purpose of providing experimental benchmark data for assessment of reactor physics computer codes. Considerable effort was devoted to benchmark calculations as a part of the HTR-PROTEUS program. References 1 and 2 provide detailed data for use in constructing models for codes to be assessed. Reference 3 is a comprehensive summary of the HTR-PROTEUS experiments and the associated benchmark program. This document draws freely from these references.

Four benchmark reports were prepared to document evaluation of the experimental configurations according to core packing and the moderator-to-fuel pebble ratios:

- PROTEUS-GCR-EXP-001
  - Cores 1, 1A, 2, and 3
  - Hexagonal Close Packing
  - 1:2 Moderator-to-Fuel Pebble Ratio
- PROTEUS-GCR-EXP-002
  - Core 4
  - Random Packing
  - 1:1 Moderator-to-Fuel Pebble Ratio
- PROTEUS-GCR-EXP-003
  - Cores 5, 6, 7, and 8
  - Columnar Hexagonal Point-On-Point Packing
  - 1:2 Moderator-to-Fuel Pebble Ratio
- PROTEUS-GCR-EXP-004
  - Cores 9 and 10
  - Columnar Hexagonal Point-On-Point Packing
  - 1:1 Moderator-to-Fuel Pebble Ratio

In its deployment as a pebble bed reactor critical facility from 1992 to 1996, the reactor was designated as HTR-PROTEUS. This experimental program was performed as part of an International Atomic Energy Agency (IAEA) Coordinated Research Project (CRP) on the Validation of Safety Related Physics Calculations for Low Enriched HTGRs (High Temperature Gas-cooled Reactors). Additional historical data regarding this IAEA CRP and the PROTEUS facility are provided in Appendix D (Ref. 3). Figure 1.0-1 shows a generic HTR-PROTEUS configuration.

Within this project, critical experiments were conducted for graphite moderated LEU (low enriched uranium) systems to determine core reactivity, flux and power profiles, reaction-rate ratios, the worth of control rods (both in-core and reflector based), the worth of burnable poisons, kinetic parameters, and the effects of moisture ingress on these parameters. Fuel for the experiments was provided by the KFA Research Center in Jülich, Germany. Initial criticality was achieved on July 7, 1992. These experiments were conducted over a range of experimental parameters such as carbon-to-uranium ratio (C/U), core height-to-diameter ratio, and simulated moisture concentration (Ref. 3).

In any PBR, the fuel elements are spherical "pebbles" roughly the size of billiard balls, composed of a graphite matrix in which thousands of tiny (~1 mm diameter) coated fuel particles are embedded. These particles are known as tristructural-isotropic (TRISO) and are composed of a central UO_2 kernel surrounded by thin layers of graphite and silicon-carbide.

In the PROTEUS set of experiments, ten different core configurations were constructed and studied. Several cores had more than one reference state either to test reproducibility or further simplify or improve upon the core configuration from the previous reference state. This means that there are slight changes but the basic core configuration remains the same. Core 4 is the only configuration using randomly placed pebbles in the core barrel. All other configurations used hand-stacked pebbles in known packing configurations. The experimenters used the term "deterministic" to denote these regular core lattices. These lattices were either hexagonal close-packed (HCP) or columnar hexagonal point-on-point (CHPOP) configurations. The former arrangement can be visualized as oranges placed in a crate (Figure 1.0-2). In the latter configuration, the pebbles in successive layers form columns without any relative lateral displacement (Figure 1.0-3). The deterministic arrangements are considered much more useful for benchmarking reactor physics computer codes.

Theoretical pebble packing fractions for the HCP and CHPOP configurations are 0.7405 and 0.6046, respectively. A reference value for the random packing of pebbles in the HTR-PROTEUS assembly is

0.61.[a] The packing fraction of the CHPOP configuration is very close to that of a PBR, as a value of 0.61 is a good approximation for the inner part of a PBR, whereas the packing fraction decreases at the core/reflector interface.[b]

Table 1.0-1 provides a brief explanation of the cores and their reference states. Additional descriptions of each core and reference state will appear throughout the reports.

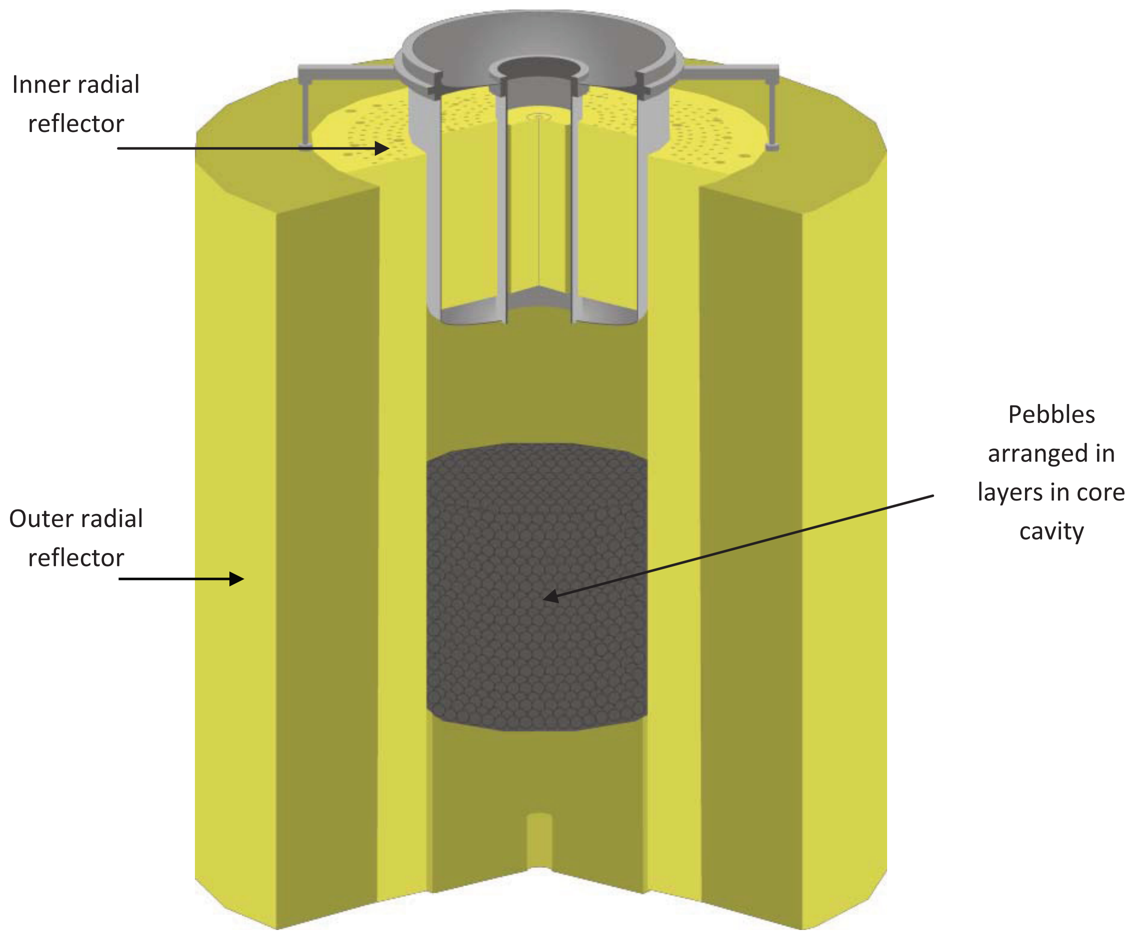

Figure 1.0-1. Generic HTR-PROTEUS configuration (derived from Ref. 2).

[a] Difilippo, F. C., "Monte Carlo Calculations of Pebble Bed Benchmark Configurations of the PROTEUS Facility," Nucl. Sci. Eng., 143, 240-253 (2003).
[b] Personal communication with Oliver Köberl at PSI (September 2, 2011).

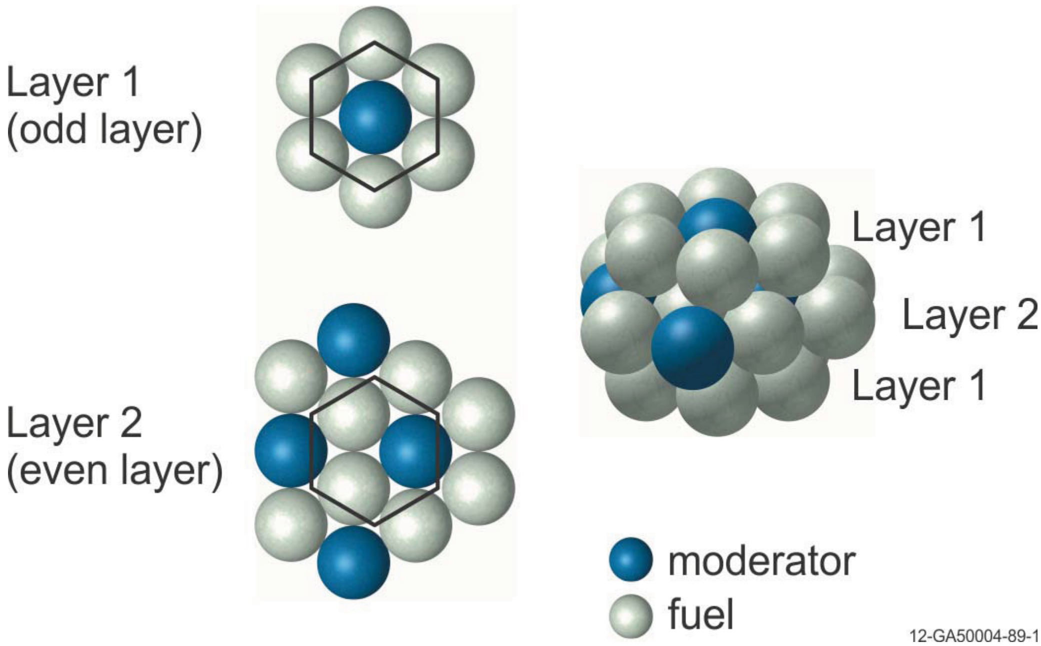

Figure 1.0-2. Subunit for Construction of the Hexagonal Close-Packed (HCP) cell.

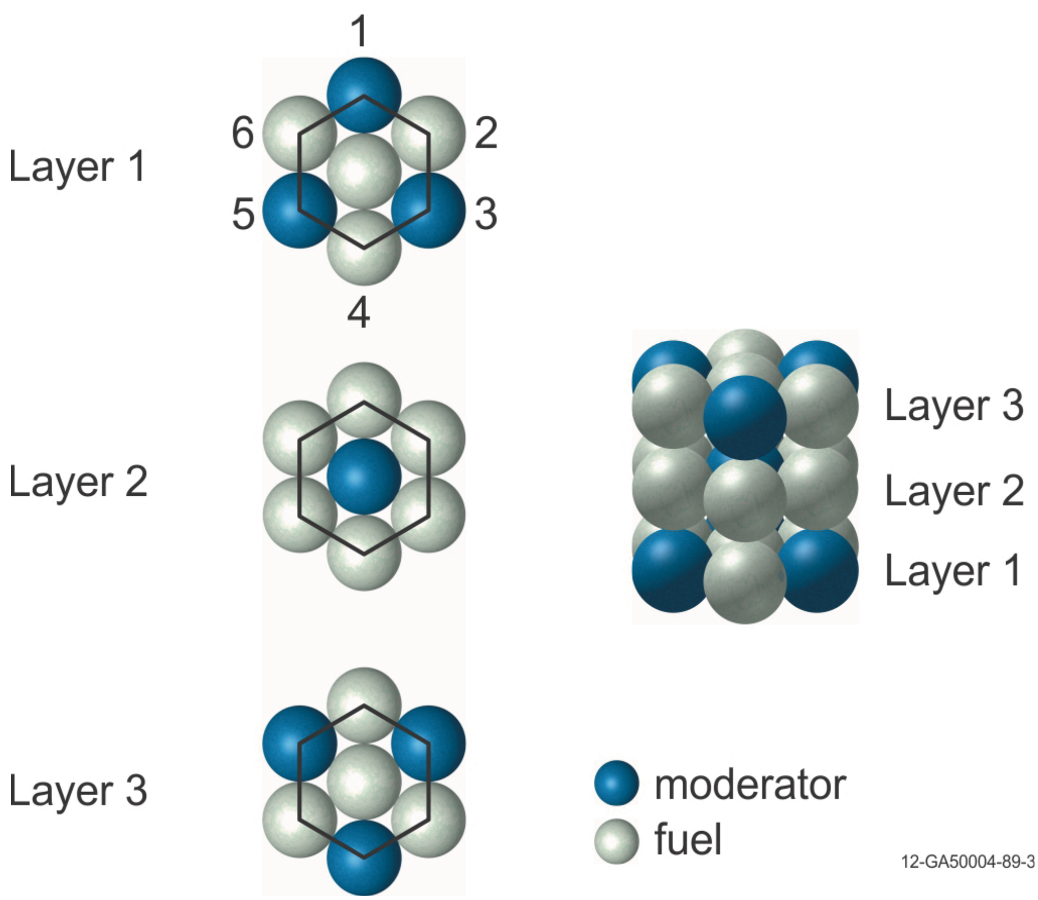

Figure 1.0-3. Subunit for Construction of the Columnar Hexagonal Point-On-Point (CHPOP) cell.

Table 1.0-1. HTR-PROTEUS Core Configurations (Ref. 1 and 3).

Core	State	Notes
1	1	Only configuration that used ZEBRA control rods. Hexagonal close-packed pebbles.
1A	1 2	Equivalent to Core 1, ZEBRA control rods replaced with withdrawable control rods. Repeat of State #1 to check reproducibility with minor configuration changes.
2	1	Similar to Core 1A with decreased core height and increased upper graphite reflection. Used to investigate "cavity effect".
3	1	Similar to Core 1A with polyethylene rods added to simulate water ingress. Every available vertical channel between pebbles contained an 8.9–mm-diameter polyethylene rod.
4.1 4.2 4.3	1 1 1	Random pebble loading using separate fuel and moderator pebble delivery tubes. Random pebble loading using a single pebble delivery tube. Random pebble loading using a single pebble delivery tube (core reload for reproducibility).
5	1 2 3	Columnar hexagonal point-on-point packing implemented to improve homogeneity of core. Coolant channels in bottom reflector open. Equivalent to Core 5, State #1, with coolant channels in bottom reflector filled with graphite. Repeat of State #2 to check reproducibility and complete some additional reactor physics measurements.
6	1	Similar to Core 5 with hollow polyethylene rods added to simulate water ingress. Copper wire absorbers were placed within the polyethylene rods to compensate for the positive reactivity addition. Maximum polyethylene loading.
7	1	Similar to Core 5 with polyethylene rods added to simulate water ingress. Maximum polyethylene loading compensated by reduced core height.
8	1	Similar to Core 5 with short polyethylene rods added to simulate water ingress in lower core region. Every vertical channel contained a 15 cm long triangular polyethylene rod.
9	1 2	Columnar hexagonal point-on-point packing with increased moderator pebble content. Essentially Core 5 with an equal number of fuel and moderator pebbles. Repeat of State #1 with additional layer of moderator pebbles.
10	1	Similar to Core 9 with polyethylene rods added to simulate water ingress. Maximum polyethylene loading compensated by reduced core height.

1.1 Description of the Critical and / or Subcritical Configuration

1.1.1 Overview of Experiment

Only Cores 5, 6, 7, and 8 are evaluated in this benchmark report due to similarities in their construction. The other core configurations of the HTR-PROTEUS program are evaluated in their respective reports as outlined in Section 1.0.

Cores 5, 6, 7, and 8 were evaluated and determined to be acceptable benchmark experiments.

1.1.2 Geometry of the Experiment Configuration and Measurement Procedure

The PROTEUS assembly can basically be described as a graphite cylinder with an outer diameter of 3262 mm and a height of 3304 mm. It has a central cavity that sits 780 mm above the bottom of the radial and lower axial reflectors and consists of a 22-sided polygon with a flat-to-flat separation distance of 1250 mm. Random or deterministic lattices of pure graphite moderator pebbles and fuel (16.7 wt.% enriched in ^{235}U) pebbles were arranged within this cavity. Additional graphite filler pieces were utilized to provide support for the irregular outer surface of the deterministic pebble arrangements, providing a 12-sided core cavity region with a flat-to-flat separation distance of ~1205 mm. A removable, 1235-mm-high, upper axial reflector assembly consisted of an aluminum tank containing a 780-mm-high graphite reflector; normally an air gap was between the upper reflector and the topmost layer of the pebble bed. An aluminum safety ring is located 1764 mm above the floor of the cavity to prevent the upper reflector from falling onto the pebble bed. Reactor shutdown was achieved using four boron-steel rods placed at a radius of 680 mm; reactor control was typically performed using four fine control rods placed at a radius of 900 mm. In Core 1, however, Cd Shutter, or ZEBRA type, rods were used in place of the fine control rods. Water ingress was simulated by using polyethylene rods introduced axially into vertical channels of the deterministic cores (Ref. 2). Schematic representations of the PROTEUS assembly are shown in Figures 1.1-1 and 1.1-2.

While there are many components of the PROTEUS that remain unchanged throughout the course of the HTR-PROTEUS experiments, many parameters did change between experiments, such as the use of graphite filler pieces, control rod types and locations, the presence of polyethylene rods to simulate water ingress, core pebble packing, and conditions at criticality. Section 1.1.2.1 provides information regarding general components common to all HTR-PROTEUS configurations. Section 1.1.2.2 provides information specific to the core configurations evaluated in this report.

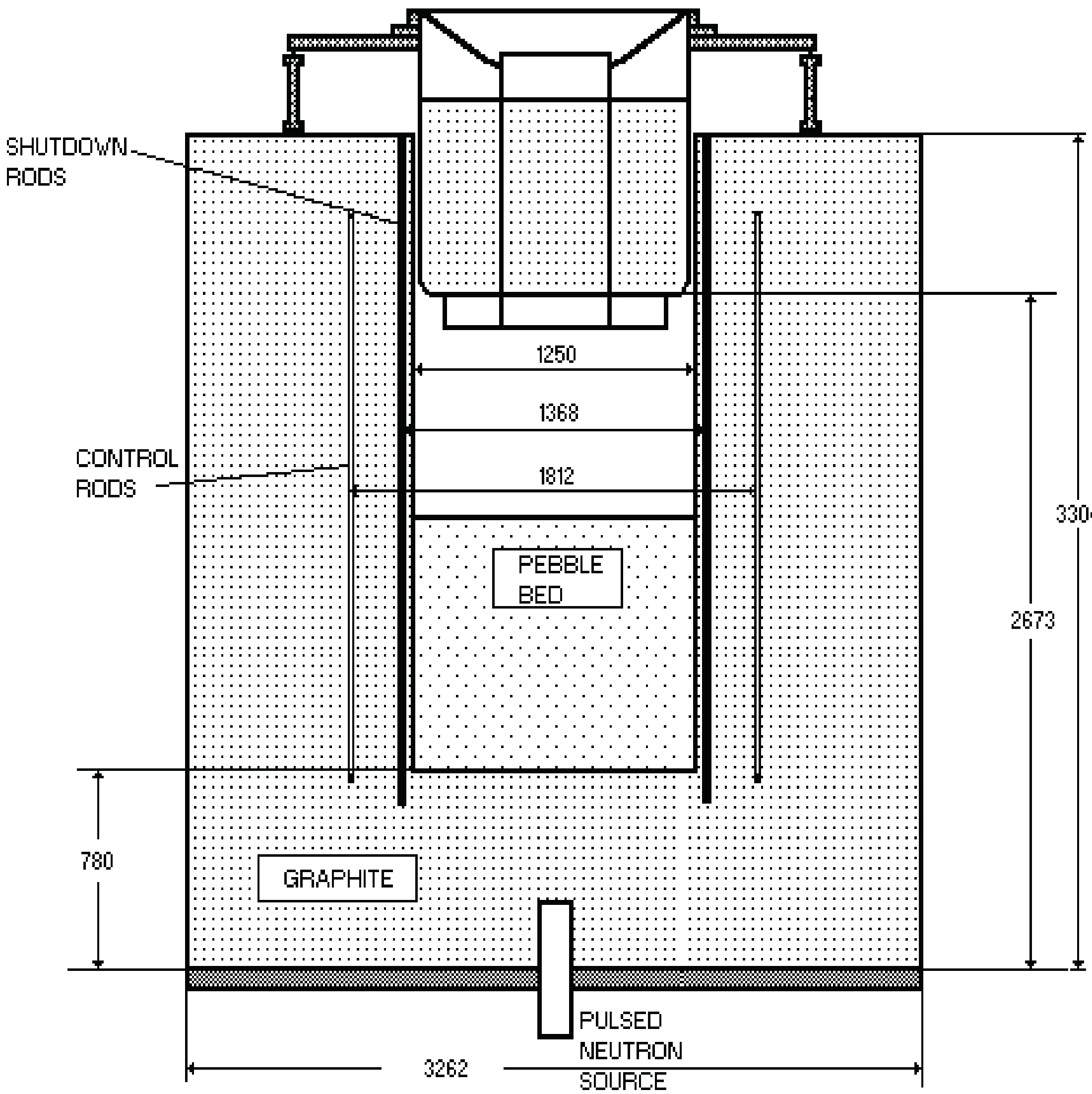

Figure 1.1-1. Schematic side view of the HTR-PROTEUS facility (dimensions in mm), (Ref. 2 and 3).

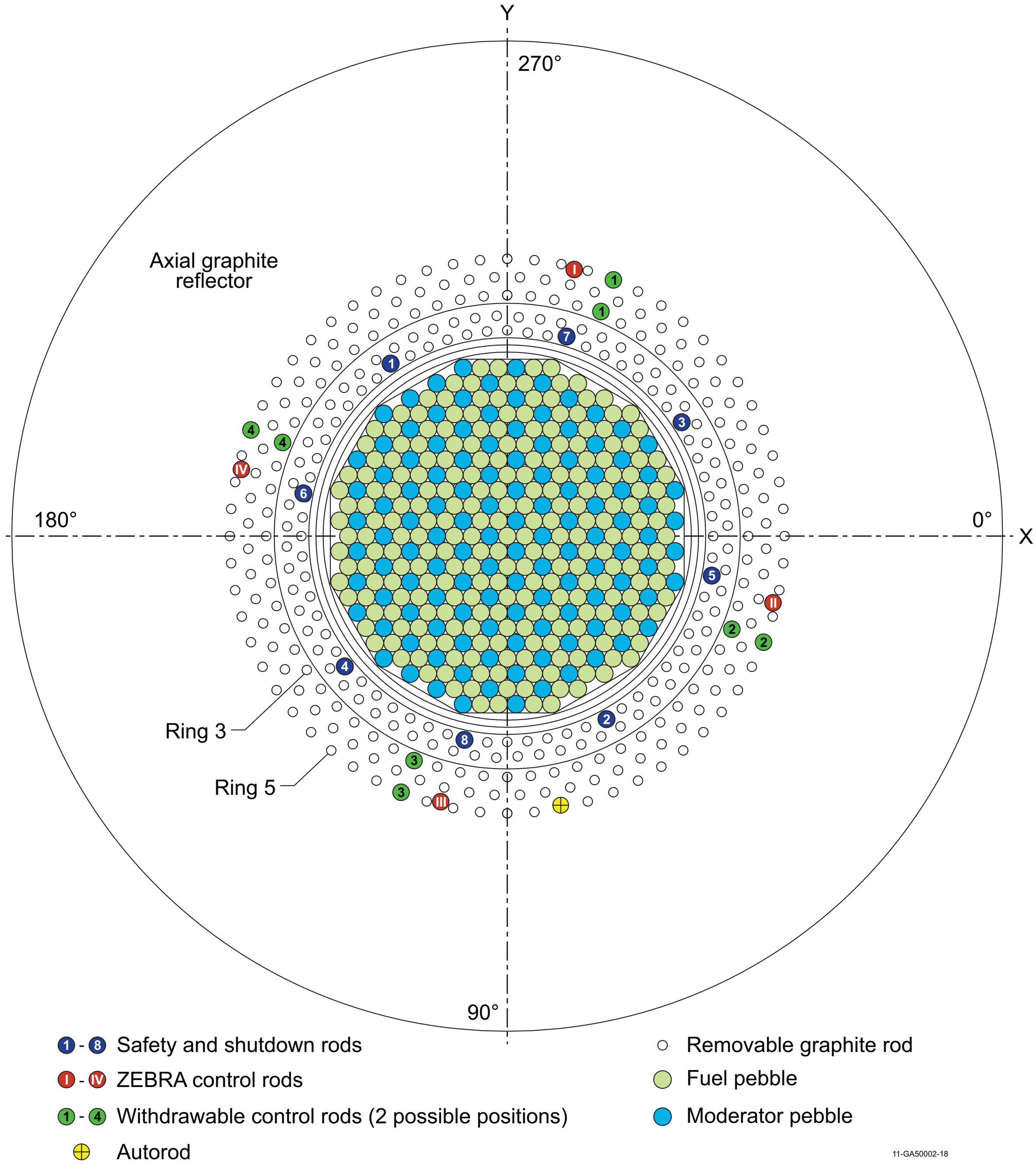

Figure 1.1-2a. HTR-PROTEUS control rod positions and bore hole locations (derived from Ref. 2).

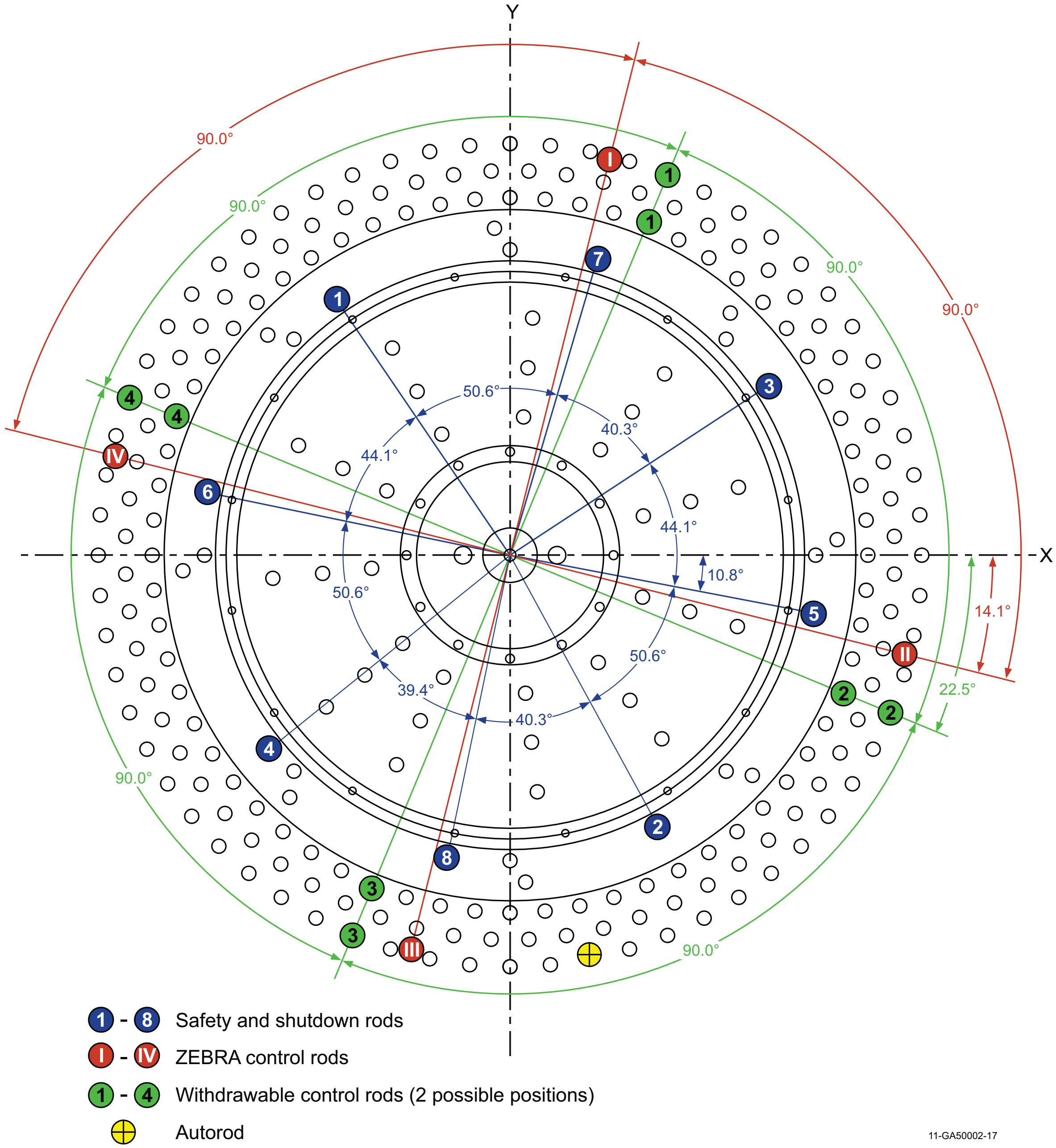

Figure 1.1-2b. HTR-PROTEUS control rod positions and bore hole locations (Ref. 2).

1.1.2.1 General HTR-PROTEUS Components

The following components are common to all HTR-PROTEUS core configurations.

Concrete

Concrete shielding surrounds the reactor system entirely (Ref. 2). The reactor is surrounded by 800 mm of concrete shielding. No significant room return effects from neutron streaming were measured.[a]

Steel Plate Pedestal

The PROTEUS assembly rests upon a stainless steel plate pedestal.[b]

Radial Reflector

The radial reflector was a 22-sided polygon with a height of 3304 mm and outer diameter of 3262 mm (see Figures 1.1-1 and 1.1-3). A central cavity sat with its base 780 mm above the reflector base and had a flat-to-flat separation distance of 1250 mm (Ref. 2 and 3). The central cavity contained fuel (16.7 wt.% enriched in ^{235}U) and moderator (pure graphite) pebbles either deterministically or randomly arranged in one of several different geometrical arrangements. Graphite filler pieces were placed at the core-reflector boundary to support the stacked pebble structures (Ref. 3).

The external boundary of the 22-sided polygon had sides located 1631.6 mm from the center, which would be an equivalent area cylinder of 1637.7 mm radius. The internal cavity was a 22-sided polygon with sides 626 mm from the center, which would be an equivalent area cylinder of 628.4 mm radius. In summary, the cavity had an average radial thickness ~1029 mm of graphite, and lower and upper axial thicknesses 780 mm of graphite.[b]

A cylindrical version of the radial reflector would have the following radius (the first value represents an equal perimeter, and the second value represents an equal area): external radius, 1643.6 and 1637.7 mm, respectively; internal radius for the 22-sided cavity, 630.6 and 628.4 mm, respectively.[c]

The radial reflector contains various minor penetrations serving as control rod and instrumentation channels. The reflector contained 308 C-Driver channels (see Figure 1.1-3), which were vertical channels of 27.43 mm diameter running the full height of the radial reflector and were left over from previous PROTEUS experiments. These channels were arranged in five concentric rings. Unless otherwise stated, these channels were filled with 26.5 mm diameter graphite rods (Ref. 2). These rods were relatively easy to remove and useful in estimating the effect of missing graphite (Ref. 3).

Attached to one side of the radial reflector was a reactor thermal column, which was a quasi-rectangular structure with a height and width of 1200 mm and a depth of ~500 mm. Its top surface was situated 1120 mm from the upper surface of the radial reflector (Ref. 2).

A safety ring was included in the design as an additional safety measure in the unlikely event that the upper axial reflector should fall into the cavity. It was comprised of a Peraluman ring 10 mm thick with inner and outer radii of 604 and 700 mm, respectively. It was situated 1764 mm above the floor of the cavity, as depicted in Figure 1.1-4 (Ref. 2).

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[a] Williams, T., "HTR PROTEUS CORE 1: Reactivity Corrections for the Critical Balance," TM-41-93-20, Paul Scherrer Institut, Villigen, October 7, 1993.
[b] Difilippo, F. C., "Monte Carlo Calculations of Pebble Bed Benchmark Configurations of the PROTEUS Facility," *Nucl. Sci. Eng.*, **143**, 240-253 (2003).
[c] Difilippo, F. C., "Applications of Monte Carlo Simulations of Thermalization Processes to the Nondestructive Assay of Graphite," *Nucl. Sci. Eng.*, **133**, 163-177 (1999).

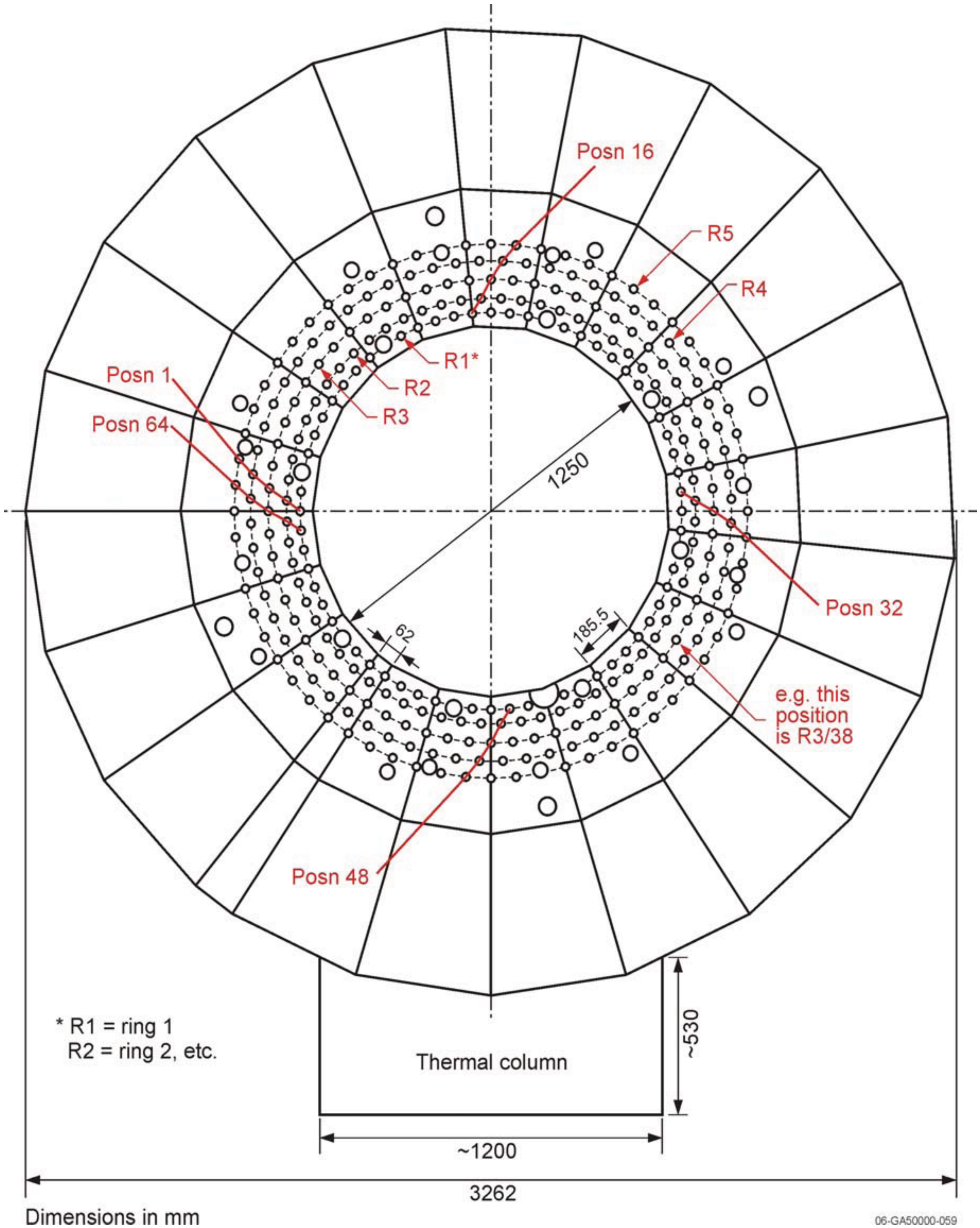

Figure 1.1-3. Cross section view of the radial reflector (Ref. 2).

The radial reflector contained various minor penetrations for the introduction of instrumentation and sources. Explicit geometries and descriptions are unavailable. When not in use, the penetrations were filled with graphite plugs.

Upper Axial Reflector

Detailed drawings of the upper axial reflector and its aluminum housing are shown in Figures 1.1-4 through 1.1-6. The graphite has two components; the first component is a central cylinder of 394 mm diameter with a central, open, 27.43 mm diameter channel, surrounded by the second component, an annulus with an inner diameter of 418.6 mm and an outer diameter of 1234 mm. The annulus contains 33 coolant channels corresponding with those found in the lower axial reflector. All 34 channels are always open. The outer graphite annulus includes a separate outer shell consisting of 36 smaller, individual rectangular pieces that do not fit exactly flush with the bulk graphite. The upper axial reflector graphite had a height of 780 mm (Ref. 2).

The upper reflector tank is a complex structure that supports the upper axial graphite reflector in place above the cavity. It was comprised of two main parts, an inner and an outer tank. The inner tank, which contained the graphite cylinder, was removable, and it had to be removed before the outer tank could be removed. The outer tank contained the graphite annulus. The dimensions and layout of the upper reflector are shown in Figures 1.1-4 through 1.1-6. A steel lid and flanges, external to the core reflector, were used to hold the upper reflector above the core cavity (Ref. 2).

The upper axial reflector closed the cavity at a height of 1863 mm from the bottom of the cavity.[a]

[a] Difilippo, F. C., “Monte Carlo Calculations of Pebble Bed Benchmark Configurations of the PROTEUS Facility,” *Nucl. Sci. Eng.*, **143**, 240-253 (2003).

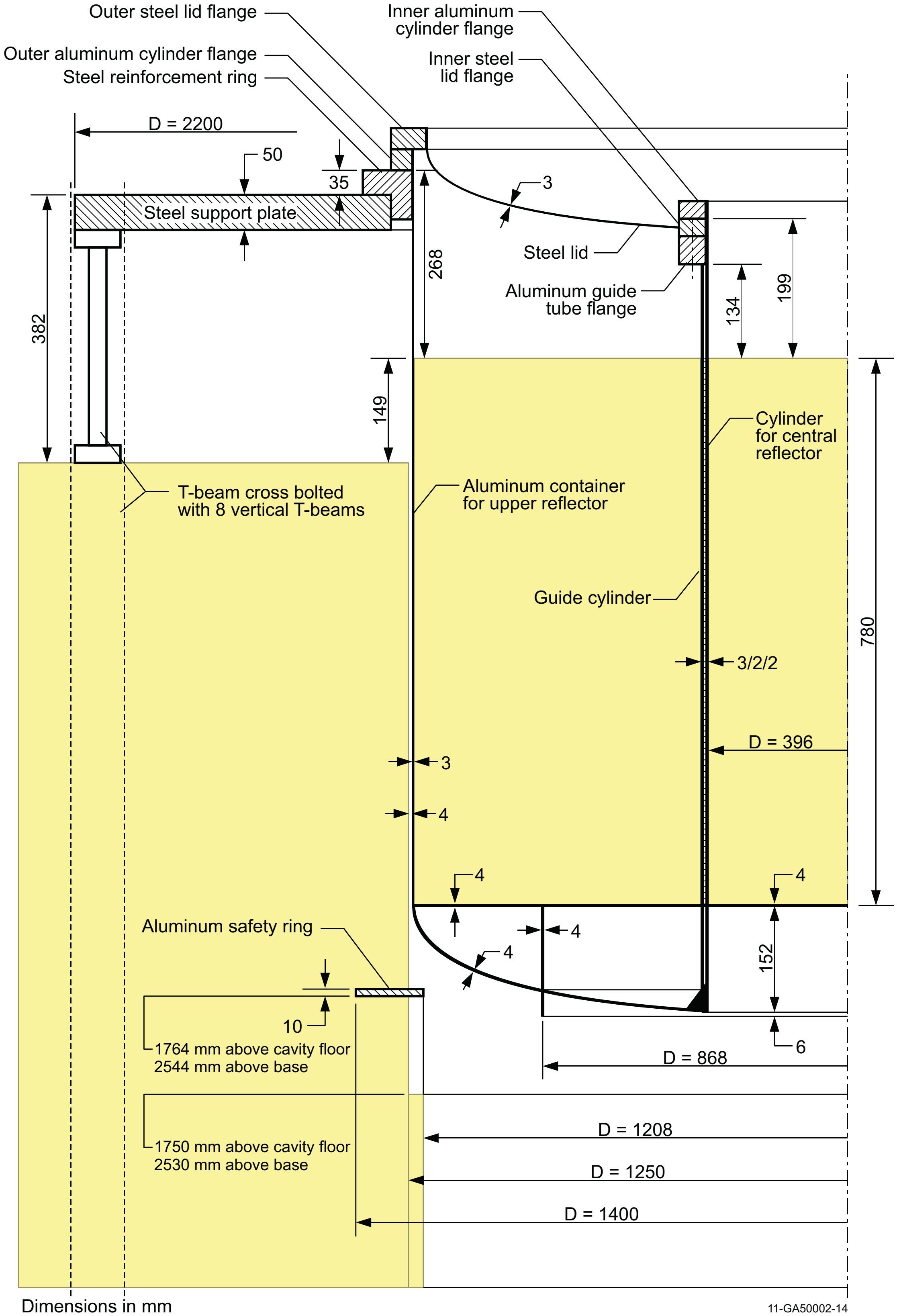

Figure 1.1-4. Placement of the upper axial reflector (Ref. 2).

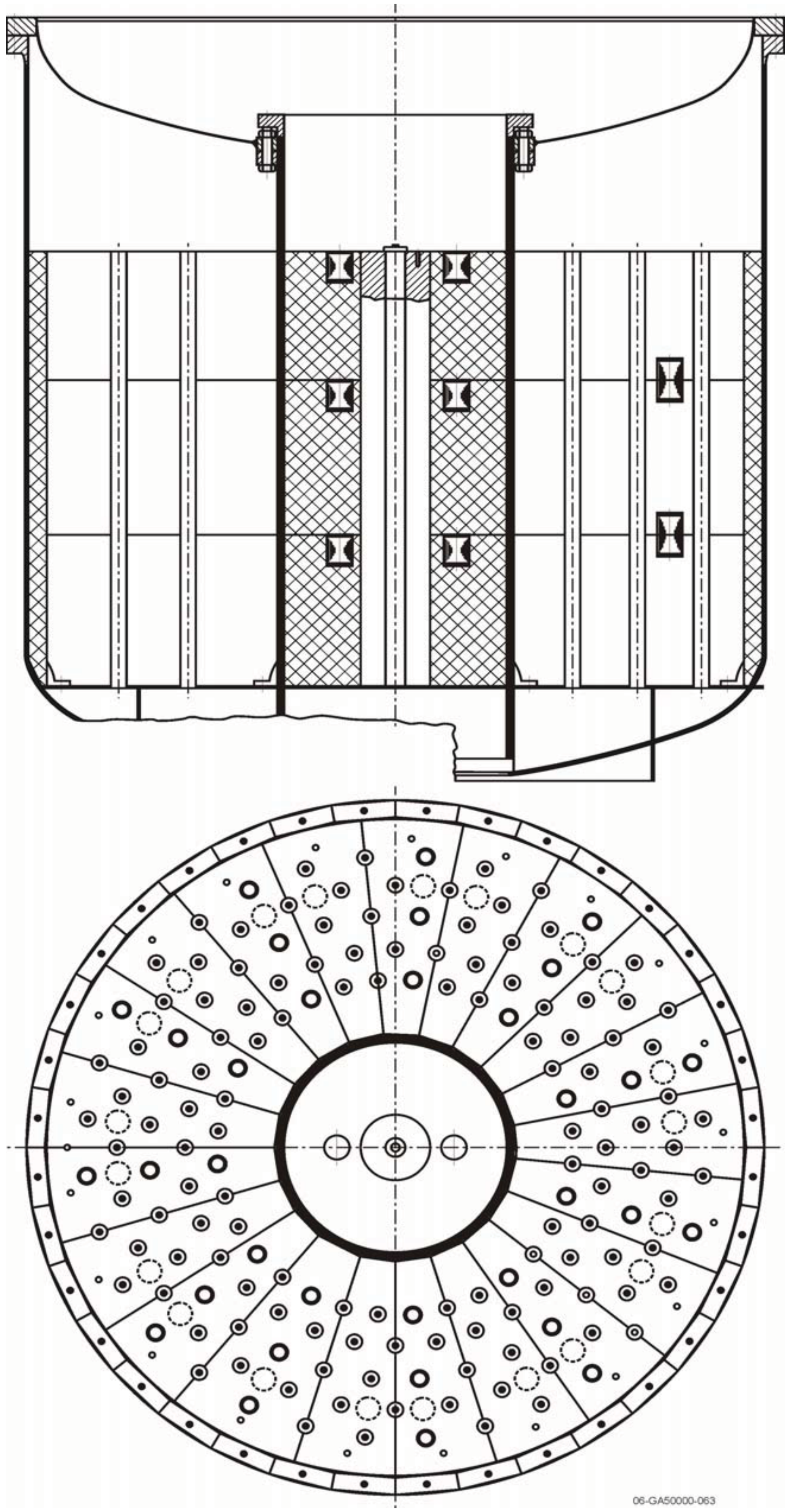

Figure 1.1-5. Non-dimensional cross sections of the upper axial reflector (Ref. 2).

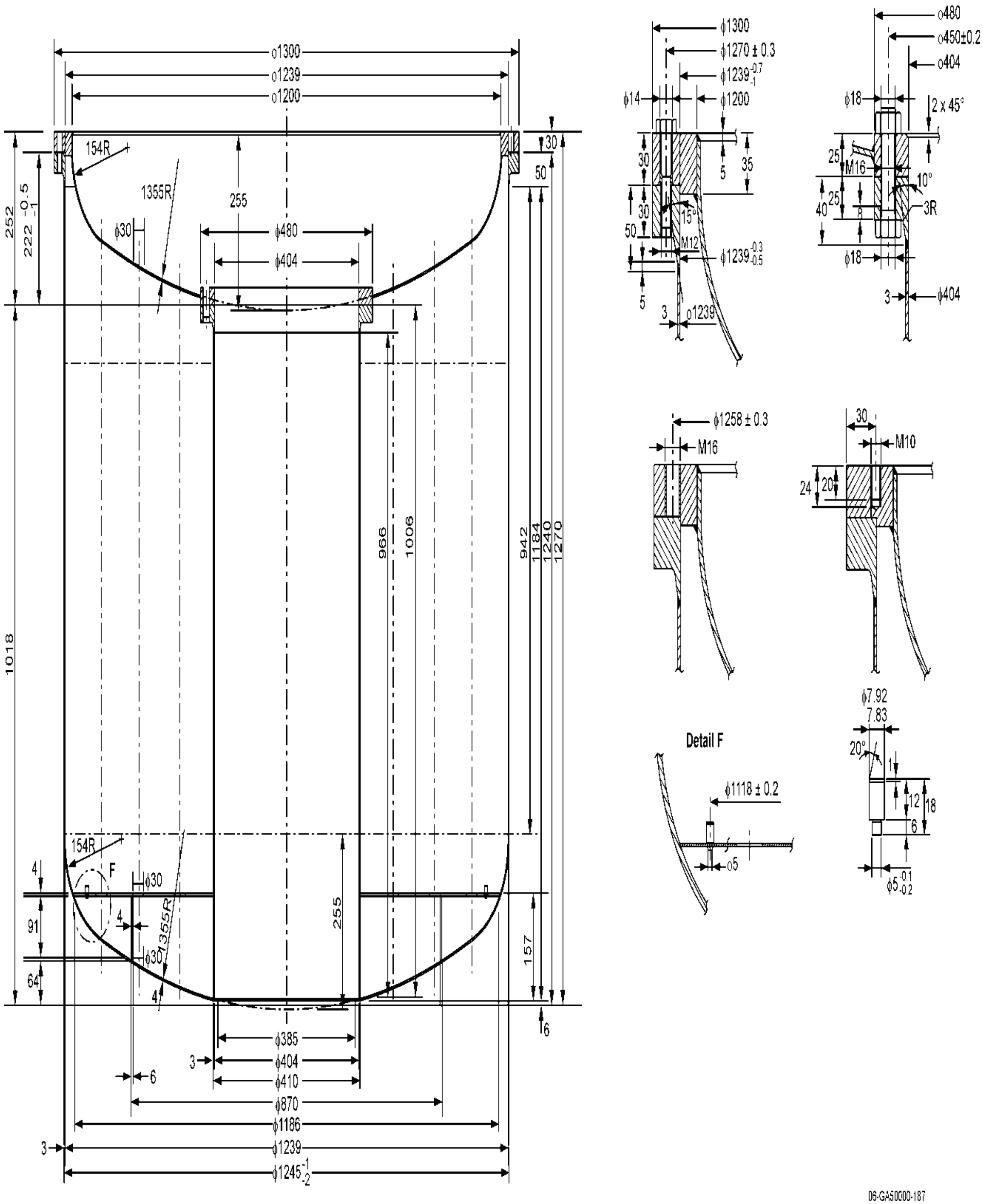

Figure 1.1-6. Details of the main aluminum structure of the upper axial reflector (Ref. 2).
Units are in millimeters.

Lower Axial Reflector

The lower axial reflector is 780 mm thick and contains, for historical reasons, 160 symmetrically positioned 27.42 mm diameter channels. At least 127 of these channels were filled with 780 mm long, 26.5 mm diameter graphite rods. The dimensions of the lower axial reflector are shown in Figure 1.1-7; the positions of the 33 (typically open) coolant channels are also indicated. The open channels are arranged in three concentric rings of radii 300, 410, and 515 mm, with each ring containing eleven channels. The channels in each ring are positioned at azimuthal angles of 16.875, 50.625, 84.375, 118.125, 140.625, 174.375, 208.125, 241.875, 275.625, 309.375, and 343.125º, as measured in the clockwise direction from the +x-axis, as shown in Figure 1.1-2 (Ref. 2). In some of the core configurations all of the coolant channels in the lower axial reflector were filled with graphite plugs (Ref. 3). In all the deterministic cores, ~12 pebbles were directly over one of the 33 cooling channels in the lower axial reflector. To avoid pebble displacement in these cases, special aluminum plugs were developed to support the pebbles in Core 1. In later cores, simple graphite rods were used (Ref. 3).

A special, 121 mm diameter, channel was provided in the center of the lower axial reflector with approximately 500 mm of graphite separating it from the core. This channel could be used for measurements using the pulsed neutron source. The pulsed neutron source, when used for subcriticality measurements, was partially inserted into the lower axial reflector. When not in use, it was replaced with a plug of graphite of dimensions 250 mm in height and 120 mm in diameter (Ref. 2 and 3).

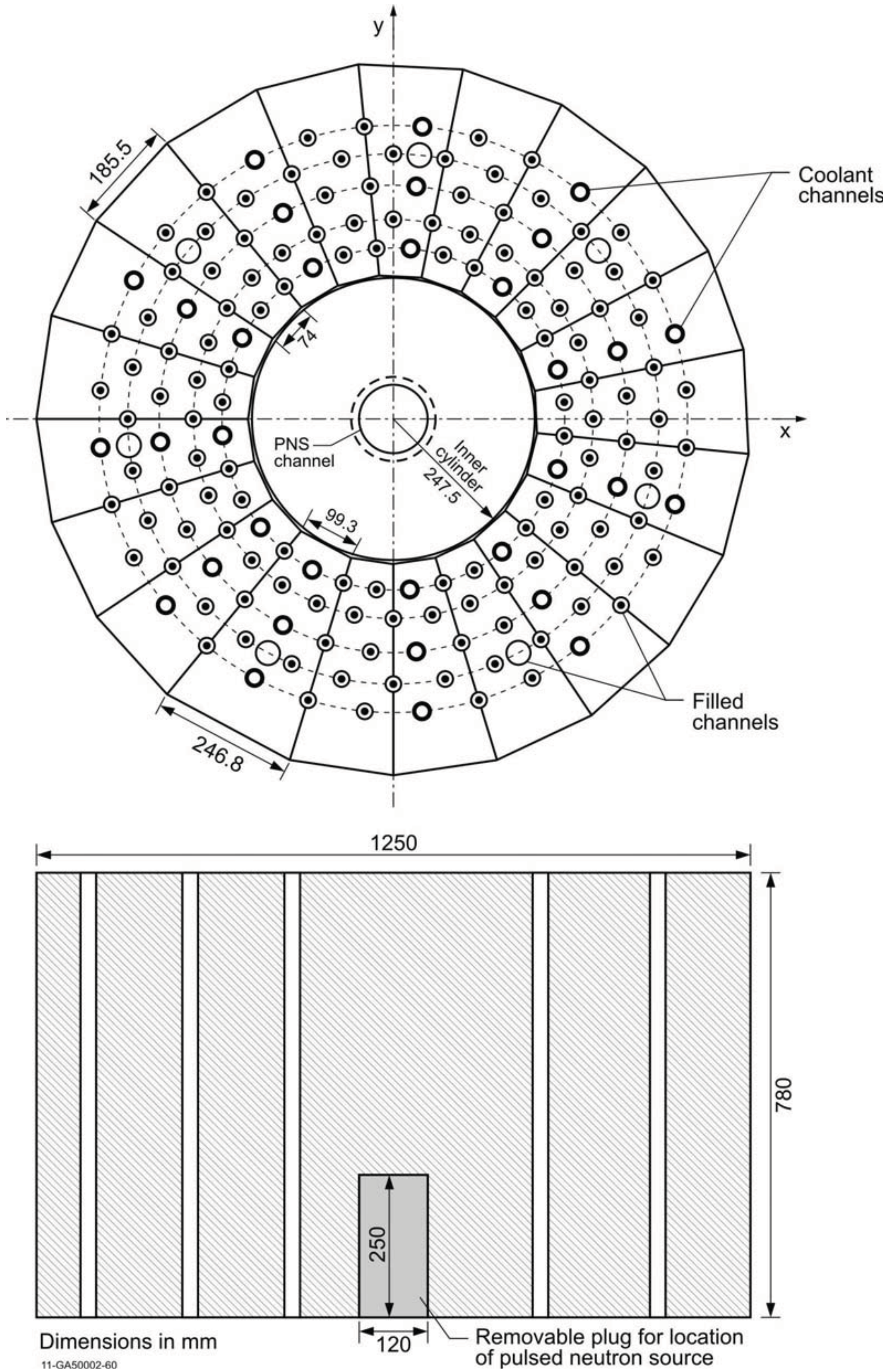

Figure 1.1-7. Details of the lower axial reflector. Note the 33 coolant channels, the small air gap between outer and inner parts, and the position of the pulsed source channel (Ref. 2).

Safety/Shutdown Rods

There were eight, identical, borated-steel safety/shutdown rods located adjacent to the core in the radial reflector (see Figure 1.1-2). These rods were separated into two groups of four rods (rods 1-4 and rods 5-8). One of these groups was selected as the “safety rod” group and the other as the “shutdown rod” group. These rods were not used as control rods, such as the four ZEBRA type rods used in Core 1 or the withdrawable stainless steel control rods used in Cores 1A through 10 (Ref. 2 and 3).

Rods numbered 1 through 4 are the shutdown rods and rods numbered 5 through 8 are the safety rods.[a]

The safety/shutdown rods consisted of 35 mm diameter borated steel rod sections enclosed in 18/8 stainless steel tubes with an inside diameter of 36 mm and outside diameter of 40 mm. The rods were located in 45 mm inner diameter graphite guide tubes within the radial reflector. The centers of the guide tubes were 684 mm from the center of the core, or about 59 mm from the inner surface of the radial reflector (without filler pieces). The azimuthal positions of the eight rods are shown in Figure 1.1-2, in which the slight azimuthal asymmetry of the rod positions should be noted (Ref. 2 and 3).

A diagram of a safety/shutdown rod is shown in Figure 1.1-8; the borated steel portion of the rods was 2100 mm in length. The fully in and out positions of the rods are shown in Figure 1.1-9; the rods traveled a total distance of 2900 mm (2530 mm free fall plus 370 mm braking distance) from fully withdrawn to fully inserted positions. When fully inserted, the bottom of the borated steel region is located 350 mm below the bottom of the reactor cavity with the top of the borated steel region slightly above the top of the 1730 mm high cavity. When fully withdrawn, the bottom of the borated steel region is 26 mm below the top surface of the radial reflector (Ref. 2).

Each rod contains six, 35 mm diameter, 350 mm long, cylindrical pieces of borated steel. Aluminum and steel shock dampers were located under each of the safety/shutdown rods, as shown in Figure 1.1-9, to prevent damage in case one of the rod cables should fail. A gap of approximately 30 mm separated the bottom of the safety rod from the upper, aluminum part of the shock damper. The aluminum parts of the shock damper was comprised of a 280.5 mm long hollow tube with 29 mm inner diameter, 40 mm outer diameter, and capped at both ends with aluminum of 2 mm thickness. The steel parts of the shock dampers (end caps, springs, and damper chamber) were affixed to the underside of the lower support plate, which itself is ~75 mm thick; only a fraction of the total mass of these components resided within the graphite reflector (Ref. 2).

The safety rods were always maintained in withdrawn positions, i.e., out of the reflector. Criticality was achieved when the four shutdown rods were also fully withdrawn and only the four control rods and the autorod were partially inserted for fine control.[b,c]

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[a] Köberl, O., and Seiler, R., “Detailed Analysis of Pebble-Bed HTR PROTEUS Experiments with the Monte Carlo Code TRIPOLI4,” Proc. 2nd Int. Topical Mtg. on High Temperature Reactor Technology, Beijing, China, September 22-24, 2004.
[b] Chawla, R., Joneja, O. P., Rosselet, M., and Williams, T., “Definition and Analysis of an Experimental Benchmark on Shutdown Rod Worths in LEU-HTR Configurations,” *Nucl. Technol.*, **139**, 50-60 (2002).
[c] Köberl, O., Seiler, R., and Chawla, R., “Experimental Determination of the Ratio of 238U Capture to 235U Fission in LEU-HTR Pebble-Bed Configurations,” *Nucl. Sci. Eng.*, **146**, 1-12 (2004).

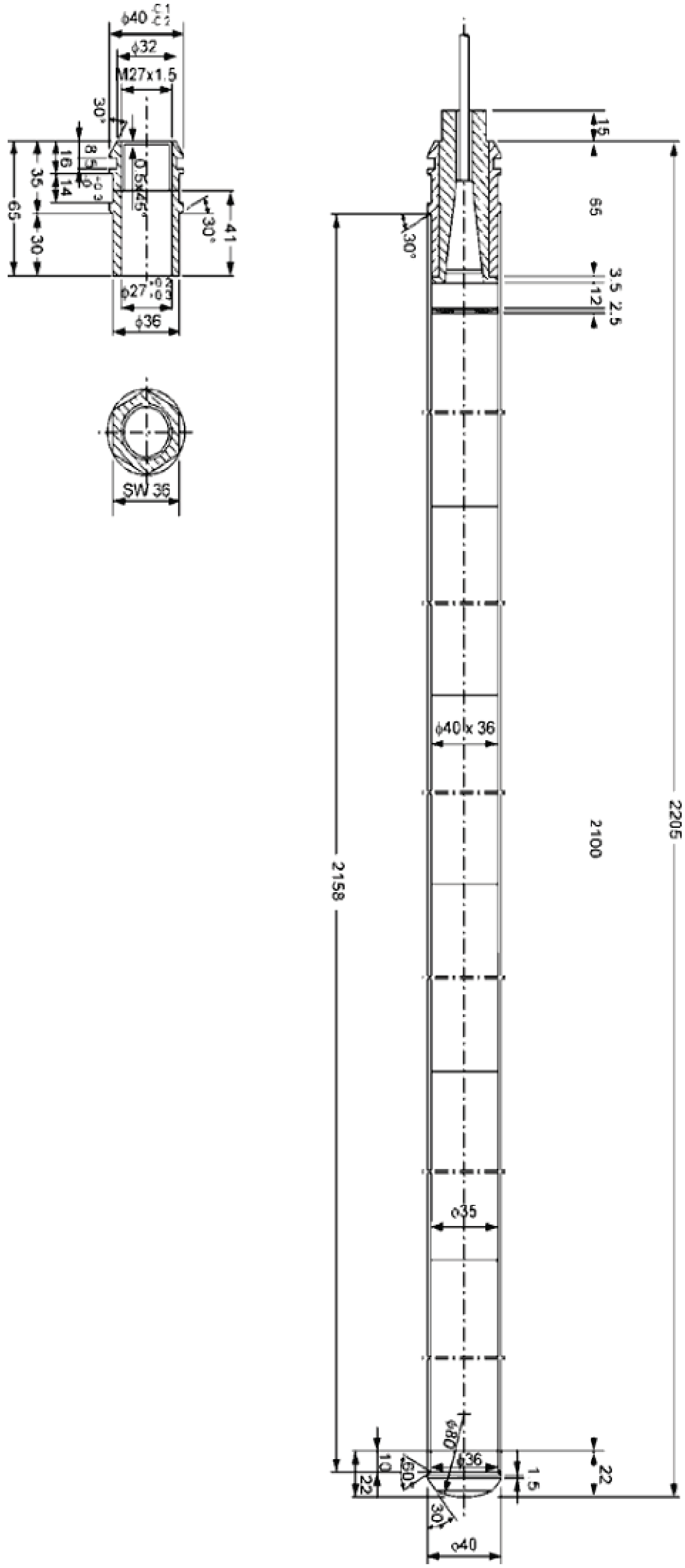

Figure 1.1-8. Details of safety/shutdown rods (Ref. 2). Units are in millimeters.

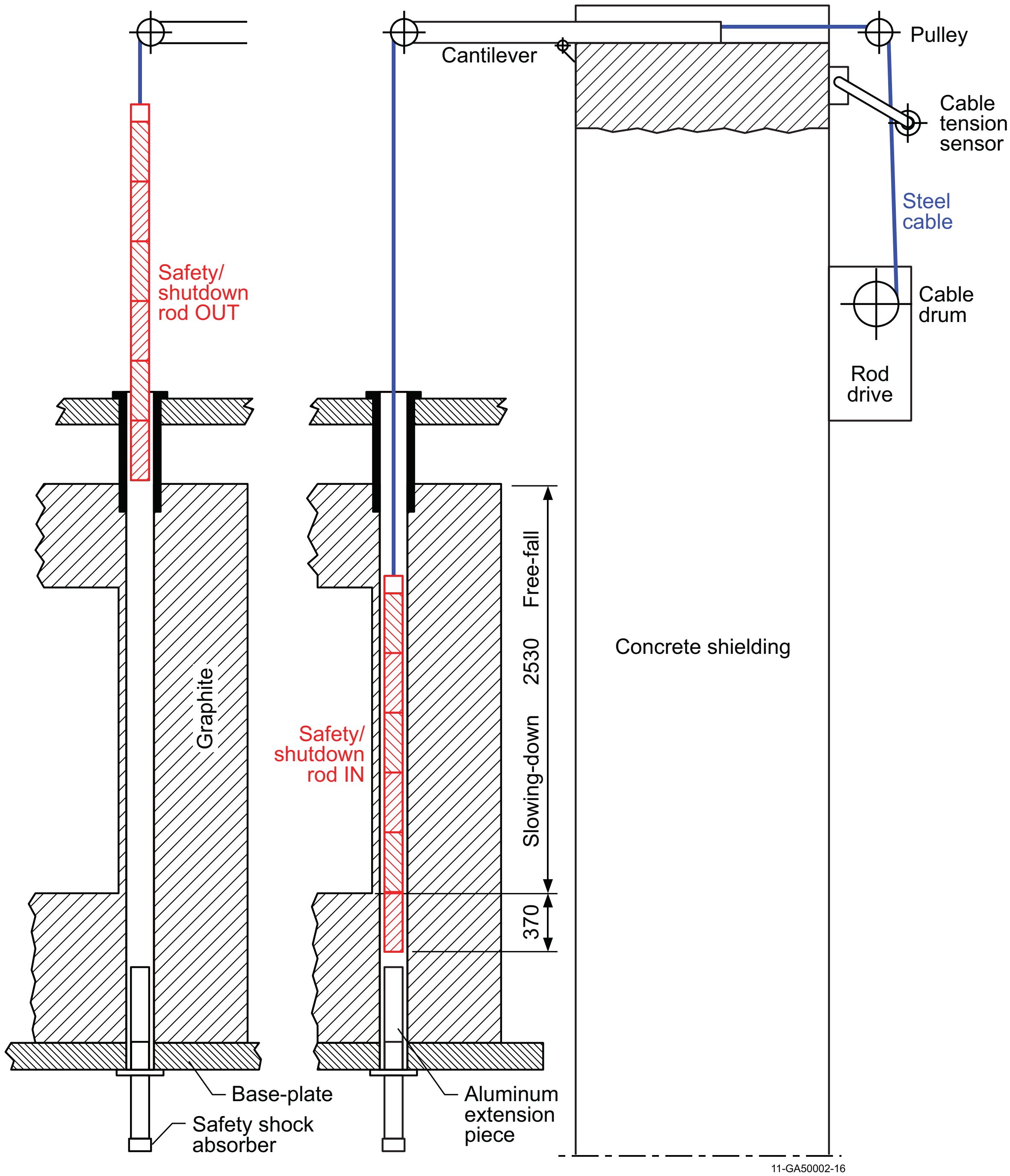

Figure 1.1-9. Safety/shutdown rod movement (Ref. 2). Units are in millimeters.

Automatic Control Rod (Autorod)

A single, fine control rod (Figure 1.1-10) was utilized to automatically maintain reactor criticality at a nominal required power. It responded to signals from a single ionization chamber (deviation channel) located in the radial reflector 810 mm above the cavity floor and ~500 mm from the outer radial boundary of the core. The rod itself is located in a vertical channel with an inside diameter of 55 mm situated 890 mm from the radial center of the system; it was located azimuthally ~80º from the x-direction in a clockwise direction (see Figure 1.1-2). The rod was comprised of a wedge shaped copper plate supported within an aluminum tube with an outer diameter of 44 mm. The copper plate was 3 mm thick, 2300 mm long, and 39 mm at its wide end with a reduction in width along its length of 17 mm per meter. The rod was fully inserted when the position display showed 0 mm and the pointed end of the copper plate was flush with the underside of the steel plate upon which the reactor stands. The complete withdrawal of the autorod was indicated by a display of 1000 mm when the pointed end of the copper plate was ~200 mm above the base of the core cavity and the blunt end was 79 mm below the top of the radial reflector graphite. Because the rod remains within the system even when fully "withdrawn" it has a significant rest worth that is larger than the total max-min worth of the rod.

The worth of the autorod exhibits a linear response over the range of 200 to 800 mm with a differential control rod worth of 6.3×10^{-3} ¢/mm ($\beta_{eff} = 0.00723$) and an uncertainty of around 5 %. The autorod response was intercalibrated with the ZEBRA (and later withdrawable) control rods.[a]

[a] Williams, T., "HTR PROTEUS CORE 1: Reactivity Corrections for the Critical Balance," TM-41-93-20, Paul Scherrer Institut, Villigen, October 7, 1993.

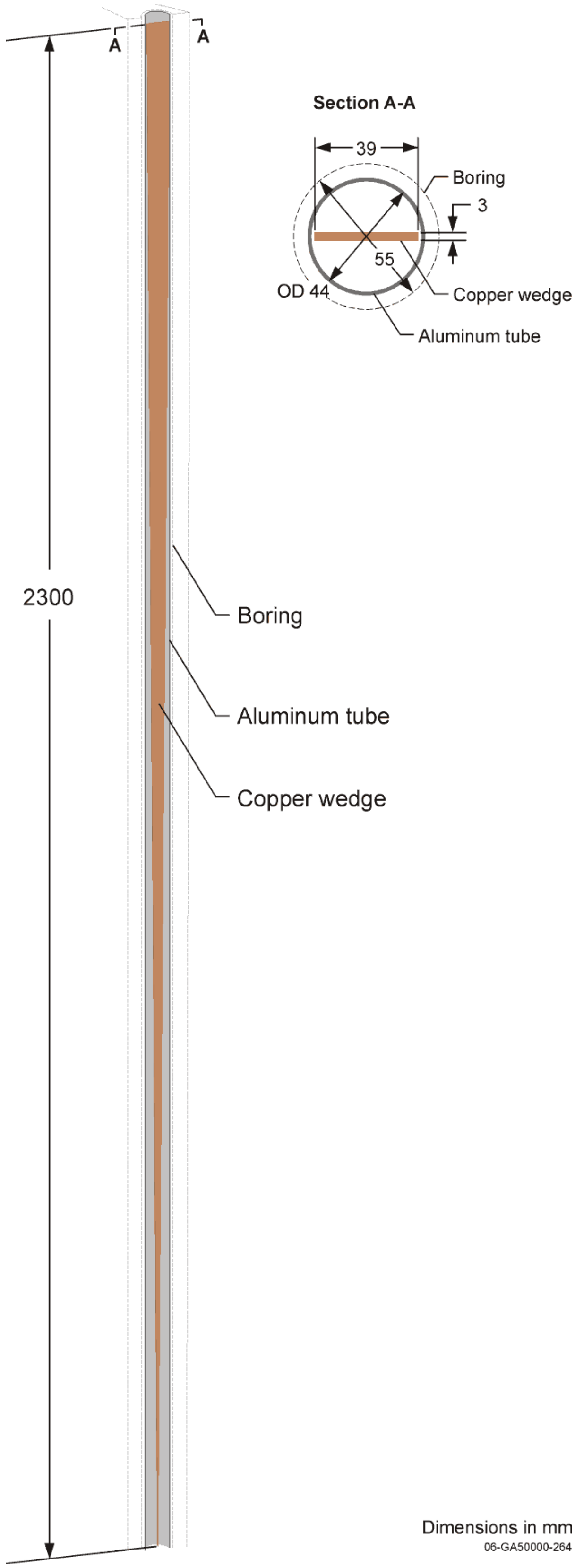

Figure 1.1-10. Automatic control rod (derived from Ref. 2).

Static Measurement Rods

Simulated control rods were manufactured for these experiments to investigate the spatial dependence of control rod worths in a particular configuration; this was necessary because the operational control rods were very restricted in their locational possibilities. These rods were designed to be inserted in either C-Driver channels in the radial reflector or into a specially designed graphite sleeve which replaced a column of pebbles in the columnar hexagonal cores. Because the core and radial reflectors were of significantly different heights, two pairs of rods were produced; apart from the axial dimensions, they were nominally identical (Ref. 2 and 3).

The rods consisted of cylindrical assemblies with an outer diameter of 26 mm and 2 mm thick Peraluman R-257 wall. The shorter pair of tubes contained eleven, 22 mm diameter, borated steel pieces of various lengths between 120 and 180 mm, totaling 1581 ± 1 mm in each assembly. The longer pair contained a total of 1711 ± 1 mm of borated steel pieces. The longer rods also contained a graphite filler piece, above the borated steel section, with a length of 1414 mm. Figure 1.1-11 and 1.1-12 show the long and short variations of the static measurement rods, respectively. The dimensions of both pairs of rods were arranged such that the borated steel regions were similarly located with respect to the axial position of the fuelled region. When the longer rods were resident in the radial reflector, the bottom of the hole in the upper hanger was flush with the upper surface of the upper steel support plate. When the shorter rod was inserted in the core region, it rested on the cavity floor. The graphite sleeve for the shorter rods (shown in Figure 1.1-13) had a length of 1730 mm, an inner diameter of 27 mm, and an outer diameter of 60 mm (Ref. 2).

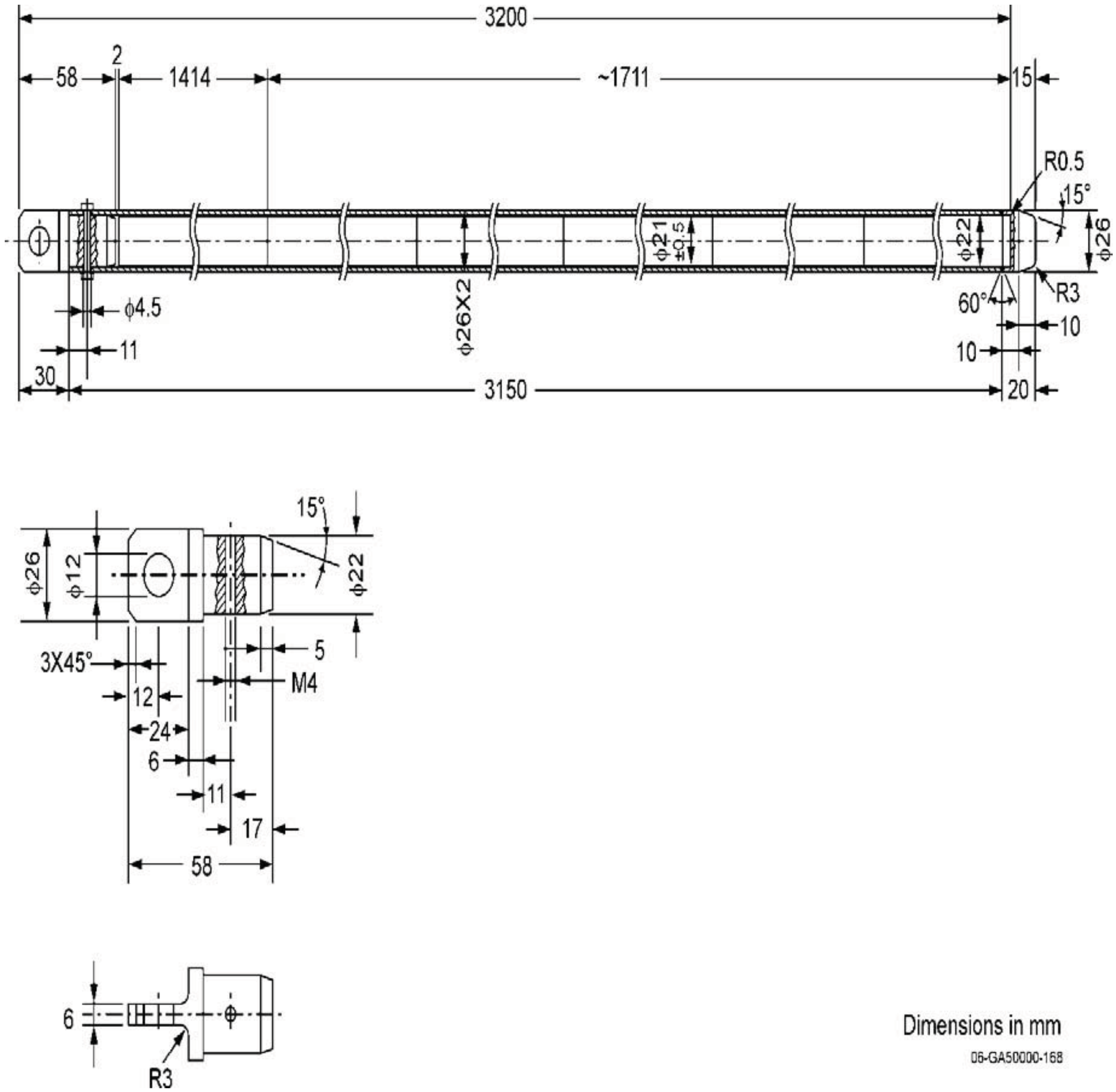

Figure 1.1-11. Details of the long static measurement rod (Ref. 2).

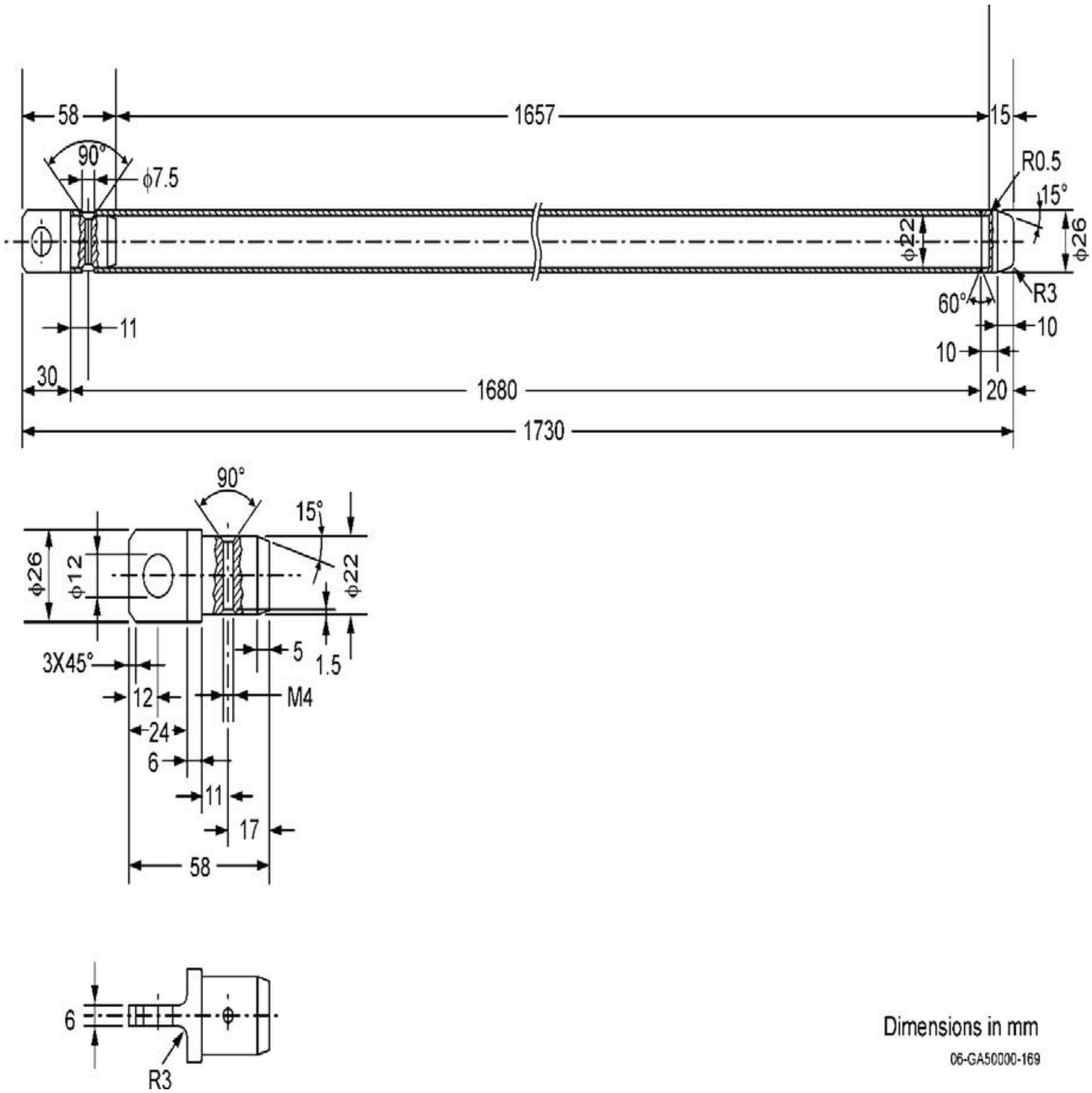

Figure 1.1-12. Details of the short static measurement rod (Ref. 2).

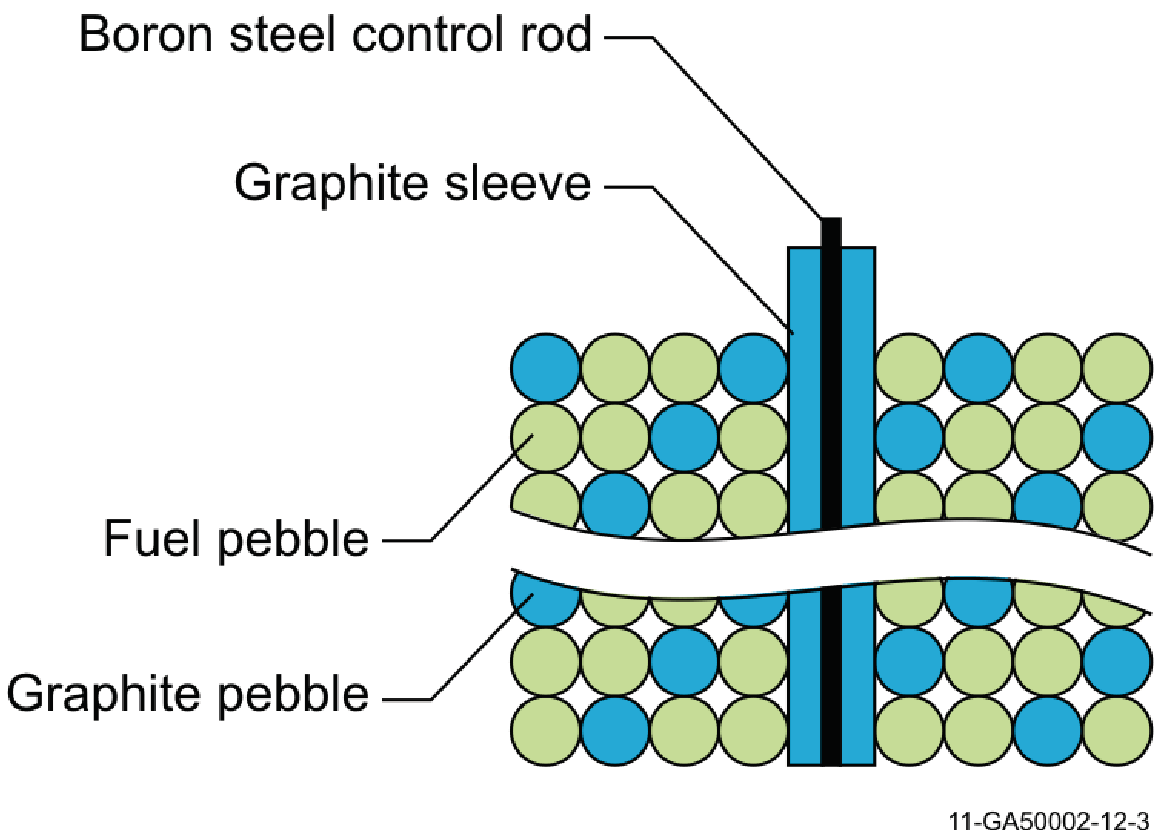

Figure 1.1-13. Graphite sleeve for short static measurement rod (Ref. 2).

Fuel Pebbles

The fuel pebble physical properties are provided in Table 1.1-1. Unless otherwise noted, these properties were obtained from the original quality control records. The specified values are averages with their corresponding 1σ standard deviations. The diameter and mass of the fuel pebbles were measured at PSI on August 17, 1992, and again on October 30, 1995. The masses of the fuel pebbles did not change significantly over the >3 year time period. However, there was a slight reduction in the fuel pebble diameter, presumably due to slight indentations of the surface caused during the loading process, and is considered insignificant.[a] Measurements performed on August 17, 1992, are recommended by PSI for use in modeling these experiments (Ref. 2 and 3). The construction and dimensions of the fuel pebble are shown in Figure 1.1-14.

Fuel for the experiments was provided by the KFA Research Center in Jülich, Germany (Ref. 3).

Arbeitsgemeinschaft Versuchsreaktor (AVR)-type fuel pebbles were employed in the HTR-PROTEUS experiments. Fuel particles were distributed randomly throughout the graphite matrix of the fuel pebbles.[b]

Some 5460 LEU AVR fuel pebbles were transferred from the LEU HTR experimental program in the AVR test facility to the PROTEUS facility in March and April of 1992.[c]

There are 9394 fuel kernels in the fuel region of each fuel pebble.[d]

[a] The HTR-PROTEUS Core 5 had been loaded three times over the course of 1.5 years; the variation in the reactivity was insignificant, which is a strong indication that the change in mass was negligible.
[b] Chawla, R., Joneja, O. P., Rosselet, M., and Williams, T., "Definition and Analysis of an Experimental Benchmark on Shutdown Rod Worths in LEU-HTR Configurations," *Nucl. Technol.*, **139**, 50-60 (2002).
[c] Brogli, R., Mathews, D., and Seiler, R., "HTR Roteus Experiments," Proc. 2nd JAERI Symposium on HTGR Technologies, Oarai, Japan, October 21-23, 1992, p. 233-239, JAERI-M 92-215 (1993).
[d] Difilippo, F. C., "Monte Carlo Calculations of Pebble Bed Benchmark Configurations of the PROTEUS Facility," *Nucl. Sci. Eng.*, **143**, 240-253 (2003).

Table 1.1-1. Fuel Pebble Physical Specifications (Ref. 2 and 3).[a]

^{234}U mass per fuel pebble	0.008	±	0.001	gram
^{235}U mass per fuel pebble	1.000	±	0.010	gram
^{236}U mass per fuel pebble	0.005	±	0.001	gram
^{238}U mass per fuel pebble	4.953	±	0.050	gram
Total uranium mass per fuel pebble	5.966	±	0.060	gram
Carbon mass per fuel pebble	193.1	±	0.2	gram
Total mass per fuel pebble[b],[c]	202.22	±	0.18	gram
Fuel pebble inner (fueled) zone radius[d]	2.350[f]	±	0.025	cm
Fuel pebble outer radius	3.0006	±	0.002	cm
Radius of fuel particles (UO_2 substrates)[e]	0.02510[f]	±	0.0010[g]	cm
Thickness of particle buffer coatings (C)	0.00915	±	0.0025[h]	cm
Thickness of particle inner PyC coatings[e]	0.00399	±	0.0010[h]	cm
Thickness of particle SiC coatings	0.00353	±	0.0004[h]	cm
Thickness of particle outer PyC coatings[e]	0.00400	±	0.0008[h]	cm
Density of fuel particles (UO_2 substrates)	10.88	±	0.04	g/cm^3
Density of fuel particle buffer coatings (C)	1.10	+0	-0.11[i]	g/cm^3
Density of fuel particle inner PyC coatings	1.90	±	0.05	g/cm^3
Density of fuel particle SiC coatings	3.20	±	0.02	g/cm^3
Density of fuel particle outer PyC coatings	1.89	±	0.05	g/cm^3

(a) The fuel pebble masses and outer diameters were measured at PSI on August 17, 1992, and October 30, 1995. The second series of measurements indicated a significant reduction of the pebble diameter over the 3 years of operation; however, since the mass measurements indicated no such decrease it was assumed that the apparent diameter reduction was due to indentations in the pebbles caused during handling and not from a general loss of material.
(b) The total mass of oxygen and silicon in the fuel pebbles was not reported.
(c) There is a discrepancy of 0.86 g (0.43 %) in the total fuel pebble mass of 201.4 g computed from the individual components provided in the table as compared with the measured fuel mass of 202.22 ± 0.18 g on August 17, 1992.
(d) The 47 ± 0.5 mm diameter of the fuelled region obtained from neutron radiographs made by E. Lehmann at the PSI Saphir reactor corresponds with the 47 mm diameter fuelled region given by Gontard et al. (KFA Jülich report HBK-IB-10/86).
(e) There are slight differences in the reported radius/thickness between this table and Figure 1.1-14; the differences are within their reported 1σ uncertainties.
(f) The last significant digit on these two values, zero, is not reported in Reference 3 but is reported in Reference 2.
(g) The uncertainty in the UO_2 particle radius is a 90 % confidence value.
(h) The uncertainties in the particle coating thicknesses are 95 % (2σ) confidence values.
(i) The density of the fuel particle buffer coatings is stated to be ≤1.1 g/cm^3. The one-sided 10 % uncertainty (1σ) was assumed by the authors of the reference reports in the absence of measured data.

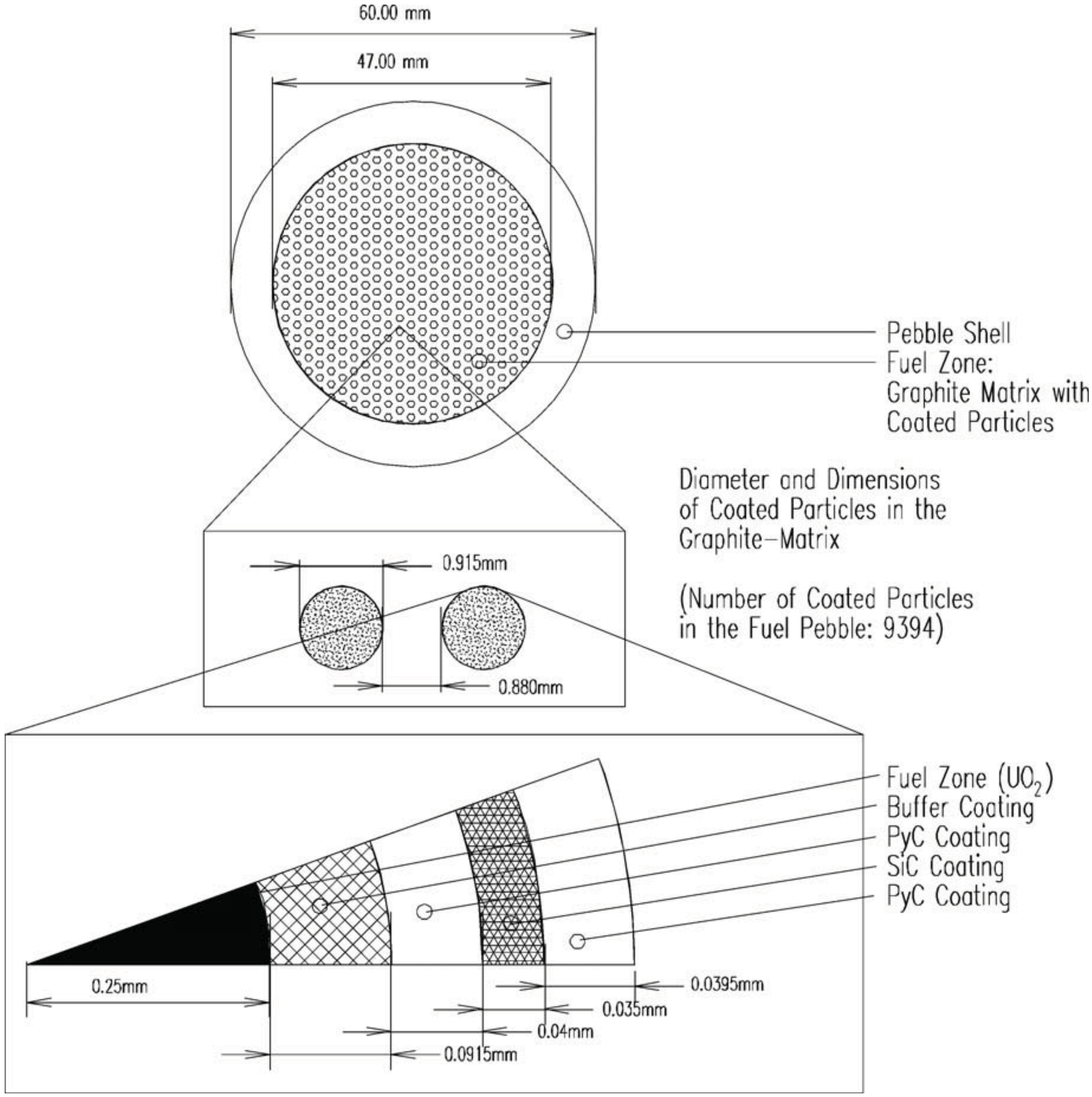

Figure 1.1-14. HTR-PROTEUS fuel pebble and coated fuel particle (Ref. 2 and 3).

Moderator Pebbles

The physical properties of the moderator pebbles (Table 1.1-2) were obtained from measurements performed at PSI on August 17, 1992, May 3, 1995, and October 30, 1995. These values correspond well with those provided in relevant quality control records. The specified values are averages with a 1σ standard deviation. There were no significant changes noted in the properties of the moderator pebbles throughout the course of these experiments (Ref. 2).

Table 1.1-2. Moderator Pebble Physical Specifications (Ref. 2 and 3).

Moderator Pebble Mass	190.54	±	1.44	g
Moderator Pebble Outer Radius	2.9979	±	0.0015	cm

Start-Up Source

The reactor start-up sources were normally in their "in" position during reactor operation. At low fluxes their reactivity effect is positive by virtue of the apparent enhanced neutron multiplication; at normal operating fluxes of $>10^7$ n/cm^2/s, their effect was negative due to parasitic neutron absorption in the source and casing. The start-up sources pass through horizontal aluminum guide tubes situated in the radial reflector at about the level of the cavity floor (Ref. 3).

Detectors

There are a total of eight detection channels used for nuclear instrumentation: three safety channels, two impulse channels, one logarithmic channel, one linear channel, and one deviation channel. Apart from the two impulse channels, which were fission chambers, all the instrumentation consisted of large ionization chambers (220 mm × 90 mm Ø) situated in horizontal channels in the reflector at a radius of ~1000 mm (Ref. 3).

Temperature Sensors

There are typically four separate temperature sensors in the system: two in the core and two in the radial reflector (Ref. 3).

1.1.2.2 Components Unique to Cores 5, 6, 7, and 8

The following components are unique to core configurations 5, 6, 7, and 8.

Graphite Fillers

Graphite filler pieces were utilized to support the outer surfaces of the various deterministic configurations and to modify the shape of the cavity floor to avoid ordering effects in random core configurations (Ref. 2). The graphite filler pieces used to modify the cavity floor were not used for Cores 5, 6, 7, and 8.

For the hexagonal close packed cores, the 22-sided cavity is converted to a 12-sided one using twelve graphite pieces running from the bottom of the cavity to just beneath the aluminum safety ring (1750 mm). Each graphite piece is unique, as shown in Figures 1.1-15 (Ref. 2). These graphite filler pieces serve as axial modifiers to the core cavity.

The 12-sided polygon cavity developed with the graphite fillers had a height of 1729 mm with sides at alternated distances of 601.5 and 603 mm from the center. The equivalent area cylinder would have a radius of 608.3 mm.[a]

A cylindrical version of the 12-sided polygon cavity would have a radius (the first value represents an equal perimeter, and the second value represents an equal area) of 615.4 and 608.3 mm, respectively.[b]

The graphite filler pieces numbered as pieces 13 and 14 in Figure 1.1-16 were not used in Cores 5, 6, 7, and 8 (Ref. 2).

[a] Difilippo, F. C., "Monte Carlo Calculations of Pebble Bed Benchmark Configurations of the PROTEUS Facility," *Nucl. Sci. Eng.*, **143**, 240-253 (2003).
[b] Difilippo, F. C., "Applications of Monte Carlo Simulations of Thermalization Processes to the Nondestructive Assay of Graphite," *Nucl. Sci. Eng.*, **133**, 163-177 (1999).

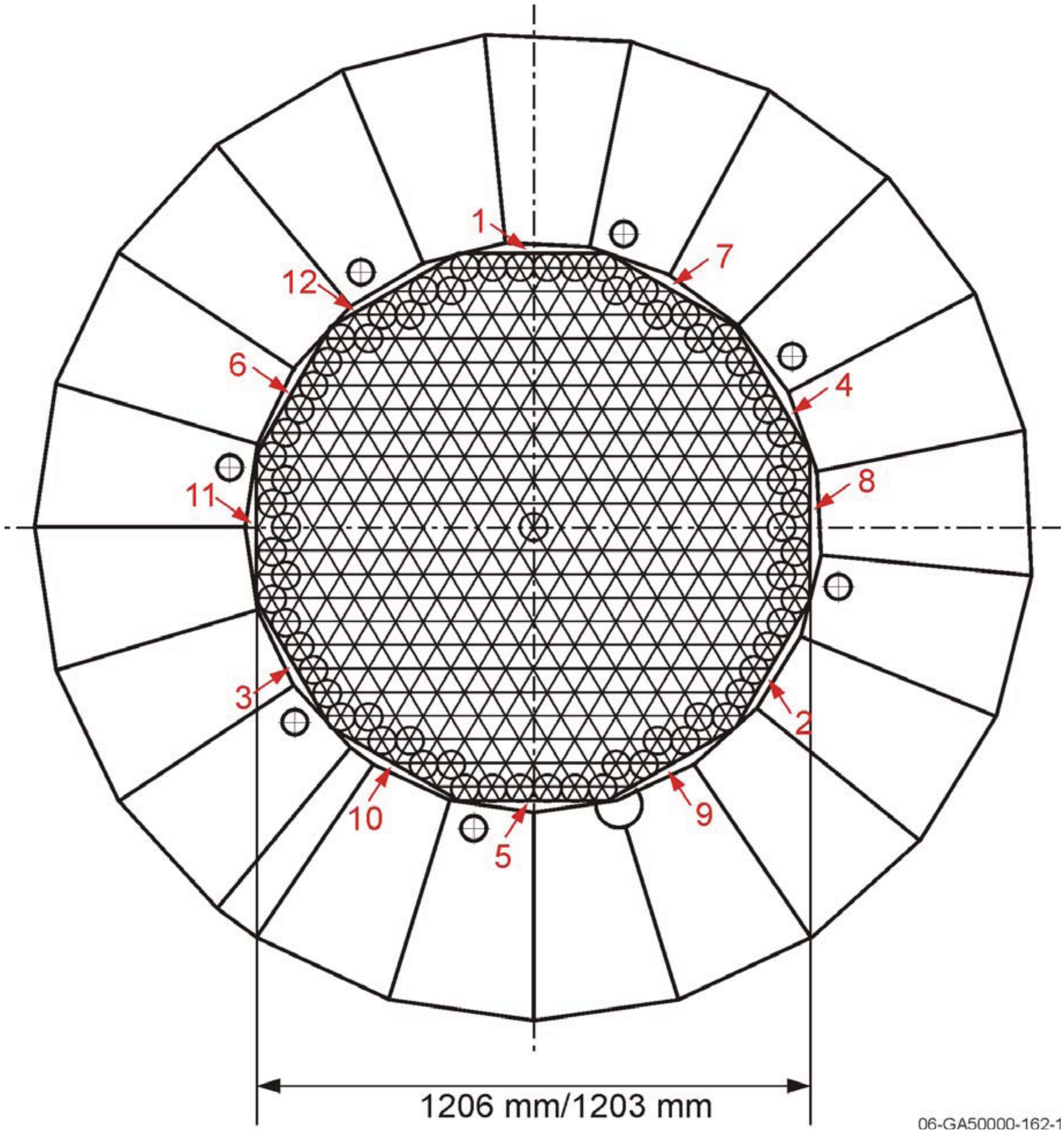

Figure 1.1-15. Positioning of the graphite filler pieces used in the deterministic cores (Ref. 2).

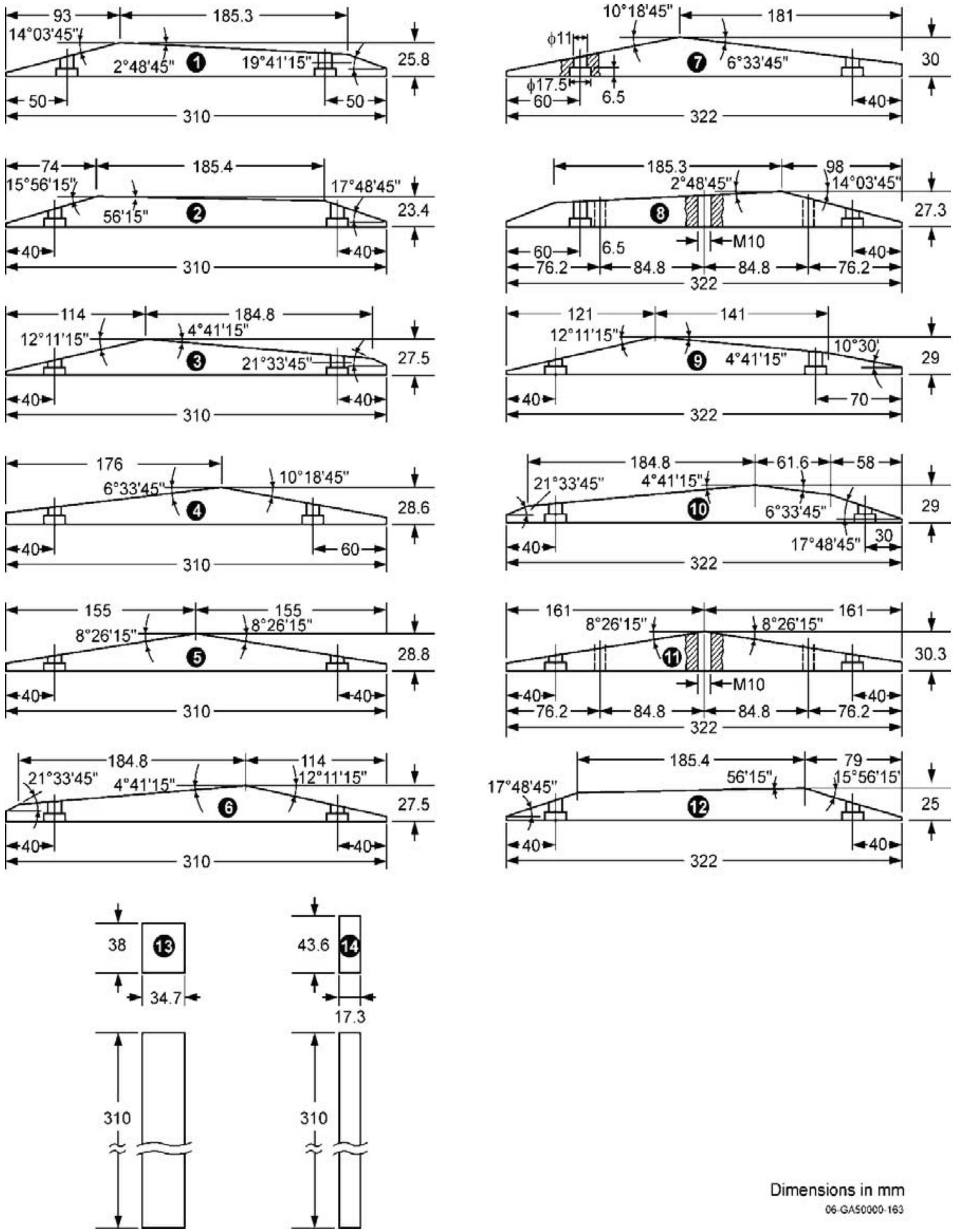

Figure 1.1-16. Graphite filler pieces used in the deterministic cores (Ref. 2). The position numbers are engraved into the top of each graphite filler piece.

ZEBRA Control Rods

The ZEBRA control rods were not used in the experiments with Cores 5, 6, 7, and 8.

Withdrawable Stainless Steel Control Rods

The ZEBRA type control rods used in Core 1were replaced with four withdrawable stainless steel control rods for Cores 1A through 10. The stainless steel rods were placed in four C-Driver channels, instead of the channels used for the ZEBRA rods, but close to the original ZEBRA positions (see Figure 1.1-2). These rods were intended to increase operational flexibility and were designed to operate at two radii: 789 mm (ring 3) or 906 mm (ring 5). They were exclusively used in ring 5 throughout the measurements due to the thermal flux gradient in the radial reflector at these positions (Ref. 2 and 3).

Each rod was comprised of two concentric stainless steel tubes. The inner stainless steel (type St1.4301) tube had an inner diameter of 9.5 mm, outer diameter of 13.5 mm, and length of 2150 mm; this tube could contain various materials, such as B_4C pellets, to further adjust the rods' worth. The outer stainless steel (type St1.4541) rod had an inner diameter of 14 mm, outer diameter of 22 mm, and length of 2149 mm; this rod was added as a means of increasing rod mass to achieve a satisfactory cable tension. Stainless steel plugs were used to seal both ends of the tubes. The total rod length, including end-stops, was 2200 mm. Technical drawings of these rods are provided in Figure 1.1-17. The rods are fully inserted when the base of the cavity in the inner tube corresponded to the core cavity floor with the tips of the rods lying 25 mm below this; the indicated rod position on the control panel was 2500 mm. The rods are fully withdrawn when the control panel indicated ~6 mm and the rod tips were just 49 mm below the upper surface of the radial reflector. The total rod range was 2494 mm. The bottom of each control rod channel was filled with a 26.5 mm diameter, 730 mm long graphite plug, leaving an air gap of 25 mm below the rod tip (Ref. 2).

No inserts were placed within these stainless steel control rods (Ref. 2).

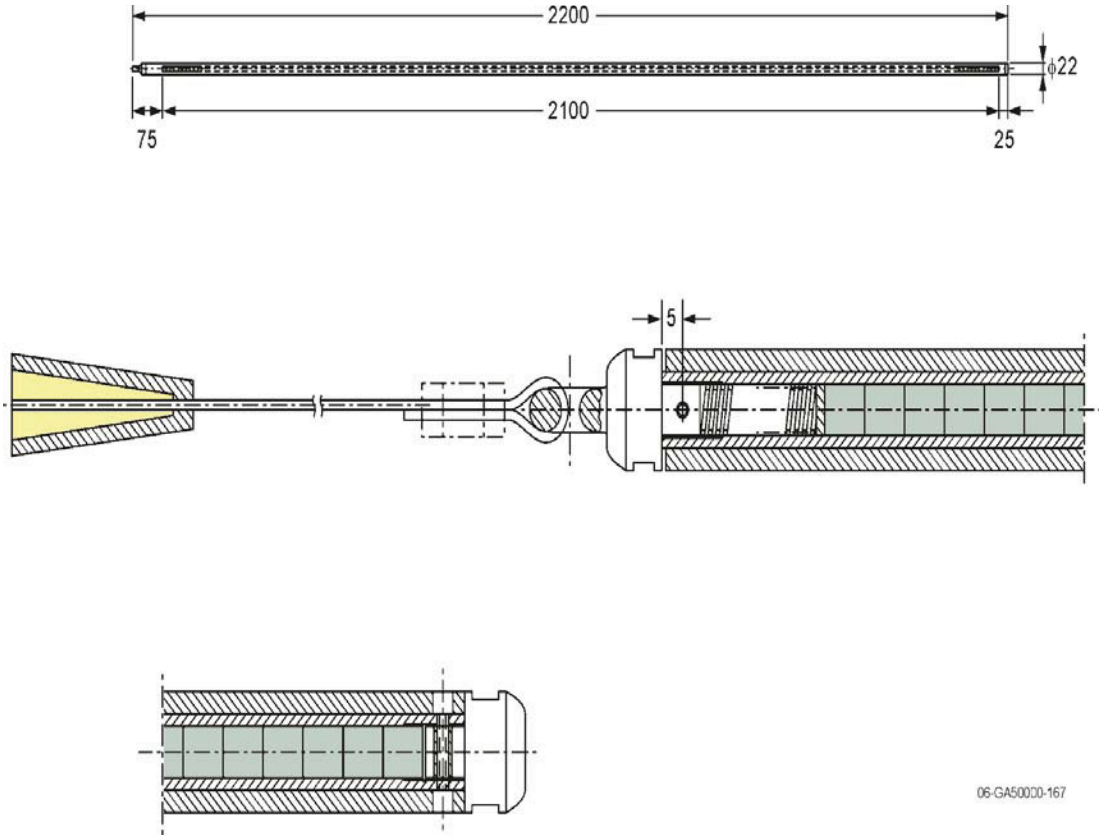

Figure 1.1-17. Details of the withdrawable stainless steel control rods (Ref. 2). Units are in millimeters.

Polyethylene Rods

One of the primary goals of the HTR-PROTEUS project was to measure the effect of accidental water ingress into the core. The use of water in the experiments was forbidden and impractical; the presence of moisture was simulated with polyethylene (CH_2) rods. Different shapes and sizes of polyethylene rods were introduced into the cores to simulate a range of water densities in the void spaces between the pebbles. The dimensions and specific linear densities of the various polyethylene rods are shown in Figure 1.1-18. Most of the rods were either unmachined, or machined down to the reported diameter from a larger diameter rod. Measurements at PSI showed that the 6 and 9 mm diameter unmachined rods demonstrated higher homogeneity than the machined versions. Additionally, the unmachined rods had not been exposed to extra 'impurity hazardous' machining environments (Ref. 2 and 3). Only the 6.5-, 8.3-, and 8.9-mm-diameter rods, and the triangular rods, were used to establish the critical core configurations of the HTR-PROTEUS experiments.

Polyethylene rods were not used in the experiments with Core 5. A total of 654 polyethylene rods were placed in the inter-pebble channels (no edge channels) of Cores 6, 7, and 8. Some rod parameters are provided in Figure 1.1-18. The hollow rods used in Core 6 had a triangular cross section, each containing a length of copper wire; the polyethylene rods were measured to be 1390 ± 6 mm in length. Polyethylene rods with a diameter of 8.3 mm and a length of 1090 ± 5 mm were utilized in Core 7. The hollow triangular rods were also used in Core 8 (without copper wire) but were shortened to the length of 15 cm (Ref. 1).

Copper Wire

Copper wire was not used in the experiments with Cores 5, 7, and 8.

Copper wire was added to Core 6 to balance the positive reactivity effect of polyethylene in the core with the absorbing effect of copper in order to obtain a core configuration similar to that of Core 5, but with a significant amount of simulated water ingress. Figure 1.1-19 shows how the copper wire was loaded into the hollow triangular polyethylene rods. The top 10 mm of each wire was bent at a right angle to support the wire within the rod (Ref. 1). The length of the copper wire was incorrectly reported as 1490 mm in Reference 1. The correct length, as reported in Reference 2, was 1400 mm. The copper wire had a nominal diameter of 1.784 mm (Refs. 2 and 3).

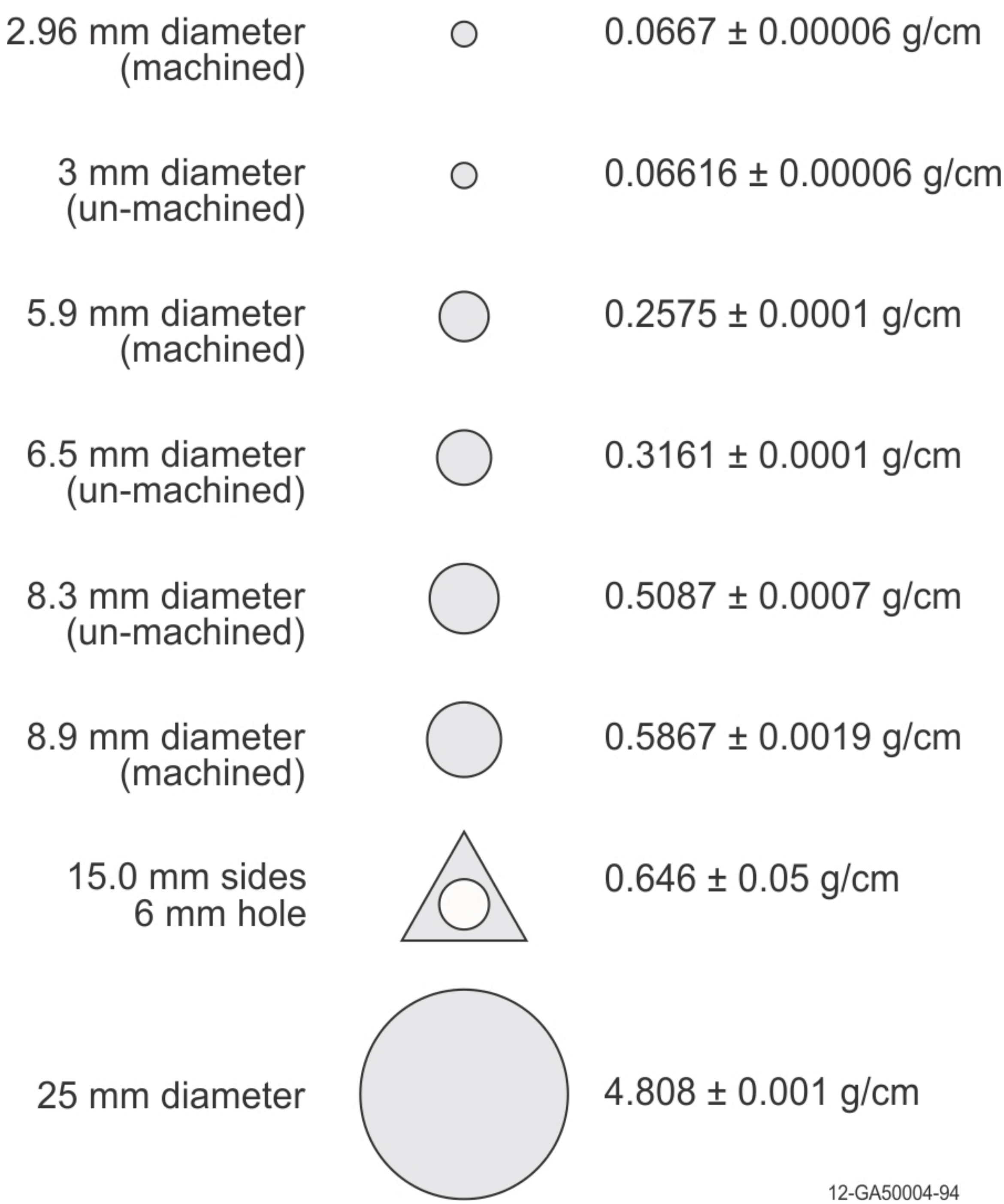

Figure 1.1-18. Physical properties of available polyethylene rods (Ref. 2 and 3). Reference 3 states that the sides of the triangular rod are 13.5 mm; however, the resultant mass density calculates to be ~1.3 g/cm^3, much greater than a typical density of 0.94 g/cm^3.

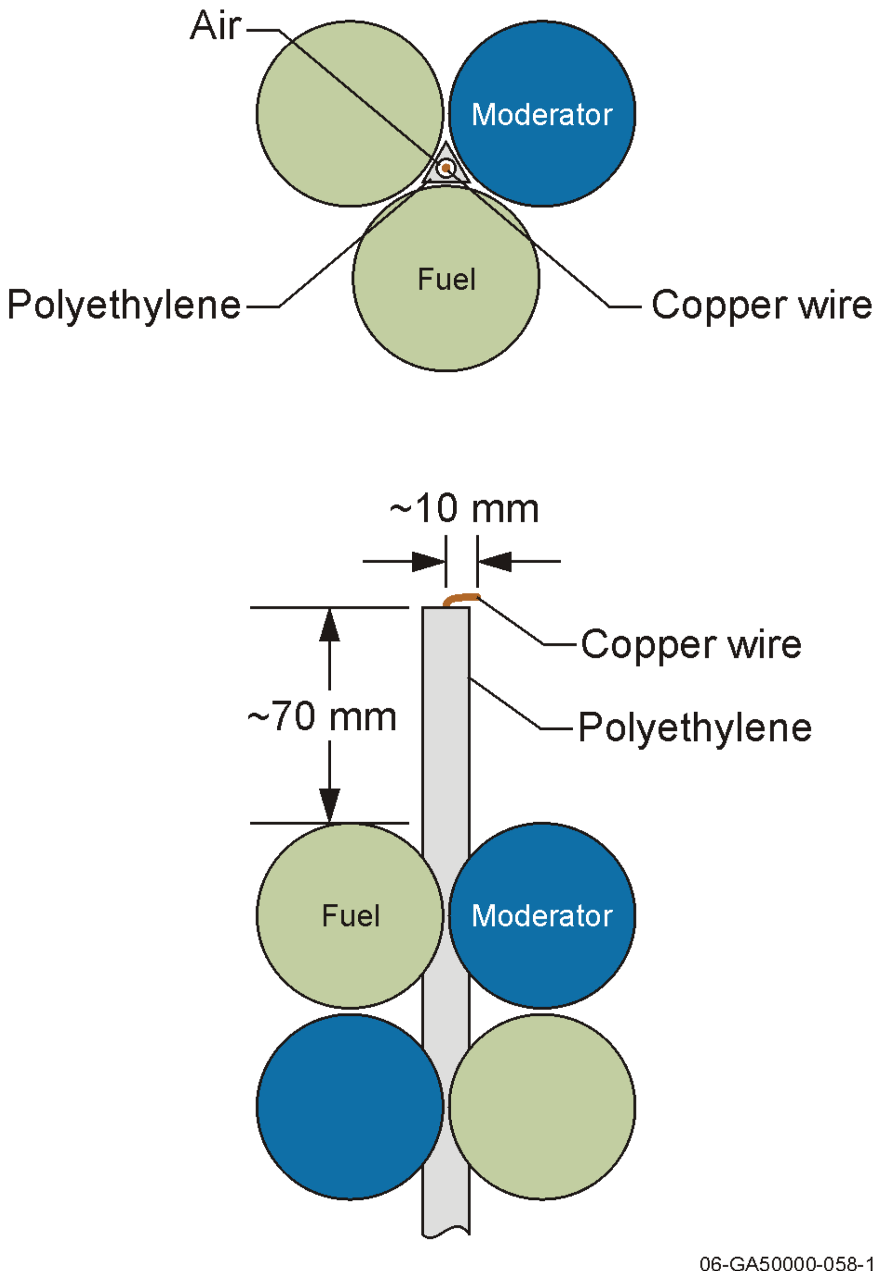

Figure 1.1-19. Placement of Copper Wire in Hollow Triangular Polyethylene Rod for Core 6 (Ref. 1).

Core Pebble Packing

Cores 5, 6, 7, and 8 were deterministically stacked in Columnar Hexagonal Point-On-Point (CHPOP) cells, as shown in Figure 1.0-3.

The deterministic configurations were loaded by hand; the fueling machine was used to deliver pebbles to the loading personnel. To facilitate access to the pebble bed, a specially constructed, shielded “loading-basket” was used. Special anodized aluminum “tripods” were constructed to facilitate with the loading of the point-on-point cores; the tripods were then removed when the layer was complete (Ref. 3).

Core Configurations

Tables 1.1-3 through 1.1-8 provide detailed summaries of the core description and critical balance information for Cores 5 though 8. Figures 1.1-20 through 1.1-25 provide scale drawings for each different pebble layer, indicating the exact type and position of every pebble, polyethylene rod, and graphite filler piece in the system. Some cores had more than one reference state, indicating either that one or more critical configurations was constructed for this core, for instance with and without the coolant channels being filled in the lower axial reflector, or, that the core was unloaded and loaded again at a later date (Ref. 1).

- Core 5 (reference state #1): Table 1.1-3 and Figures 1.1-20 through 1.1-23
- Core 5 (reference state #2): Table 1.1-4 and Figures 1.1-20 through 1.1-23
- Core 5 (reference state #3): Table 1.1-5 and Figures 1.1-20 through 1.1-23
- Core 6 (reference state #1): Table 1.1-6 and Figures 1.1-20 through 1.1-22 and 1.1-24
- Core 7 (reference state #1): Table 1.1-7 and Figures 1.1-20 through 1.1-22 and 1.1-25
- Core 8 (reference state #1): Table 1.1-8 and Figures 1.1-20 through 1.1-23

Where possible, experimental conditions had been measured directly (indicated by **M** in the tables) but in a few cases the values were estimated (**E**).

Excess reactivity worths for individual components in each core configuration are discussed in Section 1.1.5.

Table 1.1-3. Core 5 (Reference State #1) Critical Information (Ref. 1 and 3).[(a)]

Core Description			
1st Criticality	July 15, 1994		
Unloaded	April 19, 1995		
Nominal Pebble Ratio	1:2 moderator:fuel		
Pebble Count	2870 moderator, 5433 fuel		
Pebble Packing	Columnar Hexagonal Point-on-Point ABCABC… [(b)]		
Polyethylene Loading	None		
Critical Balance			
Date	February 3, 1995		
Critical Loading	23 layers	**M**[(c)]	See Figures 1.1-20 through 1.1-23
Critical Height	1.38 m	**M**	23×6 cm[(d)]
Rod Positions (Control/Autorod)	1815/880 mm	**M**	0/1000 mm = fully out[(e)]
Nominal Flux	5×10^7 n/cm^2/s	**M**	
Hall Temperature	18 ºC	**M**	
Core Temperatures (Center/Edge)	N/A		
Reflector Temperatures (R2,47/R2,15/R2,63)[(f)]	18.3 ºC	**M**	
Air Pressure	995.4 mbar[(g)]	**M**	
Air Humidity	37 %	**M**	

(a) Channels in the lower axial reflector were open.
(b) To improve the homogeneity of the core region, an ABCABC… loading scheme was adopted in which the layer pattern repeats every third layer. After loading 22 layers it was apparent that the system would not become critical and there were insufficient fuel pebbles to form a complete third layer. The remaining 138 fuel pebbles were arranged in a 2:1 lattice in the center of the 23rd layer with moderator pebbles surrounding it (see Figure 1.1-23).
(c) Directly measured experimental measurements are indicated with an **M**; sometimes a few values were estimated, and indicated with an **E**.
(d) In the columnar hexagonal point-on-point packed cores the height of each layer is ~6 cm, the approximate diameter of the pebbles. See Figure 1.0-3.
(e) The withdrawable control rods and autorod are considered fully withdrawn when their positions indicate 0 and 1000 mm, respectively.
(f) The nomenclature for the channels in the radial reflector is described in Figure 1.1-3.
(g) References 1 and 3 report an air pressure of 995 and 995.4 mbar, respectively.

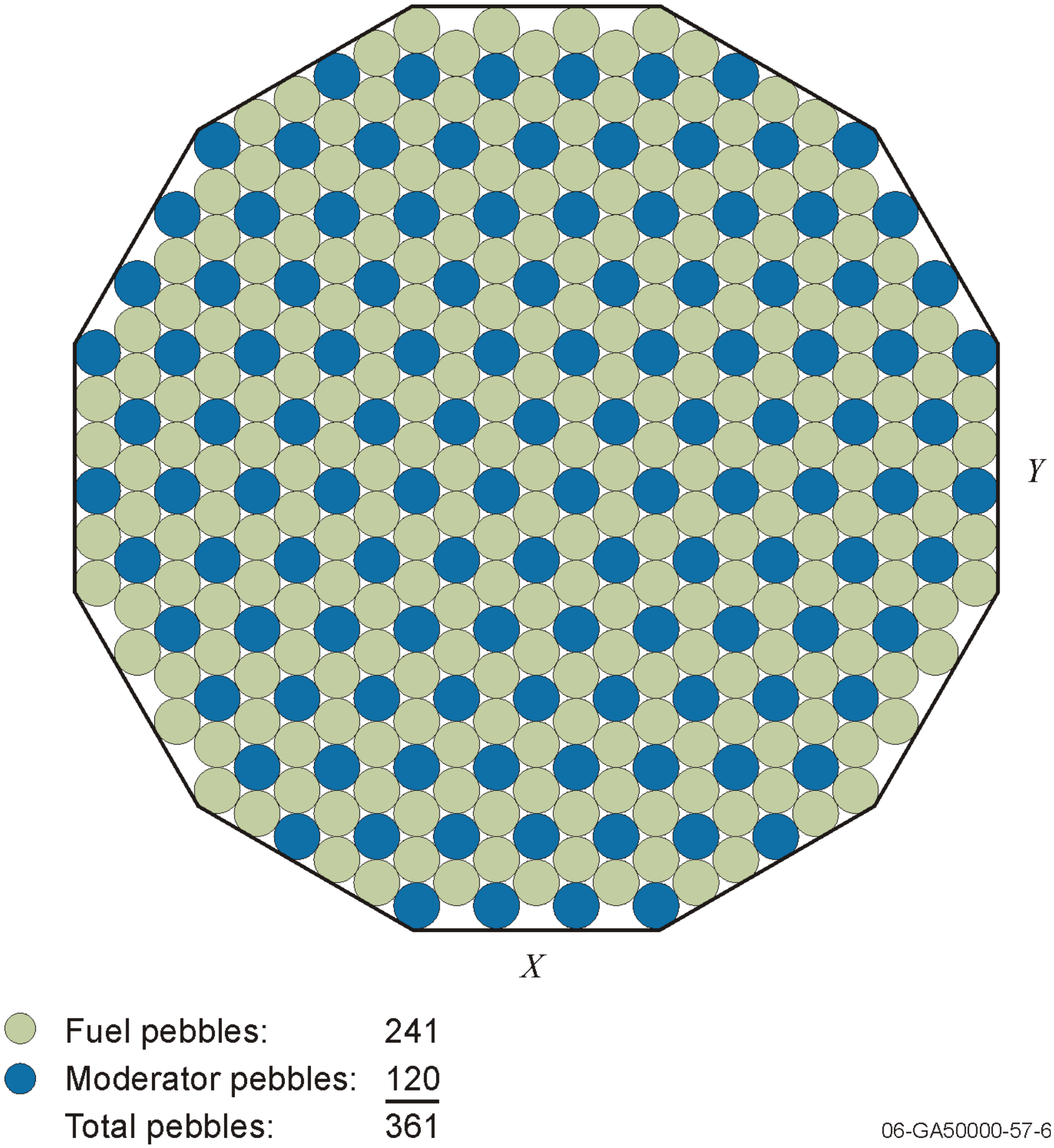

Figure 1.1-20. Layers 1, 4, 7, etc., of Cores 5, 6, 7, and 8, excluding the top layer. Polyethylene rods used in Cores 6, 7, and 8 are not shown (Ref. 1).

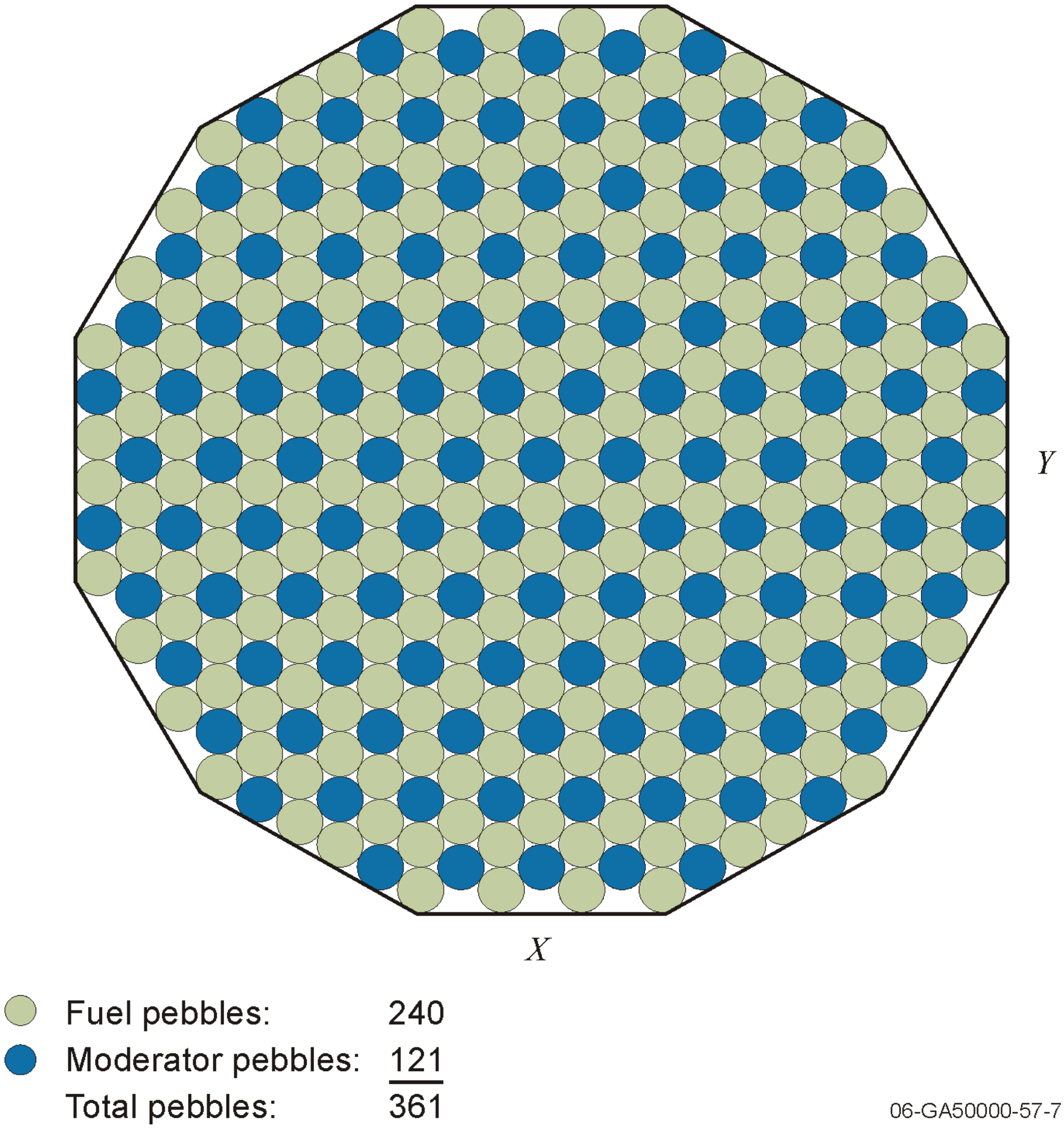

Figure 1.1-21. Layers 2, 5, 8, etc., of Cores 5, 6, 7, and 8, excluding the top layer. Polyethylene rods used in Cores 6, 7, and 8 are not shown (Ref. 1).

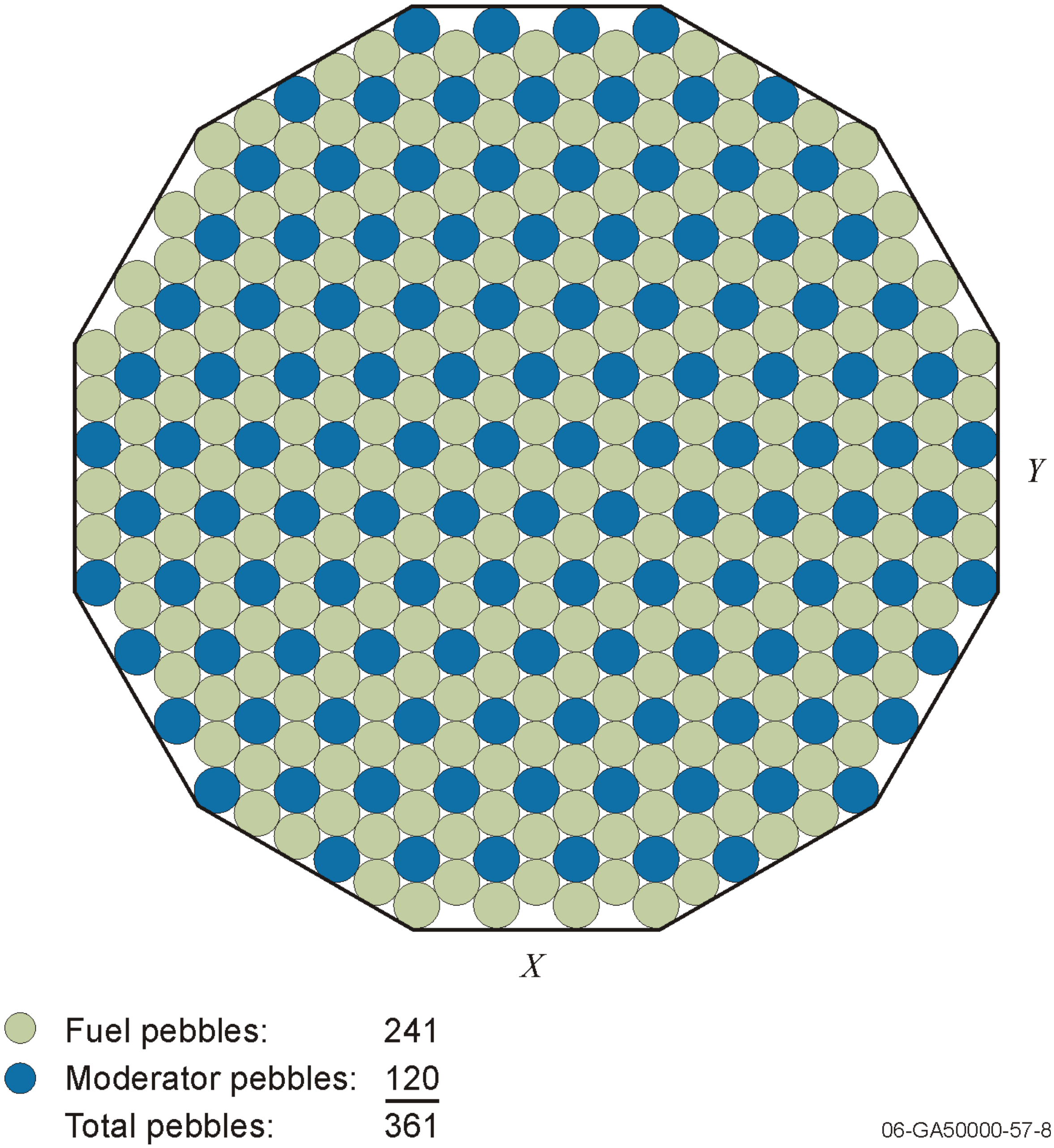

Figure 1.1-22. Layers 3, 6, 9, etc., of Cores 5, 6, 7, and 8, excluding the top layer. Polyethylene rods used in Cores 6, 7, and 8 are not shown (Ref. 1).

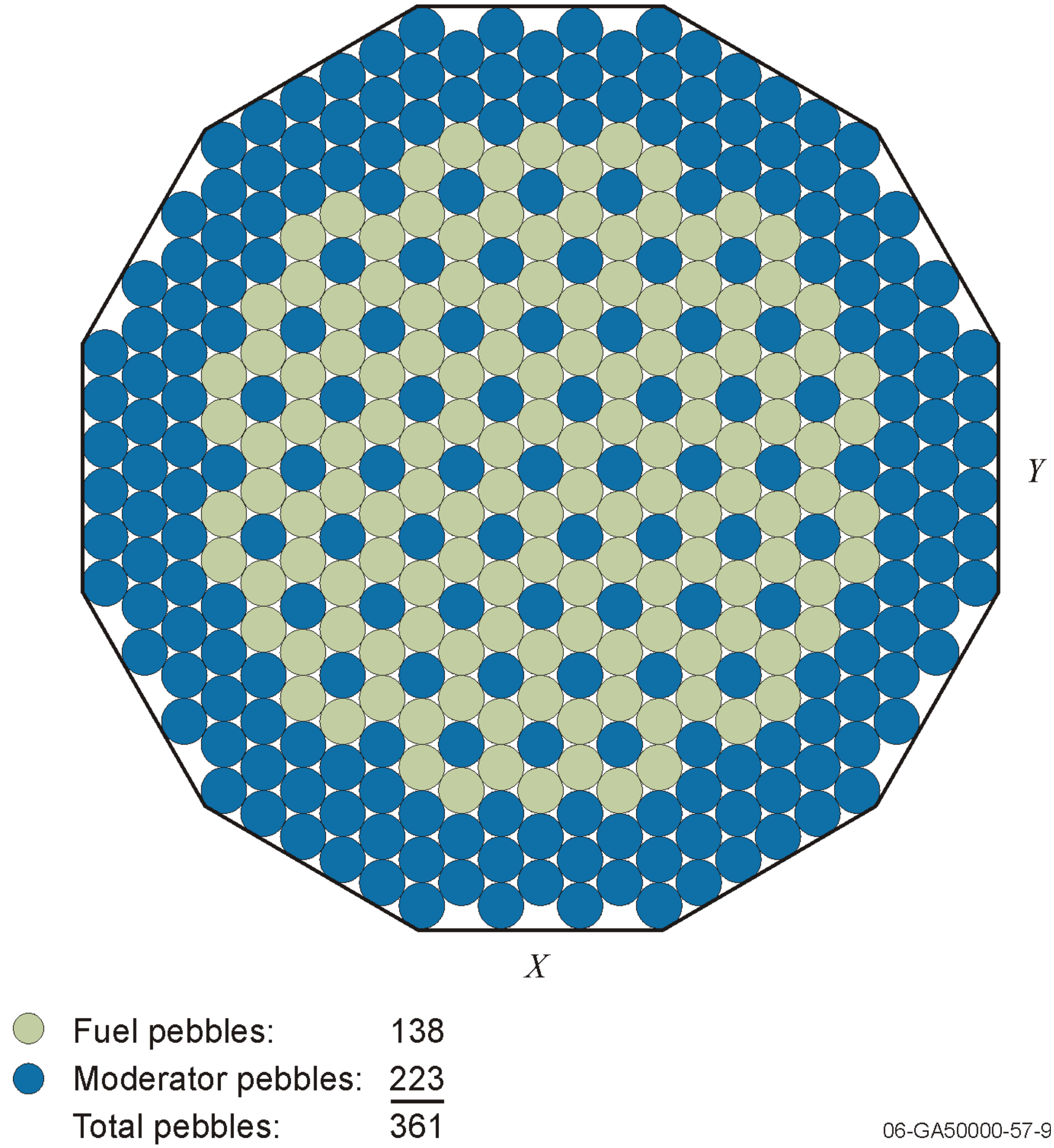

Figure 1.1-23. Top Layer (23rd) of Cores 5 and 8 (Ref. 1).

Table 1.1-4. Core 5 (Reference State #2) Critical Information (Ref. 1 and 3).[(a)]

Core Description			
1st Criticality	July 15, 1994		
Unloaded	April 19, 1995		
Nominal Pebble Ratio	1:2 moderator:fuel		
Pebble Count	2870 moderator, 5433 fuel		
Pebble Packing	Columnar Hexagonal Point-on-Point ABCABC… [(b)]		
Polyethylene Loading	None		
Critical Balance			
Date	February 3, 1995		
Critical Loading	23 layers	**M**[(c)]	See Figures 1.1-20 through 1.1-23
Critical Height	1.38 m	**M**	23×6 cm[(d)]
Rod Positions (Control/Autorod)	1945/944 mm	**M**	0/1000 mm = fully out[(e)]
Nominal Flux	5×10^7 n/cm^2/s	**M**	
Hall Temperature	18 ºC	**M**	
Core Temperatures (Center/Edge)	N/A		
Reflector Temperatures (R2,47/R2,15/R2,63)[(f)]	18.3 ºC	**M**	
Air Pressure	995 mbar[(g)]	**M**	
Air Humidity	37 %	**M**	

(a) The only difference between this state and reference state #1 is that the 33+1 coolant channels in the lower axial reflector have been filled with graphite plugs.
(b) To improve the homogeneity of the core region, an ABCABC… loading scheme was adopted in which the layer pattern repeats every third layer. After loading 22 layers it was apparent that the system would not become critical and there were insufficient fuel pebbles to form a complete third layer. The remaining 138 fuel pebbles were arranged in a 2:1 lattice in the center of the 23rd layer with moderator pebbles surrounding it (see Figure 1.1-23).
(c) Directly measured experimental measurements are indicated with an **M**; sometimes a few values were estimated, and indicated with an **E**.
(d) In the columnar hexagonal point-on-point packed cores the height of each layer is ~6 cm, the approximate diameter of the pebbles. See Figure 1.0-3.
(e) The withdrawable control rods and autorod are considered fully withdrawn when their positions indicate 0 and 1000 mm, respectively.
(f) The nomenclature for the channels in the radial reflector is described in Figure 1.1-3.
(g) References 1 and 3 report an air pressure of 995 and 995.4 mbar, respectively.

Table 1.1-5. Core 5 (Reference State #3) Critical Information (Ref. 1 and 3).[(a)]

Core Description			
1st Criticality	November 16, 1995		
Unloaded	January 25, 1996		
Nominal Pebble Ratio	1:2 moderator:fuel		
Pebble Count	2870 moderator, 5433 fuel		
Pebble Packing	Columnar Hexagonal Point-on-Point ABCABC…[(b)]		
Polyethylene Loading	None		
Critical Balance			
Date	November 16, 1995		
Critical Loading	23 layers	**M**[(c)]	See Figures 1.1-20 through 1.1-23
Critical Height	1.38 m	**M**	23×6 cm[(d)]
Rod Positions (Control/Autorod)	1945/830 mm	**M**	0/1000 mm = fully out[(e)]
Nominal Flux	5×10^7 n/cm²/s	**M**	
Hall Temperature	19.7 ºC	**M**	
Core Temperatures (Center/Edge)	N/A	**M**	
Reflector Temperatures	N/A		
Air Pressure	965 mbar	**M**	
Air Humidity	57 %	**M**	

(a) This core was repeated in order to complete some measurements that were not performed earlier. It represents a valuable check on the reproducibility of the Core 5 (reference state #2) loading.

(b) To improve the homogeneity of the core region, an ABCABC… loading scheme was adopted in which the layer pattern repeats every third layer. After loading 22 layers it was apparent that the system would not become critical and there were insufficient fuel pebbles to form a complete third layer. The remaining 138 fuel pebbles were arranged in a 2:1 lattice in the center of the 23rd layer with moderator pebbles surrounding it (see Figure 1.1-23).

(c) Directly measured experimental measurements are indicated with an **M**; sometimes a few values were estimated, and indicated with an **E**.

(d) In the columnar hexagonal point-on-point packed cores the height of each layer is ~6 cm, the approximate diameter of the pebbles. See Figure 1.0-3.

(e) The withdrawable control rods and autorod are considered fully withdrawn when their positions indicate 0 and 1000 mm, respectively.

Table 1.1-6. Core 6 (Reference State #1) Critical Information (Ref. 1 and 3).[(a)]

Core Description			
1st Criticality	April 28, 1995		
Unloaded	May 15, 1995		
Nominal Pebble Ratio	1:2 moderator:fuel		
Pebble Count	2758 moderator, 5184 fuel		
Pebble Packing	Columnar Hexagonal Point-on-Point ABCABC…		
Polyethylene Loading	654 hollow triangular CH_2 rods containing Cu wire[(b)]		
Critical Balance			
Date	May 5, 1995		
Critical Loading	22 layers[(c)]	**M**[(d)]	See Figures 1.1-20 through 1.1-22 and 1.1-24
Critical Height	1.32 m	**M**	22×6 cm[(e)]
Rod Positions (Control/Autorod)	2000/225 mm	**M**	0/1000 mm = fully out[(f)]
Nominal Flux	5×10^7 n/cm^2/s	**M**	
Hall Temperature	20.7 ºC	**M**	
Core Temperatures (Center/Edge)	N/A		
Reflector Temperatures	N/A		
Air Pressure	986 mbar	**M**	
Air Humidity	35 %	**M**	

(a) An attempt was made to balance the positive reactivity effect of polyethylene by the absorbing effect of copper wire to create a configuration with the same dimensions as Core 5 but with a significant amount of simulated water ingress. However, due to worries that the number of available fuel pebbles would be insufficient, a deliberate underestimate of the configuration reactivity was made during the planning stages which ultimately meant that one pebble layer less was required than in Core 5. The final critical loading comprised 21 layers loading similar to Core 5 with a 22nd layer with 130 fuel and 231 moderator pebbles (see Figure 1.1-24). Figure 1.1-19 Shows a close up arrangement of polyethylene and copper in a single channel.

(b) 654 hollow, triangular cross-section polyethylene rods, each containing a length of copper wire, were located in the positions indicated in Figure 1.1-24. The polyethylene rods were measured to be 1390 ± 6 mm long and the lengths of copper wire 1490 mm, of which the top 10 mm was bent at right angles to support the wire with the polyethylene rods (see Figure 1.1-19).

(c) 21 layers as Core 5 with a partially fuelled 22nd layer.

(d) Directly measured experimental measurements are indicated with an **M**; sometimes a few values were estimated, and indicated with an **E**.

(e) In the columnar hexagonal point-on-point packed cores the height of each layer is ~6 cm, the approximate diameter of the pebbles. See Figure 1.0-3.

(f) The withdrawable control rods and autorod are considered fully withdrawn when their positions indicate 0 and 1000 mm, respectively.

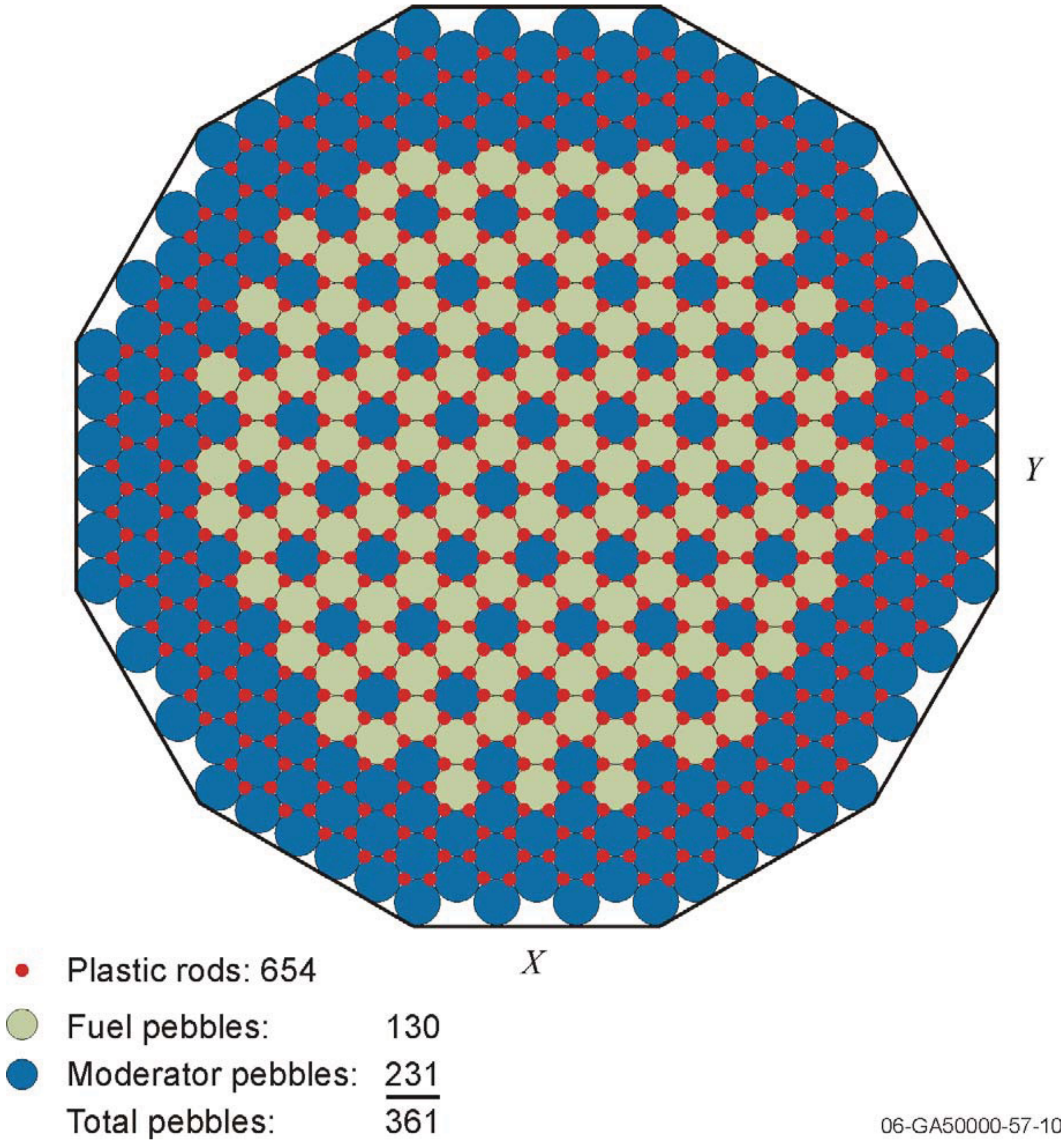

Figure 1.1-24. Top Layer (22nd) of Core 6 showing location of polyethylene rods (Ref. 1).

Table 1.1-7. Core 7 (Reference State #1) Critical Information (Ref. 1 and 3).[(a)]

Core Description			
1st Criticality	May 29, 1995		
Unloaded	October 23, 1995		
Nominal Pebble Ratio	1:2 moderator:fuel		
Pebble Count	2277 moderator, 4221 fuel		
Pebble Packing	Columnar Hexagonal Point-on-Point ABCABC…		
Polyethylene Loading	654 8.3 mm polyethylene rods[(a)]		
Critical Balance			
Date	October 12, 1995		
Critical Loading	18 layers[(b)]	**M**[(c)]	See Figures 1.1-20 through 1.1-23 and 1.1-25
Critical Height	1.08 m	**M**	18×6 cm[(d)]
Rod Positions (Control/Autorod)	1960/170 mm	**M**	0/1000 mm = fully out[(e)]
Nominal Flux	5×10^7 n/cm^2/s	**M**	
Hall Temperature	19.8 ºC	**M**	
Core Temperatures (Center/Edge)	N/A		
Reflector Temperatures	N/A		
Air Pressure	987.6 mbar	**M**	
Air Humidity	74 %	**M**	

(a) The positions of the 654 polyethylene rods are indicated in Figure 1.1-25. The rods were 8.3 mm in diameter and measured to be 1090 ± 5 mm long. These positions were identical to those in Core 6.
(b) 17 layers as Core 5 with the 18th layer only partially fuelled (see Figure 1.1-25) with 130 fuel pebbles and 231 moderator pebbles.
(c) Directly measured experimental measurements are indicated with an **M**; sometimes a few values were estimated, and indicated with an **E**.
(d) In the columnar hexagonal point-on-point packed cores the height of each layer is ~6 cm, the approximate diameter of the pebbles. See Figure 1.0-3.
(e) The withdrawable control rods and autorod are considered fully withdrawn when their positions indicate 0 and 1000 mm, respectively.

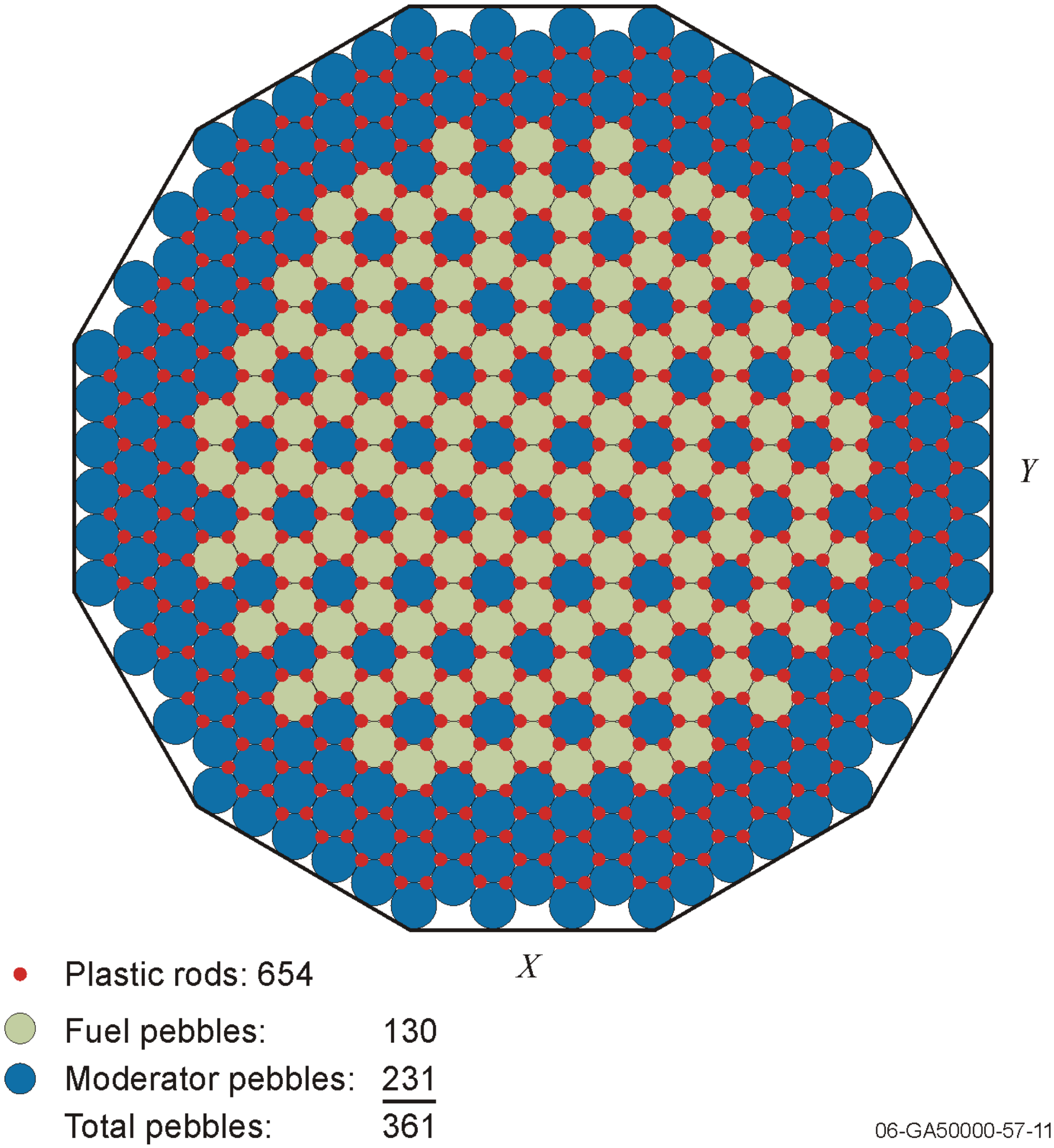

Figure 1.1-25. Top Layer (18th) of Core 7 (Ref. 1).

Table 1.1-8. Core 8 (Reference State #1) Critical Information (Ref. 1 and 3).[(a)]

Core Description			
1st Criticality	January 30, 1996		
Unloaded	February 14, 1996		
Nominal Pebble Ratio	1:2 moderator:fuel		
Pebble Count	2647+223 moderator, 5295+138 fuel[(b)]		
Pebble Packing	Columnar Hexagonal Point-on-Point ABCABC…		
Polyethylene Loading	654 15-cm-long hollow triangular rods[(b)]		
Critical Balance			
Date	February 5, 1996		
Critical Loading	23 layers[(c)]	**M**[(d)]	See Figures 1.1-20 through 1.1-23
Critical Height	1.38 m	**M**	23×6 cm[(e)]
Rod Positions (Control/Autorod)	2500/506 mm	**M**	0/1000 mm = fully out[(f)]
Nominal Flux	5×10^7 n/cm^2/s	**M**	
Hall Temperature	19.2 ºC	**M**	
Core Temperatures (Center/Edge)	N/A		
Reflector Temperatures (R2,47/R2,15)[(g)]	19.5/19.7	**M**	
Air Pressure	976 mbar	**M**	
Air Humidity	24 %	**M**	

(a) The aim of Core 8 was to produce a configuration with the same pebble loading as Core 5 but containing a substantial amount of polyethylene in the lower region of the core. This is possible because the reactivity worth of polyethylene (and therefore of water) changes from a negative effect close to the lower axial reflector to a positive one towards the center of the core. There exists a finite height of plastic which produces a null reactivity effect. It was the aim of this configuration to find this height. Initial attempts using a theoretically predicted length of 21 cm produced a configuration which was significantly more reactive than Core 5. The rods were shortened to 15 cm and criticality was obtained only with the control rods fully inserted. Because of the significant time and effort associated with unloading 654 polyethylene rods and then reloading with shorter ones, it was decided to live with this somewhat large (but well definable) excess reactivity. For the operational loading, a number of fuel pebbles were removed from the 23rd layer to reduce the control rod insertion.

(b) The total mass of polyethylene in the core was measured to be 6129.24 g.

(c) Same as for Core 5.

(d) Directly measured experimental measurements are indicated with an **M**; sometimes a few values were estimated, and indicated with an **E**.

(e) In the columnar hexagonal point-on-point packed cores the layer repeat distance is ~6 cm, the approximate diameter of the pebbles. See Figure 1.0-3.

(f) The withdrawable control rods and autorod are considered fully withdrawn when their positions indicate 0 and 1000 mm, respectively.

(g) The nomenclature for the channels in the radial reflector is described in Figure 1.1-3.

1.1.2.3 Experimental Procedure

The approach to critical for each configuration was accompanied by the usual "inverse counts versus core loading" plot with an extrapolation to 1/counts = 0 being made after each pebble loading step to give the predicted critical loading. After the first two loading steps, which were administratively limited to 1/3 and 1/6 of the number of pebbles predicted for the critical loading respectively, the remaining steps were limited to one half of the predicted additional number of pebbles required to achieve criticality, or the worth of the control rod bank, whichever was the larger value. The count rates were measured using neutron detectors situated in the radial reflector. Because the loading of a pebble bed involves a continuous core height and thus core-detector geometry change, it was expected that the approach curves would show considerable spatial dependence. For this reason, early loadings were monitored with additional detectors. The approach curves showed considerable non-linearity for detectors close to the core, with a noticeable effect as the core upper surface reached the axial position of the detector. For this reason, all subsequent approaches were made with detectors situated further out in the radial reflector (Ref. 3).

Criticality is established and power is raised by means of control rod movements. Criticality is maintained via the autorod, which is a single, radial-reflector-based rod driven automatically by the signal from a "deviation channel", to maintain reactor power and thus criticality. Since the deviation channel was comprised of an ionization chamber situated in the radial reflector, the signal noise, and hence accuracy of the determination of a critical configuration, was determined by the flux level in the reactor. The autorod itself was typically worth a total of less than 0.1$ and the uncertainty in its position represented much less than ±5 % of this range, even at relatively low fluxes. An uncertainty of <±0.005$ was typically regarded as negligible (Ref. 3).

1.1.3 Material Data

While there are many components of the PROTEUS that remain unchanged throughout the course of the HTR-PROTEUS experiments, many parameters did change between experiments, such as the use of graphite filler pieces, control rod types and locations, the presence of polyethylene rods to simulate water ingress, core pebble packing, and conditions at criticality. Section 1.1.3.1 provides information regarding general components common to all HTR-PROTEUS configurations. Section 1.1.3.2 provides information specific to the core configurations evaluated in this report.

The PROTEUS was a zero-power critical facility. It was operated at low power and temperatures; therefore, burnup of the fuel, activation of the graphite, and heating effects were negligible.

1.1.3.1 General HTR-PROTEUS Components

The following components are common to all HTR-PROTEUS core configurations.

Concrete

Concrete shielding material properties were not provided in the references. It is indicated elsewhere that barium concrete walls surrounded the experimental facility.[a]

Steel Plate Pedestal

The stainless steel plate pedestal material properties were not available.

[a] Difilippo, F. C., "Monte Carlo Calculations of Pebble Bed Benchmark Configurations of the PROTEUS Facility," *Nucl. Sci. Eng.*, **143**, 240-253 (2003).

Radial Reflector

The HTR-PROTEUS reflectors consist of graphite of various ages from several different sources. The older graphite is mainly of type "Reactor Grade A" and made by British Achesons Electrodes Ltd., of Sheffield, England, in about 1968. Some less important sections, away from the core region, were made from a similar grade material from stock material at the facility. The new graphite was manufactured in Chedde, France, by the Sociéte des Electrodes et Réfractaires Savoie in several batches over the period 1991 to 1993. The location, densities, and nominal, "as delivered", impurity contents for the graphite are summarized in Table 1.1-9 (Ref. 2).

No attempt was made to describe the impurity content of individual reflector components. A recommended global value was measured and reported, an equivalent boron content of 4.09 ± 0.05 mbarn, which includes absorbed moisture and intergranular nitrogen from air (Ref. 3).[a]

Pulsed neutron measurements were performed in the empty PROTEUS graphite reflectors (lower axial and radial) to determine the effective impurity content. The corrected measurements provide a nominal ^{10}B absorption cross section in the cavity of 2.69 ± 0.16 mbarn, which is equivalent to a concentration of 0.2696 and 0.2591 ppm for the radial and axial graphite reflectors, respectively.[b]

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[a] Williams, T., Mathews, D., and Yamane, T., "Measurement of the Absorption Properties of the HTR-PROTEUS Reflector Graphite by Means of a Pulsed-Neutron Technique," TM-41-93-34, Paul Scherrer Institut, Villigen, October 3, 1995.
[b] Difilippo, F. C., "Applications of Monte Carlo Simulations of Thermalization Processes to the Nondestructive Assay of Graphite," *Nucl. Sci. Eng.*, **133**, 163-177 (1999).

Table 1.1-9. Summary of Reactor Graphite in HTR-PROTEUS (Ref. 2 and 3).

Graphite Type	**Occurrence**	**Density (g/cm^3)**	**Nominal σ_a (mbarn/atom)[(a)]**
Old graphite remaining from previous experiments (~1968)	Majority of system	1.76 ± 0.01[(b)]	3.785 ± 0.3[(b)]
New graphite for HTR PROTEUS – Batch 1 (~1991) PSI Order Numbers 34618, 37129	1. Central part bottom axial reflector 2. Central part top axial reflector 3. Filler rods for ≈ 50 % "C-Driver" channels (inner channels) 4. Top 12 cm of radial reflector 5. Filler pieces to adjust cavity shape for required geometry	1.75 ± 0.007[(c)]	3.77 ± 0.09[(c)]
New graphite for HTR PROTEUS – Batch 2 (~1993) PSI Order Numbers 40442, 40901	1. Filler rods for ≈ 50 % "C-Driver" channels (outer channels) 2. Filler pieces for old ZEBRA rod channels 3. Alternative central part of bottom reflector with longitudinal channel to allow axial traverses	1.78[(d)]	4.08[(d)]
Moderator pebbles	Core	1.68 ± 0.03[(e)]	4.79[(e)]
Fuel pebbles	Core	1.73[(e)]	0.3829[(e)] ppm B

(a) σ_a is the neutron absorption cross section of the graphite.
(b) Reactor-based measurements reported in N.R.E. PROTEUS Construction Manual Section A.
(c) Reactor-based measurements SERS Test Certificates January 25, 1991, and October 10, 1991.
(d) Reactor-based measurements SERS Test Certificates January 7, 1993.
(e) Chemical analyses HOBEG GmbH Test Certificates for fuel and moderator pebbles.

The apparent density of seven samples from each of the four separate graphitizing heats (batches) of the Achesons graphite were measured (twenty-eight samples altogether). An average density of 1.763 ± 0.012 g/cm^3 was obtained (1σ standard deviation based on the twenty-eight reported results). Quality control documentation for the new graphite claimed densities between 1.75 and 1.78 g/cm^3, consistent with the older graphite value. The old graphite comprises the majority of the reflector system (Ref. 2).

Four samples of reflector graphite were heated to 500 ºC under vacuum for five hours at PSI on May 14, 1993. The results are shown in Table 1.1-10. Sample number three was from new graphite manufactured in 1990;[a] the other three samples were from the older 1968 graphite. The average weight loss of the older samples was 0.0241 wt.%, compared to a loss of 0.0156 wt.% for the newer graphite. The weight loss was assumed to be primarily due to the removal of absorbed moisture (Ref. 2).

[a] It is unclear how a piece of new graphite manufactured in 1990 was used in this analysis when the new graphite was delivered in batches over the course of 1991 to 1993.

Table 1.1-10. Reflector Graphite Weight Loss During Heating in a Vacuum (Ref. 2).

Sample Number (Graphite Type)	Diameter (cm)	Length (cm)	Original Mass (g)	Mass Loss	
				(g)	(wt.%)
1 (old)	4.4	6.0	150.742385	0.02033	0.0135
2 (old)	4.0	4.1	85.523130	0.02866	0.0335
3 (new)	2.65	6.0	57. 980115	0.009055	0.0156
4 (old)	2.5	6.0	46.172465	0.01161	0.0251

The safety ring was comprised of Peraluman-300 (Table 1.1-11) and had a total mass of 10.42 kg (Ref. 2).

Table 1.1-11. Peraluman-300 (Ref. 2).

Element	Composition (wt.%)
B	<0.001
Mg	<3.1
Al	95.55
Si	0.4
Mn	<0.5
Fe	0.3
Cu	0.05
Zn	0.1
Ga	<0.01
Cd	<0.001

Upper Axial Reflector

The total mass of the graphite contained in the upper axial reflector was 1585.64 kg (Ref. 2).

The location of old and new graphite in the upper axial reflector is shown in Table 1.1-9.

The aluminum housing consisted of Peraluman-300, shown in Table 1.1-11. The total mass of Peraluman contained in this structure, below the upper surface of the graphite, was 71.48 kg (Ref. 2).

Lower Axial Reflector

The total mass of the graphite contained in the lower axial reflector was not reported.

The location of old and new graphite in the lower axial reflector is shown in Table 1.1-9.

Graphite Plugs

New graphite was used for the graphite plugs placed into holes in the reflectors (Table 1.1-9).

Safety/Shutdown Rods

The borated steel rod sections contain nominally 5 wt.% boron and are enclosed in 18/8 stainless steel tubes. The borated steel used in the HTR-PROTEUS experiments was similar to those used in previous PROTEUS experiments but was manufactured in 1991 by Böhler AG, Edelstahlwerke, Düsseldorf, Germany for the HTR-PROTEUS experiments. The steel was chemically analyzed by the manufacturer and by PSI. The Böhler measurements, performed on June 14, 1991, indicated a boron content of 4.95 %; the PSI measurements, performed on January, 8, 1992, indicated a boron content of 4.70 %. Böhler indicated that their chemical analyses were performed prior to the final casting and machining steps and that some boron could have been lost during these steps. It was not originally reported whether these measurements were performed in at.% or wt.%; the measurements were believed to be in wt.% (Ref. 2).[a]

The borated steel density, 6.878 g/cc, was measured at PSI on December 15, 1993, and has the composition shown in Table 1.1-12. The 18/8 stainless steel cladding material (Table 1.1-13) had specified elemental compositions and density, 7.92 g/cc (Ref. 2).

The aluminum parts of the shock damper were pure aluminum alloy with a measured mass of 633.65 g (Ref. 2).

Table 1.1-12. Borated Steel (Ref. 2).[(a)]

Element	Composition (wt.%)
^{10}B	0.94
^{11}B	3.76
Si	1.02
Cr	40.4
Mn	1.30
Fe	41.8
Ni	9.83
Total	99.05

(a) Measurement performed on January 8, 1992, by R. Keil of PSI.

Table 1.1-13. 18/8 Stainless Steel (Ref. 2).

Element	Composition (wt.%)
Cr	18
Fe	74
Ni	8

Automatic Control Rod (Autorod)

The autorod is comprised of a copper plate within an aluminum tube. Detailed material properties were not available in the reference reports.

[a] A boron content of ~5 wt.% is equal to ~20 at.%; therefore, the assumption that the original measurements were reported in wt.% is correct.

Static Measurement Rods

The static measurement rods were comprised of a Peraluman R-257 tube containing borated steel pieces. The Peraluman R-257 density was 2.65 g/cm^3 with the specified composition shown in Table 1.1-14. Peraluman R-257 has lower neutron absorption than Peraluman-300 due to the reduced manganese content. The borated steel had a nominal boron content of 5 wt.%. Some borated steel sections were analyzed separately at PSI on January 8, 1992 (see Table 1.1-12). The borated steel density was measured on December 17, 1993, using three as-built pieces; the density was 7.199 ± 0.029 g/cc. The long pair of rods also contained a graphite filler piece. The short pair of rods was placed within a graphite sleeve, which had a mass of 6.80 kg (Ref. 2).

Table 1.1-14. Peraluman R-257 (Ref. 2).

Element	Composition (wt.%)
B	<0.001
Mg	<2.8
Al	96.658
Si	0.2
Mn	<0.01
Fe	0.2
Cu	0.02
Zn	0.1
Ga	<0.01
Cd	<0.001

Fuel Pebbles

Fuel masses are shown in Table 1.1-1.

Impurities in the UO_2 used in the TRISO fuel particles are provided in Table 1.1-15. The specified values are averages taken from the fuel pebble quality control records. Impurity estimates for five elements contributing less than 1 % of the total boron equivalent were not given (Ref. 2).

The graphite impurities in the assembled fuel pebbles are provided in Table 1.1-16. The specified values are averages taken from the fuel pebble quality control records. Impurity estimates for five elements contributing less than 1 % of the total boron equivalent were not given (Ref. 2).

Table 1.1-15. UO_2 Impurities (Ref. 2).

Element	Concentration (ppm by wt.)
Ag	<0.2
B	0.085
Ca	51
Cd	<0.2
Cl	<3
Co	<1
Cr	23
Dy	<0.02
Eu	<0.02
Fe	28
Gd	<0.02
Li	<1
Mn	7.5
Mo	<3
Ni	2.5
S	<0.04
Ti	<10
V	<10

Table 1.1-16. Fuel Pebble Graphite Impurities (Ref. 2).

Element	Concentration (ppm by wt.)
Ag	<0.2
B	0.101
Ca	9.28
Cd	<0.103
Cl	<3
Co	<0.13
Cr	1.81
Dy	<0.01
Eu	<0.01
Fe	2.95
Gd	<0.01
Li	<1
Mn	0.43
Ni	<1
S	<0.011
Ti	0.497
V	<0.433

Moderator Pebbles

Moderator pebble impurities are given in Table 1.1-17, and were obtained from the moderator pebble quality control records. Uncertainties for the moderator pebble impurities were not available, and values for fourteen elements contributing less than 0.1 % to the total boron equivalent were not given. The table does not include values for absorbed moisture in the pebbles. The quantity of moisture contained in the pebbles was measured at PSI by randomly selecting two moderator pebbles and heating them to 500 ºC under vacuum for five hours. Each pebble showed a weight loss of 0.02 g, 0.01 wt.% (Ref. 2).

Table 1.1-17. Moderator Pebble Impurities (Ref. 2).

Element	Concentration (ppm by wt.)
B	0.76
Ca	129
Cd	<0.6
Cl	18.64
Dy	0.065
Eu	0.13
Fe	5.9
Gd	0.040
Li	0.88
Ni	0.78
S	140
Si	35
Sm	0.086
Ti	10
V	13

Start-Up Source

The material properties of the start-up source were not available in the reference reports.

Detectors

The material properties of the detectors (six ionization chambers and two fission chambers) were not available in the reference reports.

Temperature Sensors

The material properties of the temperature sensors were not available in the reference reports.

1.1.3.2 Components Unique to Cores 5, 6, 7, and 8

The following components are unique to core configurations 5, 6, 7, and 8.

Graphite Fillers

The total mass of the twelve filler pieces used to convert the 22-sided cavity into a 12-sided one was 211.2 kg (Ref. 2).

ZEBRA Control Rods

The ZEBRA control rods were not used in the experiments with Cores 5, 6, 7, and 8.

Withdrawable Stainless Steel Control Rods

The inner tube of the withdrawable stainless steel control rods was St1.4301 (Table 1.1-18) and the outer tube was St1.4541 (Table 1.1-19). Both steels had a density of 7.9 g/cm^3 (Ref. 2).

Table 1.1-18. St1.4301 (Ref. 2).

Element	Composition (wt.%)
C	≤0.07
Si	≤1.0
Mn	≤2.0
Cr	17.0-20.0
Ni	9.0-11.5

Table 1.1-19. St1.4541 (Ref. 2).

Element	Composition (wt.%)
C	≤0.10
Si	≤1.0
Mn	≤2.0
Cr	17.0-19.0
Ni	9.0-11.5
Ti	≥x %C

Polyethylene Rods

Great care was taken during the manufacture of the plastic to avoid contamination with foreign isotopes. Samples of the polyethylene were sent for an elemental analysis to three independent organic chemistry laboratories; unfortunately, the results from one laboratory were inconsistent with the others, leading to additional uncertainty in the CH_2 stoichiometry. The recommended value is $CH_{2.03\pm0.03}$, which is consistent with the elemental analyses and experimental comparisons between CH_2 and H_2O worths in Cores 5, 7, and 9. The linear densities of the polyethylene rods are shown in Figure 1.1-18 (Ref. 2).

Copper Wire

Copper wire was not used in the experiments with Cores 5, 7, and 8.

The copper wire in Core 6 was reported to have a purity of 99.9 %. Twenty-five of the 1400-mm lengths used in Core 6 had a mass of 781.22 g, yielding a specific density of 0.2232 g/cm (Refs. 2 and 3).

Ambient Air

Ambient (hall) temperatures, air pressure, and humidity for HTR-PROTEUS critical experiments, Cores 5, 6, 7, and 8, are provided in the following tables:

- Core 5 (reference state #1): Table 1.1-3
- Core 5 (reference state #2): Table 1.1-4
- Core 5 (reference state #3): Table 1.1-5
- Core 6 (reference state #1): Table 1.1-6
- Core 7 (reference state #1): Table 1.1-7
- Core 8 (reference state #1): Table 1.1-8

1.1.4 Temperature Data

Room (hall) and reflector temperatures for HTR-PROTEUS critical experiments, Cores 5, 6, 7, and 8, are provided in the following tables (core, and some reflector, temperatures were not measured):

- Core 5 (reference state #1): Table 1.1-3
- Core 5 (reference state #2): Table 1.1-4
- Core 5 (reference state #3): Table 1.1-5
- Core 6 (reference state #1): Table 1.1-6
- Core 7 (reference state #1): Table 1.1-7
- Core 8 (reference state #1): Table 1.1-8

The reactor was operated at room temperature with the power limited to 1 kW so that no active cooling systems were required.[a]

1.1.5 Additional Information Relevant to Critical and Subcritical Measurements

An estimate of excess reactivity, in units of dollars, was provided for each of the core configurations. The value of β_{eff} is provided for each case. The excess reactivity was provided in terms of individual component worths such that users could pick and choose which simplifications to incorporate into their models. Where possible, the component worths had been measured directly in the relevant configurations (indicated by **M** in the tables) but in many cases the values had to be calculated (**C**), estimated (**E**), or scaled from another configuration (**S**). Most reference component worth measurements were performed in Cores 1 and 5 (Ref. 1). These measurements represent deviations of the real-life assembly from an ideal, clean core configuration. The effects of these deviations are quantified; an example of how these measurements were performed was provided elsewhere for Core 1.[b] Reactivity corrections for Cores 5 through 8, provided in the original references, are summarized in the following tables:

- Core 5 (reference state #1): Table 1.1-20
- Core 5 (reference state #2): Table 1.1-21
- Core 5 (reference state #3): Table 1.1-22
- Core 6 (reference state #1): Table 1.1-23
- Core 7 (reference state #1): Table 1.1-24
- Core 8 (reference state #1): Table 1.1-25

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[a] Köberl, O., Seiler, R., and Chawla, R., "Experimental Determination of the Ratio of 238U Capture to 235U Fission in LEU-HTR Pebble-Bed Configurations," *Nucl. Sci. Eng.*, **146**, 1-12 (2004).
[b] Williams, T., "HTR PROTEUS CORE 1: Reactivity Corrections for the Critical Balance," TM-41-93-20, Paul Scherrer Institut, Villigen, October 7, 1993.

The worth of various core components was provided to allow for the development of simplified models for calculation of the HTR-PROTEUS experiments. The measured worths of the individual components are normally evaluated against the worths of the ZEBRA/control rods, which were carefully calibrated using the stable period technique, or against the autorod worth, which had been subsequently inter-calibrated with the ZEBRA/control rods (Ref. 3).

A small degree of inhomogeneity in the radial graphite reflector was inevitable. Axial holes were required for control and shutdown rod insertion and radial and axial holes for nuclear instrumentation. The C-Driver holes in the inner radial reflector, left over from the previous experiments, had to be filled with graphite rods. These rods were relatively easy to remove and useful in estimating the effect of missing graphite. Correction for the air gaps between the 27.5 mm ID C-Driver channels and the 26.5 mm OD graphite filler rods were calculated by V. D. Davidenko of the Kurchatov Institute using the Cristall code system (Ref. 3).

No explicit measurements were made to determine the worth of the four empty ZEBRA/control rod channels. The values reported in the tables were made on the basis of the results of the C-Driver hole measurements. For safety reasons, the worth of the eight safety and shutdown rod channels cannot be measured and their values were calculated at PSI using the TWODANT code. It was considered reasonable to include them in the calculational model, removing them from the reactivity excess list (Ref. 3).

The upper and lower axial reflectors were furnished with 33 "ventilation holes" to enable air-cooling of the core. The axial thermal flux peak is strongly shifted downwards and graphite density variations in the upper part of the lower axial reflector were of greater significance than those above. Unfortunately, for practical reasons, it was difficult to measure the effect in the lower reflector and satisfactory measurements could only be made in the upper axial reflector. In the upper reflector, measurements were made with 11 of the 33 holes plugged with graphite. Because full access to the ventilation holes in the lower axial reflector is impeded from below, it was not possible to measure their worth in the usual manner. At best, it was possible to partially fill some of the channels with graphite and linearly scale the effect to 33 filled channels. In some of the core configurations all of the coolant channels in the lower axial reflector were filled with graphite plugs (Ref. 3).

In all the deterministic cores, ~12 pebbles were directly over one of the 33 cooling channels in the lower axial reflector. To avoid pebble displacement in these cases, special aluminum plugs were developed to support the pebbles in Core 1. In later cores, simple graphite rods were used (Ref. 3).

The reactor start-up sources were normally in their "in" position during reactor operation. At low fluxes their reactivity effect is positive by virtue of the apparent enhanced neutron multiplication; at normal operating fluxes of $>10^7$ n/cm^2/s, their effect was negative due to parasitic neutron absorption in the source and casing. The start-up sources pass through horizontal aluminum guide tubes situated in the radial reflector at about the level of the cavity floor. The worth of these penetrations were also measured (Ref. 3).

The pulsed neutron source, when used for subcriticality measurements, was partially inserted into the lower axial reflector. Its reactivity worth was measured by replacing it with a plug of graphite of dimensions 250 mm × 120 mm Ø (Ref. 3).

The worth of one of the six ionization chambers compared with a graphite plug was measured by opening a plugged channel and inserting a spare ionization chamber. The worth of one of the two impulse channels in the outer radial reflector was also measured by means of filling a similar channel first with a replacement detector and then with a graphite plug (Ref. 3).

The temperature sensors were systematically removed from the system in order to assess their reactivity worths (Ref. 3).

The value of β_{eff} was calculated for each of the cores (Ref. 3).

Table 1.1-20. Core 5 (Reference State #1) Reactivity Corrections (Ref. 1 and 3).

Reactivity Corrections to Critical Loading	No.		Total ¢			Comments
Control Rod Insertion (1815 mm)[a]	4	M	-68.8	±	1	
Control Rod Channels[b]	4	M	-2.2	±	0.2	
Autorod Rest Worth[c]	1	S	-10.9	±	0.3	Scaled from Total Autorod Worth
Autorod Insertion (880 mm)	1	M	-1.3	±	0.2	
Autorod Channel	1	S	-0.6	±	0.2	Scaled from Core 1A
Safety and Shutdown Rod Channels[d]	8	C	-28	±	6	Scaled from Core 1A
Empty Channels R2[b,e]	3	M	-4	±	1	
Air Gaps in C-Driver Holes[f]	320	C	-9.2			
Channels in Upper Reflector[g]	34	S	-3.6	±	2.0	= Core 1 Value
Channels in Lower Reflector[b,h]	34	M	-14.8	±	0.2	
Start-up Source Penetrations	2	S	-1	±	0.1	= Core 1 Value
Nuclear Instrumentation (Ionization)[b]	6	M	-8.0	±	1.2	
Nuclear Instrumentation (Fission)	2	S	-0.8	±	0.6	Scaled from Core 1A
Total Correction			153	±	7	
Corrected k_{eff} (β_{eff} = 0.00720)			1.0111	±	0.0005	

(a) The control rods are fully inserted when 2500 mm is indicated. Their integral and differential worths were measured using stable period measurements, yielding a total bank worth of 1.34 ± 0.04 dollars.
(b) Measured explicitly in Core 5.
(c) Not measured explicitly, but the max-min worth, measured in Core 5, was scaled according to the ratio of (rest worth)/(max-min) measured in Core 1.
(d) For safety reasons the worth of these eight channels cannot be measured and the values were calculated at PSI using the TWODANT code. It is reasonable to remove them from the reactivity excess list and to include them in the calculational model. In the table, the calculation made for Core 1 was scaled by the ratio of the control rod bank worths in Cores 1A and 4.3. Independent calculations by V. D. Davidenko of the Kurchatov Institute yielded a value of 17.9 cents for this core.
(e) R2 indicates the second ring of the C-Driver channels.
(f) Corrects for the air gaps between the 27.5 mm ID C-Driver channels and the 26.5 mm OD graphite filler rods. The value here was calculated by V. D. Davidenko of the Kurchatov Institute using the Cristall code system.
(g) Core 1 values taken but uncertainty increased.
(h) Note that the 34 channels in the lower reflector were open, but that their worth was explicitly measured in Core 5.

Table 1.1-21. Core 5 (Reference State #2) Reactivity Corrections (Ref. 1 and 3).

Reactivity Corrections to Critical Loading	**No.**		**Total ¢**			**Comments**
Control Rod Insertion (1945 mm)[(a)]	4	M	-84.2	±	1	
Control Rod Channels[(b)]	4	M	-2.2	±	0.2	
Autorod Rest Worth[(c)]	1	S	-10.9	±	0.3	Scaled from Total Autorod Worth
Autorod Insertion (944 mm)	1	M	-0.6	±	0.2	
Autorod Channel	1	S	-0.6	±	0.2	Scaled from Core 1A
Safety and Shutdown Rod Channels[(d)]	8	C	-28	±	6	Scaled from Core 1A
Empty Channels R2[(b,e)]	3	M	-4	±	1	
Air Gaps in C-Driver Holes[(f)]	320	C	-9.2			
Channels in Upper Reflector[(g)]	34	S	-3.6	±	2.0	= Core 1A Value
Start-up Source Penetrations	2	S	-1	±	0.1	= Core 1A Value
Nuclear Instrumentation (Ionization)[(b)]	6	M	-8.0	±	1.2	
Nuclear Instrumentation (Fission)	2	S	-0.8	±	0.6	Scaled from Core 1A
Total Correction			153	±	7	
Corrected k_{eff} (β_{eff} = 0.00720)			1.0111	±	0.0005	

(a) The control rods are fully inserted when 2500 mm is indicated. Their integral and differential worths were measured using stable period measurements, yielding a total bank worth of 1.34 ± 0.04 dollars.
(b) Measured explicitly in Core 5.
(c) Not measured explicitly, but the max-min worth, measured in Core 5, was scaled according to the ratio of (rest worth)/(max-min) measured in Core 1.
(d) For safety reasons the worth of these eight channels cannot be measured and the values were calculated at PSI using the TWODANT code. It is reasonable to remove them from the reactivity excess list and to include them in the calculational model. In the table, the calculation made for Core 1 was scaled by the ratio of the control rod bank worths in Cores 1A and 4.3. Independent calculations by V. D. Davidenko of the Kurchatov Institute yielded a value of 17.9 cents for this core.
(e) R2 indicates the second ring of the C-Driver channels.
(f) Corrects for the air gaps between the 27.5 mm ID C-Driver channels and the 26.5 mm OD graphite filler rods. The value here was calculated by V. D. Davidenko of the Kurchatov Institute using the Cristall code system.
(g) Core 1 values taken but uncertainty increased.

Table 1.1-22. Core 5 (Reference State #3) Reactivity Corrections (Ref. 1 and 3).

Reactivity Corrections to Critical Loading	**No.**		**Total ¢**			**Comments**
Control Rod Insertion (1945 mm)[(a)]	4	M	-84.2	±	1	
Control Rod Channels[(b)]	4	M	-2.2	±	0.2	
Autorod Rest Worth[(c)]	1	S	-10.9	±	0.3	Scaled from Total Autorod Worth
Autorod Insertion (830 mm)	1	M	-1.7	±	0.2	
Autorod Channel	1	S	-0.6	±	0.2	Scaled from Core 1A
Safety and Shutdown Rod Channels[(d)]	8	C	-28	±	6	Scaled from Core 1A
Empty Channels R2[(b,e)]	3	M	-4	±	1	
Air Gaps in C-Driver Holes[(f)]	320	C	-9.2			
Channels in Upper Reflector[(g)]	34	S	-3.6	±	2.0	= Core 1A Value
Start-up Source Penetrations	2	S	-1	±	0.1	= Core 1A Value
Nuclear Instrumentation (Ionization)[(b)]	6	M	-8.0	±	1.2	
Nuclear Instrumentation (Fission)	2	S	-0.8	±	0.6	Scaled from Core 1A
Total Correction			154	±	7	
Corrected k_{eff} (β_{eff} = 0.00720)			1.0112	±	0.0005	

(a) The control rods are fully inserted when 2500 mm is indicated. Their integral and differential worths were measured using stable period measurements, yielding a total bank worth of 1.34 ± 0.04 dollars.
(b) Measured explicitly in Core 5.
(c) Not measured explicitly, but the max-min worth, measured in Core 5, was scaled according to the ratio of (rest worth)/(max-min) measured in Core 1.
(d) For safety reasons the worth of these eight channels cannot be measured and the values were calculated at PSI using the TWODANT code. It is reasonable to remove them from the reactivity excess list and to include them in the calculational model. In the table, the calculation made for Core 1 was scaled by the ratio of the control rod bank worths in Cores 1A and 4.3. Independent calculations by V. D. Davidenko of the Kurchatov Institute yielded a value of 17.9 cents for this core.
(e) R2 indicates the second ring of the C-Driver channels.
(f) Corrects for the air gaps between the 27.5 mm ID C-Driver channels and the 26.5 mm OD graphite filler rods. The value here was calculated by V. D. Davidenko of the Kurchatov Institute using the Cristall code system.
(g) Core 1 values taken but uncertainty increased.

Table 1.1-23. Core 6 (Reference State #1) Reactivity Corrections (Ref. 1 and 3).

Reactivity Corrections to Critical Loading	No.		Total ¢			Comments
Control Rod Insertion (2000 mm)[(a)]	4	M	-51.7	±	1	
Control Rod Channels[(b)]	4	M	-1.3	±	1	Scaled from Core 1A
Autorod Rest Worth[(b)]	1	S	-5.0	±	0.5	Scaled from Core 1A
Autorod Insertion (225 mm)[(d)]	1	S	-4.9	±	0.5	Scaled from Core 1A
Autorod Channel[(b)]	1	S	-0.5	±	0.15	Scaled from Core 1A
Safety and Shutdown Rod Channels[(b,c)]	8	C,S	-16	±	4	Scaled from Core 1A
Empty Channels R2[(b,d)]	3	S	-2.7	±	1	Scaled from Core 1A
Air Gaps in C-Driver Holes[(e)]	320	C	-6.8			
Channels in Upper Reflector[(f)]	34	S	-3.6	±	2	= Core 1A Value
Start-up Source Penetrations[(f)]	2	S	-1	±	1	= Core 1A Value
Nuclear Instrumentation (Ionization)[(b)]	6	S	-5.6	±	1.8	Scaled from Core 1A
Nuclear Instrumentation (Fission)[(f)]	2	S	-0.8	±	0.6	= Core 1A Value
Total Correction			100	±	5	
Corrected k_{eff} (β_{eff} = 0.00720)			1.0075	±	0.0004	

(a) The control rods are fully inserted when 2500 mm is indicated. Stable period measurements of the total control rod bank worth in Core 6 yielded a value of 79.4 cents.
(b) The values of those components residing in the radial reflector have been scaled from the Core 1A value by the ratio of the control rod bank worths in the two cores (~0.68, very similar to Core 3).
(c) For safety reasons the worth of these eight channels cannot be measured and the values were calculated at PSI using the TWODANT code. And then scaled as in **b** above. It is recommended to remove them from the reactivity excess list and to include them in the calculational model
(d) R2 indicates the second ring of the C-Driver channels.
(e) Corrects for the air gaps between the 27.5 mm ID C-Driver channels and the 26.5 mm OD graphite filler rods. The value here was calculated by V. D. Davidenko of the Kurchatov Institute using the Cristall code system – **for Core 3**, and was considered to be applicable here because of the very similar control rod bank worths and hence reflector importances in Cores 6 and 3.
(f) Although, as a result of the increased core moderation and reduced core height, the worth of these components will be reduced compared to Core 1A, the small size of the effect does not warrant any serious attention. Instead, the Core 1A value has been adopted, but with an increased uncertainty.

Table 1.1-24. Core 7 (Reference State #1) Reactivity Corrections (Ref. 1 and 3).

Reactivity Corrections to Critical Loading	No.		Total ¢			Comments
Control Rod Insertion (1960 mm)[(a)]	4	M	-48	±	1	
Control Rod Channels[(b)]	4	S	-1.3	±	1	Scaled from Core 1A
Autorod Rest Worth[(c)]	1	M,S	-5.8	±	1	Scaled from Total
Autorod Insertion (170 mm)[(c)]	1	M	-0.8	±	0.1	Measured in Core 7
Autorod Channel[(c)]	1	S	-0.5	±	0.5	Scaled from Total
Safety and Shutdown Rod Channels[(d)]	8	C	-16	±	4	= Core 3 Value
Empty Channels R2[(b,e)]	3	S	-2.7	±	1	Scaled from Core 1A
Air Gaps in C-Driver Holes[(f)]	320	C	-6.8			= Core 3 Value
Channels in Upper Reflector[(g)]	34	S	-3.6	±	2	= Core 1A Value
Start-up Source Penetrations[(g)]	2	S	-1	±	1	= Core 1A Value
Nuclear Instrumentation (Ionization)[(b)]	6	M	-5.6	±	1.8	= Core 3 Value
Nuclear Instrumentation (Fission)[(g)]	2	S	-0.8	±	0.6	= Core 1A Value
Total Correction			93	±	5	
Corrected k_{eff} (β_{eff} = 0.00720)			1.0067	±	0.004	

(a) The control rods are fully inserted when 2500 mm is indicated. Stable period measurements of the total control rod bank worth in Core 7 yielded a value of 86 cents.

(b) The values of those components residing in the radial reflector have been scaled from the Core 1A value by the ratio of the control rod bank worths in the two cores (~0.74, very similar to Core 3).

(c) The max-min worth of the autorod was measured in Core 7 to be around 5 cents. The rest worth and channel worth have been obtained by scaling this value by the ratios of the worths of these components obtained in Core 1.

(d) For safety reasons the worth of these eight channels cannot be measured and the values were calculated for Core 1A at PSI using the TWODANT code and then scaled as in **b** above. It is recommended to remove them from the reactivity excess list and to include them in the calculational model.

(e) R2 indicates the second ring of the C-Driver channels.

(f) Corrects for the air gaps between the 27.5 mm ID C-Driver channels and the 26.5 mm OD graphite filler rods. The value here was calculated by V. D. Davidenko of the Kurchatov Institute using the Cristall code system – for Core 3, and was considered to be applicable here because of the very similar control rod bank worths and hence reflector importances in Cores 7 and 3.

(g) Although, as a result of the increased core moderation and reduced core height, the worth of these components will be reduced compared to Core 1A. The small size of the effect does not warrant any serious attention. Instead, the Core 1A value has been adopted, but with an increased uncertainty.

Table 1.1-25. Core 8 (Reference State #1) Reactivity Corrections (Ref. 1 and 3).

Reactivity Corrections to Critical Loading	No.		Total ¢			Comments
Control Rod Insertion (2500 mm)[a]	4	S	-134	±	1	Using Core 5 Calibration
Control Rod Channels	4	S	-2.2	±	0.2	Core 5 Value
Autorod Rest Worth	1	S	-10.9	±	0.3	Core 5 Value
Autorod Insertion (506 mm)	1	S	-4.0	±	0.2	Using Core 5 Calibration
Autorod Channel	1	S	-0.6	±	0.2	Core 5 Value
Safety and Shutdown Rod Channels	8	S	-28	±	6	Core 5 Value
Empty Channels R2	3	S	-4	±	1	Core 5 Value
BF_3 Detectors in R2[b]	3	M	-8.6	±	0.5	To Reduce Reactivity
Air Gaps in C-Driver Holes	320	S	-9.2			Core 5 Value
Channels in Upper Reflector[c]	34	S	-3.6	±	2	Core 5 Value
Start-up Source Penetrations	2	S	-1	±	0.1	Core 5 Value
Nuclear Instrumentation (Ionization)	6	S	-8.0	±	1.2	Core 5 Value
Nuclear Instrumentation (Fission)	2	S	-0.8	±	0.6	Core 5 Value
Total Correction			218	±	7	
Corrected k_{eff} (β_{eff} = 0.00722)			1.0160	±	0.0005	

(a) The control rods are fully inserted when 2500 mm is indicated. Total bank worth = as measured in Core 5. Spot-check measurements in Core 8 showed that the control-rod bank worths in Core 8 were essentially the same as those in Core 5.
(b) Without these detectors in place, the system was supercritical, even with the control rods fully inserted.
(c) The 34 channels in the lower axial reflector were also open, again to reduce reactivity. The worth of these channels was measured in Core 5, but it is not advisable to adopt this value for Core 8, as a consequence of the proximity of the polyethylene in this case. They must therefore be modeled; the critical balance, and any comparisons, should be made between Core 8 and Core 5 reference state #1.

1.2 Description of Buckling and Extrapolation Length Measurements

Buckling and extrapolation length measurements were made but have not yet been evaluated.

1.3 Description of Spectral Characteristics Measurements

Spectral characteristics measurements were not made.

1.4 Description of Reactivity Effects Measurements

Reactivity effects measurements were made but have not yet been evaluated.

1.5 Description of Reactivity Coefficient Measurements

Reactivity coefficient measurements were made but have not yet been evaluated.

1.6 Description of Kinetics Measurements

Kinetics measurements were made but have not yet been evaluated.

1.7 Description of Reaction-Rate Distribution Measurements

Reaction-rate distribution measurements were made but have not yet been evaluated.

1.8 Description of Power Distribution Measurements

Power distribution measurements were not made.

1.9 Description of Isotopic Measurements

Isotopic measurements were not made.

1.10 Description of Other Miscellaneous Types of Measurements

Other miscellaneous types of measurements were not made.

2.0 EVALUATION OF EXPERIMENTAL DATA

2.1 Evaluation of Critical and / or Subcritical Configuration Data

Four benchmark experiments were evaluated in this report: Cores 5, 6, 7, and 8. These core configurations represent the columnar hexagonal point-on-point (CHPOP) configurations of the HTR-PROTEUS experiment with a moderator-to-fuel pebble ratio of 1:2. All four cores use withdrawable, hollow, stainless steel control rods. Core 5 has 23 pebble layers; three configurations, or states, of Core 5 were constructed. The first state had 33 empty coolant channels in the lower axial reflector. All the channels were filled with graphite plugs for the second and third state; the latter two states slightly differed, only in the position of the autorod. An average autorod position was selected from states two and three to represent Core 5. The initial state of Core 5 was not evaluated as it was very similar in core design. Cores 6, 7, and 8 retained similar pebble loadings as Core 5, but with 22, 18, and 23 layers, respectively. The latter three core configurations each contained 654 polyethylene rods inserted between pebbles to simulate water ingress. Core 6 had triangular rods with hollow centers containing copper wire to counteract the reactivity effect of the polyethylene. Core 7 had solid polyethylene rods. Core 8 used the triangular rods, without wire, but only placed at the bottom 15 cm of the core instead of the full stack height of the pebbles.

The benchmark critical configurations for Cores 5, 6, 7, and 8 will be referred to as Cases 1, 2, 3, and 4, respectively. Both methods of identification are utilized throughout the rest of this report to facilitate users with differing familiarities with HTR-PROTEUS and IRPhEP benchmark format.

Monte Carlo n-Particle (MCNP) version 5-1.60 calculations were utilized to estimate the biases and uncertainties associated with the experimental results in this evaluation. MCNP is a general-purpose, continuous-energy, generalized-geometry, time-dependent, coupled n-particle Monte Carlo transport code.[a] The Evaluated Neutron Data File library, ENDF/B-VII.0,[b] cross section data was also used in this evaluation. The statistical uncertainty in k_{eff} and Δk_{eff} is ≤0.00007 and ≤0.00010, respectively. Calculations were performed with 1,650 generations with 100,000 neutrons per generation. The k_{eff} estimates (with the first 150 generations skipped) are the result of 150,000,000 neutron histories.

Variations of the benchmark model provided in Section 3 were utilized with perturbations of the model parameters to estimate uncertainties in k_{eff} due to uncertainties in parameter values defining the benchmark experiment. Some perturbations required more detail than that retained in the benchmark model. More detailed models (Appendix C) were utilized to evaluate these uncertainties. Transformation from the detailed model to the benchmark model is described in Section 3.1.1.1. Where applicable, comparison of the upper and lower perturbation k_{eff} values to evaluate the uncertainty in the eigenvalue were utilized to minimize correlation effects, if any, induced by comparing all perturbations to the original benchmark model configuration, as discussed elsewhere.[c]

Unless specifically stated otherwise, all uncertainty values in this section correspond to 1σ. When the change in k_{eff} between the base case and the perturbed model (single-sided perturbation), or two perturbed models (double-sided perturbation directly comparing an upper and a lower perturbation from the base case), is less than the statistical uncertainty of the Monte Carlo results, the changes in the variable are amplified, if possible, and the calculations repeated. The resulting calculated change is then scaled back, using a scaling factor, corresponding to the actual uncertainty, assuming that it is linear, which should be adequate for these changes in k_{eff}. Throughout Section 2, the difference in eigenvalues

[a] X-5 Monte Carlo Team, "MCNP – a General Monte Carlo n-Particle Transport Code, version 5," LA-UR-03-1987, Los Alamos National Laboratory (2003).
[b] M. B. Chadwick, et al., "ENDF/B-VII.0: Next Generation Evaluated Nuclear Data Library for Nuclear Science and Technology," *Nucl. Data Sheets*, **107**: 2931-3060 (2006).
[c] D. Mennerdahl, "Statistical Noise for Nuclear Criticality Safety Specialists," *Trans. Am. Nucl. Soc.*, **101**: 465-466 (2009).

computed using the perturbation method described is denoted with Δk_p; the scaled 1σ uncertainty is denoted as Δk_{eff}. All Δk_{eff} uncertainties are considered to be absolute values whose magnitude applies both positively and negatively to the experimental k_{eff}, as shown in Tables 2.1-32 through 2.1-35. Negative signs are retained in other tables in Section 2, where the effective uncertainty is reported for a given uncertainty perturbation, to demonstrate whether the effect in k_{eff} was directly or indirectly proportional to the uncertainty.

Evaluated uncertainties ≤0.00010 are considered negligible because their calculated worth is within the statistical uncertainty of the Monte Carlo approach being utilized.

Elemental data such as molecular weights and isotopic abundances were taken from the 16th edition of the Chart of the Nuclides.[a] These values are summarized in Appendix E.

Milling and finishing of the graphite components to tight tolerances would be necessary to fit all the components of this assembly together. Small dimensional inconsistencies would result in increased void fractions between graphite components. The effect of these void fractions would be minor compared to the uncertainty in graphite density. The dimensions of some of the graphite parts used in this experiment series are often recorded with many significant digits. While the number of significant digits may not always represent the accuracy or precision of their respective measured value, it is assumed by the evaluator that an uncertainty of ±1 in the last reported significant digit should be adequate in evaluating the uncertainty in reported graphite dimensions. Similar discussion of tight manufacturing tolerances and the resultant small or negligible uncertainties can be found in other gas-cooled thermal reactor benchmarks (HTTR-GCR-RESR-001, -002, -003, and HTR10-GCR-RESR-001)

The total evaluated uncertainty in k_{eff} for this experiment is provided in Section 2.1.8; individual uncertainties are summed under quadrature to obtain the total uncertainty in the experimental k_{eff}.

When evaluating parameters such as measured diameters, heights, and mass, all parts of a given type are perturbed at the same time: e.g., the uranium mass in all fuel pebbles is simultaneously increased or decreased. Then the calculated uncertainty is reduced by the square root of the number of components perturbed, representative of a random uncertainty. For many of these uncertainties, there is insufficient information available to evaluate what portion of the total evaluated uncertainty is systematic instead of random. All uncertainties involving the perturbation of multiple assembly components are treated as 15% systematic in this evaluation, unless otherwise specified.

This assumption provides a basic prediction of the effect on k_{eff}. Most systematic uncertainties should be below 50 % of the total uncertainty and above the historic approach of ignoring the unknown systematic components (i.e., treat it with a 0 % probability). In actuality, careful experimenters may have an unknown systematic uncertainty that is approximately 10-15 % of their total reported uncertainty. Because significant effort had gone into the development of benchmark quality HTR-PROTEUS experiments, a systematic uncertainty of 15 % is assumed. Evaluated uncertainties are listed as calculated, such that the readers may themselves adjust results according to some desired systematic-to-random uncertainty ratio.

The following evaluated uncertainties would have both systematic and random uncertainties (Table 2.1-1). Many of these uncertainties are negligible without adjusting the computed value to account for multiple assembly components (i.e., treating the uncertainty as 100 % systematic is still negligible). The systematic and random components are only evaluated in more detail when the evaluated uncertainty (assuming 100 % systematic) is not negligible (>0.00010).

[a] E. M. Baum, H. D. Knox, and T. R. Miller, *Nuclides and Isotopes: 16th Edition*, Knolls Atomic Power Laboratory (2002).

Table 2.1-1. Summary of Uncertainties with Systematic and Random Components.

• Radial Reflector – C-Driver Positions – C-Driver Hole Diameter – ZEBRA Rod Hole Positions – ZEBRA Rod Hole Diameter – ZEBRA Hole Filler Diameter – ZEBRA Hole Filler Length – Safety/Shutdown Rod Positions – Safety/Shutdown Rod Hole Diameter – C-Driver Plug Diameter – C-Driver Plug Length • Upper Axial Reflector – Coolant Channel Positions – Coolant Channel Diameter – Plug Diameter – Plug Length • Lower Axial Reflector – Coolant Channel Positions – Coolant Channel Diameter – Plug Diameter – Plug Length • Safety/Shutdown Rods – Borated Steel Rod Diameter – Borated Steel Rod Length – Steel Tube Diametrical Thickness – Steel Tube Length	• Fuel Pebbles – Kernel Radius – Buffer Thickness – IPyC Thickness – SiC Thickness – OPyC Thickness – Fuel Zone Radius – Pebble Radius – Total Uranium Mass – Total Carbon Mass • Moderator Pebbles – Radius – Mass • Graphite Fillers – Axial Modifier Thickness – Axial Modifier Height • Stainless Steel Control Rods – Inner Tube Diametrical Thickness – Outer Tube Diametrical Thickness – Length of Tubes and End Plugs • Polyethylene Rods – Diameter – Length • Copper Wire – Diameter – Length • Measurements – Safety/Shutdown Rod Positions – Withdrawable Control Rod Positions – Core Height

2.1.1 Streamlining the Uncertainty Analysis

A comprehensive uncertainty analysis was performed for the initial HTR-PROTEUS configurations, Cores 1, 1A, 2, and 3 (PROTEUS-GCR-EXP-001). The evaluated uncertainty for many of the perturbed parameters were determined to be negligible (≤0.00010 Δk), resulting in a much shorter list of uncertainties actually contributing to the total uncertainty (see Section 2.1.22 of PROTEUS-GCR-EXP-001). Further evaluation of Cores 9 and 10 (PROTEUS-GCR-EXP-004) supported the fact that ignoring the contribution of uncertainties ≤0.00030 Δk of the total uncertainty could also be considered negligible due to the contributions from some of the more significant uncertainties. A summary of negligible uncertainties pertinent to the current benchmark configurations is provided in Table 2.1-2; these uncertainties were not evaluated as their contribution to the total uncertainty in the benchmark configurations is judged to be negligible. Table 2.1-3 contains a list of uncertainties that are individually evaluated in this report. Uncertainties relating to the ZEBRA control rods and associated holes were not evaluated as they were only pertinent in Core 1. Uncertainties in the polyethylene rod diameter, length, and impurity content were included in this analysis because Cores 6, 7, and 8 contains polyethylene rods of varying type and dimensions. Uncertainties in the copper wire, as it was used with the polyethylene rods in Core 6, are also included in this evaluation.

Table 2.1-2. Summary of Negligible Uncertainties Not Evaluated for Cores 5, 6, 7, and 8.

- Concrete
  - Thickness
  - Density
  - Composition
- Steel Plate Pedestal
  - Thickness
  - Density
  - Composition
- Radial Reflector
  - Inner Diameter
  - Outer Diameter
  - Height
  - C-Driver Hole Positions
  - C-Driver Hole Diameter
  - Autorod Hole Position
  - Autorod Hole Diameter
  - ZEBRA Rod Hole Positions
  - ZEBRA Rod Hole Diameter
  - ZEBRA Hole Filler Diameter
  - ZEBRA Hole Filler Length
  - ZEBRA Hole Filler Density
  - ZEBRA Hole Filler Impurity Content
  - Safety/Shutdown Rod Positions
  - Safety/Shutdown Rod Hole Diameter
  - Thermal Column Width
  - Thermal Column Depth
  - Thermal Column Height
  - Safety Ring Vertical Thickness
  - Safety Ring Diametrical Thickness
  - Safety Ring Density
  - Safety Ring Composition
  - C-Driver Plug Diameter
  - C-Driver Plug Length
  - C-Driver Plug Density
  - C-Driver Plug Impurities
- Upper Axial Reflector
  - Cylinder Diameter
  - Annulus Inner Diameter
  - Annulus Outer Diameter
  - Annulus Geometry
  - Height
  - Graphite Mass
  - Graphite Impurity Content
  - Coolant Channel Positions
  - Coolant Channel Diameter
  - Plug Diameter
  - Plug Length
  - Plug Density
  - Plug Impurity Content
  - Aluminum Density
- Lower Axial Reflector
  - Cylinder Diameter
  - Annulus Inner Diameter
  - Annulus Outer Diameter
  - Height
  - Cylinder Density
  - Annulus Density
  - Cylinder Impurity Content
  - Annulus Impurity Content
  - Coolant Channel Positions
  - Coolant Channel Diameter
  - Plug Diameter
  - Plug Length
  - Plug Density
  - Plug Impurity Content
  - Source Position Diameter
  - Source Position Length
  - Source Plug Diameter
  - Source Plug Length
  - Source Plug Density
  - Source Plug Impurity Content
- Safety/Shutdown Rods
  - Borated Steel Rod Diameter
  - Borated Steel Rod Length
  - Borated Steel Density
  - Boron Content of Borated Steel
  - Borated Steel Composition
  - Steel Tube Diametrical Thickness
  - Steel Tube Length
  - Steel Tube Density
  - Steel Tube Composition
  - Shock Damper Dimensions
  - Shock Damper Mass
  - Shock Damper Composition
- Autorod
  - Copper Wedge Thickness
  - Copper Wedge Length
  - Copper Wedge Density
  - Copper Wedge Composition
  - Orientation of Copper Wedge
  - Tube Thickness
  - Tube Length
  - Tube Density
  - Tube Composition

Table 2.1-2. (cont.). Summary of Negligible Uncertainties Not Evaluated for Cores 5, 6, 7, and 8.

• Fuel Pebbles – Quantity of Pebbles – Pebble Packing Fraction – Pebble Random Packing – TRISO Random Packing – Kernel Radius – Buffer Thickness – IPyC Thickness – SiC Thickness – OPyC Thickness – Fuel Zone Radius – Pebble Radius – ^{234}U Isotopic Content – ^{236}U Isotopic Content – ^{238}U Isotopic Content – Total Carbon Mass – Total Pebble Mass – Kernel Density – Buffer Density – IPyC Density – SiC Density – OPyC Density – Kernel Impurity Content – Buffer Impurity Content – IPyC Impurity Content – SiC Impurity Content – OPyC Impurity Content – Pebble Water Content – Oxygen-to-Uranium Ratio	• Moderator Pebbles – Quantity of Pebbles – Radius – Mass – Water Content • Graphite Fillers – Axial Modifier Thickness – Axial Modifier Height – Axial Modifier Mass • Stainless Steel Control Rods – Inner Tube Diametrical Thickness – Outer Tube Diametrical Thickness – Length of Tubes and End Plugs – Inner Tube Density – Outer Tube Density – Inner Tube Composition – Outer Tube Composition • Measurements – Measurement of k_{eff} – Autorod Position – Safety/Shutdown Rod Positions – Withdrawable Control Rod Positions – Temperature – Stacked Pebble Height • Ambient Air – Temperature – Pressure – Humidity • Isotopic Abundance of Boron

Table 2.1-3. Summary of Uncertainties Evaluated for Cores 5, 6, 7, and 8.

• Radial Reflector – Density – Impurity Content • Upper Axial Reflector – Location – Aluminum Support Structure Dimensions – Aluminum Composition • Fuel Pebbles – ^{235}U Isotopic Content – Pebble Uranium Mass – Fueled Zone Impurity Content – Unfueled Zone Impurity Content	• Moderator Pebbles – Impurity Content • Polyethylene Rods – Diameter – Length – Density – H:C Ratio – Impurity Content • Copper Wire – Diameter – Length – Density – Composition

2.1.2 Radial Reflector

2.1.2.1 Graphite Density

The graphite for the majority of the system, which includes much of the radial reflector and thermal column, was reported to have a density of 1.76 ± 0.01 g/cm^3 (Table 1.1-9), obtained from reactor-based measurements. Measurement of 28 graphite samples resulted in an apparent average density of 1.763 ± 0.012 g/cm^3. A value of 1.76 ± 0.012 g/cm^3 (1σ) was selected to represent the graphite utilized in the radial reflector and thermal column, using the reported average density from the construction of the assembly and the larger uncertainty obtained from apparent density measurements. All graphite (excluding pebbles) used in the HTR-PROTEUS experiments are assumed to have the same density uncertainty unless otherwise specified.

The density of the radial reflector surrounding the core, and the thermal column, was 1.76 g/cm^3. The uncertainty in the density was 0.012 g/cm^3 (1σ). A double-sided perturbation was performed in which the density was perturbed by ±0.036 g/cm^3 to estimate the uncertainty in k_{eff} due to the uncertainty in the density of the radial reflector. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty. Results are shown in Table 2.1-4.

Table 2.1-4. Effect of Uncertainty in Graphite Density.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$
1 (5)	±0.036 g/cm^3	0.00323	±	0.00005	3	0.00108	±	0.00002
2 (6)	±0.036 g/cm^3	0.00183	±	0.00004	3	0.00061	±	0.00001
3 (7)	±0.036 g/cm^3	0.00221	±	0.00004	3	0.00074	±	0.00001
4 (8)	±0.036 g/cm^3	0.00305	±	0.00005	3	0.00102	±	0.00002

2.1.2.2 Graphite Impurities

Various values were reported for the nominal absorption cross section or boron content for the graphite material used in the core (Table 1.1-9). Subtraction of the absorption cross section of graphite (~3.5 mbarn/atom) allows for estimation of the equivalent boron content (EBC) using nominal boron data (3,840,000 mbarn/atom ^{10}B, 19.9 % ^{10}B in B_{nat}).[a] These values, however, are low since they do not account for the water or air content absorbed into the graphite. Table 1.1-10 with its accompanying text provides some insight into the evaluated water content. Pulsed neutron source measurements were performed to obtain global impurity measurements for the entire core that included moisture content and intergranular nitrogen from the air. These measurements were performed in the empty PROTEUS graphite reflectors and were initially evaluated using diffusion theory.[b] Later Monte Carlo methods were used to evaluate the measured data to provide a nominal ^{10}B concentration of 2.69 ± 0.16 (assumed units of mbarn/atom), which corresponds to 0.2696 and 0.2591 ppma in the radial and axial reflectors, respectively.[c] The average EBC is 1.33 ppm (by at.%). The uncertainty in the initial reported concentration (±0.16 mbarn/atom) is propagated to obtain an uncertainty in the EBC of ±0.08 ppma (1σ).

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[a] E. M. Baum, H. D. Knox, and T. R. Miller, *Nuclides and Isotopes: 16th Edition*, Knolls Atomic Power Laboratory (2002).
[b] Williams, T., Mathews, D., and Yamane, T., "Measurement of the Absorption Properties of the HTR-PROTEUS Reflector Graphite by Means of a Pulsed-Neutron Technique," TM-41-93-34, Paul Scherrer Institut, Villigen, October 3, 1995.
[c] Difilippo, F. C., "Applications of Monte Carlo Simulations of Thermalization Processes to the Nondestructive Assay of Graphite," *Nucl. Sci. Eng.*, **133**, 163-177 (1999).

All graphite (excluding pebbles) used in the HTR-PROTEUS experiments are assumed to have the same impurity content and uncertainty unless otherwise specified.

The impurity content of the radial reflector surrounding the core and the thermal column was 1.33 ppm (EBC by atom percent). The uncertainty in the impurity content was 0.08 ppma (1σ). A double-sided perturbation was performed in which the impurity content was perturbed by ±0.24 ppma to estimate the uncertainty in k_{eff} due to the uncertainty in the impurity content of the radial reflector. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty. Results are shown in Table 2.1-5.

Table 2.1-5. Effect of Uncertainty in Graphite Impurity Content.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$
1 (5)	±0.24 ppma	-0.00309	±	0.00005	3	-0.00103	±	0.00002
2 (6)	±0.24 ppma	-0.00157	±	0.00004	3	-0.00052	±	0.00001
3 (7)	±0.24 ppma	-0.00197	±	0.00004	3	-0.00066	±	0.00001
4 (8)	±0.24 ppma	-0.00289	±	0.00005	3	-0.00096	±	0.00002

2.1.3 Upper Axial Reflector

2.1.3.1 Location above Core

The bottom surface of the graphite in the upper axial reflector is located 1893 mm above the top surface of the lower axial reflector, creating a core cavity with a height of 1893 mm. This value is obtained by calculating the difference between reported heights in Figure 1.1-1. Elsewhere it has been reported that this height is 1863 mm.[a] It is believed that this latter value was reported incorrectly. The suspended position of the upper axial reflector was measured to within 3 to 5 mm.[b]

The location of the upper axial reflector above the inside bottom of the core cavity is 1893 mm. The uncertainty in this location was assumed to be 5 mm (bounding limit with uniform probability distribution). A double-sided perturbation was performed in which the location was perturbed by ±15 mm to estimate the uncertainty in k_{eff} due to the uncertainty in the location of the upper axial reflector. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty. Results are shown in Table 2.1-6.

Table 2.1-6. Effect of Uncertainty in the Location of the Upper Axial Reflector.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$
1 (5)	±15 mm	-0.00059	±	0.00005	$3\sqrt{3}$	-0.00011	±	0.00001
2 (6)	±15 mm	-0.00024	±	0.00004	$3\sqrt{3}$	-0.00005	±	0.00001
3 (7)	±15 mm	-0.00034	±	0.00004	$3\sqrt{3}$	-0.00007	±	0.00001
4 (8)	±15 mm	-0.00056	±	0.00005	$3\sqrt{3}$	-0.00011	±	0.00001

[a] Difilippo, F. C., "Monte Carlo Calculations of Pebble Bed Benchmark Configurations of the PROTEUS Facility," *Nucl. Sci. Eng.*, **143**, 240-253 (2003).
[b] Personal communication with Oliver Köberl at PSI (October 26, 2011).

2.1.3.2 Aluminum Dimensions

A detailed model was prepared (see Appendix C) where the aluminum support structure for the upper axial reflector (see Figures 1.1-4 and 1.1-6) was included with the geometry and dimensions modeled as identical as possible to those provided in the figures. Components of the aluminum support structure were included below the upper surface of the upper axial reflector. Uncertainty in the exact geometry is assumed to be negligible since the effective bias for compacting the curved surface below the graphite components of the reflector was negligible (see Section 3.1.1.1). An uncertainty was assumed of 1 mm in the thickness of all aluminum sheet material used to manufacture the structural support for the upper axial reflector. Due to the difficulty in exactly modeling the dimensions of all aluminum components, this uncertainty is treated as systematic and total aluminum mass was not conserved.

The uncertainty in dimensions of the aluminum support structure was assumed to be 1 mm (bounding limit with uniform probability distribution). A single-sided perturbation was performed in which all thicknesses were simultaneously decreased by 2 mm (material replaced by void) to estimate the uncertainty in k_{eff} due to the uncertainty in the dimensions of the aluminum support structure. The calculated results were then scaled to obtain the 1σ uncertainty. The total mass of the aluminum was not conserved. Results are shown in Table 2.1-7.

Table 2.1-7. Effect of Uncertainty in Aluminum Dimensions.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$
1 (5)	-2 mm	-0.00209	±	0.00010	2√3	-0.00060	±	0.00003
2 (6)	-2 mm	-0.00090	±	0.00008	2√3	-0.00026	±	0.00002
3 (7)	-2 mm	-0.00124	±	0.00008	2√3	-0.00036	±	0.00002
4 (8)	-2 mm	-0.00182	±	0.00010	2√3	-0.00053	±	0.00003

2.1.3.3 Aluminum Composition

The composition specifications for Peraluman-300 is provided in Table 1.1-11. The composition values listed as less than a given value are taken at half this maximum value in the nominal material composition. The aluminum content is adjusted such that the total composition adds up to 100 %. The nominal composition used for evaluation of the uncertainty in the composition of the safety ring is in Table 2.1-8.

A double-sided perturbation was performed in which the plate composition was perturbed by minimizing and maximizing the aluminum content in the Peraluman, while simultaneously maximizing or minimizing the other elemental constituents within the specified limits, to estimate the uncertainty in k_{eff} due to the uncertainty in the composition of the aluminum support structure for the upper axial reflector. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty assuming a bounding limit with uniform probability distribution. Results are shown in Table 2.1-9.

Table 2.1-8. Composition of the Peraluman-300.

Element	Minimum wt.%	Maximum wt.%	Nominal wt.%	Nominal Atoms/barn-cm
B	--	0.001	0.0005	7.3807E-07
Mg	--	3.1	1.55	1.0177E-03
Al	Balance		97.344	5.7575E-02
Si	0.4	0.4	0.4	2.2729E-04
Mn	--	0.5	0.25	7.2621E-05
Fe	0.3	0.3	0.3	8.5730E-05
Cu	0.05	0.05	0.05	1.2557E-05
Zn	0.1	0.1	0.1	2.4398E-05
Ga	--	0.01	0.005	1.1444E-06
Cd	--	0.001	0.0005	7.0983E-08
Total	--	--	100	5.9018E-02

Table 2.1-9. Effect of Uncertainty in Support Structure Composition.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$
1 (5)	Min/Max Al	0.00060	±	0.00005	√3	0.00034	±	0.00003
2 (6)	Min/Max Al	0.00021	±	0.00004	√3	0.00012	±	0.00002
3 (7)	Min/Max Al	0.00038	±	0.00004	√3	0.00022	±	0.00002
4 (8)	Min/Max Al	0.00053	±	0.00005	√3	0.00031	±	0.00003

2.1.4 Fuel Pebbles

2.1.4.1 Quantity of Pebbles

Exact quantities of fuel and moderator pebbles were placed in the cores. There is no associated uncertainty. The number of fuel pebbles reported for each core configuration is summarized in Table 2.1-10.

Table 2.1-10. Number of Fuel Pebbles.

Case (Core)	# Fuel Pebbles
1 (5)	5433
2 (6)	5184
3 (7)	4221
4 (8)	5433

2.1.4.2 Pebble Packing Fraction

The theoretical packing fraction for an infinite columnar hexagonal point-on-point (CHPOP) packed configuration is 0.6046.[a] The packing fraction for each core configuration was computed by taking the total volume of pebbles within the core cavity (assumed diameter of 6.000 cm apiece) and dividing by the total core volume within the 12-sided region of the cavity and the pebble stack height. The packing fraction is approximately 58 vol.%, due to additional void space at the core/reflector interface. The pebbles were placed in exact positions, there is small uncertainty in the packing fraction due to the small uncertainties in the diameters of the pebbles and dimensions of the graphite reflector. This uncertainty is not evaluated because it is negligible.

Table 2.1-11. Pebble Packing Fraction.

Case (Core)	Total # Pebbles	Pebble Volume (m^3)	Pebble Stack Height (m)	Core Volume (m^3)	Packing Fraction (vol.%)[(a)]
1 (5)	8303	~0.9390	1.38	~1.6094	~58.35
2 (6)	7942	~0.8982	1.32	~1.5394	~58.35
3 (7)	6498	~0.7349	1.08	~1.2595	~58.35
4 (8)	8303	~0.9390	1.38	~1.6094	~58.35

(a) An infinite columnar hexagonal point-on-point packed lattice has a theoretical filling factor of 0.6046.

2.1.4.3 Isotopic Content (Mass) ^{235}U

The mass and uncertainty of each uranium isotope in a fuel pebble was reported in Table 1.1-1. The isotopic content of the fuel would have been measured and the mass of each isotope calculated based upon the total uranium mass within each pebble. The isotopic content (in wt.%) of each isotope was computed for both the uranium metal and UO_2 fuel kernel (see Table 2.1-12).

The mass of ^{235}U reported was 1.000 g per pebble (Table 1.1-1). The uncertainty in the ^{235}U mass was 0.010 g (~0.17 wt.%, 1σ). A double-sided perturbation was performed in which the ^{235}U mass was perturbed by ±0.030 g (~0.50 wt.%) to estimate the uncertainty in k_{eff} due to the uncertainty in the isotopic content of ^{235}U. To conserve total uranium mass, the ^{238}U mass was adjusted. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty. Results are shown in Table 2.1-13.

[a] Difilippo, F. C., "Monte Carlo Calculations of Pebble Bed Benchmark Configurations of the PROTEUS Facility," *Nucl. Sci. Eng.*, **143**, 240-253 (2003).

Table 2.1-12. Isotopic Composition of Uranium.

Isotope/Element	Mass (g)	Uranium Metal Composition (wt.%)	UO_2 Composition (wt.%)
^{234}U	0.008	0.134	0.118
^{235}U	1.000	16.762	14.77
^{236}U	0.005	0.084	0.074
^{238}U	4.953	83.020	73.155
O	--	--	11.87
Impurities	--	--	0.013
Total	5.966	100.000	100.000

Table 2.1-13. Effect of Uncertainty in the ^{235}U content.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$
1 (5)	±0.030 g (~0.50 wt.%)	0.00700	±	0.00005	3	0.00233	±	0.00002
2 (6)	±0.030 g (~0.50 wt.%)	0.01004	±	0.00004	3	0.00334	±	0.00001
3 (7)	±0.030 g (~0.50 wt.%)	0.00914	±	0.00004	3	0.00305	±	0.00001
4 (8)	±0.030 g (~0.50 wt.%)	0.00736	±	0.00005	3	0.00245	±	0.00002

2.1.4.4 Uranium Mass

Table 1.1-1 reports a mass uncertainty in the fuel of ±0.060 g, which appears to be a sum of the uncertainties in the ^{235}U and ^{238}U masses and equates to a mass density uncertainty in the UO_2 fuel of approximately 0.11 g/cm^3. However, this table also reports the uncertainty in the UO_2 density as ±0.04 g/cm^3, almost a factor of 3 smaller. The table has footnotes for some of the uncertainties to explain the confidence level of the measured parameters; however, no additional information is provided for the uranium fuel mass or UO_2 density. A fuel mass of 5.966 g (UO_2 density of 10.88 g/cm^3) was selected for the fuel kernels and the larger uncertainty of 0.060 g (0.11 g/cm^3) selected to represent the 1σ uncertainty in the uranium mass.

The total mass of uranium per fuel pebble was 5.966 g (Table 1.1-1). The uncertainty in the mass was 0.060 g (0.068 g UO_2, 0.11 g/cm^3, 1σ). A double-sided perturbation was performed in which the uranium dioxide density was perturbed by ±0.12 g/cm^3 to estimate the uncertainty in k_{eff} due to the uncertainty in the uranium mass per fuel pebble. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty. The radius of the UO_2 kernels and the oxygen-to-uranium ratio was held constant. Results are shown in Table 2.1-14.

The calculated Δk_{eff} uncertainty was adjusted to account for random and systematic components of the total uncertainty. The systematic component is assumed to represent 15 % of the total uncertainty; the random component is negligible due to the perturbation of a large quantity of objects. The final adjusted Δk_{eff} uncertainty is therefore only the preserved systematic uncertainty.

Table 2.1-14. Effect of Uncertainty in the Fuel Pebble Uranium Mass.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor[(a)]	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$	Systematic Component of Δk_{eff} (1σ)
1 (5)	±0.065 g (0.12 g/cm^3)	0.00200	±	0.00005	12/11	0.00183	±	0.00005	0.00028
2 (6)	±0.065 g (0.12 g/cm^3)	0.00338	±	0.00004	12/11	0.00310	±	0.00004	0.00046
3 (7)	±0.065 g (0.12 g/cm^3)	0.00297	±	0.00004	12/11	0.00272	±	0.00004	0.00041
4 (8)	±0.065 g (0.12 g/cm^3)	0.00217	±	0.00005	12/11	0.00199	±	0.00005	0.00030

(a) The scaling factor converts the perturbation uncertainty of 0.12 g/cm^3, which represents the reported 3σ uncertainty in the UO_2 mass density to the 0.11 g/cm^3 1σ uncertainty in the mass density based upon the reported uncertainty in the uranium mass measurements.

2.1.4.5 Fueled Zone Impurities

The reported impurity content for the fuel pebbles is listed in Table 1.1-16. The composition values listed as less than a given value are taken at half this maximum value in the nominal material composition. The fueled zone composition (graphite region within the pebble surrounding the TRISO particles) is adjusted such that the total composition adds up to 100 %. The nominal impurity content used for evaluation of the uncertainty in the fueled zone impurities is in Table 2.1-15.

The nominal fueled zone impurity content is shown in Table 2.1-15. The selected uncertainty in each impurity was 50 % of the nominal value (1σ). A double-sided perturbation was performed in which all impurities were simultaneously perturbed by ±50 % to estimate the uncertainty in k_{eff} due to the uncertainty in the fueled zone impurity content. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty.

The scaling factor was obtained by first determining the equivalent boron content (EBC) of each impurity based upon their concentration in the graphite and their respective ASTM EBC factor.[a] The ratio of the equivalent boron content for each individual impurity to the total EBC was calculated; most ratios were small compared to the dominant impurities of boron (~41 %) and lithium (~30 %). Sample perturbations were performed to confirm that perturbations of the dominant impurities produced uncertainties in k_{eff}, divided by the total uncertainty obtained by perturbing all impurities simultaneously, would produce ratios approximately equal to the EBC ratios. The EBC ratios for all the graphite impurities were combined taking the square root of the sum of the squares to obtain a scaling factor of 53 %, which is needed to convert the additive perturbation of impurity content into one representing the quadrative summation expected for perturbing each impurity individually by 50 %. Results are shown in Table 2.1-16.

[a] ASTM C1233-03, "Standard Practice for Determining Equivalent Boron Contents of Nuclear Materials," ASTM International, West Conshohocken, PA (2009).

Table 2.1-15. Fuel Pebble Impurities.

Element	Minimum ppm (wt.%)	Maximum ppm (wt.%)	Nominal ppm (wt.%)
Ag	--	0.2	0.1
B	0.101	0.101	0.101
Ca	9.28	9.28	9.28
Cd	--	0.103	0.0515
Cl	--	3	1.5
Co	--	0.13	0.065
Cr	1.81	1.81	1.81
Dy	--	0.01	0.005
Eu	--	0.01	0.005
Fe	2.95	2.95	2.95
Gd	--	0.01	0.005
Li	--	1	0.5
Mn	0.43	0.43	0.43
Ni	--	1	0.5
S	--	0.011	0.0055
Ti	0.497	0.497	0.497
V	--	0.433	0.2165
Total	--	--	18.0215

Table 2.1-16. Effect of Uncertainty in the Fueled Zone Impurities.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$
1 (5)	±50 %	-0.00026	±	0.00005	1/0.53	-0.00014	±	0.00003
2 (6)	±50 %	-0.00017	±	0.00004	1/0.53	-0.00009	±	0.00002
3 (7)	±50 %	-0.00020	±	0.00004	1/0.53	-0.00011	±	0.00002
4 (8)	±50 %	-0.00016	±	0.00005	1/0.53	-0.00008	±	0.00003

2.1.4.6 Unfueled Zone Impurities

The reported impurity content for the fuel pebbles is listed in Table 1.1-16. It is assumed that the unfueled zone impurities are the same as the fueled zone impurities in Section 2.1.4.5. The composition values listed as less than a given value are taken at half this maximum value in the nominal material composition. The unfueled zone composition (graphite shell surrounding the fueled zone of the pebble) is adjusted such that the total composition adds up to 100 %. The nominal impurity content used for evaluation of the uncertainty in the unfueled zone impurities is in Table 2.1-15.

The nominal unfueled zone impurity content is shown in Table 2.1-15. The selected uncertainty in each impurity was 50 % of the nominal value (1σ). A double-sided perturbation was performed in which all impurities were simultaneously perturbed by ±50 % to estimate the uncertainty in k_{eff} due to the uncertainty in the unfueled zone impurity content. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty.

The scaling factor was obtained by first determining the equivalent boron content (EBC) of each impurity based upon their concentration in the graphite and their respective ASTM EBC factor.[a] The ratio of the equivalent boron content for each individual impurity to the total EBC was calculated; most ratios were small compared to the dominant impurities of boron (~41 %) and lithium (~30 %). Sample perturbations were performed to confirm that perturbations of the dominant impurities produced uncertainties in k_{eff}, divided by the total uncertainty obtained by perturbing all impurities simultaneously, would produce ratios approximately equal to the EBC ratios. The EBC ratios for all the graphite impurities were combined taking the square root of the sum of the squares to obtain a scaling factor of 53 %, which is needed to convert the additive perturbation of impurity content into one representing the quadrative summation expected for perturbing each impurity individually by 50 %. Results are shown in Table 2.1-17.

Table 2.1-17. Effect of Uncertainty in the Unfueled Zone Impurities.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$
1 (5)	±50 %	-0.00031	±	0.00005	1/0.53	-0.00016	±	0.00003
2 (6)	±50 %	-0.00013	±	0.00004	1/0.53	-0.00007	±	0.00002
3 (7)	±50 %	-0.00026	±	0.00004	1/0.53	-0.00014	±	0.00002
4 (8)	±50 %	-0.00035	±	0.00005	1/0.53	-0.00018	±	0.00003

2.1.5 Moderator Pebbles

2.1.5.1 Quantity of Pebbles

Exact quantities of fuel and moderator pebbles were placed in the cores. There is no associated uncertainty. The number of moderator pebbles reported for each core configuration is given in Table 2.1-18.

Table 2.1-18. Number of Moderator Pebbles.

Case (Core)	# Moderator Pebbles
1 (5)	2870
2 (6)	2758
3 (7)	2277
4 (8)	2870

[a] ASTM C1233-03, "Standard Practice for Determining Equivalent Boron Contents of Nuclear Materials," ASTM International, West Conshohocken, PA (2009).

2.1.5.2 Impurities

The reported impurity content for the moderator pebbles is listed in Table 1.1-17. The composition values listed as less than a given value are taken at half this maximum value in the nominal material composition. The moderator pebble composition is adjusted such that the total composition adds up to 100 %. The nominal impurity content used for evaluation of the uncertainty in the unfueled zone impurities is in Table 2.1-19.

The nominal moderator pebble impurity content is shown in Table 2.1-19. The selected uncertainty in each impurity was 50 % of the nominal value (1σ). A double-sided perturbation was performed in which all impurities were simultaneously perturbed by ±50 % to estimate the uncertainty in k_{eff} due to the uncertainty in the moderator pebble impurity content. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty.

The scaling factor was obtained by first determining the equivalent boron content (EBC) of each impurity based upon their concentration in the graphite and their respective ASTM EBC factor.[a] The ratio of the equivalent boron content for each individual impurity to the total EBC was calculated; most ratios were small compared to the dominant impurities of boron (~47 %), chlorine (~16 %) and gadolinium (~11 %). Sample perturbations were performed to confirm that perturbations of the dominant impurities produced uncertainties in k_{eff}, divided by the total uncertainty obtained by perturbing all impurities simultaneously, would produce ratios approximately equal to the EBC ratios. The EBC ratios for all the graphite impurities were combined taking the square root of the sum of the squares to obtain a scaling factor of 52 %, which is needed to convert the additive perturbation of impurity content into one representing the quadrative summation expected for perturbing each impurity individually by 50 %. Results are shown in Table 2.1-20.

Table 2.1-19. Moderator Pebble Impurities.

Element	Minimum ppm (wt.%)	Maximum ppm (wt.%)	Nominal ppm (wt.%)
B	0.76	0.76	0.76
Ca	129	129	129
Cd	--	0.6	0.3
Cl	18.64	18.64	18.64
Dy	0.065	0.065	0.065
Eu	0.13	0.13	0.13
Fe	5.9	5.9	5.9
Gd	0.040	0.040	0.040
Li	0.88	0.88	0.88
Ni	0.78	0.78	0.78
S	140	140	140
Si	35	35	35
Sm	0.086	0.086	0.086
Ti	10	10	10
V	13	13	13
Total	--	--	354.581

[a] ASTM C1233-03, "Standard Practice for Determining Equivalent Boron Contents of Nuclear Materials," ASTM International, West Conshohocken, PA (2009).

Table 2.1-20. Effect of Uncertainty in the Moderator Pebble Impurities.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$
1 (5)	50 %	-0.00168	±	0.00005	1/0.52	-0.00087	±	0.00003
2 (6)	50 %	-0.00145	±	0.00004	1/0.52	-0.00076	±	0.00002
3 (7)	50 %	-0.00148	±	0.00004	1/0.52	-0.00077	±	0.00002
4 (8)	50 %	-0.00155	±	0.00005	1/0.52	-0.00081	±	0.00003

2.1.6 Polyethylene Rods

2.1.6.1 Diameter

The polyethylene rods for Cores 6 and 8 had a cross section of an equilateral triangle with 15.0 mm sides and a hole centered in the triangle with a diameter of 6 mm; the polyethylene rods in Core 7 had a diameter of 8.3 mm (Figure 1.1-18). The uncertainty in side length of the triangular rods and the diameter of the hole in the triangular rods and of the rods in Core 7 was assumed to be 0.1 mm (bounding limit with uniform probability distribution). A double-sided perturbation was performed in which the diameter was perturbed by ±0.3 mm to estimate the uncertainty in k_{eff} due to the uncertainty in the diameter of the polyethylene rods. In the case of the triangular rods, the side lengths were concurrently perturbed by ±0.3 mm along with the hole diameter, thus maximizing and minimizing the effective cross-sectional area. Linear density, which is the unit mass per length of rod, was conserved. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty. Results are shown in Table 2.1-21.

The calculated Δk_{eff} uncertainty was adjusted to account for random and systematic components of the total uncertainty. The systematic component is assumed to represent 15 % of the total uncertainty; the random component is negligible due to the perturbation of a large quantity of objects. The final adjusted Δk_{eff} uncertainty is therefore only the preserved systematic uncertainty. The calculated uncertainty is negligible (≤0.00010).

Table 2.1-21. Effect of Uncertainty in the Polyethylene Rod Diameter.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$	Systematic Component of Δk_{eff} (1σ)
1 (5)	NA	NA			NA	NA			NA
2 (6)	±0.3 mm	0.00035	±	0.00004	3√3	0.00007	±	0.00001	0.00001
3 (7)	±0.3 mm	0.00072	±	0.00004	3√3	0.00014	±	0.00001	0.00002
4 (8)	±0.3 mm	0.00008	±	0.00005	3√3	0.00001	±	0.00001	<0.00001

2.1.6.2 Length

The length of the polyethylene rods was 1390, 1090, and 150 mm for Cores 6, 7, and 8, respectively. The uncertainty in length was reported to be 6 mm (assumed to be 1σ) for Core 6 and 5 mm for Core 7 (assumed to be 1σ). Because the rods in Core 8 were trimmed in an attempt to obtain an accurate simulation of partial water ingress, it is believed that an uncertainty of 1 mm (1σ) would be appropriate. A double-sided perturbation was performed in which the length was perturbed by 3σ to estimate the uncertainty in k_{eff} due to the uncertainty in the length of the polyethylene rods. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty. Results are shown in Table 2.1-22.

The calculated Δk_{eff} uncertainty was adjusted to account for random and systematic components of the total uncertainty. The systematic component is assumed to represent 15 % of the total uncertainty; the random component is negligible due to the perturbation of a large quantity of objects. The final adjusted Δk_{eff} uncertainty is therefore only the preserved systematic uncertainty. The calculated uncertainty is negligible (≤0.00010).

Table 2.1-22. Effect of Uncertainty in the Polyethylene Rod Length.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$	Systematic Component of Δk_{eff} (1σ)
1 (5)	NA	NA			NA	NA			NA
2 (6)	±18 mm	-0.00019	±	0.00004	3	-0.00006	±	0.00001	-0.00001
3 (7)	±15 mm	-0.00016	±	0.00004	3	-0.00005	±	0.00001	-0.00001
4 (8)	±3 mm	0.00027	±	0.00005	3	0.00005	±	0.00001	0.00001

2.1.6.3 Density

The linear density of the polyethylene rods was 0.646 g/cm (mass density: 0.93415 g/cm^3) for Cores 6 and 8, and 0.5087 g/cm (mass density: 0.94019 g/cm^3) for Core 7 (Figure 1.1-18). The uncertainty in the linear density was 0.05 g/cm (0.07231 g/cm^3, 1σ) for Cores 6 and 8, and 0.0007 g/cm (0.00129 g/cm^3, 1σ) for Core 7. A double-sided perturbation was performed in which the density was perturbed by ±1σ for Cores 6 and 8, and ±3σ for Core 7 to estimate the uncertainty in k_{eff} due to the uncertainty in the density of the polyethylene rods. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty. Results are shown in Table 2.1-23.

Table 2.1-23. Effect of Uncertainty in the Polyethylene Rod Density.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$
1 (5)	NA	NA			NA	NA		
2 (6)	±0.05 g/cm (0.07231 g/cm^3)	-0.00190	±	0.00004	1	-0.00190	±	0.00004
3 (7)	±0.0021 g/cm (0.00387 g/cm^3)	-0.00012	±	0.00004	3	-0.00004	±	0.00001
4 (8)	±0.05 g/cm (0.07231 g/cm^3)	-0.00017	±	0.00005	1	-0.00017	±	0.00005

2.1.6.4 Hydrogen-to-Carbon Ratio

The hydrogen-to-carbon ratio of the polyethylene rods was 2.03. The uncertainty in the ratio was 0.03 (1σ). A double-sided perturbation was performed in which the ratio was perturbed by ±0.09 to estimate the uncertainty in k_{eff} due to the uncertainty in the hydrogen-to-carbon ratio of the polyethylene rods. The bulk density of the polyethylene rods was conserved. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty. Results are shown in Table 2.1-24.

Table 2.1-24. Effect of Uncertainty in the Hydrogen-to-Carbon Ratio.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$
1 (5)	NA		NA		NA		NA	
2 (6)	±0.09	-0.00121	±	0.00004	3	-0.00040	±	0.00001
3 (7)	±0.09	-0.00023	±	0.00004	3	-0.00008	±	0.00001
4 (8)	±0.09	-0.00013	±	0.00005	3	-0.00004	±	0.00002

2.1.6.5 Impurities

The impurity content of the polyethylene rods was not reported. An EBC of 0.5 ± 0.5 ppm (by wt.%) was assumed to represent a reasonable estimate for the impurity content with its respective uncertainty, and is included in the composition of the polyethylene rods. The effect of impurities in these rods are insignificant compared to the impurity content of the graphite blocks and pebbles, therefore larger contents and uncertainties were not investigated further.

The impurity content of the polyethylene rods was 0.5 ppm (EBC by weight). The uncertainty in the impurity content was 0.5 ppm (bounding limit with uniform probability distribution). A double-sided perturbation was performed in which the impurity content was perturbed by ±0.5 ppm to estimate the uncertainty in k_{eff} due to the uncertainty in the impurity content of the polyethylene rods. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty. Results are shown in Table 2.1-25.

Table 2.1-25. Effect of Uncertainty in the Polyethylene Impurities.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$
1 (5)	NA		NA		NA		NA	
2 (6)	±0.5 ppm	-0.00013	±	0.00004	1	-0.00013	±	0.00004
3 (7)	±0.5 ppm	-0.00007	±	0.00004	1	-0.00007	±	0.00004
4 (8)	±0.5 ppm	0.00004	±	0.00005	1	0.00004	±	0.00005

2.1.7 Copper Wire

2.1.7.1 Diameter

The diameter of the copper wire was nominally 1.784 mm. Copper wire with a diameter of 1.784 mm is commonly used for electrical and sound systems. Annealed copper wire, as an international standard, has an average density of 8.89 g/cm^3.[a] As discussed in Section 2.1.7.3, the measured density of the copper wire was ~8.93 g/cm^3. A diameter of ~1.788 mm would be required to reduce the wire density to the standard value. An value of ±0.004 mm (1σ) was judged appropriate to encompass the uncertainty in the diameter of the copper wire. A double-sided perturbation was performed in which the diameter was perturbed by ±0.012 mm to estimate the uncertainty in k_{eff} due to the uncertainty in the diameter of the

[a] H. Pender and W. A. Del Mar, Eds. *Electrical Engineer's Handbook*, 4th ed., John Wiley & Sons, New York (1962).

copper wire. The measured mass was conserved. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty. Results are shown in Table 2.1-26.

The calculated Δk_{eff} uncertainty was adjusted to account for random and systematic components of the total uncertainty. The systematic component is assumed to represent 15 % of the total uncertainty; the random component is negligible due to the perturbation of a large quantity of objects. The final adjusted Δk_{eff} uncertainty is therefore only the preserved systematic uncertainty. The calculated uncertainty is negligible (≤0.00010).

Table 2.1-26. Effect of Uncertainty in the Copper Wire Diameter.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$	Systematic Component of Δk_{eff} (1σ)
1 (5)	NA		NA		NA		NA		NA
2 (6)	±0.012 mm	-0.00001	±	0.00004	3	<0.00001	±	0.00001	<0.00001
3 (7)	NA		NA		NA		NA		NA
4 (8)	NA		NA		NA		NA		NA

2.1.7.2 Length

The length of the copper wire was 1400 mm. The length was incorrectly reported in the text of Reference 1 even though it was clearly shown in the figure (see Figure 1.1-19) that the wire was approximately 10 mm longer than the polyethylene rod. The top of the wire was then bent over to provide support and facilitate removal of the wires from the polyethylene rods. The uncertainty in length was not reported, but would have to be of sufficient length to protrude from the polyethylene rods; the uncertainty is assumed to be ±10 mm (bounding limit with uniform probability distribution). A double-sided perturbation was performed in which the length was perturbed by ±10 mm to estimate the uncertainty in k_{eff} due to the uncertainty in the length of the copper wire. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty. To simplify the calculations, the copper wire was not bent over the top of the polyethylene rods; the resultant bias was assumed to be negligible. Results are shown in Table 2.1-27.

The calculated Δk_{eff} uncertainty was adjusted to account for random and systematic components of the total uncertainty. The systematic component is assumed to represent 15 % of the total uncertainty; the random component is negligible due to the perturbation of a large quantity of objects. The final adjusted Δk_{eff} uncertainty is therefore only the preserved systematic uncertainty. The calculated uncertainty is negligible (≤0.00010).

Table 2.1-27. Effect of Uncertainty in the Copper Wire Length.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$	Systematic Component of Δk_{eff} (1σ)
1 (5)	NA	NA			NA	NA			NA
2 (6)	±10 mm	-0.00004	±	0.00004	√3	-0.00002	±	0.00002	<0.00001
3 (7)	NA	NA			NA	NA			NA
4 (8)	NA	NA			NA	NA			NA

2.1.7.3 Density

The mass of 25 copper wires was 781.22 g, yielding a linear density of 0.22321 g/cm and a mass density of 8.9295 g/cm^3. A nominal uncertainty in the mass density ±0.01 g/cm^3 (1σ) was assumed, which equates to an uncertainty in the mass of 25 copper wires of approximately ±1 g. A double-sided perturbation was performed in which the density was perturbed by ±0.03 g/cm^3 to estimate the uncertainty in k_{eff} due to the uncertainty in the density of the copper wire. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty. Results are shown in Table 2.1-28. The calculated uncertainty is negligible (≤0.00010).

Table 2.1-28. Effect of Uncertainty in the Copper Wire Density.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$
1 (5)	NA	NA			NA	NA		
2 (6)	±0.03 g/cm^3	-0.00017	±	0.00004	3	-0.00006	±	0.00001
3 (7)	NA	NA			NA	NA		
4 (8)	NA	NA			NA	NA		

2.1.7.4 Composition

The composition and type of copper wire used were not reported. However, the wire was reported to have a purity of 99.9%, which corresponds with Type C110 copper with the composition shown in Table 2.1-29 (see footnote to table for reference information).

The composition of the copper wire was assumed to be that of nominal copper, Type C110 (see Table 2.1-29). A double-sided perturbation was performed in which the copper composition was perturbed by minimizing and maximizing the copper content in the copper wire (metallic impurities were perturbed by ±100% of their nominal content), while simultaneously maximizing or minimizing the other elemental constituents within the specified limits, to estimate the uncertainty in k_{eff} due to the uncertainty in copper composition. Half of the differences between the calculated upper and lower perturbed values were then scaled to obtain the 1σ uncertainty assuming a bounding limit with uniform probability distribution. Results are shown in Table 2.1-30. The calculated uncertainty is negligible (≤0.00010).

Table 2.1-29. Composition of Copper C110.[a]

Element	Minimum wt.%	Maximum wt.%	Nominal wt.%
Cu	99.9	--	99.95
O	--	0.04	0.02
Ag	--	--	0.0075
S	--	--	0.0075
Ni	--	--	0.0075
Fe	--	--	0.0075
Total	--	--	100

(a) Copper-110, Bohler Uddeholm Australia, http://www.buau.com.au/english/files/110.pdf (Accessed 8/30/2011).

Table 2.1-30. Effect of Uncertainty in the Copper Wire Composition.

Case (Core)	Deviation	Δk_p	±	$\sigma_{\Delta kp}$	Scaling Factor	Δk_{eff} (1σ)	±	$\sigma_{\Delta keff}$
1 (5)	NA		NA		NA		NA	
2 (6)	Min/Max Cu	0.00009	±	0.00004	√3	0.00005	±	0.00002
3 (7)	NA		NA		NA		NA	
4 (8)	NA		NA		NA		NA	

2.1.8 Total Experimental Uncertainty

A compilation of the total evaluated uncertainty in the critical configurations of Cores 5, 6, 7, and 8 (Cases 1, 2, 3, and 4, respectively) of the HTR-PROTEUS experiments is provided in Tables 2.1-31 through 2.1-34, respectively. As discussed earlier, uncertainties that are not treated as 100 % systematic, because perturbation analyses were simultaneously applied to multiple components are treated as 15 % systematic (to preserve some uncertainty due to possible, yet unknown, systematic effects) and 85 % random. The random portion of the uncertainty is then divided by the square root of the number of perturbed components, and is negligible for most uncertainties. The total evaluated uncertainty is the root-sum square of all individual uncertainties. A graphical representation of the primary sources of uncertainty is shown in Figure 2.1-1.

Uncertainties ≤0.00010 are reported as negligible (neg) and those that do not apply to a given configuration because they are not used or included as part of the evaluation of a different uncertainty are marked as not applicable (NA). The most significant contribution to the overall uncertainty is the fuel enrichment; the density of the polyethylene rods utilized in Case 2 (Core 6) significantly contributes to the uncertainty in that experimental configuration. All uncertainties providing at least 0.05 %Δk_{eff} are highlighted in Tables 2.1-31 through 2.1-34. The uncertainties in the experimental critical configurations for Cores 5, 6, 7, and 8 were evaluated and determined to be acceptable.

Table 2.1-31. Summary of Evaluated Uncertainties in HTR-PROTEUS Case 1 (Core 5).

Perturbed Parameter	**Parameter Value**	**1σ Uncertainty**	**Δk_{eff} (1σ)**
Radial Reflector Density (g/cm^3)	1.76	0.012	0.00108
Radial Reflector Impurities (ppma EBC)	1.33	0.08	0.00103
Location of Upper Axial Reflector (mm)	1893	5 / √3	0.00011
Upper Axial Aluminum Dimensions (mm)	Figure 1.1-4	1 / √3	0.00060
Upper Axial Aluminum Composition	Table 2.1-8	1 / √3	0.00034
^{235}U Isotopic Content (wt.%)	~16.762	~0.17	0.00233
Fuel Pebble Uranium Mass (g)	5.966	0.060	0.00028
Fueled Zone Impurities (ppm)	Table 2.1-15	50 %	0.00014
Unfueled Zone Impurities (ppm)	Table 2.1-15	50 %	0.00016
Moderator Pebble Impurities (ppm)	Table 2.1-19	50 %	0.00087
Polyethylene Rod Diameter (mm)	--	--	NA
Polyethylene Rod Length (mm)	--	--	NA
Polyethylene Rod Linear Density (g/cm)	--	--	NA
Polyethylene Rod H:C Ratio	--	--	NA
Polyethylene Rod Impurities (ppm EBC)	--	--	NA
Copper Wire Diameter (mm)	--	--	NA
Copper Wire Length (mm)	--	--	NA
Copper Wire Density (g/cm)	--	--	NA
Copper Wire Composition (wt.%)	--	--	NA
Total Experimental Uncertainty	**--**	**--**	**0.00301**

Table 2.1-32. Summary of Evaluated Uncertainties in HTR-PROTEUS Case 2 (Core 6).

Perturbed Parameter	**Parameter Value**	**1σ Uncertainty**	**Δk_{eff} (1σ)**
Radial Reflector Density (g/cm^3)	1.76	0.012	0.00061
Radial Reflector Impurities (ppma EBC)	1.33	0.08	0.00052
Location of Upper Axial Reflector (mm)	1893	5 / √3	neg
Upper Axial Aluminum Dimensions (mm)	Figure 1.1-4	1 / √3	0.00026
Upper Axial Aluminum Composition	Table 2.1-8	1 / √3	0.00012
^{235}U Isotopic Content (wt.%)	~16.762	~0.17	0.00334
Fuel Pebble Uranium Mass (g)	5.966	0.060	0.00046
Fueled Zone Impurities (ppm)	Table 2.1-15	50 %	neg
Unfueled Zone Impurities (ppm)	Table 2.1-15	50 %	neg
Moderator Pebble Impurities (ppm)	Table 2.1-19	50 %	0.00076
Polyethylene Rod Diameter (mm)	15.0 Δ, 6 O	0.1 / √3	neg
Polyethylene Rod Length (mm)	1390	6	neg
Polyethylene Rod Linear Density (g/cm)	0.646	0.05	0.00190
Polyethylene Rod H:C Ratio	2.03	0.03	0.00040
Polyethylene Rod Impurities (ppm EBC)	0.5	0.5	0.00013
Copper Wire Diameter (mm)	1.784	0.004	neg
Copper Wire Length (mm)	1400	10 / √3	neg
Copper Wire Density (g/cm)	8.93	0.01	neg
Copper Wire Composition (wt.%)	Table 2.1-29	1 / √3	neg
Total Experimental Uncertainty	**--**	**--**	**0.00406**

Table 2.1-33. Summary of Evaluated Uncertainties in HTR-PROTEUS Case 3 (Core 7).

Perturbed Parameter	**Parameter Value**	**1σ Uncertainty**	**Δk_{eff} (1σ)**
Radial Reflector Density (g/cm^3)	1.76	0.012	0.00074
Radial Reflector Impurities (ppma EBC)	1.33	0.08	0.00066
Location of Upper Axial Reflector (mm)	1893	5 / √3	neg
Upper Axial Aluminum Dimensions (mm)	Figure 1.1-4	1 / √3	0.00036
Upper Axial Aluminum Composition	Table 2.1-8	1 / √3	0.00022
^{235}U Isotopic Content (wt.%)	~16.762	~0.17	0.00305
Fuel Pebble Uranium Mass (g)	5.966	0.060	0.00041
Fueled Zone Impurities (ppm)	Table 2.1-15	50 %	0.00011
Unfueled Zone Impurities (ppm)	Table 2.1-15	50 %	0.00014
Moderator Pebble Impurities (ppm)	Table 2.1-19	50 %	0.00077
Polyethylene Rod Diameter (mm)	8.3	0.1 / √3	neg
Polyethylene Rod Length (mm)	1090	5	neg
Polyethylene Rod Linear Density (g/cm)	0.5087	0.0007	neg
Polyethylene Rod H:C Ratio	2.03	0.03	neg
Polyethylene Rod Impurities (ppm EBC)	0.5	0.5	neg
Copper Wire Diameter (mm)	--	--	NA
Copper Wire Length (mm)	--	--	NA
Copper Wire Density (g/cm)	--	--	NA
Copper Wire Composition (wt.%)	--	--	NA
Total Experimental Uncertainty	**--**	**--**	**0.00335**

Table 2.1-34. Summary of Evaluated Uncertainties in HTR-PROTEUS Case 4 (Core 8).

Perturbed Parameter	**Parameter Value**	**1σ Uncertainty**	**Δk_{eff} (1σ)**
Radial Reflector Density (g/cm^3)	1.76	0.012	0.00102
Radial Reflector Impurities (ppma EBC)	1.33	0.08	0.00096
Location of Upper Axial Reflector (mm)	1893	5 / √3	0.00011
Upper Axial Aluminum Dimensions (mm)	Figure 1.1-4	1 / √3	0.00053
Upper Axial Aluminum Composition	Table 2.1-8	1 / √3	0.00031
^{235}U Isotopic Content (wt.%)	~16.762	~0.17	0.00245
Fuel Pebble Uranium Mass (g)	5.966	0.060	0.00030
Fueled Zone Impurities (ppm)	Table 2.1-15	50 %	neg
Unfueled Zone Impurities (ppm)	Table 2.1-15	50 %	0.00018
Moderator Pebble Impurities (ppm)	Table 2.1-19	50 %	0.00081
Polyethylene Rod Diameter (mm)	15.0 Δ, 6 O	0.1 / √3	neg
Polyethylene Rod Length (mm)	150	1	neg
Polyethylene Rod Linear Density (g/cm)	0.646	0.05	0.00017
Polyethylene Rod H:C Ratio	2.03	0.03	neg
Polyethylene Rod Impurities (ppm EBC)	0.5	0.5	neg
Copper Wire Diameter (mm)	--	--	NA
Copper Wire Length (mm)	--	--	NA
Copper Wire Density (g/cm)	--	--	NA
Copper Wire Composition (wt.%)	--	--	NA
Total Experimental Uncertainty	**--**	**--**	**0.00303**

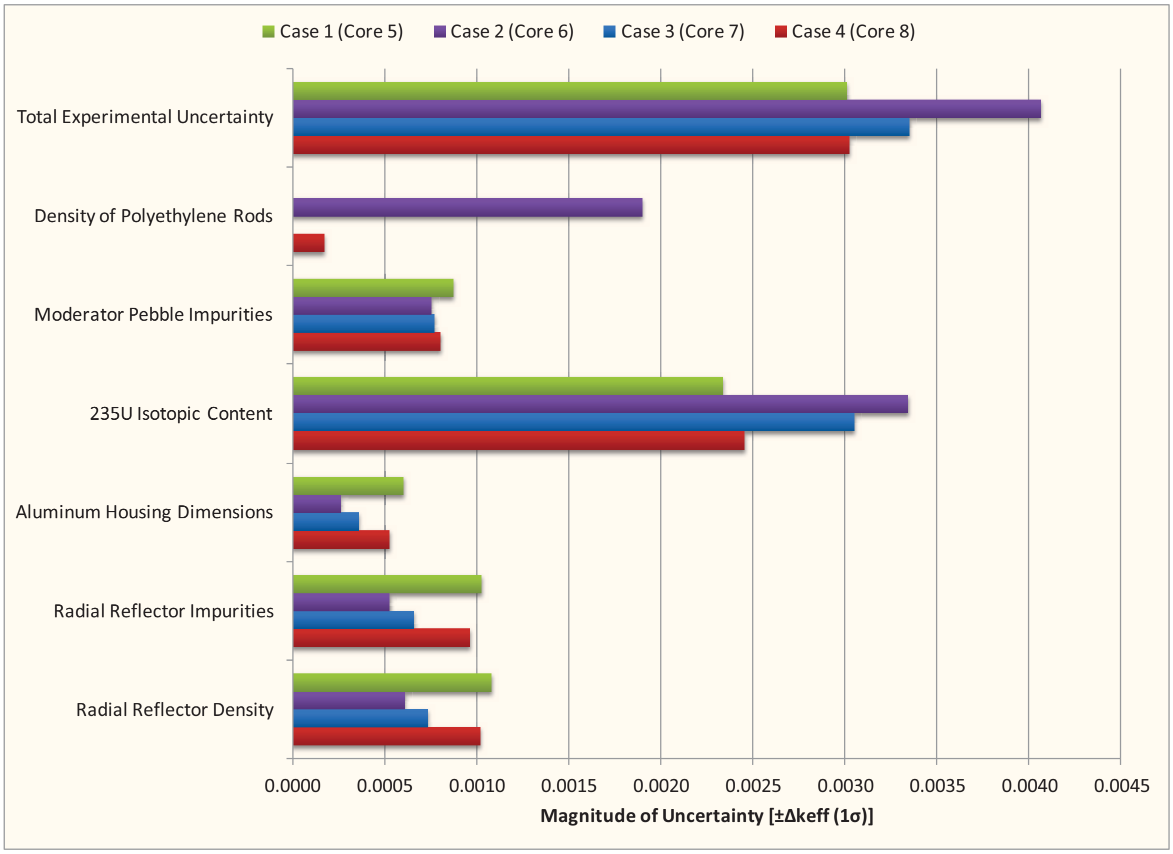

Figure 2.1-1. Graphical Representation of Primary Uncertainties in HTR-PROTEUS.

2.2 Evaluation of Buckling and Extrapolation Length Data

Buckling and extrapolation length measurements were made but have not yet been evaluated.

2.3 Evaluation of Spectral Characteristics Data

Spectral characteristics measurements were not made.

2.4 Evaluation of Reactivity Effects Data

Reactivity effects measurements were made but have not yet been evaluated.

2.5 Evaluation of Reactivity Coefficient Data

Reactivity coefficient measurements were made but have not yet been evaluated.

2.6 Evaluation of Kinetics Measurements Data

Kinetics measurements were made but have not yet been evaluated.

2.7 Evaluation of Reaction-Rate Distributions

Reaction-rate distribution measurements were made but have not yet been evaluated.

2.8 Evaluation of Power Distribution Data

Power distribution measurements were not made.

2.9 Evaluation of Isotopic Measurements

Isotopic measurements were not made.

2.10 Evaluation of Other Miscellaneous Types of Measurements

Other miscellaneous types of measurements were not made.

3.0 BENCHMARK SPECIFICATIONS

3.1 Benchmark-Model Specifications for Critical and / or Subcritical Measurements

Four benchmark experiments were evaluated in this report: Cores 5, 6, 7, and 8. These core configurations represent the columnar hexagonal point-on-point (CHPOP) configurations of the HTR-PROTEUS experiment with a moderator-to-fuel pebble ratio of 1:2. All four cores use withdrawable, hollow, stainless steel control rods. Core 5 has 23 pebble layers; three configurations, or states, of Core 5 were constructed. The first state had 33 empty coolant channels in the lower axial reflector. All the channels were filled with graphite plugs for the second and third state; the latter two states slightly differed, only in the position of the autorod. An average autorod position was selected from states two and three to represent Core 5. The initial state of Core 5 was not evaluated as it was very similar in core design. Cores 6, 7, and 8 retained similar pebble loadings as Core 5, but with 22, 18, and 23 layers, respectively. The latter three core configurations each contained 654 polyethylene rods inserted between pebbles to simulate water ingress. Core 6 had triangular rods with hollow centers containing copper wire to counteract the reactivity effect of the polyethylene. Core 7 had solid polyethylene rods. Core 8 used the triangular rods, without wire, but only placed at the bottom 15 cm of the core instead of the full stack height of the pebbles.

The benchmark critical configurations for Cores 5, 6, 7, and 8 will be referred to as Cases 1, 2, 3, and 4, respectively. Both methods of identification are utilized throughout the rest of this report to facilitate users with differing familiarities with HTR-PROTEUS and IRPhEP benchmark format.

The HTR-PROTEUS configurations consist of a thick annular graphite reflector surrounding a pair of thick axial graphite reflectors that sandwich a core cavity region containing fuel and moderator pebbles (see Figures 3.1-16 and 3.1-23). Most core configurations in the HTR-PROTEUS experimental series included exact placement of the pebbles, as is the case with Cases 1 through 4 evaluated in this benchmark report. Penetrations in the graphite reflectors were provided for control rods and instrumentation; typically these holes were filled with graphite plugs or filler pieces when not in use.

Case 1 (Core 5) represented the initial critical experiment, or "base case", against which Cases 2, 3, and 4 (Core 6, 7, and 8, respectively), which included polyethylene rods placed in channels between the pebbles, were constructed to simulate water ingress effects within pebble bed systems. Both cores could be compared with the hexagonal close-packed configurations (Cores 1, 1A, 2, and 3) with the same moderator:fuel pebble ratio of 1:2 (see PROTEUS-GCR-EXP-001).

3.1.1 Description of the Benchmark Model Simplifications

Various simplifications were necessary to prepare benchmark model specifications for the critical core configurations. Experimental measurements were performed or estimated based on experimental measurements for a variety of simplifications (see Section 1.1.5), since the original intent of this experimental series was to provide benchmark quality experiments that could be easily modeled. Only a selection of the measured simplifications was retained as biases to be applied to the benchmark models (see Tables 3.1-1 and 3.1-2). Some of the core features were retained in the models to reduce the total effective bias, since they could be modeled easily. The retained measured biases generally represent simplifications of the benchmark models where insufficient information existed to reproduce the measurement with a calculation or reverse the simplification by adding more detail to the benchmark model. Simplifications that were simulated in the original reference reports (also reported in Section 1.1.5) were not retained, but instead recalculated.

Significant simplifications in assembly geometries and compositions were investigated for the first HTR-PROTEUS cores: 1, 1A, 2, and 3 (PROTEUS-GCR-EXP-001). Those simplifications that yielded small ($\leq$0.00100 Δk) or negligible ($\leq$0.00010 Δk) biases that were incorporated into the other benchmark models are now also included in these benchmark models (see Table 3.1-3). Biases calculated for the removal of control rods, coolant channels in the axial reflectors, removal of upper axial reflector aluminum support structure, and voiding of air were large and considered unacceptable for the benchmark models of Cores 1, 1A, 2, and 3. Therefore, these simplifications were not performed and the features were retained in the benchmark models of Cores 5, 6, 7, and 8.

3.1.1.1 Evaluation of Benchmark Model Biases

A summary of the experimentally measured reactivity corrections utilized for the benchmark models is provided in Tables 3.1-1 through 3.1-4 for Cases 1 through 4, respectively. The values for Cases 1 and 4 were obtained from Tables 1.1-20 through 1.1-25. The calculated β_{eff} values are 0.00720 for Cases 1, 2, and 3 (Cores 5, 6, and 7) and 0.00722 for Case 4 (Core 8). The reported β_{eff} values were used to convert the reactivity corrections and their associated uncertainties from their original measured reactivities in units of ¢ into Δk; it was assumed that there was an additional bias uncertainty due to the use of the reported β_{eff} values of 5% (1σ) of the reported value (~0.00036 $\Delta\beta_{eff}$). Many of the measurement biases were used directly, since sufficient information was not available to include most of them in the models.

The autorod position for the benchmark model of Core 5 was obtained by taking the average of the reported autorod positions for Core 5 reference states #1 and #2. Due to the low worth of the autorod when adjusting between the two positions, any additional bias or bias uncertainty is negligible.

Some of the C-Driver channels in the 2nd and 3rd rings of the radial reflector contained instrumentation instead of graphite rods. The effect of filling these empty positions with graphite rods was measured.

Start-up sources with associated penetrations were used in HTR-PROTEUS. The effect of removing these sources and filling the penetrations with graphite was measured.

Instrumentation and detectors in the core were removed and the effect was measured.

Typically 33 coolant channels in the lower axial reflector and 34 coolant channels in the upper axial reflector were empty during many of the HTR-PROTEUS experiments. However, for Cores 5, 6, and 7, the channels in the lower axial reflector were filled. All three core configurations were modeled with the open coolant channels in the upper reflector and filled coolant channels in the lower reflector. Core 8 was modeled with the coolant channels open in both the lower and upper reflectors, as was performed experimentally.

Table 3.1-1. Experimentally Determined Reactivity Corrections for Case 1 (Core 5).

Measured Effect	Reactivity Correction			Reactivity Correction		
	ρ¢	**±**	**σ**	**Δk**	**±**	**σ**
Empty Channels in Ring 2 of Radial Reflector	4	±	1	0.00029	±	0.00007
Start-Up Source Penetrations	1	±	0.1	0.00007	±	0.00001
Nuclear Instrumentation (Ionization)	8.0	±	1.2	0.00058	±	0.00009
Nuclear Instrumentation (Fission)	0.8	±	0.6	0.00006	±	0.00004
Total (Reported β_{eff} = 0.00720)[(a)]	13.80	±	1.68	0.00099	±	0.00013

(a) Assumed uncertainty in β_{eff} of 5% (1σ).

Table 3.1-2. Experimentally Determined Reactivity Corrections for Case 2 (Core 6).

Measured Effect	**Reactivity Correction**			**Reactivity Correction**		
	ρ¢	**±**	**σ**	**Δk**	**±**	**σ**
Empty Channels in Ring 2 of Radial Reflector	2.7	±	1	0.00019	±	0.00007
Start-Up Source Penetrations	1	±	1	0.00007	±	0.00007
Nuclear Instrumentation (Ionization)	5.6	±	1.8	0.00040	±	0.00013
Nuclear Instrumentation (Fission)	0.8	±	0.6	0.00006	±	0.00004
Total (Reported β_{eff} = 0.00720)[(a)]	10.10	±	2.37	0.00073	±	0.00017

(a) Assumed uncertainty in β_{eff} of 5% (1σ).

Table 3.1-3. Experimentally Determined Reactivity Corrections for Case 3 (Core 7).

Measured Effect	**Reactivity Correction**			**Reactivity Correction**		
	ρ¢	**±**	**σ**	**Δk**	**±**	**σ**
Empty Channels in Ring 2 of Radial Reflector	2.7	±	1	0.00019	±	0.00007
Start-Up Source Penetrations	1	±	1	0.00007	±	0.00007
Nuclear Instrumentation (Ionization)	5.6	±	1.8	0.00040	±	0.00013
Nuclear Instrumentation (Fission)	0.8	±	0.6	0.00006	±	0.00004
Total (Reported β_{eff} = 0.00720)[(a)]	10.10	±	2.37	0.00073	±	0.00017

(a) Assumed uncertainty in β_{eff} of 5% (1σ).

Table 3.1-4. Experimentally Determined Reactivity Corrections for Case 4 (Core 8).

Measured Effect	**Reactivity Correction**			**Reactivity Correction**		
	ρ¢	**±**	**σ**	**Δk**	**±**	**σ**
Empty Channels in Ring 2 of Radial Reflector	4	±	1	0.00029	±	0.00007
BF_3 Detectors in Ring 2 of Radial Reflector	8.6	±	0.5	0.00062	±	0.00005
Start-Up Source Penetrations	1	±	0.1	0.00007	±	0.00001
Nuclear Instrumentation (Ionization)	8.0	±	1.2	0.00058	±	0.00009
Nuclear Instrumentation (Fission)	0.8	±	0.6	0.00006	±	0.00004
Total (Reported β_{eff} = 0.00722)[(a)]	22.40	±	1.75	0.00161	±	0.00013

(a) Assumed uncertainty in β_{eff} of 5% (1σ).

Additional biases were evaluated for the benchmark simplifications of Cores 1, 1A, 2, and 3 (PROTEUS-GCR-EXP-001); a summary of the biases is listed in Table 3.1-5. The effective bias for most of the individually calculated biases were negligible compared to the statistical uncertainty for Cores 1, 1A, 2, and 3, except for the bias for homogenizing the radial reflector; therefore, individual calculations were not performed for Cores 5, 6, 7, and 8, and only a summary of the simplifications is provided with the total effective bias for incorporation of these simplifications in the benchmark models. The effective simplification bias was computed by comparing calculated eigenvalues obtained with MCNP5 input decks (Appendix A) of the benchmark models described in Section 3 and detailed models (Appendix C).

Simplifications to the benchmark models include the removal of many of the assembly components external to the large radial reflector, such as the concrete walls, steel support pedestal, and thermal column (Figures 1.1-1, 1.1-3, and 1.1-9). Experimental measurements confirmed that room return effects were negligible for this series of experiments and therefore deemed unnecessary in the benchmark models.

The safety/shutdown rods and the aluminum shock dampers (Figure 1.1-9) were removed from the benchmark models. The eight channels for these rods were retained in the models (Figure 1.1-2b). Since the safety/shutdown rods were fully withdrawn from the core, their removal from the benchmark models was effectively negligible.

The radial reflector was homogenized with the axial modifiers in the core cavity, C-Driver channels, and graphite plugs in the C-Driver channels (Figures 1.1-2 and 1.1-3). Only penetrations for control rod use were retained: withdrawable control rods, safety/shutdown rods, and autorod. The withdrawable control rods were placed in four of the C-Driver channels in ring 5 of the radial reflector. The ZEBRA rod channels from the initial core, Core 1, were filled with graphite plugs. Radial reflector simplifications facilitate ease of modeling these benchmark configurations. The outer and inner 22-sided polygon surfaces of the radial reflector were converted to cylindrical surfaces; the core cavity region retained its 12-sided polygon surface.

The safety ring (Figure 1.1-4) is removed from the benchmark model and the aluminum support structure of the upper axial reflector was simplified such that the aluminum spherical surfaces (Figures 1.1-4 and 1.1-6) are modeled as an aluminum disc, 1-cm-thick, retaining the outer diameter of the aluminum structure (104.2 cm). The aluminum support structure was a complex entity and very difficult to model with exact detail.

The lower axial reflector was simplified by cylinderizing the graphite annulus and filling the small source gap with graphite (Figure 1.1-7). As with simplification of the radial reflector, removal of the exact location of vertices for the multifaceted polygons used to generate this core by using cylindrical representations greatly simplifies modeling of these benchmark configurations.

All pebbles in the models have a radius of 3.000 cm. The mass of the pebbles was conserved and the resultant bias is negligible.

Impurities in the TRISO particles are removed from the models.

A standard air composition was used for all models with a temperature of 20°C, pressure of 980 mbar, and 50 % humidity. Neon, helium, and krypton are not included in the benchmark model; the bias for their removal is negligible.

The copper wire was not bent over the top of the polyethylene rods in Core 6; the resultant bias was assumed to be negligible as the quantity of copper wire bent, per rod, was small, and the location of the bend was 7 cm above the top of the core.

Table 3.1-5. Calculated Simplification Biases.

- Removal of Concrete Walls
- Removal of Steel Support Pedestal
- Removal of Thermal Column
- Removal of Safety/Shutdown Rods
  - Includes Shock Dampers
- Cylinderization of Radial Reflector
  - Outer and inner 22-sided polygon surfaces converted to cylindrical surfaces; the core cavity region retained its 12-sided polygon surface
- Removal of Safety Ring
- Homogenization of Radial Reflector
  - Remove All Penetrations Except Those for Control Rods
- Simplify Aluminum Support Structure of Upper Axial Reflector
- Cylinderize Lower Axial Reflector Annulus
- Fill Source Gap with Graphite
- Model All Pebbles with a Radius of 3.000 cm
- Remove UO_2 Impurities in the TRISO Kernels
- Remove Impurities in the TRISO Layers
- Use a Standard Air Composition for All Models
  - Remove Ne, He, and Kr from Air Composition
- Top ends of copper wire not bent (Core 6 only)

Case (Core)	1 (5)	2 (6)
Bias (Δk)	0.00138 ± 0.00010	0.00065 ± 0.00008
Case (Core)	3 (7)	4 (8)
Bias (Δk)	0.00094 ± 0.00008	0.00135 ± 0.00010

The total bias for each benchmark configuration (Table 3.1-6) is obtained by summation of the experimentally measured corrections (Tables 3.1-1 through 3.1-4) with the computed simplification bias (Table 3.1-5). The total bias uncertainties are obtained by summing under quadrature the individual bias uncertainties. For example, for Case 1 (Core 5), the measured correction of 0.00099 ± 0.00013 Δk (Table 3.1-1) is added to the calculated simplification bias of 0.00138 ± 0.00010 Δk (Table 3.1-5) to obtain a total simplification bias for the benchmark model of 0.00237 ± 0.00016 Δk (Table 3.1-6).

Table 3.1-6. Total Benchmark Biases (Δk).

Case (Core)	1 (5)	2 (6)
Measured Corrections	0.00099 ± 0.00013	0.00073 ± 0.00017
Calculated Simplifications	0.00138 ± 0.00010	0.00065 ± 0.00008
Total Bias	**0.00237 ± 0.00016**	**0.00138 ± 0.00019**
Case (Core)	3 (7)	4 (8)
Measured Corrections	0.00073 ± 0.00017	0.00161 ± 0.00013
Calculated Simplifications	0.00094 ± 0.00008	0.00135 ± 0.00010
Total Bias	**0.00167 ± 0.00019**	**0.00297 ± 0.00017**

3.1.2 Dimensions

3.1.2.1 Radial Reflector

The graphite radial reflector (Figure 3.1-1) is an annulus with an equivalent inner radius of 62.83398 cm, an equivalent outer radius of 163.76986 cm, and a height of 330.4 cm. The portion of the radial reflector surrounding the core cavity region can be described as a cylinder with a dodecagon (12-sided polygon) cross section; the distance between the midpoint of each side alternates between 60.15 and 60.3 cm from the core center. This region of the radial reflector extends 172.9 cm upward from the base of the cavity region, located 78.0 cm above the bottom of the radial reflector. Penetrations in the radial reflector are provided for eight safety/shutdown rods, an autorod, and four withdrawable control rods. These holes axially penetrate completely through the radial reflector with the x,y positions provided in Table 3.1-7 and shown in Figure 3.1-2. While the penetrations for the safety/shutdown rods are preserved in the benchmark model, the rods themselves are not included.

Table 3.1-7. Penetrations in Radial Reflector (dimensions in cm).

Penetration Purpose	x-Coordinate	y-Coordinate	Hole Diameter
Safety/Shutdown Rod Hole 1	-38.45	56.57	4.5
Safety/Shutdown Rod Hole 2	32.74	-60.05	4.5
Safety/Shutdown Rod Hole 3	57.17	37.55	4.5
Safety/Shutdown Rod Hole 4	-53.23	-42.95	4.5
Safety/Shutdown Rod Hole 5	67.19	-12.82	4.5
Safety/Shutdown Rod Hole 6	-66.98	13.87	4.5
Safety/Shutdown Rod Hole 7	19.31	65.62	4.5
Safety/Shutdown Rod Hole 8	-13.87	-66.98	4.5
Autorod Hole	17.36	-87.29	5.5
Withdrawable Control Rod Hole 1	-83.70	34.67	2.743
Withdrawable Control Rod Hole 2	34.67	83.70	2.743
Withdrawable Control Rod Hole 3	83.70	-34.67	2.743
Withdrawable Control Rod Hole 4	-34.67	-83.70	2.743

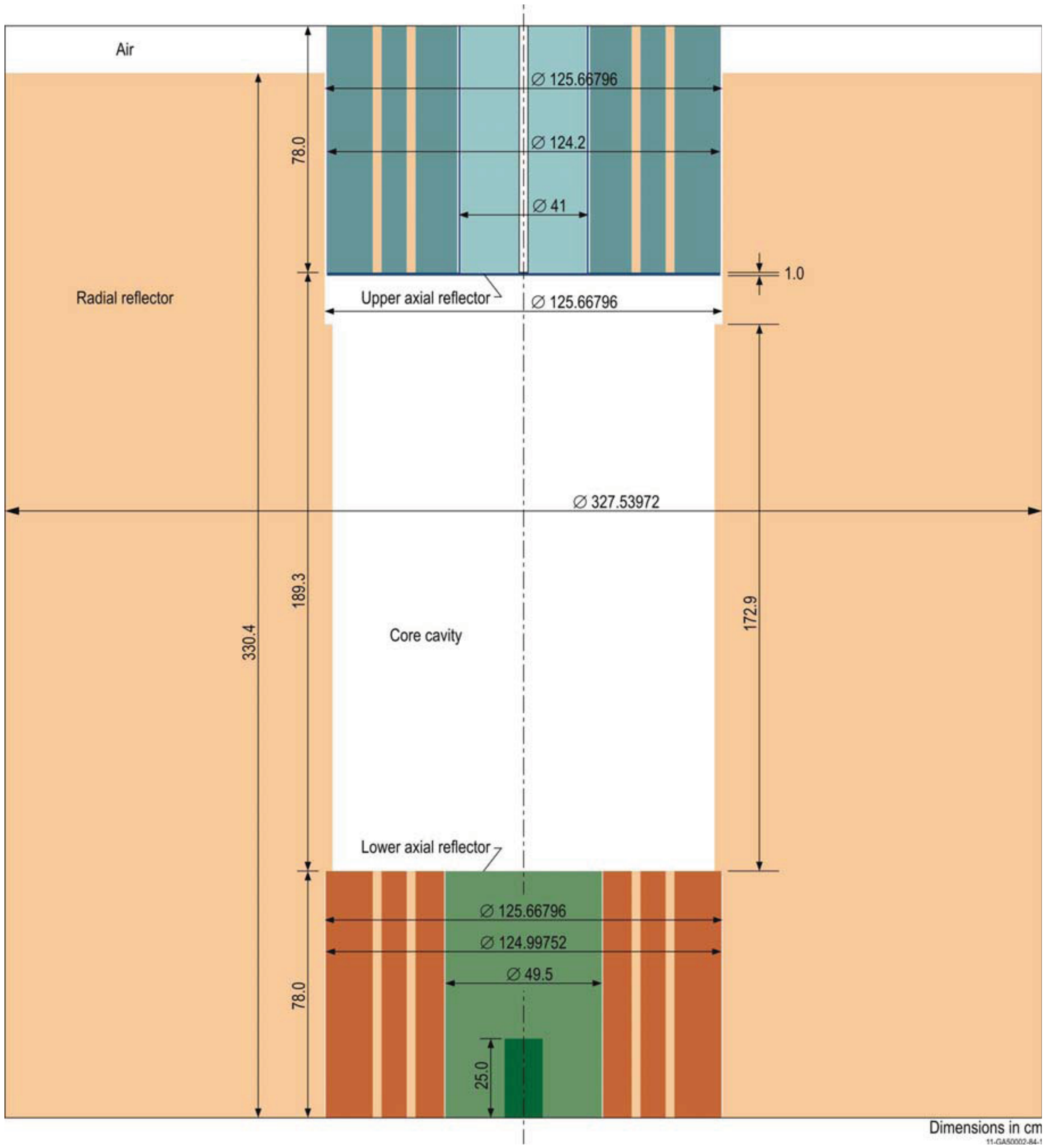

Figure 3.1-1. Radial and Axial Reflectors Surrounding Core Cavity Region.

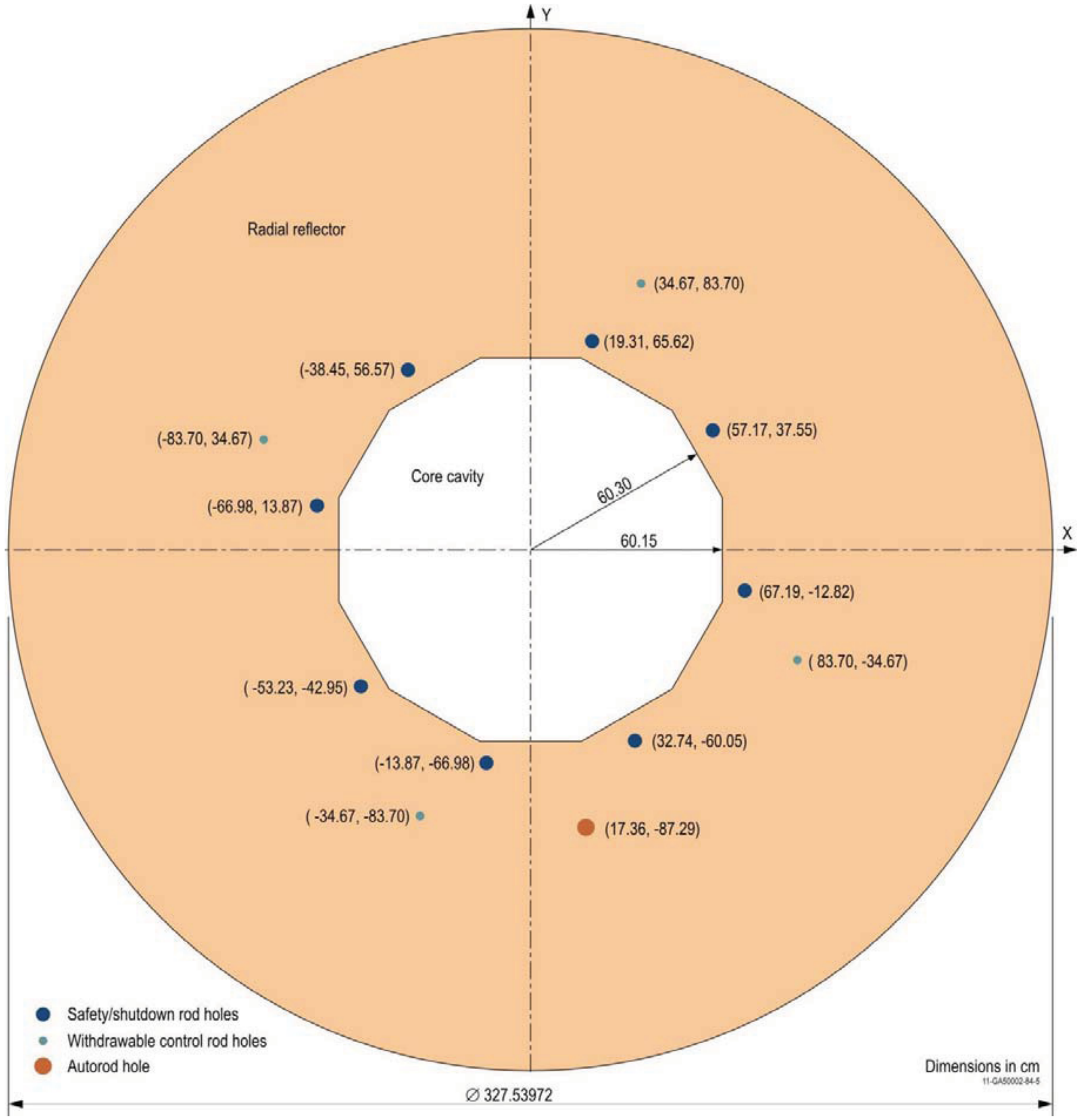

Figure 3.1-2. Radial Reflector Surrounding Core Cavity Region.

3.1.2.2 Upper Axial Reflector

The upper axial reflector consists of a graphite cylinder (radius of 19.7 cm) with a single coolant channel (diameter of 2.743 cm) and a graphite annulus (inner radius of 20.93 cm and outer radius of 61.7 cm) with 160 coolant channels (diameters of 2.743 cm) distributed equally and uniformly spaced within 5 annular locations with distances of 30.0, 35.5, 41.0, 46.25, and 51.5 cm radially from the center of the reflector (see Figure 3.1-3 and Table 3.1-8). Of the 161 channels, 127 are filled with graphite plugs (diameter of 2.65 cm), as noted in Table 3.1-8 with a "Y". The height of all graphite components is 78.0 cm. An aluminum structure supports the graphite components of the upper axial reflector with an inner annular sheet (19.8 cm inner radius and 20.5 cm outer radius) separating the graphite annulus and cylinder and another outer annular sheet (61.8 cm inner radius and 62.1 cm outer radius) surrounding the entire axial reflector. Air gaps exist between the graphite and aluminum portions of the reflector. The thickness of the aluminum structure below the graphite is 1.0 cm. The bottom of the graphite in the upper axial reflector rests 189.3 cm above the top of the lower axial reflector. The inside radius of the radial reflector surrounding the upper axial reflector is 62.83398 cm.

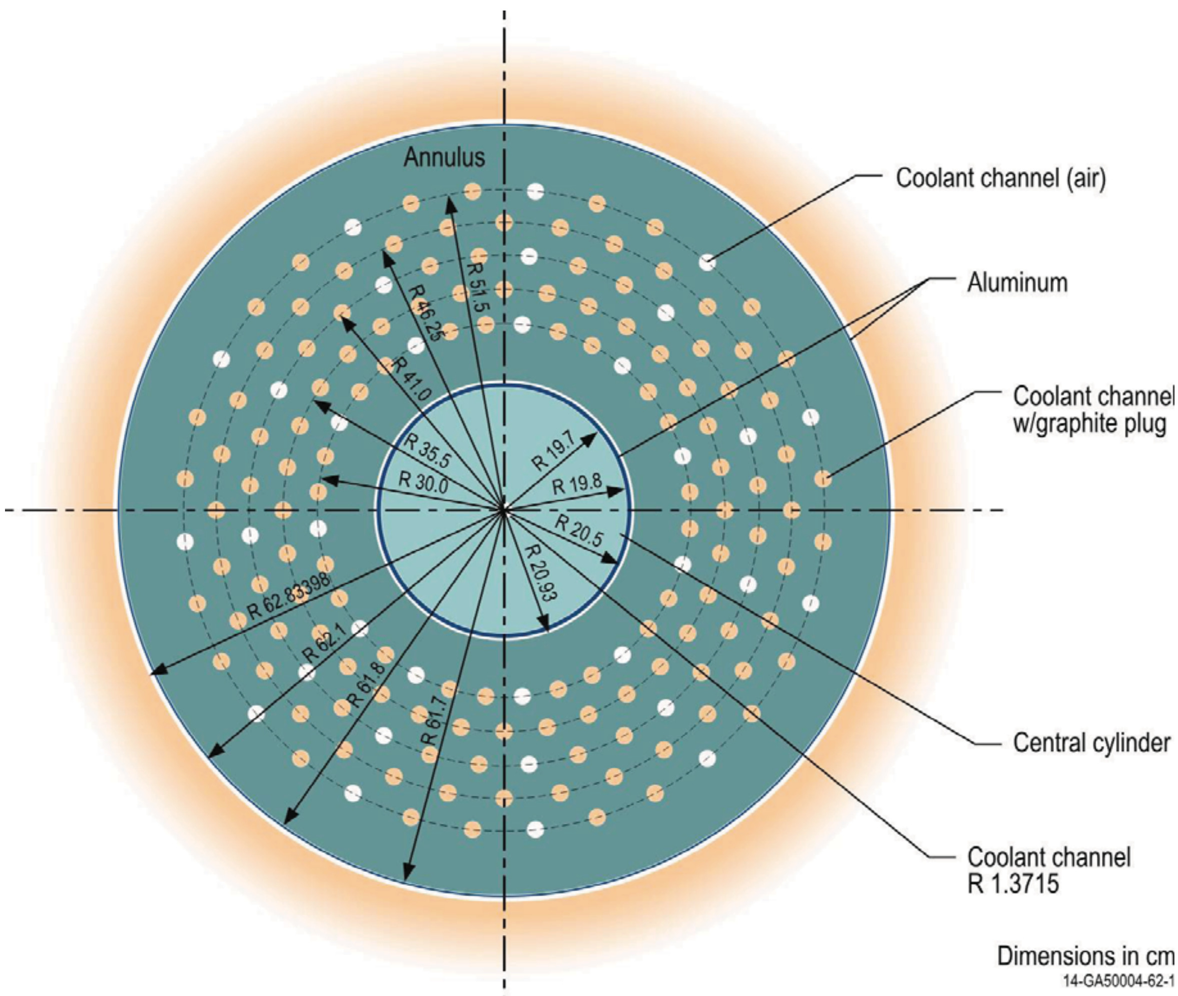

Figure 3.1-3. Upper Axial Reflector.

Table 3.1-8. Penetration Coordinates in the Axial Reflectors (dimensions in cm).

Ring	1			2			3		
Position	**x**	**y**	**Plug?[(a)]**	**x**	**y**	**Plug?[(a)]**	**x**	**y**	**Plug?[(a)]**
1	-29.86	2.94	Y	-34.82	6.93	Y	-39.23	11.90	Y
2	-28.71	8.71	Y	-32.80	13.59	Y	-36.16	19.33	N
3	-26.46	14.14	N	-29.52	19.72	Y	-31.69	26.01	Y
4	-23.19	19.03	Y	-25.10	25.10	Y	-26.01	31.69	Y
5	-19.03	23.19	Y	-19.72	29.52	Y	-19.33	36.16	N
6	-14.14	26.46	N	-13.59	32.80	Y	-11.90	39.23	Y
7	-8.71	28.71	Y	-6.93	34.82	Y	-4.02	40.80	Y
8	-2.94	29.86	Y	0.00	35.50	Y	4.02	40.80	N
9	2.94	29.86	N	6.93	34.82	Y	11.90	39.23	Y
10	8.71	28.71	Y	13.59	32.80	Y	19.33	36.16	Y
11	14.14	26.46	Y	19.72	29.52	Y	26.01	31.69	N
12	19.03	23.19	N	25.10	25.10	Y	31.69	26.01	Y
13	23.19	19.03	Y	29.52	19.72	Y	36.16	19.33	Y
14	26.46	14.14	Y	32.80	13.59	Y	39.23	11.90	N
15	28.71	8.71	N	34.82	6.93	Y	40.80	4.02	Y
16	29.86	2.94	Y	35.50	0.00	Y	40.80	-4.02	Y
17	29.86	-2.94	Y	34.82	-6.93	Y	39.23	-11.90	N
18	28.71	-8.71	N	32.80	-13.59	Y	36.16	-19.33	Y
19	26.46	-14.14	Y	29.52	-19.72	Y	31.69	-26.01	Y
20	23.19	-19.03	Y	25.10	-25.10	Y	26.01	-31.69	N
21	19.03	-23.19	N	19.72	-29.52	Y	19.33	-36.16	Y
22	14.14	-26.46	Y	13.59	-32.80	Y	11.90	-39.23	Y
23	8.71	-28.71	Y	6.93	-34.82	Y	4.02	-40.80	N
24	2.94	-29.86	N	0.00	-35.50	Y	-4.02	-40.80	Y
25	-2.94	-29.86	Y	-6.93	-34.82	Y	-11.90	-39.23	Y
26	-8.71	-28.71	Y	-13.59	-32.80	Y	-19.33	-36.16	N
27	-14.14	-26.46	N	-19.72	-29.52	Y	-26.01	-31.69	Y
28	-19.03	-23.19	Y	-25.10	-25.10	Y	-31.69	-26.01	N
29	-23.19	-19.03	N	-29.52	-19.72	Y	-36.16	-19.33	Y
30	-26.46	-14.14	Y	-32.80	-13.59	Y	-39.23	-11.90	Y
31	-28.71	-8.71	Y	-34.82	-6.93	Y	-40.80	-4.02	N
32	-29.86	-2.94	N	-35.50	0.00	Y	-40.80	4.02	Y

Table 3.1-8. (cont.). Penetration Coordinates in the Axial Reflectors (dimensions in cm).

Ring	4			5		
Position	**x**	**y**	**Plug?[(a)]**	**x**	**y**	**Plug?[(a)]**
1	-42.73	17.70	Y	-45.42	24.28	N
2	-38.46	25.70	Y	-39.81	32.67	Y
3	-32.70	32.70	Y	-32.67	39.81	Y
4	-25.70	38.46	Y	-24.28	45.42	N
5	-17.70	42.73	Y	-14.95	49.28	Y
6	-9.02	45.36	Y	-5.05	51.25	Y
7	0.00	46.25	Y	5.05	51.25	N
8	9.02	45.36	Y	14.95	49.28	Y
9	17.70	42.73	Y	24.28	45.42	Y
10	25.70	38.46	Y	32.67	39.81	N
11	32.70	32.70	Y	39.81	32.67	Y
12	38.46	25.70	Y	45.42	24.28	Y
13	42.73	17.70	Y	49.28	14.95	N
14	45.36	9.02	Y	51.25	5.05	Y
15	46.25	0.00	Y	51.25	-5.05	Y
16	45.36	-9.02	Y	49.28	-14.95	N
17	42.73	-17.70	Y	45.42	-24.28	Y
18	38.46	-25.70	Y	39.81	-32.67	Y
19	32.70	-32.70	Y	32.67	-39.81	N
20	25.70	-38.46	Y	24.28	-45.42	Y
21	17.70	-42.73	Y	14.95	-49.28	Y
22	9.02	-45.36	Y	5.05	-51.25	N
23	0.00	-46.25	Y	-5.05	-51.25	Y
24	-9.02	-45.36	Y	-14.95	-49.28	Y
25	-17.70	-42.73	Y	-24.28	-45.42	N
26	-25.70	-38.46	Y	-32.67	-39.81	Y
27	-32.70	-32.70	Y	-39.81	-32.67	N
28	-38.46	-25.70	Y	-45.42	-24.28	Y
29	-42.73	-17.70	Y	-49.28	-14.95	Y
30	-45.36	-9.02	Y	-51.25	-5.05	N
31	-46.25	0.00	Y	-51.25	5.05	Y
32	-45.36	9.02	Y	-49.28	14.95	Y

(a) This column notes whether a graphite plug is (marked by "Y") or is not (marked by "N") located within the coolant channel.

3.1.2.3 Lower Axial Reflector

The lower axial reflector consists of a graphite cylinder (radius of 24.75 cm) containing a removable source plug and a graphite annulus (equivalent inner radius of 25.05171 cm and equivalent outer radius of 62.71754 cm) with 160 coolant channels (diameter of 2.742 cm) with the same XY positions as the upper axial reflector (see Figures 3.1-4 and 3.1-5 and Table 3.1-8). Graphite plugs (diameter of 2.65 cm) fill all 160 coolant channel positions for Cases 1, 2, and 3 (Cores 5, 6, and 7), as shown in Figure 3-1.4. Thirty-three channels were empty for Case 4 (Core 8) as shown in Figure 3.1-5. The height of all graphite components, except the source plug, is 78.0 cm. The source plug is located at the bottom of the graphite cylinder along its axis and has a radius of 6.0 cm and height of 25.0 cm, located within a hole in the graphite cylinder with the same dimensions. The inside radius of the radial reflector surrounding the lower axial reflector is 62.83398 cm.

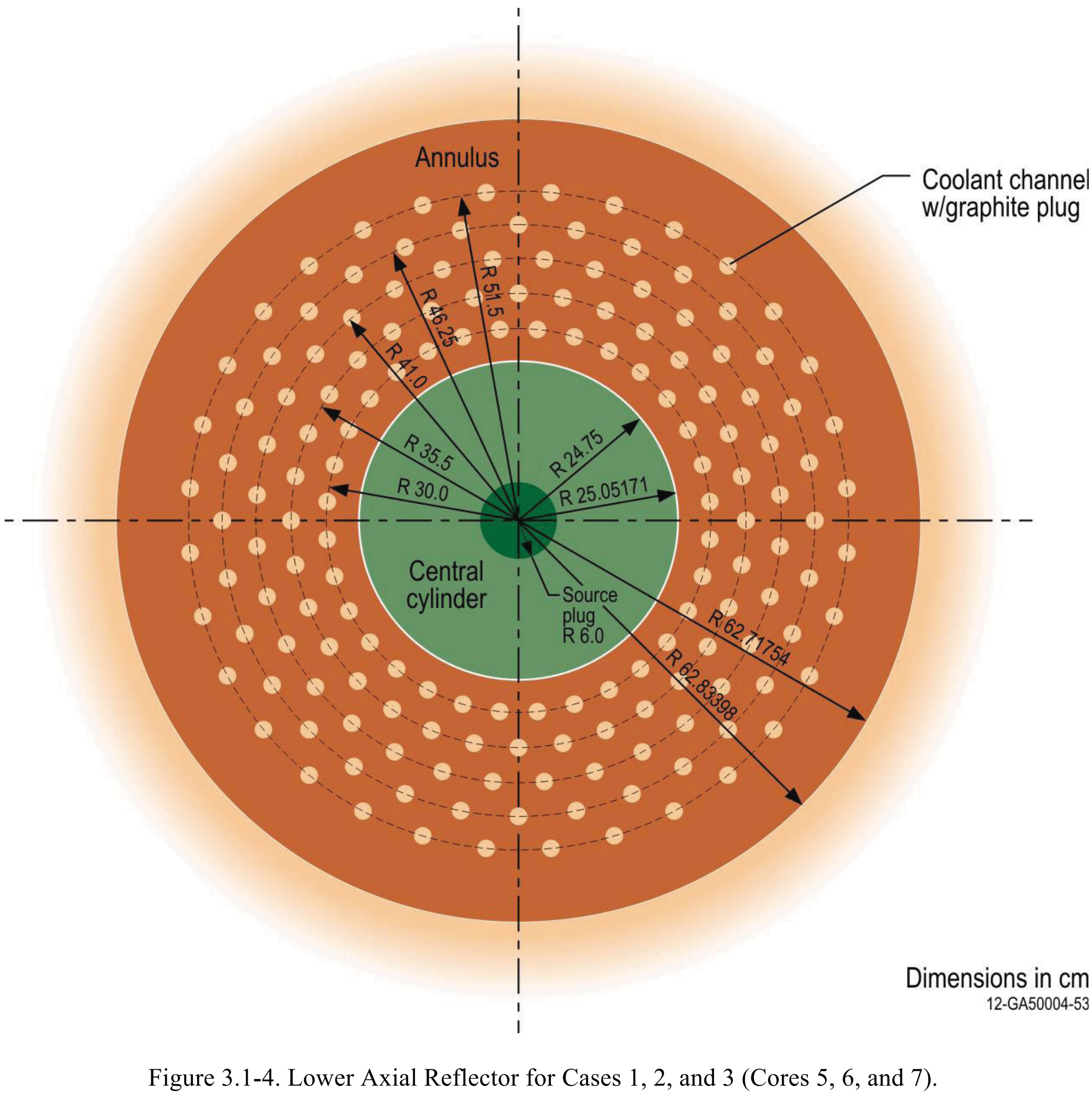

Figure 3.1-4. Lower Axial Reflector for Cases 1, 2, and 3 (Cores 5, 6, and 7).

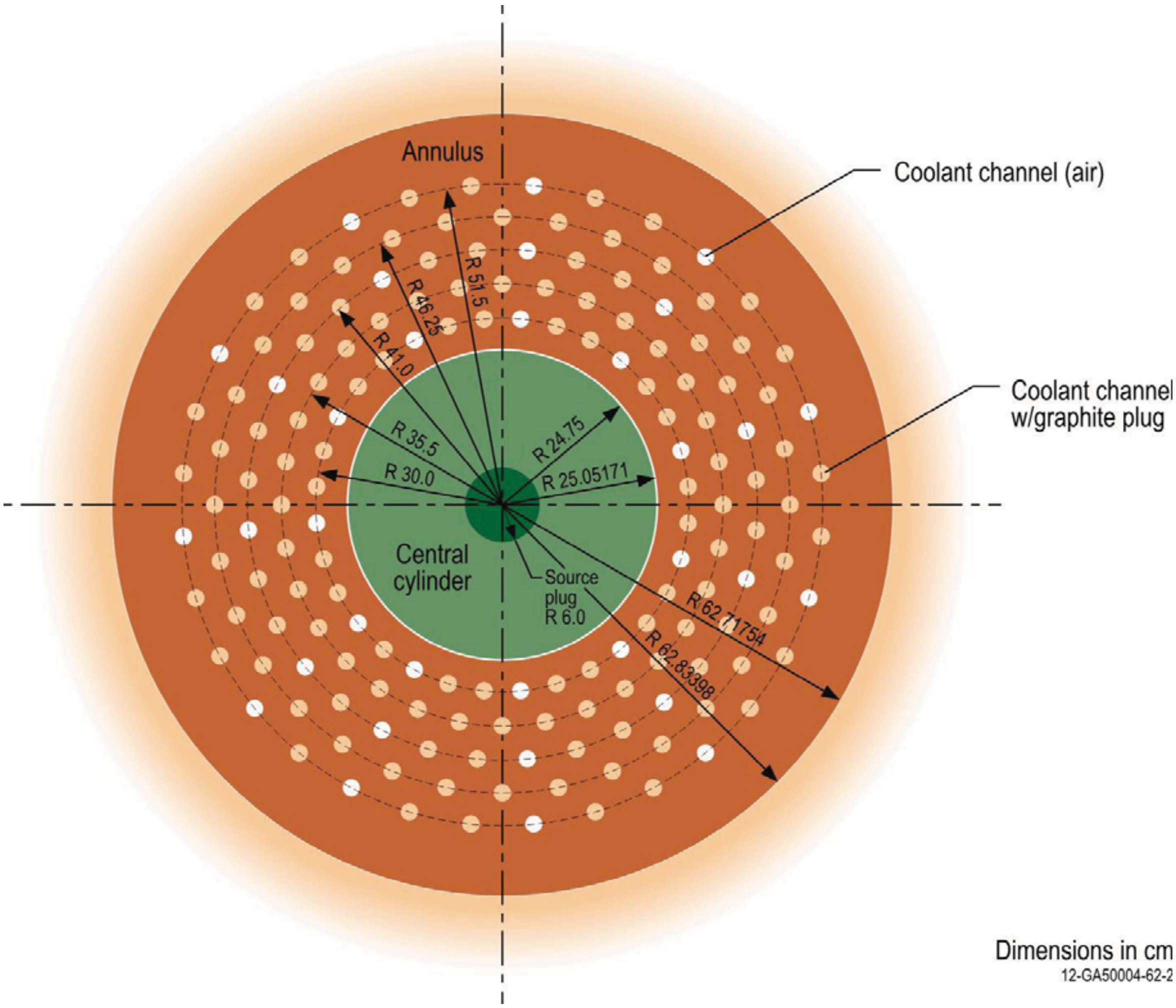

Figure 3.1-5. Lower Axial Reflector for Case 4 (Core 8).

3.1.2.4 Autorod

The autorod (Figures 3.1-6 and 3.1-7) consists of an aluminum guide tube (inner diameter of 4 cm and outer diameter of 4.4 cm) running the full length of its penetration in the radial reflector. A copper wedge can be raised or lowered within the tube for fine reactivity control of the assembly. The copper wedge has a thickness of 0.3 cm and a length of 230 cm. The top of the wedge has a width of 3.9 cm and tapers to a point at the bottom of the wedge. The XY position of the autorod compared to the core is shown in Figure 3.1-2 with the orientation shown in Figure 3.1-6. When fully inserted, the tip of the autorod is located 7.5 cm below the bottom of the radial reflector. The autorod is considered fully "withdrawn" in its uppermost position of 100.0 cm above its fully inserted position (see Figure 3.1-7). The distance the autorod is withdrawn from the fully inserted position for each core configuration is provided in Table 3.1-9.

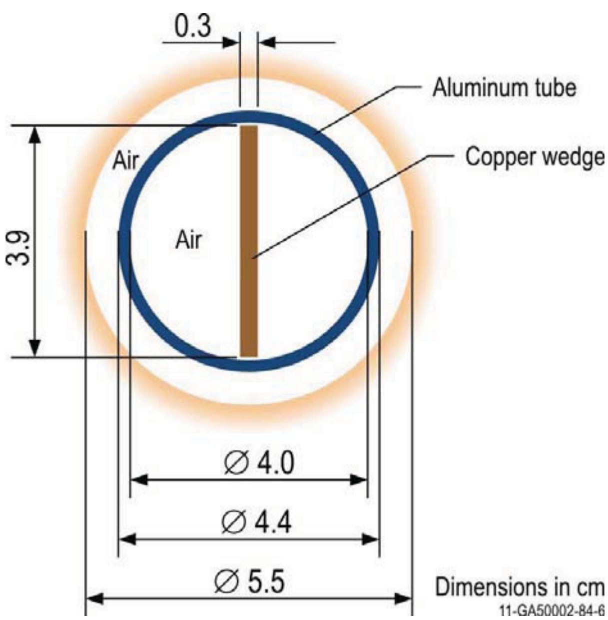

Figure 3.1-6. Top View of Autorod.

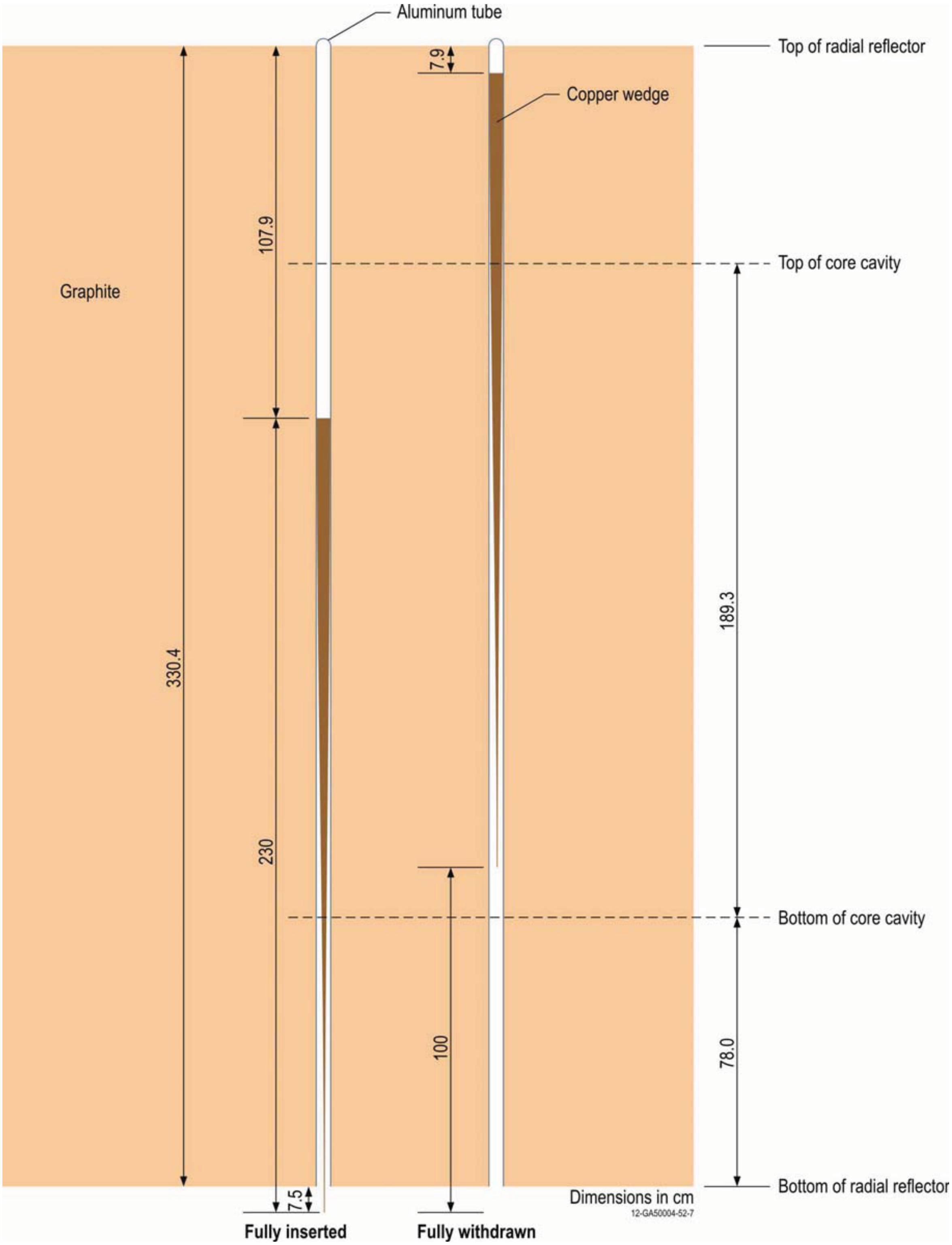

Figure 3.1-7. Autorod Vertical Position within Axial Reflector.

Table 3.1-9. Control Rod Positions (distance in cm).

Case (Core)	1 (5)	2 (6)	3 (7)	4 (8)
Control Rod	Withdrawn Distance	Withdrawn Distance	Withdrawn Distance	Withdrawn Distance
Safety/Shutdown Rod 1	NA	NA	NA	NA
Safety/Shutdown Rod 2	NA	NA	NA	NA
Safety/Shutdown Rod 3	NA	NA	NA	NA
Safety/Shutdown Rod 4	NA	NA	NA	NA
Safety/Shutdown Rod 5	NA	NA	NA	NA
Safety/Shutdown Rod 6	NA	NA	NA	NA
Safety/Shutdown Rod 7	NA	NA	NA	NA
Safety/Shutdown Rod 8	NA	NA	NA	NA
Autorod	88.7	22.5	17.0	50.6
Withdrawable Control Rod 1	55.5	50.0	54.0	0.0
Withdrawable Control Rod 2	55.5	50.0	54.0	0.0
Withdrawable Control Rod 3	55.5	50.0	54.0	0.0
Withdrawable Control Rod 4	55.5	50.0	54.0	0.0

3.1.2.5 Fuel Pebbles

The graphite fuel pebbles have a diameter of 6.000 cm. A total of 9394 TRISO particles are randomly distributed within the graphite matrix of the fueled zone (diameter of 4.700 cm) of each fuel pebble (Figure 3.1-8). The fuel pebbles are located in the core cavity; their positions in each core configuration are described in more detail in Section 3.1.2.11. Each TRISO particle consists of four layers surrounding a UO_2 kernel. The fuel kernel has a diameter of 0.0502 cm. A graphite buffer layer (thickness of 0.00915 cm) surrounds the fuel kernel. An inner pyrolytic carbon (IPyC) layer (thickness of 0.00399 cm), SiC layer (thickness of 0.00353 cm), and outer pyrolytic carbon (OPyC) layer (thickness of 0.00400 cm) then each, in succession, surround the growing TRISO particle, as shown in Figure 3.1-8.

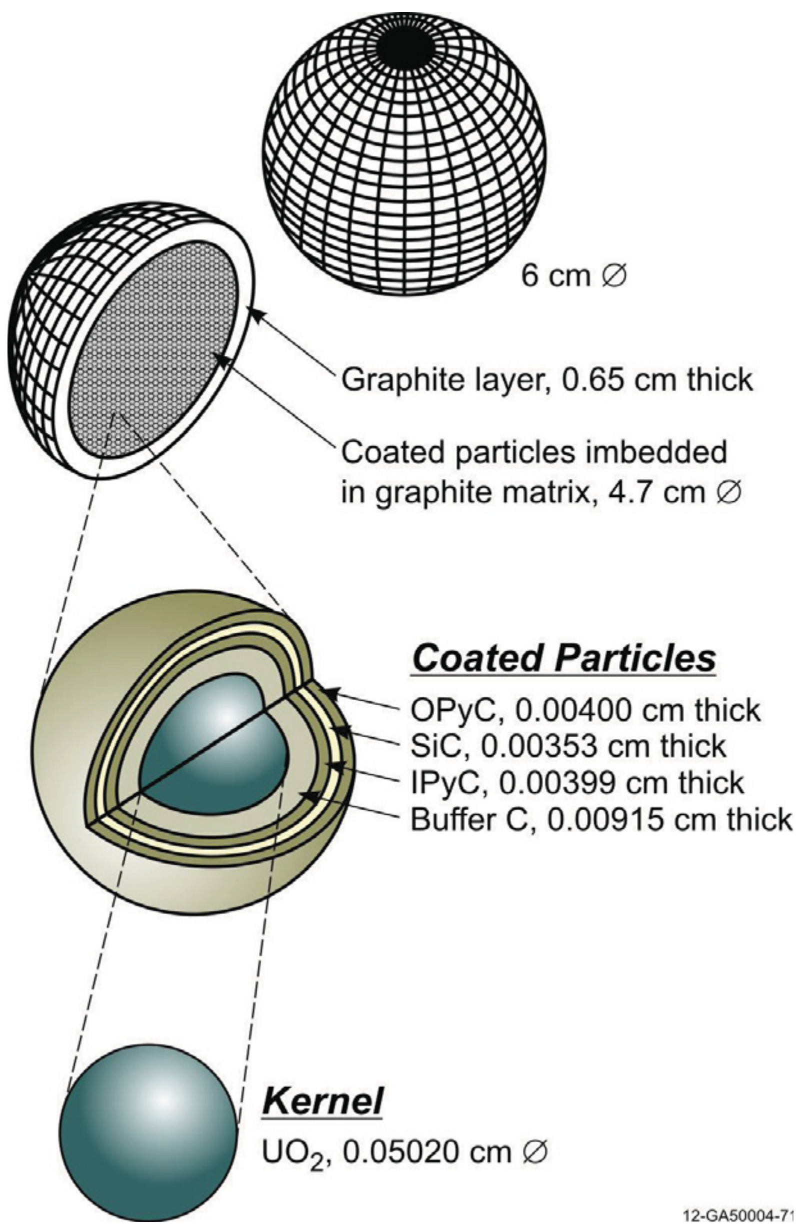

Figure 3.1-8. Fuel Pebble and TRISO Particle.

3.1.2.6 Moderator Pebbles

The graphite moderator pebbles have a diameter of 6.000 cm. They are located in the core cavity; their positions in each core configuration are described in more detail in Section 3.1.2.11.

3.1.2.7 Withdrawable Stainless Steel Control Rods

The withdrawable control rods (Figures 3.1-9 through 3.1-11) are comprised of two concentric stainless steel tubes with end plugs. The inner tube has an inner diameter of 0.95 cm and an outer diameter of 1.35 cm. The outer tube has an inner diameter of 1.4 cm and an outer diameter of 2.2 cm. Both tubes have a total length of 215.0 cm. The dimensions for the end plugs are shown in Figure 3.1-10. The stainless steel control rods are completely inserted into the core when the bottom surface of the bottom end plug is located 75.5 cm above the bottom of the radial reflector; they are completely withdrawn when raised 249.4 cm from the fully inserted position (see Figure 3.1-11). A graphite plug (diameter of 2.65 cm and height of 73.0 cm) is located in the bottom of each penetration for the withdrawable control rods. The withdrawn positions of the withdrawable control rods are provided in Table 3.1-9.

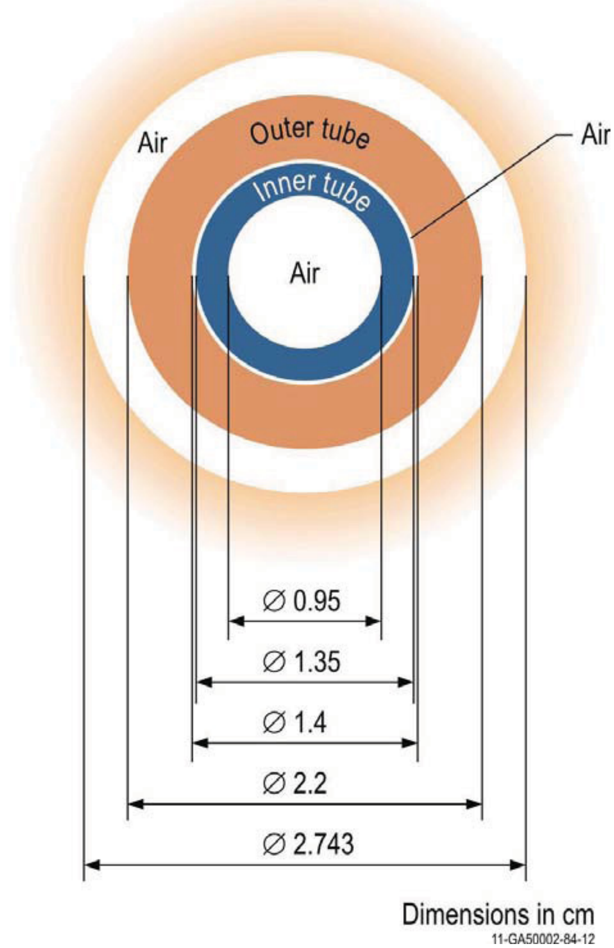

Figure 3.1-9. Top View of Withdrawable Control Rod.

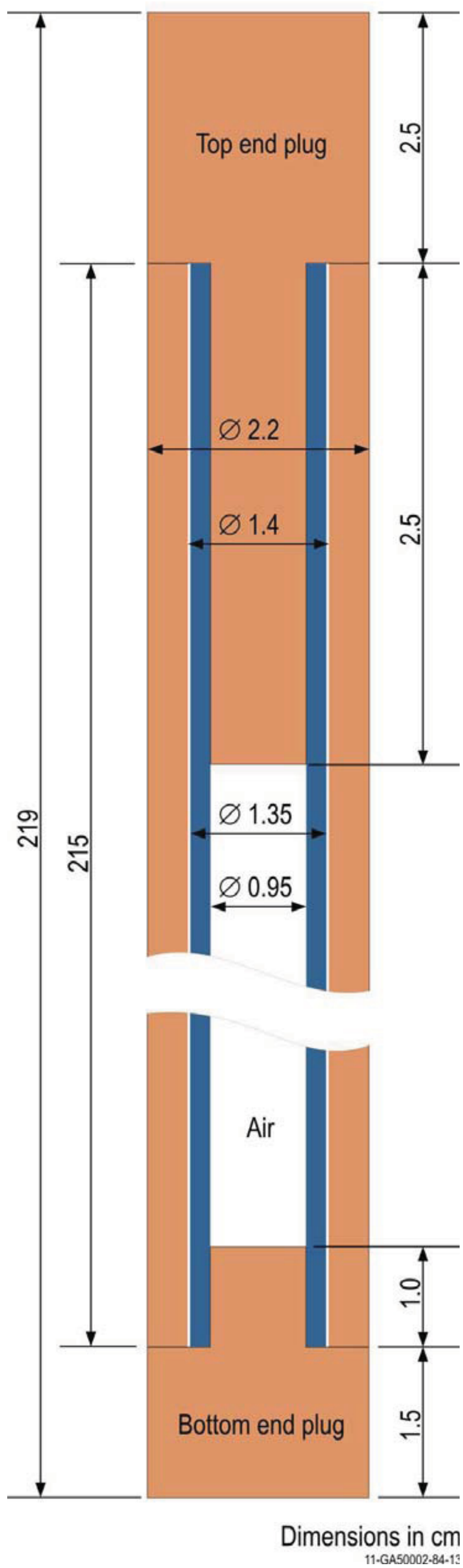

Figure 3.1-10. Axial View of Withdrawable Control Rod.

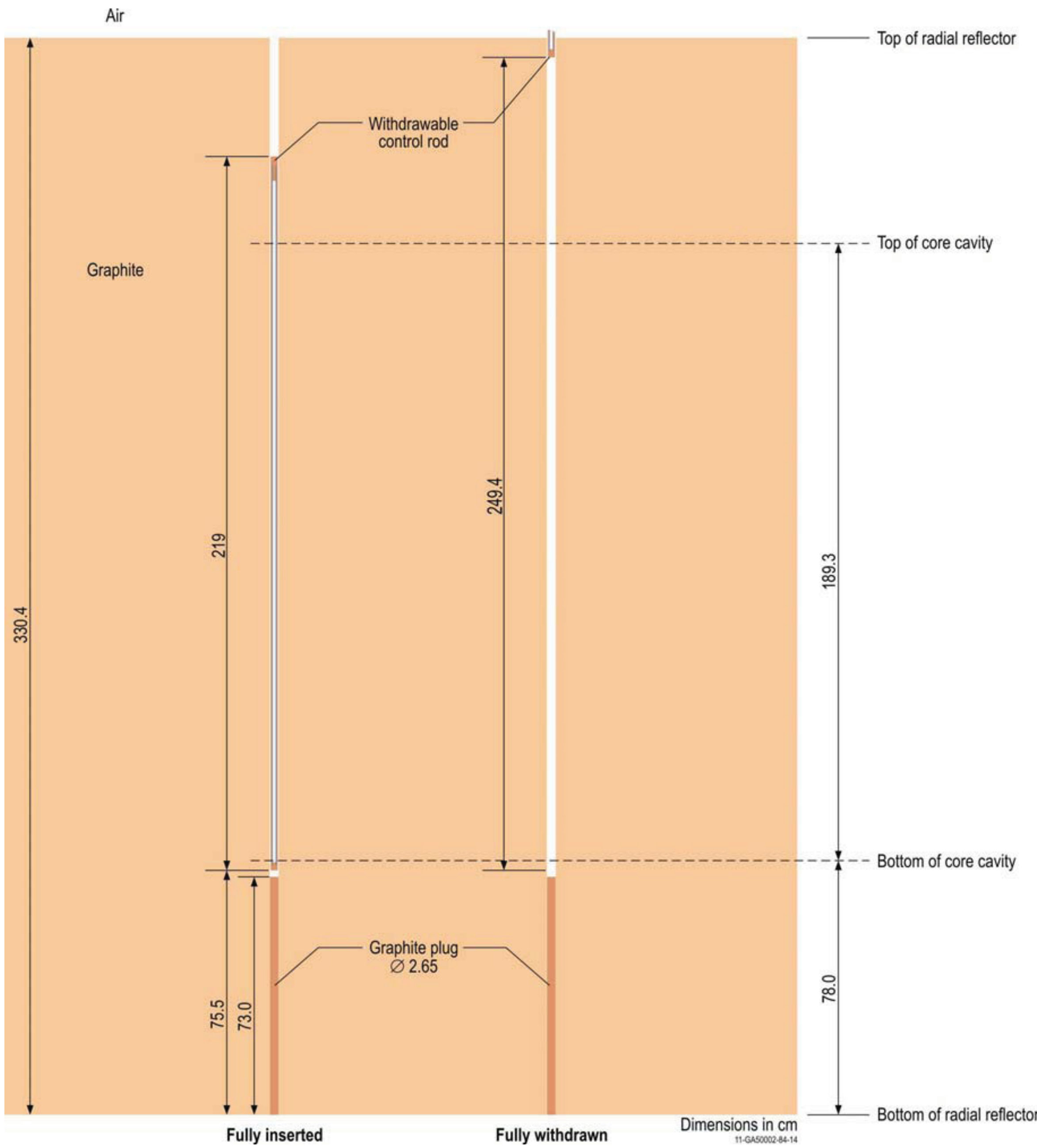

Figure 3.1-11. Withdrawable Control Rod Vertical Position within Axial Reflector.

3.1.2.8 Polyethylene Rods

Polyethylene (sometimes referred to as plastic) rods are used to simulate water ingress in Cases 2, 3, and 4 (Cores 6, 7, and 8). Polyethylene rods are placed vertically in interstitial pebble channels within the core (see Figures 3.1-20 through 3.1-23 and 3.1.25). Dimensions of the polyethylene rods are provided in Table 3.1-10. The hollow rods used in Core 6 had a triangular cross section, each containing a length of copper wire, as shown in Figure 3.1-12. Shortened hollow rods were used in Core 8, but without the copper wire.

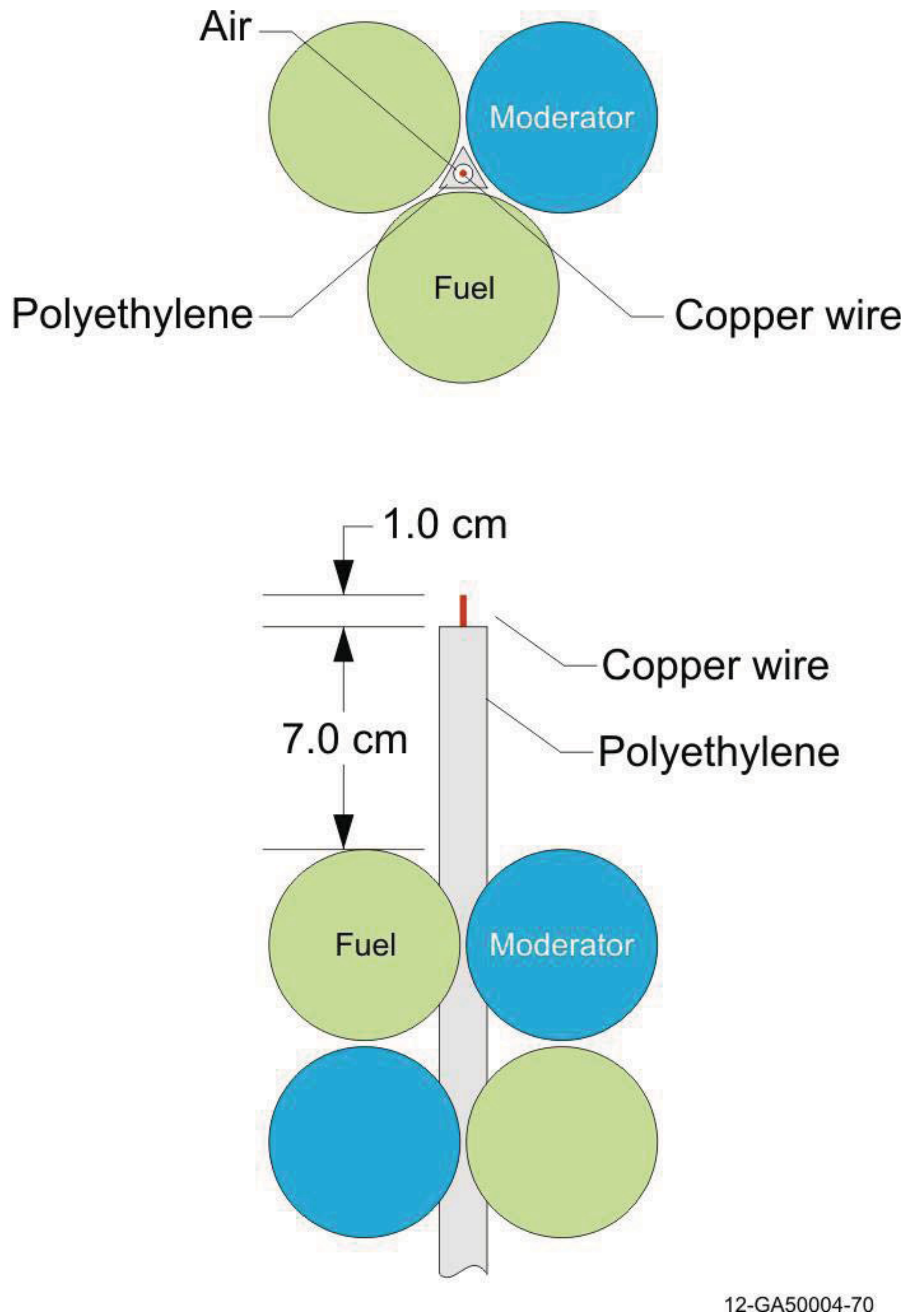

Figure 3.1-12. Copper Wire within Hollow Triangular Polyethylene Rod for Case 2 (Core 6).

Table 3.1-10. Polyethylene Rod and Copper Wire Parameters (units in cm).

Case (Core)	# Rods	Polyethylene Rod		Copper Wire	
		Diameter	Length	Diameter	Length
1 (5)	0	NA	NA	NA	NA
2 (6)	654	1.50 Δ Sides 0.6 θ Hole	139.0	0.1784	140.0
3 (7)	654	0.83	109.0	NA	NA
4 (8)	654	1.50 Δ Sides 0.6 θ Hole	15	NA	NA

3.1.2.9 Copper Wire

Figure 3.1-12 shows how the copper wire was loaded into the hollow triangular polyethylene rods. The top 1.0 cm of each wire extended above the top of the polyethylene rod. Dimensions of the copper wire are provided in Table 3.1-10.

3.1.2.10 Ambient Air

Air is located in any gaps, holes, or penetrations within the benchmark model that does not contain the graphite reflectors, graphite plugs, aluminum support structure, pebbles, lattice supports, or control rods.

3.1.2.11 Core Configurations

Each core has a unique configuration of fuel and moderator pebbles stacked within the core cavity. The position of each pebble is known since the pebbles are deterministically placed in columnar hexagonal point-on-point packed lattices, as shown in Figure 3.1-13. Information corresponding to the loading of each configuration is provided in Table 3.1-11 with additional visualization of the core descriptions in Figures 3.1-14 through 3.1-25.

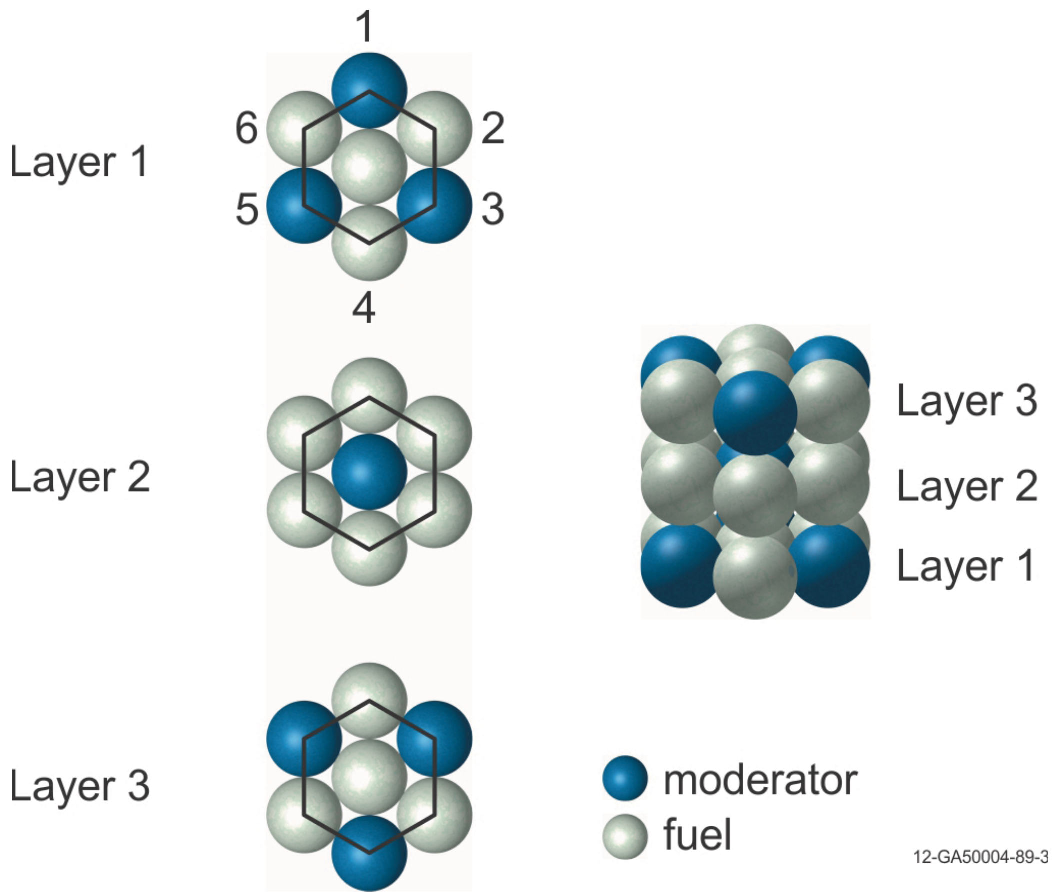

Figure 3.1-13. Subunit for Construction of the Columnar Hexagonal Point-On-Point (CHPOP) Cell.

Table 3.1-11. Additional Core Configuration Parameters.

Case	Core	# Fuel Pebbles	# Moderator Pebbles	# Pebble Layers	Core Height (m)	# Polyethylene Rods	Associated Figures
1	5	5433	2870	23	1.38	0	3.1-14 to 3.1-18
2	6	5184	2758	22	1.32	654	3.1-19 to 3.1-23
3	7	4221	2277	18	1.08	654	3.1.20 to 3.1-22 and 3.1-24 to 3.1-25
4	8	5433	2870	23	1.38	654	3.1-14 to 3.1-18 and 3.1-20 to 3.1-22

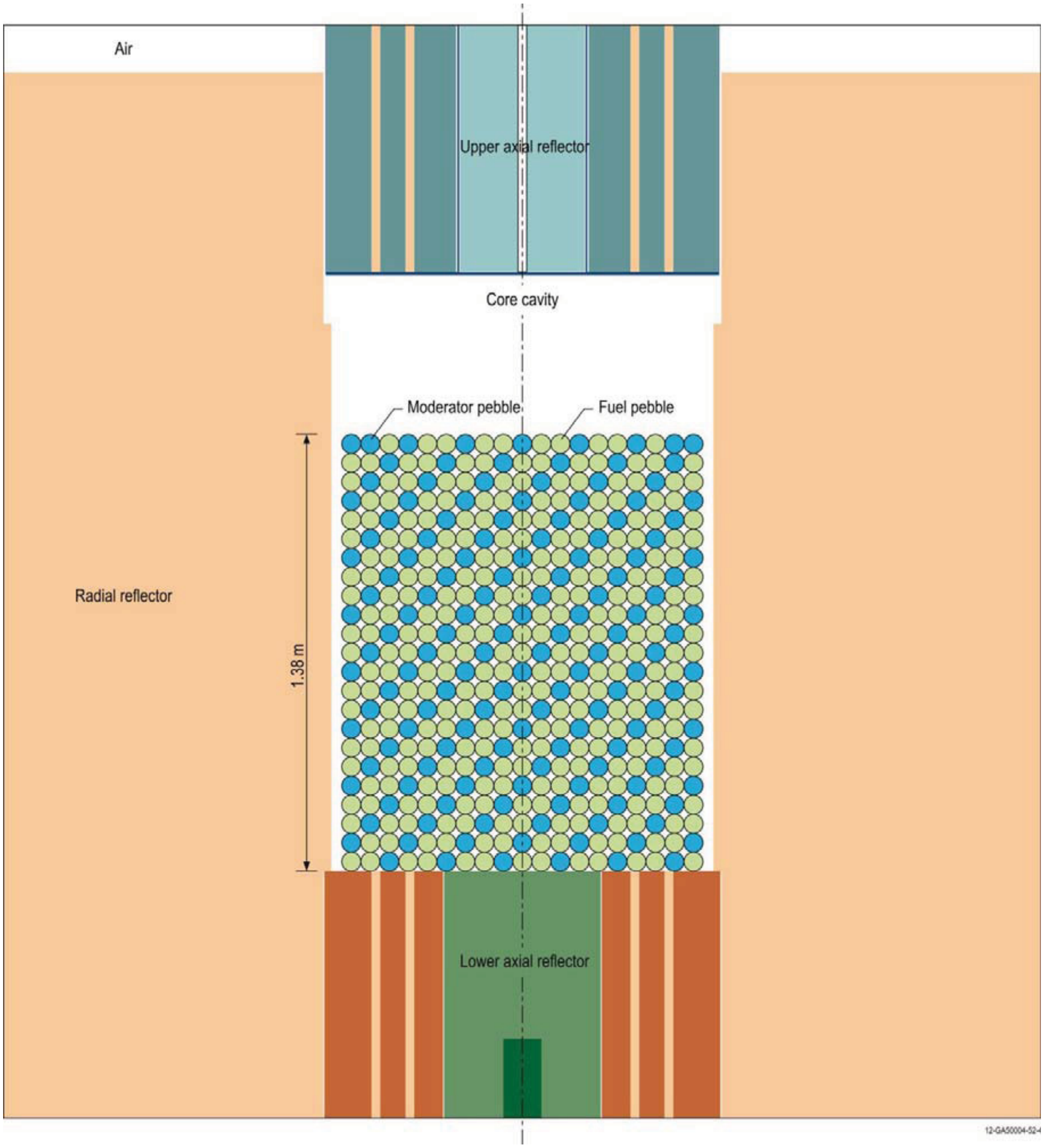

Figure 3.1-14. Vertical Profile of Cases 1 and 4 (Cores 5 and 8).

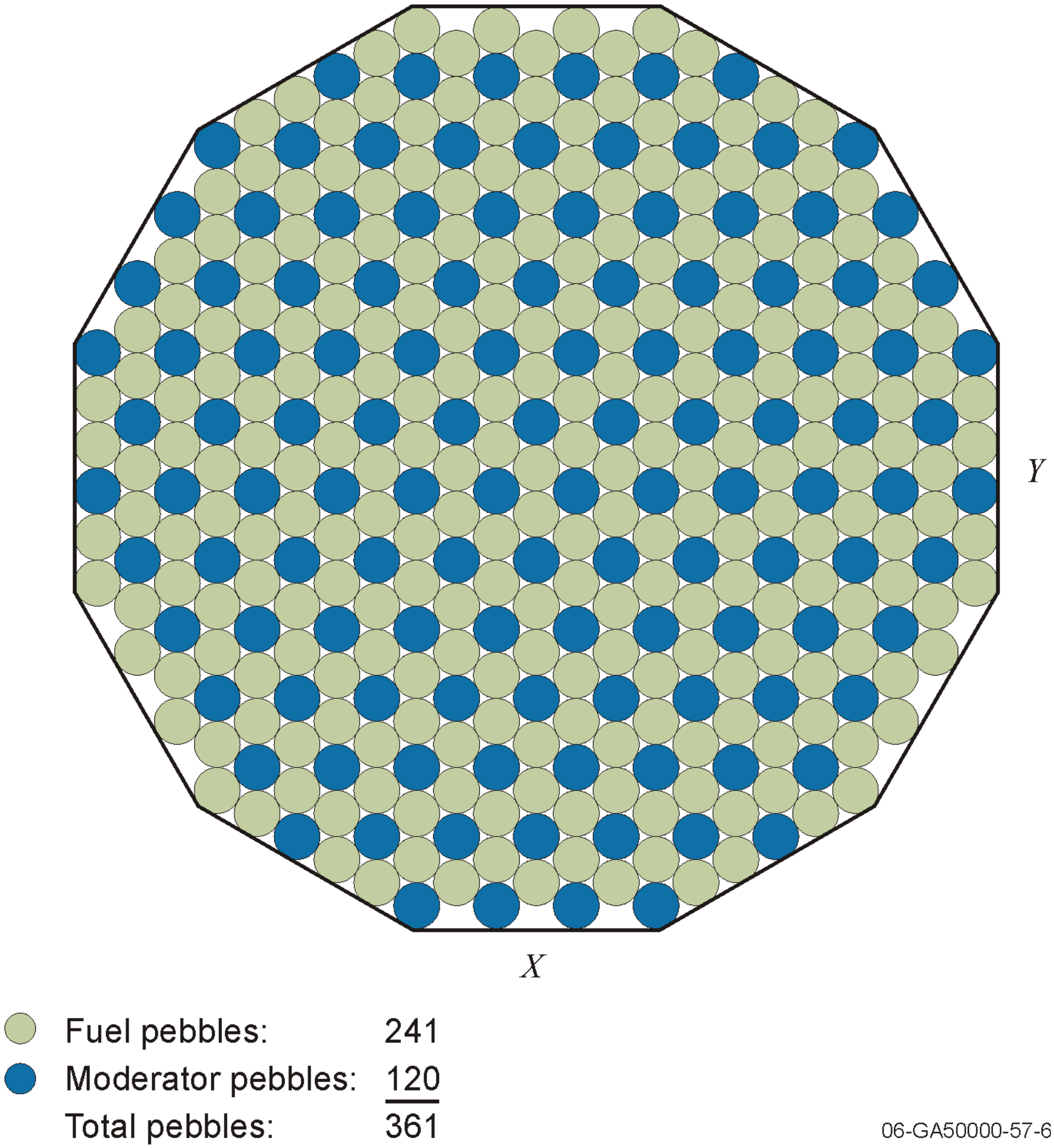

Figure 3.1-15. Layers 1, 4, 7, etc., of Cases 1 and 4 (Cores 5 and 8) except Layer 1 of Case 4 (Core 8). Layer 1 of Case 4 (Core 8), which contains polyethylene rods, is shown in Figure 3.1-20.

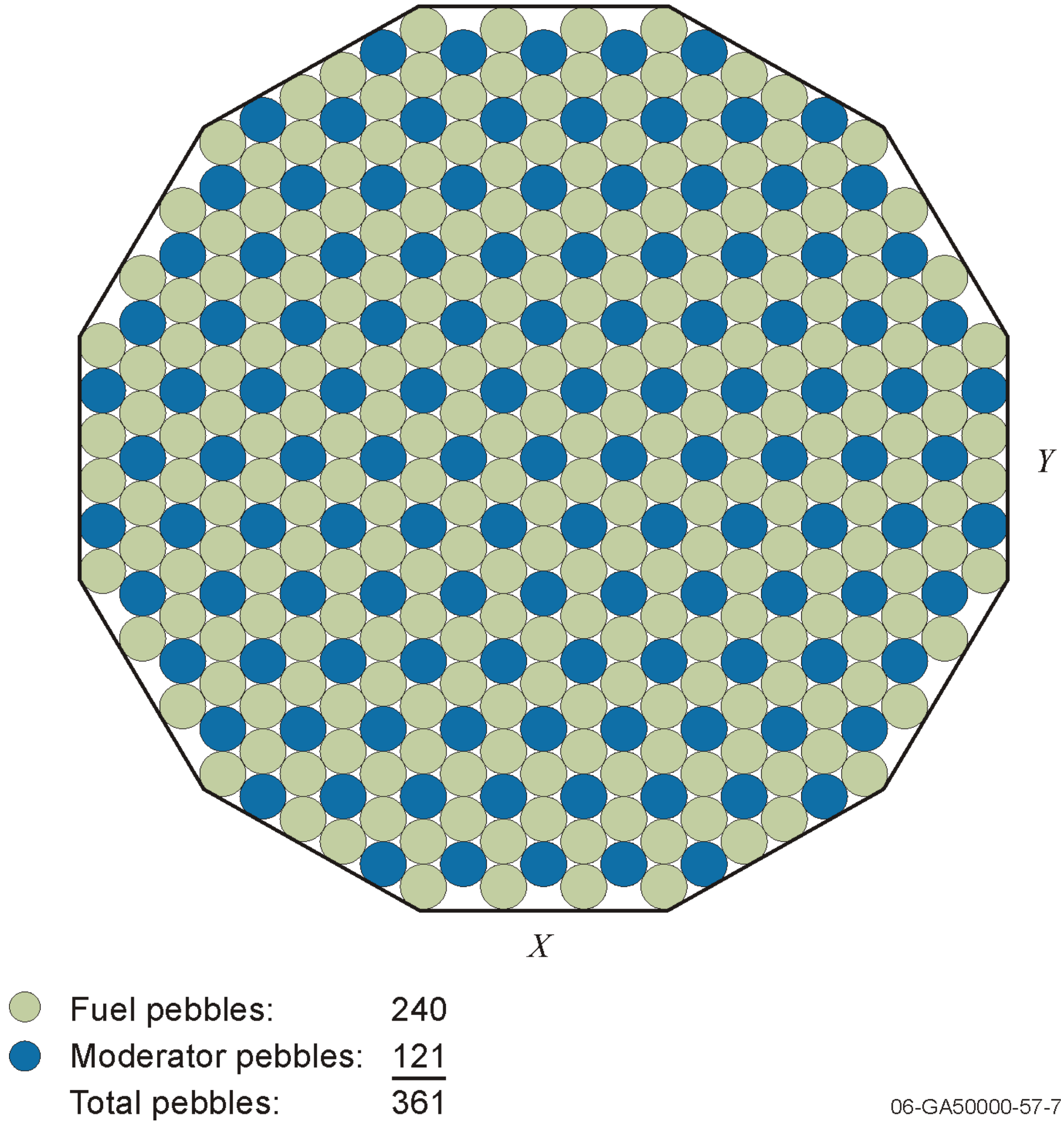

Figure 3.1-16. Layers 2, 5, 8, etc., of Cases 1 and 4 (Cores 5 and 8) except Layer 2 of Case 4 (Core 8). Layer 2 of Case 4 (Core 8), which contains polyethylene rods, is shown in Figure 3.1-21.

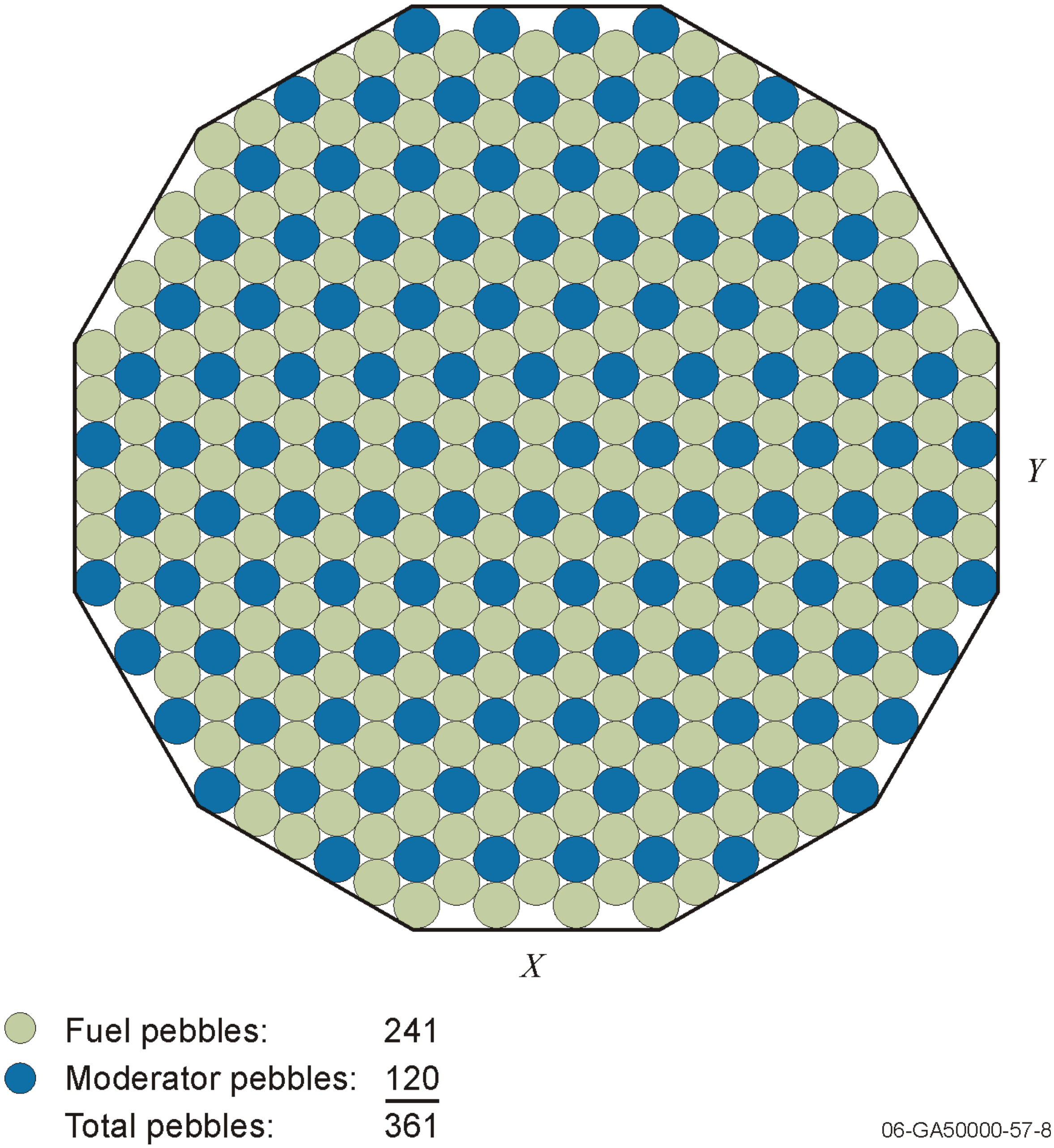

Figure 3.1-17. Layers 3, 6, 9, etc., of Cases 1 and 4 (Cores 5 and 8) except Layer 3 of Case 4 (Core 8). Layer 3 of Case 4 (Core 8), which contains polyethylene rods, is shown in Figure 3.1-22.

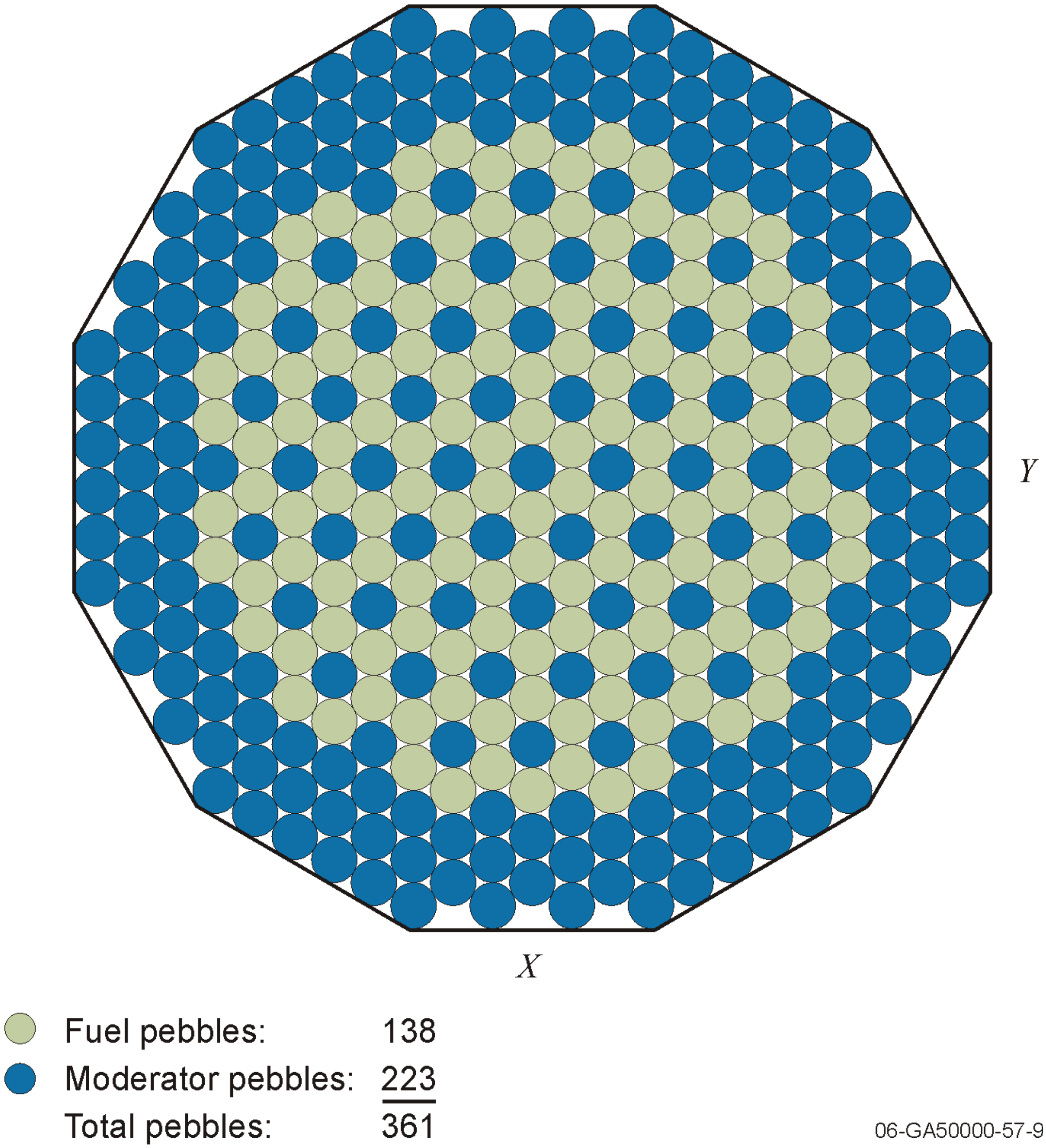

Figure 3.1-18. Top Layer (23rd) of Cases 1 and 4 (Cores 5 and 8).

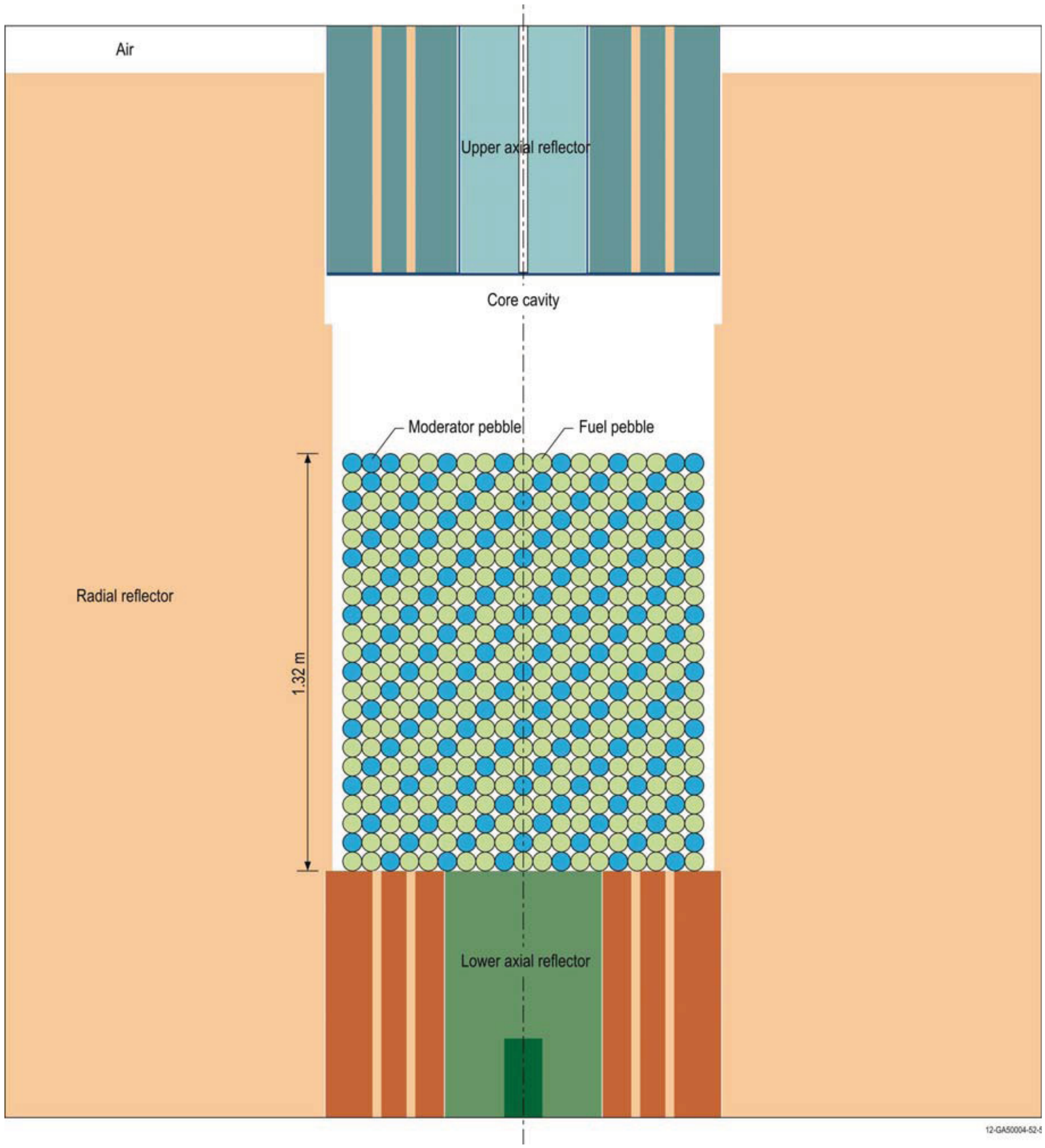

Figure 3.1-19. Vertical Profile of Case 2 (Core 6).

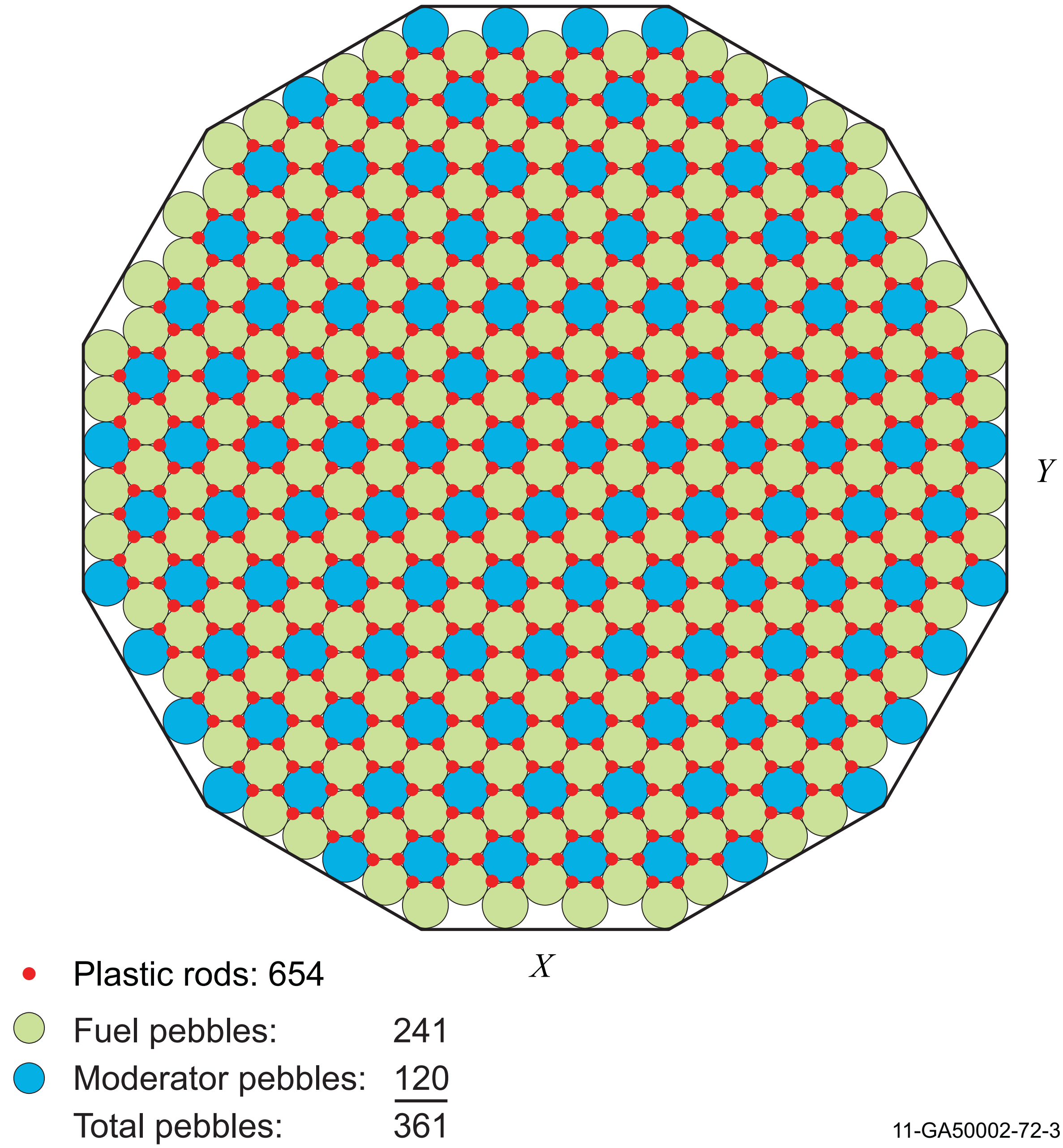

Figure 3.1-20. Layers 1, 4, 7, etc., of Cases 2 and 3 (Cores 6 and 7) and Layer 1 of Case 4 (Core 8).

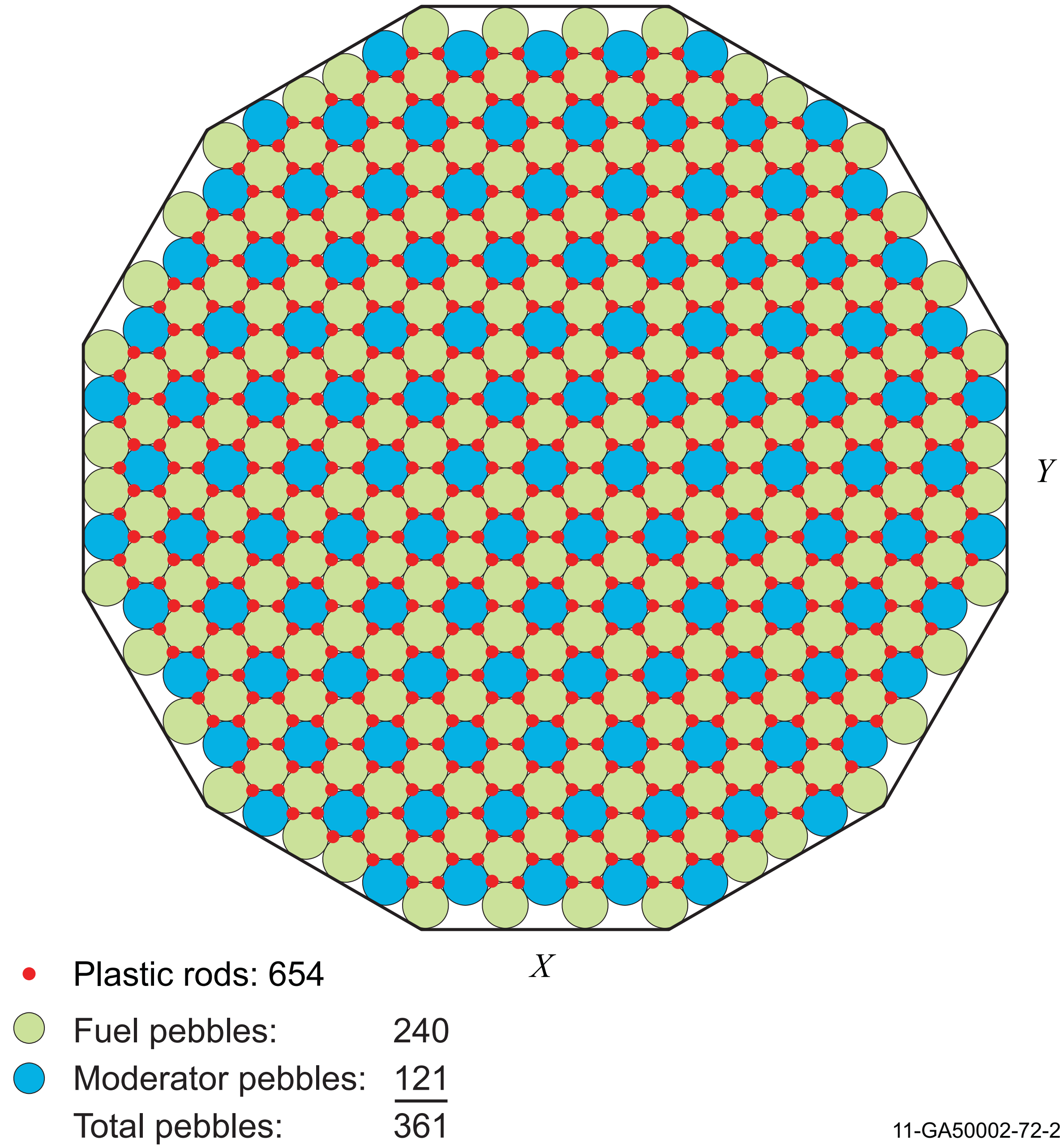

Figure 3.1-21. Layers 2, 5, 8, etc., of Cases 2 and 3 (Cores 6 and 7) and Layer 2 of Case 4 (Core 8).

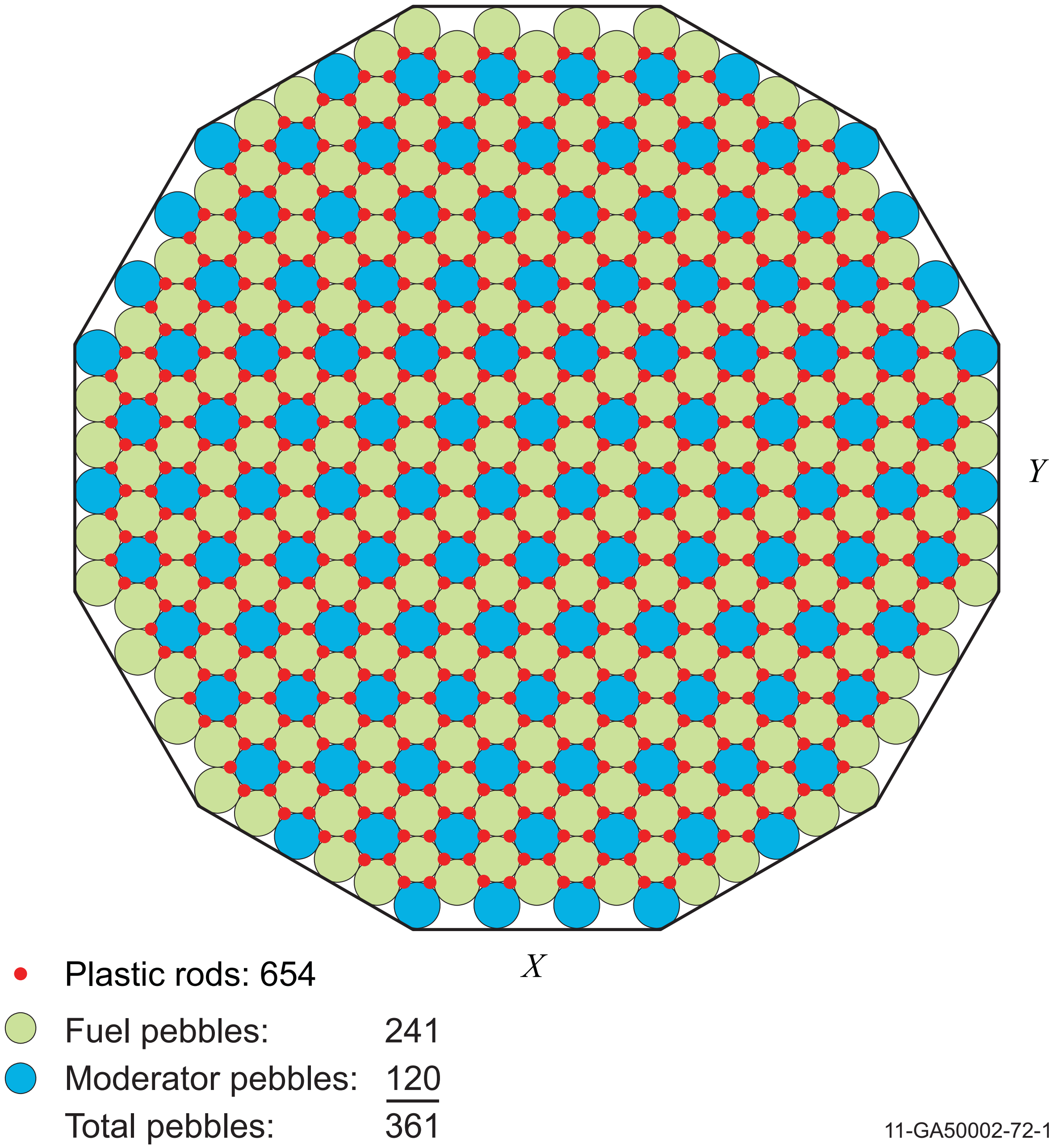

Figure 3.1-22. Layers 3, 6, 9, etc., of Cases 2 and 3 (Cores 6 and 7) and Layer 3 of Case 4 (Core 8).

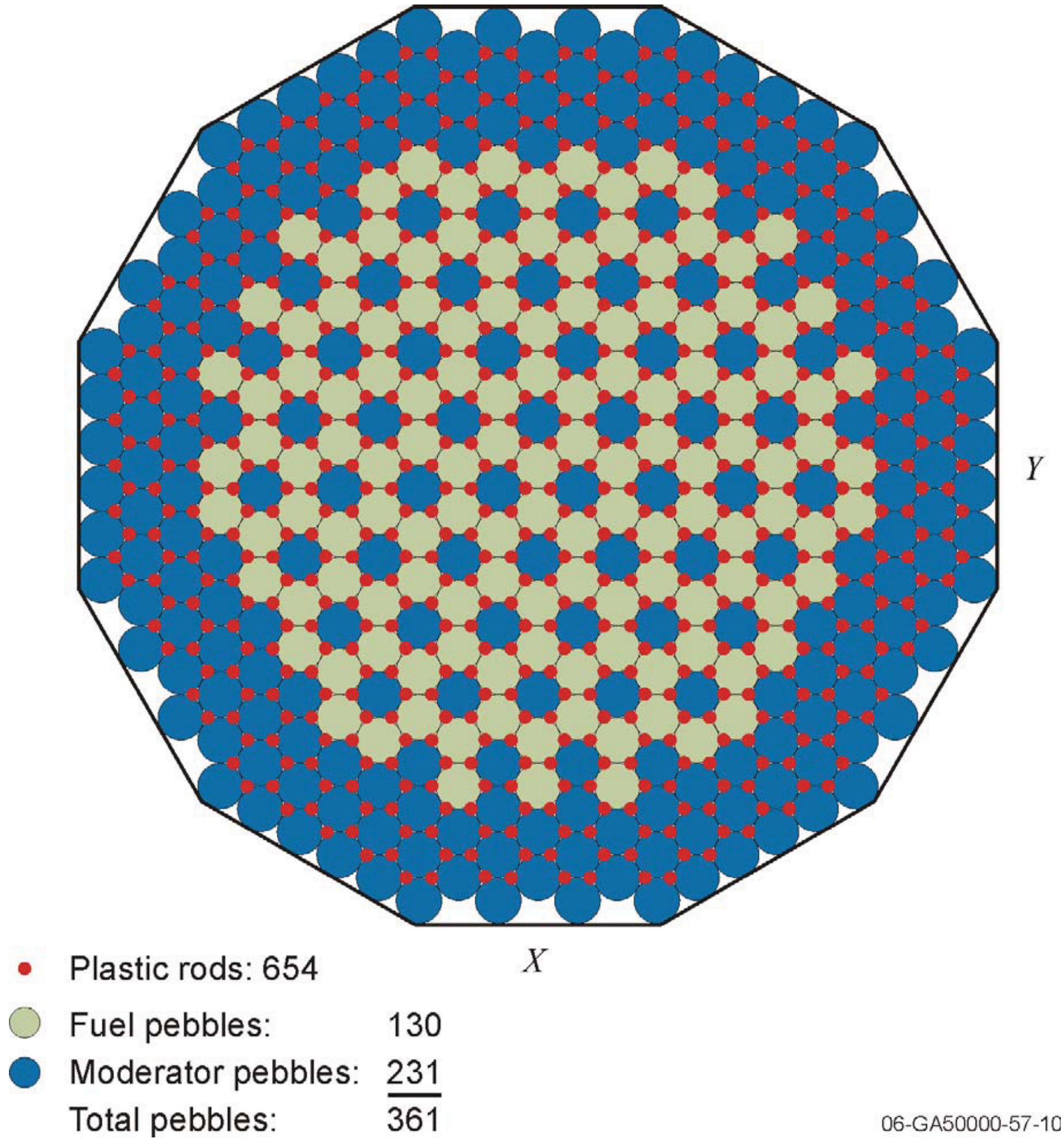

Figure 3.1-23. Top Layer (22nd) of Case 2 (Core 6).

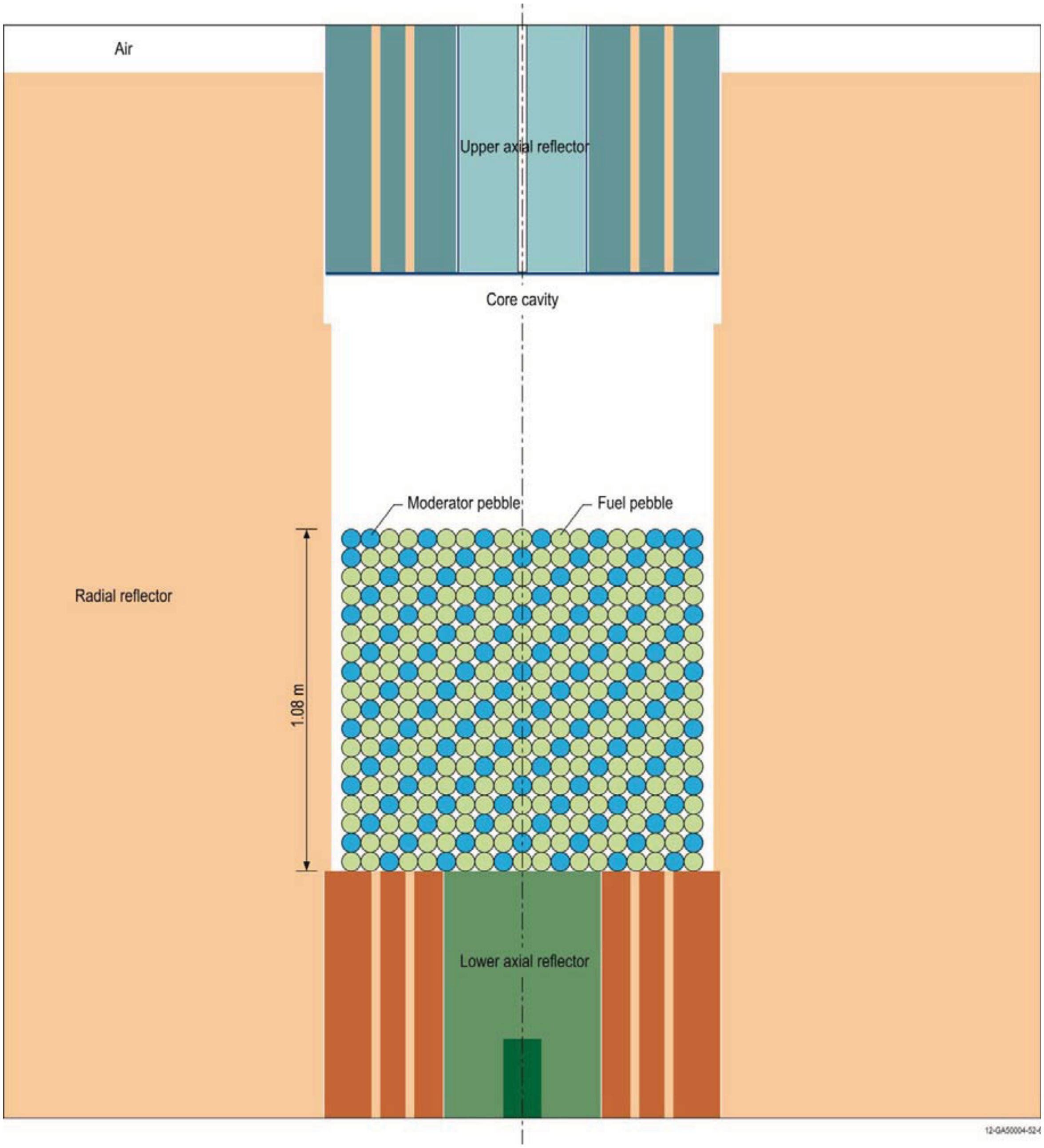

Figure 3.1-24. Vertical Profile of Case 3 (Core 7).

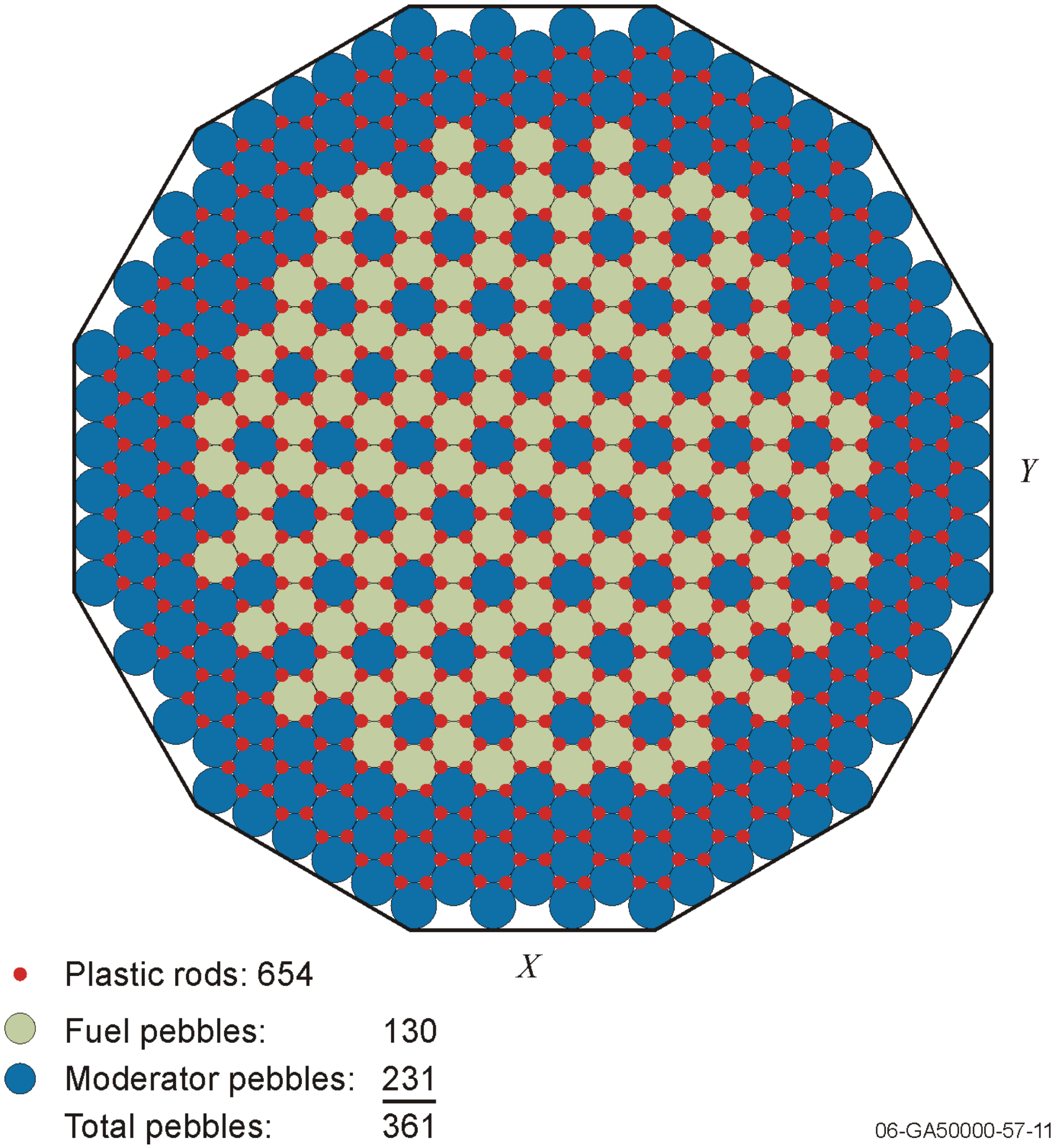

Figure 3.1-25. Top Layer (18th) of Case 3 (Core 7).

3.1.3 Material Data

3.1.3.1 Radial Reflector

The homogenized (see Section 3.1.1.1) graphite radial reflector has the compositions in Table 3.1-12. The graphite in the radial reflector has 1.33 ppm EBC (by at.%), which equates to a nominal ^{10}B concentration of 2.69 mbarn/atom.

Table 3.1-12. Radial Reflector Graphite Composition.

Isotope/Element	Atoms/barn-cm
^{10}B	2.3253E-08
^{11}B	9.3597E-08
C	8.7857E-02
Total	8.7857E-02
Mass Density (g/cm^3)	1.752264

3.1.3.2 Upper Axial Reflector

The upper axial reflector graphite is comprised of three compositions, depending on the component of the assembly (see Table 3.1-13). The support structure into which the graphite material is placed is Peraluman-300 (Table 3.1-14).

Table 3.1-13. Upper Axial Reflector Graphite Composition (see Figure 3.1-3).

Component	Cylinder	Annulus	Plugs
Isotope/Element	**Atoms/barn-cm**	**Atoms/barn-cm**	**Atoms/barn-cm**
^{10}B	2.3235E-08	2.3368E-08	2.3356E-08
^{11}B	9.3524E-08	9.4059E-08	9.4011E-08
C	8.7789E-02	8.8291E-02	8.8245E-02
Total	8.7789E-02	8.8291E-02	8.8245E-02
Mass Density (g/cm^3)	1.750896	1.760901	1.76

Table 3.1-14. Upper Axial Reflector Peraluman-300 Support Structure Composition.

Isotope/Element	Atoms/barn-cm
^{10}B	1.4688E-07
^{11}B	5.9119E-07
Mg	1.0177E-03
Al	5.7575E-02
Si	2.2729E-04
Mn	7.2621E-05
Fe	8.5730E-05
Cu	1.2557E-05
Zn	2.4398E-05
Ga	1.1444E-06
Cd	7.0983E-08
Total	5.9018E-02
Mass Density (g/cm^3)	2.65

3.1.3.3 Lower Axial Reflector

The lower axial reflector graphite is comprised of two compositions, depending on the component of the assembly (see Table 3.1-15).

Table 3.1-15. Lower Axial Reflector Graphite Composition.

Component	**Cylinder**	**Annulus / Source Plug**
Isotope/Element	**Atoms/barn-cm**	**Atoms/barn-cm**
^{10}B	2.3223E-08	2.3356E-08
^{11}B	9.3476E-08	9.4011E-08
C	8.7744E-02	8.8245E-02
Total	8.7744E-02	8.8245E-02
Mass Density (g/cm^3)	1.75	1.76

3.1.3.4 Autorod

The autorod consists of copper wedge (Table 3.1-16) within an aluminum guide tube (Table 3.1-17).

Table 3.1-16. Autorod Copper (Type C110) Wedge Composition.

Element	Atoms/barn-cm
Cu	8.4206E-02
O	6.6923E-05
Ag	3.7224E-06
S	1.2522E-05
Ni	6.8410E-06
Fe	7.1900E-06
Total	8.4303E-02
Mass Density (g/cm^3)	8.89

Table 3.1-17. Autorod Aluminum (Type 1100) Tube Composition.

Element	Atoms/barn-cm
Si	2.8947E-04
Fe	1.4558E-04
Cu	3.1984E-05
Mn	7..661E-06
Zn	1.2429E-05
Co	6.8975E-05
Ni	6.9257E-05
Sn	3.4242E-05
Al	5.9087E-02
Total	5.9746E-02
Mass Density (g/cm^3)	2.70

3.1.3.5 Fuel Pebbles

The UO_2 fuel used for the TRISO kernels has the composition provided in Table 3.1-18. The compositions of the additional SiC and graphite layers surrounding the kernel to form the TRISO particle are in Table 3.1-19. The fuel pebble graphite matrix surrounding the TRISO particles in the fueled zone and forming the outer unfueled layer has the composition shown in Table 3.1-20.

Table 3.1-18. UO_2 Fuel Kernel Composition.

Isotope/Element	**Atoms/barn-cm**
O	4.8612E-02
^{234}U	3.3079E-05
^{235}U	4.1172E-03
^{236}U	2.0499E-05
^{238}U	2.0135E-02
Total	7.2917E-02
Mass Density (g/cm^3)	10.88

Table 3.1-19. TRISO SiC and Graphite Layer Compositions.

Layer	**Buffer**	**IPyC**	**SiC**	**OPyC**
Isotope/Element	**Atoms/barn-cm**	**Atoms/barn-cm**	**Atoms/barn-cm**	**Atoms/barn-cm**
C	5.2640E-02	9.5254E-02	4.8055E-02	9.4752E-02
Si	--	--	4.8055E-02	--
Total	5.2640E-02	9.5254E-02	9.6110E-02	9.4752E-02
Mass Density (g/cm^3)	1.05	1.90	3.20	1.89

Table 3.1-20. Fuel Pebble Graphite Composition.

Isotope/Element	**Atoms/barn-cm**
C	8.6842E-02
Ag	9.6706E-10
^{10}B	1.9393E-09
^{11}B	7.8061E-09
Ca	2.4154E-07
Cd	4.7791E-10
Cl	4.4135E-08
Co	1.1505E-09
Cr	3.6312E-08
Dy	3.2097E-11
Eu	3.4322E-11
Fe	5.5104E-08
Gd	3.3169E-11
^{6}Li	5.7034E-09
^{7}Li	6.9441E-08
Mn	8.1647E-09
Ni	8.8864E-09
S	1.7893E-10
Ti	1.0831E-08
V	4.4334E-09
H	1.1581E-05
O	5.7904E-06
Total	8.6859E-02
Mass Density (g/cm^3)	1.732204

3.1.3.6 Moderator Pebbles

The composition of the graphite moderator pebbles is in Table 3.1-21.

Table 3.1-21. Moderator Pebble Graphite Composition.

Isotope/Element	**Atoms/barn-cm**
C	8.4434E-02
^{10}B	1.4193E-08
^{11}B	5.7130E-08
Ca	3.2656E-06
Cd	2.7077E-09
Cl	5.3343E-07
Dy	4.0583E-10
Eu	8.6793E-10
Fe	1.0719E-07
Gd	2.5808E-10
^{6}Li	9.7630E-09
^{7}Li	1.1887E-07
Ni	1.3483E-08
S	4.4297E-06
Si	1.2644E-06
Sm	5.8029E-10
Ti	2.1196E-07
V	2.5891E-07
H	1.1263E-05
O	5.6317E-06
Total	8.4461E-02
Mass Density (g/cm^3)	1.684743

3.1.3.7 Withdrawable Control Rods

The withdrawable control rods consist of an inner stainless steel tube (Table 3.1-22) held within an outer stainless steel tube with end plugs (Table 3.1-23).

Table 3.1-22. Control Rod Stainless Steel (Type St1.4301) Tube Composition.

Element	Atoms/barn-cm
C	1.3864E-04
Si	8.4696E-04
Mn	8.6597E-04
Cr	1.6927E-02
Ni	8.3083E-03
Fe	5.9391E-02
Total	8.6477E-02
Mass Density (g/cm^3)	7.9

Table 3.1-23. Control Rod Stainless Steel (Type St1.4541) Tube and End Plug Composition.

Element	Atoms/barn-cm
C	1.9805E-04
Si	8.4696E-04
Mn	8.6597E-04
Cr	1.6469E-02
Ni	8.3083E-03
Ti	4.9695E-05
Fe	5.9761E-02
Total	8.6499E-02
Mass Density (g/cm^3)	7.9

3.1.3.8 Polyethylene Rods

The composition of the polyethylene (sometimes referred to as plastic) rods is in Table 3.1-24.

Table 3.1-24. Polyethylene Rod Composition.

Case (Core)	**2 (6) and 4 (8)**	**3 (7)**
Isotope/Element	**Atoms/barn-cm**	**Atoms/barn-cm**
^{10}B	5.1775E-09	5.2110E-09
^{11}B	2.0840E-08	2.0975E-08
H	8.1241E-02	8.1766E-02
C	4.0020E-02	4.0279E-02
Total	1.2126E-01	1.2204E-01
Mass Density (g/cm^3)	0.93415	0.94019

3.1.3.9 Copper Wire

The composition of the copper wire used in Case 2 (Core 6) is in Table 3.1-25.

Table 3.1-25. Copper (Type C110) Wire Composition.

Case (Core)	**2 (6)**
Element	**Atoms/barn-cm**
Cu	8.4580E-02
O	6.7220E-05
Ag	3.7389E-06
S	1.2578E-05
Ni	6.8714E-06
Fe	7.2219E-06
Total	8.4678E-02
Mass Density (g/cm^3)	8.9295

3.1.3.10 Ambient Air

The composition of the ambient air is in Table 3.1-26. The air has a temperature of 293 K, pressure of 980 mbar, and 50 % humidity.

Table 3.1-26. Ambient Air Composition.

Element	Atoms/barn-cm
H	5.7098E-07
N	3.7362E-05
O	1.0326E-05
Ar	2.2345E-07
C	9.1319E-09
Total	4.8492E-05
Mass Density (g/cm^3)	0.00115932

3.1.4 Temperature Data

The benchmark model temperature is 293 K.

3.1.5 Experimental and Benchmark-Model k_{eff} and / or Subcritical Parameters

The experimental k_{eff} was approximately at unity, maintained at delayed critical with the 1σ uncertainty summarized in Section 2.1.8 for each of the four configurations. Simplification biases and uncertainties, as discussed in Section 3.1.1.1 were applied to the benchmark model. The benchmark k_{eff} is shown in Table 3.1-27 for each of the four cases. The uncertainty in the benchmark k_{eff} value is obtained by summing under quadrature the total experimental uncertainty (Tables 2.1-32 through 2.1-35) and the total bias uncertainty (Table 3.1-6).

Table 3.1-27. Experimental and Benchmark Eigenvalues, Biases, and Uncertainties.

		Experimental			**Bias**			**Benchmark**		
Case	**Core**	**k_{eff}**	**±**	**σ**	**Δk**	**±**	**σ**	**k_{eff}**	**±**	**σ**
1	5	1.0000	±	0.0030	0.0024	±	0.0002	1.0024	±	0.0030
2	6	1.0000	±	0.0041	0.0014	±	0.0002	1.0014	±	0.0041
3	7	1.0000	±	0.0034	0.0017	±	0.0002	1.0017	±	0.0034
4	8	1.0000	±	0.0030	0.0030	±	0.0002	1.0030	±	0.0030

3.2 Benchmark-Model Specifications for Buckling and Extrapolation-Length Measurements

Buckling and extrapolation length measurements were made but have not yet been evaluated.

3.3 Benchmark-Model Specifications for Spectral Characteristics Measurements

Spectral characteristics measurements were not made.

3.4 Benchmark-Model Specifications for Reactivity Effects Measurements

Reactivity effects measurements were made but have not yet been evaluated.

3.5 Benchmark-Model Specifications for Reactivity Coefficient Measurements

Reactivity coefficient measurements were made but have not yet been evaluated.

3.6 Benchmark-Model Specifications for Kinetics Measurements

Kinetics measurements were made but have not yet been evaluated.

3.7 Benchmark-Model Specifications for Reaction-Rate Distribution Measurements

Reaction-rate distribution measurements were made but have not yet been evaluated.

3.8 Benchmark-Model Specifications for Power Distribution Measurements

Power distribution measurements were not made.

3.9 Benchmark-Model Specifications for Isotopic Measurements

Isotopic measurements were not made.

3.10 Benchmark-Model Specifications for Other Miscellaneous Types of Measurements

Other miscellaneous types of measurements were not made.

4.0 RESULTS OF SAMPLE CALCULATIONS

4.1 Results of Calculations of the Critical or Subcritical Configurations

The benchmark models described in Section 3 were modeled using MCNP5 (see Appendix A.1 for sample input deck for Case 1) and ENDF/B-VII.0 neutron cross section data. Random particles are not easily modeled in MCNP, therefore all 9394 TRISO particles were modeled within a cubic lattice with sides 0.1758 cm in length. All TRISO particles are completely contained within the fueled region of the fuel pebbles (see Figure 4.1-1); this was verified by visually inspecting each layer in a visual editor. The effect of random particle placement was determined to be essentially negligible relative to a regular array of particles in a fuel pebble (see Section 2.1.9.4 of PROTEUS-GCR-EXP-001).[a]

Monte Carlo calculations were performed with 1,650 generations with 100,000 neutrons per generation. The k_{eff} estimates are based on 150 skipped generations and a total of 150,000,000 neutron histories each. Calculated eigenvalues are shown in Table 4.1-1. All calculated eigenvalues are greater than the benchmark value but within 1 % and within the 3σ uncertainty. Models developed by Difilippo using MCNP4C with ENDF/B-VI (DLC-189) neutron cross sections produced calculation biases of +90, -30, and +400 pcm for Cases 1 through 3 (Cores 5 through 7), respectively, with a statistical uncertainty of ~80 pcm.[b] There is no known significant difference between the benchmark models described in Section 3 and the models developed by Difilippo. Case 4 (Core 8) was not evaluated by Difilippo. The models by Difilippo include water content within the graphite reflectors. Evaluation of the water content indicates that the small quantity has a negligible impact on the neutron scattering and only provides additional negative reactivity (~100 pcm) to the system. However, the addition of water absorption seems to be incorrect as the analysis of the equivalent boron content in the graphite reflectors should have already included absorption from water contained within the graphite blocks. Another difference exists for the density of the polyethylene rods; Difilippo reports polyethylene with a mass density of ~0.77 g/cm^3 when the density calculated for the benchmark models is ~0.94 g/cm^3. This latter difference only impacts those models containing polyethylene rods.

Monte Carlo calculations of k_{eff} for graphite-moderated reactors and assemblies typically compute greater than the benchmark values, as seen for the High Temperature Engineering Test Reactor (HTTR-GCR-RESR-001, -002, and -003), the HTR-10 Pebble-Bed Reactor (HTR10-GCR-RESR-001), and the other HTR-PROTEUS configurations (PROTEUS-GCR-EXP-001, -002, and -004). Computations of the ASTRA critical facility with the MCU-REA1 code agree well with the benchmark k_{eff} (ASTRA-GCR-EXP-001) but calculate high when using MCNP.[c] The MCU computer program was developed to include a special feature to evaluate systems with double-heterogeneity, such as TRISO particles in a HTGR.[d] The computational bias using MCNP is on the order of 1-2 % greater than the benchmark values. The HTTR configurations are closer to 2 % and it has been previously discussed that the bias is possibly due to uncertainties in the impurity

[a] Uner, C. and Seker, V., "Monte Carlo Criticality Calculations for a Pebble Bed Reactor with MCNP," *Nucl. Sci. Eng.*, **149**, 131-137 (2005).
[b] Difilippo, F. C., "Monte Carlo Calculations of Pebble Bed Benchmark Configurations of the PROTEUS Facility," *Nucl. Sci. Eng.*, **143**, 240-253 (2003).
[c] Z. Zibi and F. Albornoz, "Validating the MCNP Modelling of the ASTRA Critical Facility," *Proc. HTR 2010*, Prague, Czech Republic, October 18-20, 2010.
[d] N. N. Ponomarev-Stepnoi, et al., "Using the MCU Computer Program to Analyze the Results of Critical Experiments with HTGR Fuel Pellets on ASTRA Testing Stand," *Atomic Energy*, **97**, pp. 669-677 (2004).

content of the graphite blocks[a,b] and a need to increase the thermal neutron capture cross section of carbon.[c]

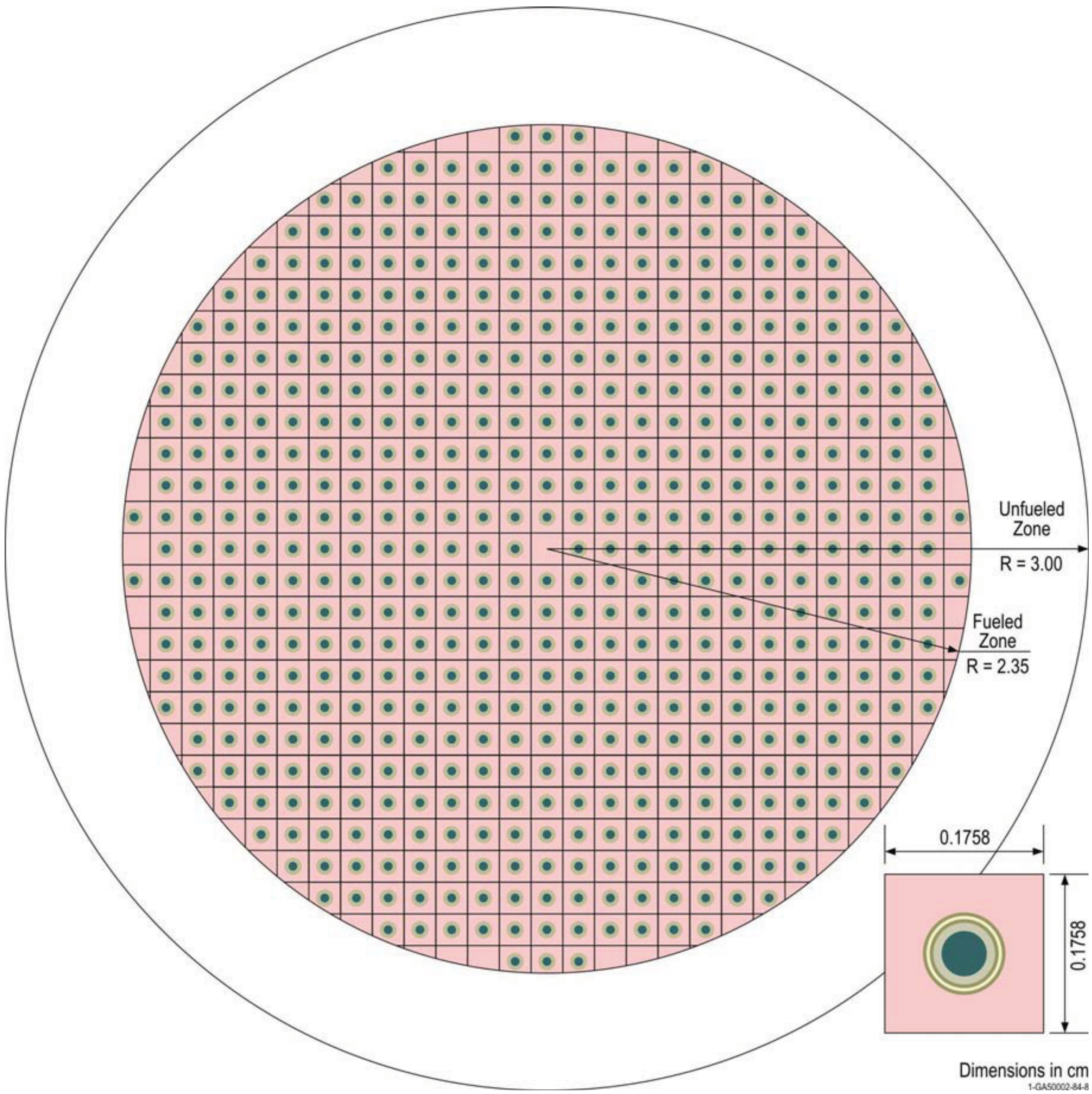

Figure 4.1-1. Regular TRISO Lattice Used in MCNP Calculations of the Benchmark Models.

[a] K. Yamashita, et al., "Startup Core Physics Tests of High Temperature Engineering Test Reactor (HTTR), (I)," *J. At. Energy Soc. Jpn.*, **42**, pp. 30-42 (2000) [in Japanese].
[b] N. Fujimoto, et al., "Startup Core Physics Tests of High Temperature Engineering Test Reactor (HTTR) (II)," *J. At. Energy Soc. Jpn.*, **42**, pp. 458-464 (2000) [in Japanese].
[c] S. Shimakawa, M. Goto, S. Nakagawa, and Y. Tachibana, "Impact of Capture Cross-Section of Carbon on Nuclear Design for HTGRs," *Proc. HTR 2010*, Prague, Czech Republic, October 18-20, 2010.

Table 4.1-1. Comparison of Benchmark Eigenvalues.

Case	Core	Neutron Cross Section Library	Calculated (MCNP5)			Benchmark			$\frac{C-E}{E}(\%)$	Difference (pcm)
			k_{eff}	±	σ	k_{eff}	±	σ		
1	5	ENDF/B-VII.0	1.00714	±	0.00007	1.0024	±	0.0030	0.47	474
2	6		1.00650	±	0.00006	1.0014	±	0.0041	0.51	510
3	7		1.00863	±	0.00006	1.0017	±	0.0034	0.69	693
4	8		1.00812	±	0.00007	1.0030	±	0.0030	0.51	512

4.2 Results of Buckling and Extrapolation Length Calculations

Buckling and extrapolation length measurements were made but have not yet been evaluated.

4.3 Results of Spectral-Characteristics Calculations

Spectral characteristics measurements were not made.

4.4 Results of Reactivity-Effects Calculations

Reactivity effects measurements were made but have not yet been evaluated.

4.5 Results of Reactivity Coefficient Calculations

Reactivity coefficient measurements were made but have not yet been evaluated.

4.6 Results of Kinetics Parameter Calculations

Kinetics measurements were made but have not yet been evaluated.

4.7 Results of Reaction-Rate Distribution Calculations

Reaction-rate distribution measurements were made but have not yet been evaluated.

4.8 Results of Power Distribution Calculations

Power distribution measurements were not made.

4.9 Results of Isotopic Calculations

Isotopic measurements were not made.

4.10 Results of Calculations for Other Miscellaneous Types of Measurements

Other miscellaneous types of measurements were not made.

5.0 REFERENCES

1. Williams, T., “LEU-HTR PROTEUS: Configuration Descriptions and Critical Balances for the Cores of the HTR-PROTEUS Experimental Programme,” TM-41-95-18, v. 1.00, Paul Sherrer Institut, Villigen, November 25, 1996.
2. Mathews, D. and Williams, T., “LEU-HTR PROTEUS System Component Description,” TM-41-93-43, v. 2.0, Paul Scherrer Institut, Villigen, November 25, 1996.
3. Williams, T., Rosselet, M., and Scherer, W. (editors), “Critical Experiments and Reactor Physics Calculations for Low-Enriched High Temperature Gas Cooled Reactors,” IAEA-TECDOC-1249, International Atomic Energy Agency, Vienna (2001).

APPENDIX A: COMPUTER CODES, CROSS SECTIONS, AND TYPICAL INPUT LISTINGS

A.1 Critical/Subcritical Configurations

A.1.1 Name(s) of code system(s) used.

Monte Carlo n-Particle, version 5.1.60 (MCNP5).

A.1.2 Bibliographic references for the codes used.

X-5 Monte Carlo Team, "MCNP – a General Monte Carlo n-Particle Transport Code, version 5," LA-UR-03-1987, Los Alamos National Laboratory (2003).

A.1.3 Origin of cross-section data.

The Evaluated Neutron Data File library, ENDF/B-VII.0[a] was utilized in the benchmark model analysis.

A.1.4 Spectral calculations and data reduction methods used.

Not applicable.

A.1.5 Number of energy groups or if continuous-energy cross sections are used in the different phases of calculation.

Continuous-energy cross sections.

A.1.6 Component calculations.

- Type of cell calculation – Reactor core, reflectors, and moderator
- Geometry – TRISO particles in graphite pebbles
- Theory used – Not applicable
- Method used – Monte Carlo
- Calculation characteristics
  - MCNP5 – histories/cycles/cycles skipped = 100,000/1,650/150 continuous-energy cross sections

A.1.7 Other assumptions and characteristics.

Not applicable.

A.1.8 Typical input listings for each code system type.

The input deck provided below is for core configuration 5 (Case 1). The following portions of the code need reconfigured for core configurations 6 through 8 (Cases 2 through 4, respectively):

- Autorod position,
- Withdrawable control rod positions,
- All closed (Cores 5, 6, and 7) or 33 open coolant channels (Core 8) in the lower axial reflector, and
- Core cavity filled with correct pebble configuration (including polyethylene rods).

[a] M. B. Chadwick, et al., "ENDF/B-VII.0: Next Generation Evaluated Nuclear Data Library for Nuclear Science and Technology," *Nucl. Data Sheets*, **107**: 2931-3060 (2006).

MCNP5 Input Deck for Case 1 (Core 5) [can be modified for Cases 2 through 4 (Cores 6 through 8)]:

```
HTR-PROTEUS :: Cores 5, 6, 7 & 8
c Pebble Bed Experimental Program
c Columnar Hexagonal Point-On-Point Packing with a 1:2 Moderator to Fuel Pebble Ratio
c
c John Darrell Bess - Idaho National Laboratory
c Last Updated: July 23, 2012
c
c Cell Cards ******************************************************************
c ------ Air Above Reflector ------
5    10 4.8492E-05  32 -1202 33 -34
          (1101 1102 1103 1104 1105 1106 1107 1108)
          (503 519 535 551 1113) imp:n=1
c
c ------ Radial Reflector ------
11   3 8.7858E-02  (33 -34 31 -32
          (1101 1102 1103 1104 1105 1106 1107 1108)
          (503 519 535 551 1113)):((7001:7002) 1811 -7003 -33) imp:n=1
c
c ------ Air Gap Above Core ------
22   10 4.8492E-05  7003 -1801 -33
          imp:n=1
c
c --- Control Rod Channels -----------------------------------------------------
c ------ Safety/Shutdown Rod Holes ------
1101 10 4.8492E-05  -1101 31 -1202 imp:n=1  $ Rod 1
1102 10 4.8492E-05  -1102 31 -1202 imp:n=1  $ Rod 2
1103 10 4.8492E-05  -1103 31 -1202 imp:n=1  $ Rod 3
1104 10 4.8492E-05  -1104 31 -1202 imp:n=1  $ Rod 4
1105 10 4.8492E-05  -1105 31 -1202 imp:n=1  $ Rod 5
1106 10 4.8492E-05  -1106 31 -1202 imp:n=1  $ Rod 6
1107 10 4.8492E-05  -1107 31 -1202 imp:n=1  $ Rod 7
1108 10 4.8492E-05  -1108 31 -1202 imp:n=1  $ Rod 8
c
c ------ Withdrawable Control Rod Holes ------
503  10 4.8492E-05   -503 1003 31 -3091 imp:n=1  $ Position 3 Hole
1003 29 8.8245E-02  -1003 31 -3091 imp:n=1  $ Position 3 Plug
3105 0    -503 3091 -1202 imp:n=1 fill=21 (-83.70  34.67 0)  $ Control Rod 4
519  10 4.8492E-05   -519 1019 31 -3091 imp:n=1  $ Position 19 Hole
1019 29 8.8245E-02  -1019 31 -3091 imp:n=1  $ Position 19 Plug
3102 0    -519 3091 -1202 imp:n=1 fill=18 ( 34.67  83.70 0)  $ Control Rod 1
535  10 4.8492E-05   -535 1035 31 -3091 imp:n=1  $ Position 35 Hole
1035 29 8.8245E-02  -1035 31 -3091 imp:n=1  $ Position 35 Plug
3103 0    -535 3091 -1202 imp:n=1 fill=19 ( 83.70 -34.67 0)  $ Control Rod 2
551  10 4.8492E-05   -551 1051 31 -3091 imp:n=1  $ Position 51 Hole
1051 29 8.8245E-02  -1051 31 -3091 imp:n=1  $ Position 51 Plug
3104 0    -551 3091 -1202 imp:n=1 fill=20 (-34.67 -83.70 0)  $ Control Rod 3
c
c ------ Autorod Hole ------
1113 0  -1113 31 -1202 imp:n=1 fill=11 (17.36 -87.29 0)
c
c --- Upper Axial Reflector ----------------------------------------------------
c ------ Central Cylinder ------
1201 10 4.8492E-05  1201 -1202 -1203 imp:n=1  $ Central Coolant Channel
1202 6 8.7789E-02  1201 -1202 1203 -1204 imp:n=1  $ Graphite
c
c ------ Graphite Annulus ------
1211 7 8.8291E-02  1201 -1202 1211 -1333
          (1301 1302 1303 1304 1305 1306 1307 1308 1309 1310 1311 1312 1313
           1314 1315 1316 1317 1318 1319 1320 1321 1322 1323 1324 1325 1326
           1327 1328 1329 1330 1331 1332)
           imp:n=1  $ Ring 1 Region
1212 7 8.8291E-02  1201 -1202 1333 -1433
          (1401 1402 1403 1404 1405 1406 1407 1408 1409 1410 1411 1412 1413
           1414 1415 1416 1417 1418 1419 1420 1421 1422 1423 1424 1425 1426
           1427 1428 1429 1430 1431 1432)
           imp:n=1  $ Ring 2 Region
1213 7 8.8291E-02  1201 -1202 1433 -1533
          (1501 1502 1503 1504 1505 1506 1507 1508 1509 1510 1511 1512 1513
           1514 1515 1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526
           1527 1528 1529 1530 1531 1532)
           imp:n=1  $ Ring 3 Region
```

```
1214 7 8.8291E-02  1201 -1202 1533 -1633
          (1601 1602 1603 1604 1605 1606 1607 1608 1609 1610 1611 1612 1613
           1614 1615 1616 1617 1618 1619 1620 1621 1622 1623 1624 1625 1626
           1627 1628 1629 1630 1631 1632)
           imp:n=1  $ Ring 4 Region
1215 7 8.8291E-02  1201 -1202 1633 -1212
          (1701 1702 1703 1704 1705 1706 1707 1708 1709 1710 1711 1712 1713
           1714 1715 1716 1717 1718 1719 1720 1721 1722 1723 1724 1725 1726
           1727 1728 1729 1730 1731 1732)
           imp:n=1  $ Ring 5 Region
c
c ------ Coolant Channels ------
c --------- Ring 1 ---------
1301 10 4.8492E-05  2401 -1301 1201 -1202 imp:n=1  $ Position 1
1302 10 4.8492E-05  2402 -1302 1201 -1202 imp:n=1  $ Position 2
1303 10 4.8492E-05       -1303 1201 -1202 imp:n=1  $ Position 3
1304 10 4.8492E-05  2404 -1304 1201 -1202 imp:n=1  $ Position 4
1305 10 4.8492E-05  2405 -1305 1201 -1202 imp:n=1  $ Position 5
1306 10 4.8492E-05       -1306 1201 -1202 imp:n=1  $ Position 6
1307 10 4.8492E-05  2407 -1307 1201 -1202 imp:n=1  $ Position 7
1308 10 4.8492E-05  2408 -1308 1201 -1202 imp:n=1  $ Position 8
1309 10 4.8492E-05       -1309 1201 -1202 imp:n=1  $ Position 9
1310 10 4.8492E-05  2410 -1310 1201 -1202 imp:n=1  $ Position 10
1311 10 4.8492E-05  2411 -1311 1201 -1202 imp:n=1  $ Position 11
1312 10 4.8492E-05       -1312 1201 -1202 imp:n=1  $ Position 12
1313 10 4.8492E-05  2413 -1313 1201 -1202 imp:n=1  $ Position 13
1314 10 4.8492E-05  2414 -1314 1201 -1202 imp:n=1  $ Position 14
1315 10 4.8492E-05       -1315 1201 -1202 imp:n=1  $ Position 15
1316 10 4.8492E-05  2416 -1316 1201 -1202 imp:n=1  $ Position 16
1317 10 4.8492E-05  2417 -1317 1201 -1202 imp:n=1  $ Position 17
1318 10 4.8492E-05       -1318 1201 -1202 imp:n=1  $ Position 18
1319 10 4.8492E-05  2419 -1319 1201 -1202 imp:n=1  $ Position 19
1320 10 4.8492E-05  2420 -1320 1201 -1202 imp:n=1  $ Position 20
1321 10 4.8492E-05       -1321 1201 -1202 imp:n=1  $ Position 21
1322 10 4.8492E-05  2422 -1322 1201 -1202 imp:n=1  $ Position 22
1323 10 4.8492E-05  2423 -1323 1201 -1202 imp:n=1  $ Position 23
1324 10 4.8492E-05       -1324 1201 -1202 imp:n=1  $ Position 24
1325 10 4.8492E-05  2425 -1325 1201 -1202 imp:n=1  $ Position 25
1326 10 4.8492E-05  2426 -1326 1201 -1202 imp:n=1  $ Position 26
1327 10 4.8492E-05       -1327 1201 -1202 imp:n=1  $ Position 27
1328 10 4.8492E-05  2428 -1328 1201 -1202 imp:n=1  $ Position 28
1329 10 4.8492E-05       -1329 1201 -1202 imp:n=1  $ Position 29
1330 10 4.8492E-05  2430 -1330 1201 -1202 imp:n=1  $ Position 30
1331 10 4.8492E-05  2431 -1331 1201 -1202 imp:n=1  $ Position 31
1332 10 4.8492E-05       -1332 1201 -1202 imp:n=1  $ Position 32
c
c --------- Ring 2 ---------
1401 10 4.8492E-05  2501 -1401 1201 -1202 imp:n=1  $ Position 1
1402 10 4.8492E-05  2502 -1402 1201 -1202 imp:n=1  $ Position 2
1403 10 4.8492E-05  2503 -1403 1201 -1202 imp:n=1  $ Position 3
1404 10 4.8492E-05  2504 -1404 1201 -1202 imp:n=1  $ Position 4
1405 10 4.8492E-05  2505 -1405 1201 -1202 imp:n=1  $ Position 5
1406 10 4.8492E-05  2506 -1406 1201 -1202 imp:n=1  $ Position 6
1407 10 4.8492E-05  2507 -1407 1201 -1202 imp:n=1  $ Position 7
1408 10 4.8492E-05  2508 -1408 1201 -1202 imp:n=1  $ Position 8
1409 10 4.8492E-05  2509 -1409 1201 -1202 imp:n=1  $ Position 9
1410 10 4.8492E-05  2510 -1410 1201 -1202 imp:n=1  $ Position 10
1411 10 4.8492E-05  2511 -1411 1201 -1202 imp:n=1  $ Position 11
1412 10 4.8492E-05  2512 -1412 1201 -1202 imp:n=1  $ Position 12
1413 10 4.8492E-05  2513 -1413 1201 -1202 imp:n=1  $ Position 13
1414 10 4.8492E-05  2514 -1414 1201 -1202 imp:n=1  $ Position 14
1415 10 4.8492E-05  2515 -1415 1201 -1202 imp:n=1  $ Position 15
1416 10 4.8492E-05  2516 -1416 1201 -1202 imp:n=1  $ Position 16
1417 10 4.8492E-05  2517 -1417 1201 -1202 imp:n=1  $ Position 17
1418 10 4.8492E-05  2518 -1418 1201 -1202 imp:n=1  $ Position 18
1419 10 4.8492E-05  2519 -1419 1201 -1202 imp:n=1  $ Position 19
1420 10 4.8492E-05  2520 -1420 1201 -1202 imp:n=1  $ Position 20
1421 10 4.8492E-05  2521 -1421 1201 -1202 imp:n=1  $ Position 21
1422 10 4.8492E-05  2522 -1422 1201 -1202 imp:n=1  $ Position 22
1423 10 4.8492E-05  2523 -1423 1201 -1202 imp:n=1  $ Position 23
1424 10 4.8492E-05  2524 -1424 1201 -1202 imp:n=1  $ Position 24
1425 10 4.8492E-05  2525 -1425 1201 -1202 imp:n=1  $ Position 25
1426 10 4.8492E-05  2526 -1426 1201 -1202 imp:n=1  $ Position 26
1427 10 4.8492E-05  2527 -1427 1201 -1202 imp:n=1  $ Position 27
1428 10 4.8492E-05  2528 -1428 1201 -1202 imp:n=1  $ Position 28
```

```
1429 10 4.8492E-05  2529 -1429 1201 -1202 imp:n=1  $ Position 29
1430 10 4.8492E-05  2530 -1430 1201 -1202 imp:n=1  $ Position 30
1431 10 4.8492E-05  2531 -1431 1201 -1202 imp:n=1  $ Position 31
1432 10 4.8492E-05  2532 -1432 1201 -1202 imp:n=1  $ Position 32
c
c --------- Ring 3 ---------
1501 10 4.8492E-05  2601 -1501 1201 -1202 imp:n=1  $ Position 1
1502 10 4.8492E-05       -1502 1201 -1202 imp:n=1  $ Position 2
1503 10 4.8492E-05  2603 -1503 1201 -1202 imp:n=1  $ Position 3
1504 10 4.8492E-05  2604 -1504 1201 -1202 imp:n=1  $ Position 4
1505 10 4.8492E-05       -1505 1201 -1202 imp:n=1  $ Position 5
1506 10 4.8492E-05  2606 -1506 1201 -1202 imp:n=1  $ Position 6
1507 10 4.8492E-05  2607 -1507 1201 -1202 imp:n=1  $ Position 7
1508 10 4.8492E-05       -1508 1201 -1202 imp:n=1  $ Position 8
1509 10 4.8492E-05  2609 -1509 1201 -1202 imp:n=1  $ Position 9
1510 10 4.8492E-05  2610 -1510 1201 -1202 imp:n=1  $ Position 10
1511 10 4.8492E-05       -1511 1201 -1202 imp:n=1  $ Position 11
1512 10 4.8492E-05  2612 -1512 1201 -1202 imp:n=1  $ Position 12
1513 10 4.8492E-05  2613 -1513 1201 -1202 imp:n=1  $ Position 13
1514 10 4.8492E-05       -1514 1201 -1202 imp:n=1  $ Position 14
1515 10 4.8492E-05  2615 -1515 1201 -1202 imp:n=1  $ Position 15
1516 10 4.8492E-05  2616 -1516 1201 -1202 imp:n=1  $ Position 16
1517 10 4.8492E-05       -1517 1201 -1202 imp:n=1  $ Position 17
1518 10 4.8492E-05  2618 -1518 1201 -1202 imp:n=1  $ Position 18
1519 10 4.8492E-05  2619 -1519 1201 -1202 imp:n=1  $ Position 19
1520 10 4.8492E-05       -1520 1201 -1202 imp:n=1  $ Position 20
1521 10 4.8492E-05  2621 -1521 1201 -1202 imp:n=1  $ Position 21
1522 10 4.8492E-05  2622 -1522 1201 -1202 imp:n=1  $ Position 22
1523 10 4.8492E-05       -1523 1201 -1202 imp:n=1  $ Position 23
1524 10 4.8492E-05  2624 -1524 1201 -1202 imp:n=1  $ Position 24
1525 10 4.8492E-05  2625 -1525 1201 -1202 imp:n=1  $ Position 25
1526 10 4.8492E-05       -1526 1201 -1202 imp:n=1  $ Position 26
1527 10 4.8492E-05  2627 -1527 1201 -1202 imp:n=1  $ Position 27
1528 10 4.8492E-05       -1528 1201 -1202 imp:n=1  $ Position 28
1529 10 4.8492E-05  2629 -1529 1201 -1202 imp:n=1  $ Position 29
1530 10 4.8492E-05  2630 -1530 1201 -1202 imp:n=1  $ Position 30
1531 10 4.8492E-05       -1531 1201 -1202 imp:n=1  $ Position 31
1532 10 4.8492E-05  2632 -1532 1201 -1202 imp:n=1  $ Position 32
c
c --------- Ring 4 ---------
1601 10 4.8492E-05  2701 -1601 1201 -1202 imp:n=1  $ Position 1
1602 10 4.8492E-05  2702 -1602 1201 -1202 imp:n=1  $ Position 2
1603 10 4.8492E-05  2703 -1603 1201 -1202 imp:n=1  $ Position 3
1604 10 4.8492E-05  2704 -1604 1201 -1202 imp:n=1  $ Position 4
1605 10 4.8492E-05  2705 -1605 1201 -1202 imp:n=1  $ Position 5
1606 10 4.8492E-05  2706 -1606 1201 -1202 imp:n=1  $ Position 6
1607 10 4.8492E-05  2707 -1607 1201 -1202 imp:n=1  $ Position 7
1608 10 4.8492E-05  2708 -1608 1201 -1202 imp:n=1  $ Position 8
1609 10 4.8492E-05  2709 -1609 1201 -1202 imp:n=1  $ Position 9
1610 10 4.8492E-05  2710 -1610 1201 -1202 imp:n=1  $ Position 10
1611 10 4.8492E-05  2711 -1611 1201 -1202 imp:n=1  $ Position 11
1612 10 4.8492E-05  2712 -1612 1201 -1202 imp:n=1  $ Position 12
1613 10 4.8492E-05  2713 -1613 1201 -1202 imp:n=1  $ Position 13
1614 10 4.8492E-05  2714 -1614 1201 -1202 imp:n=1  $ Position 14
1615 10 4.8492E-05  2715 -1615 1201 -1202 imp:n=1  $ Position 15
1616 10 4.8492E-05  2716 -1616 1201 -1202 imp:n=1  $ Position 16
1617 10 4.8492E-05  2717 -1617 1201 -1202 imp:n=1  $ Position 17
1618 10 4.8492E-05  2718 -1618 1201 -1202 imp:n=1  $ Position 18
1619 10 4.8492E-05  2719 -1619 1201 -1202 imp:n=1  $ Position 19
1620 10 4.8492E-05  2720 -1620 1201 -1202 imp:n=1  $ Position 20
1621 10 4.8492E-05  2721 -1621 1201 -1202 imp:n=1  $ Position 21
1622 10 4.8492E-05  2722 -1622 1201 -1202 imp:n=1  $ Position 22
1623 10 4.8492E-05  2723 -1623 1201 -1202 imp:n=1  $ Position 23
1624 10 4.8492E-05  2724 -1624 1201 -1202 imp:n=1  $ Position 24
1625 10 4.8492E-05  2725 -1625 1201 -1202 imp:n=1  $ Position 25
1626 10 4.8492E-05  2726 -1626 1201 -1202 imp:n=1  $ Position 26
1627 10 4.8492E-05  2727 -1627 1201 -1202 imp:n=1  $ Position 27
1628 10 4.8492E-05  2728 -1628 1201 -1202 imp:n=1  $ Position 28
1629 10 4.8492E-05  2729 -1629 1201 -1202 imp:n=1  $ Position 29
1630 10 4.8492E-05  2730 -1630 1201 -1202 imp:n=1  $ Position 30
1631 10 4.8492E-05  2731 -1631 1201 -1202 imp:n=1  $ Position 31
1632 10 4.8492E-05  2732 -1632 1201 -1202 imp:n=1  $ Position 32
c
c --------- Ring 5 ---------
1701 10 4.8492E-05       -1701 1201 -1202 imp:n=1  $ Position 1
```

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1702 10 4.8492E-05  2802 -1702 1201 -1202 imp:n=1  $ Position 2
1703 10 4.8492E-05  2803 -1703 1201 -1202 imp:n=1  $ Position 3
1704 10 4.8492E-05       -1704 1201 -1202 imp:n=1  $ Position 4
1705 10 4.8492E-05  2805 -1705 1201 -1202 imp:n=1  $ Position 5
1706 10 4.8492E-05  2806 -1706 1201 -1202 imp:n=1  $ Position 6
1707 10 4.8492E-05       -1707 1201 -1202 imp:n=1  $ Position 7
1708 10 4.8492E-05  2808 -1708 1201 -1202 imp:n=1  $ Position 8
1709 10 4.8492E-05  2809 -1709 1201 -1202 imp:n=1  $ Position 9
1710 10 4.8492E-05       -1710 1201 -1202 imp:n=1  $ Position 10
1711 10 4.8492E-05  2811 -1711 1201 -1202 imp:n=1  $ Position 11
1712 10 4.8492E-05  2812 -1712 1201 -1202 imp:n=1  $ Position 12
1713 10 4.8492E-05       -1713 1201 -1202 imp:n=1  $ Position 13
1714 10 4.8492E-05  2814 -1714 1201 -1202 imp:n=1  $ Position 14
1715 10 4.8492E-05  2815 -1715 1201 -1202 imp:n=1  $ Position 15
1716 10 4.8492E-05       -1716 1201 -1202 imp:n=1  $ Position 16
1717 10 4.8492E-05  2817 -1717 1201 -1202 imp:n=1  $ Position 17
1718 10 4.8492E-05  2818 -1718 1201 -1202 imp:n=1  $ Position 18
1719 10 4.8492E-05       -1719 1201 -1202 imp:n=1  $ Position 19
1720 10 4.8492E-05  2820 -1720 1201 -1202 imp:n=1  $ Position 20
1721 10 4.8492E-05  2821 -1721 1201 -1202 imp:n=1  $ Position 21
1722 10 4.8492E-05       -1722 1201 -1202 imp:n=1  $ Position 22
1723 10 4.8492E-05  2823 -1723 1201 -1202 imp:n=1  $ Position 23
1724 10 4.8492E-05  2824 -1724 1201 -1202 imp:n=1  $ Position 24
1725 10 4.8492E-05       -1725 1201 -1202 imp:n=1  $ Position 25
1726 10 4.8492E-05  2826 -1726 1201 -1202 imp:n=1  $ Position 26
1727 10 4.8492E-05       -1727 1201 -1202 imp:n=1  $ Position 27
1728 10 4.8492E-05  2828 -1728 1201 -1202 imp:n=1  $ Position 28
1729 10 4.8492E-05  2829 -1729 1201 -1202 imp:n=1  $ Position 29
1730 10 4.8492E-05       -1730 1201 -1202 imp:n=1  $ Position 30
1731 10 4.8492E-05  2831 -1731 1201 -1202 imp:n=1  $ Position 31
1732 10 4.8492E-05  2832 -1732 1201 -1202 imp:n=1  $ Position 32
c
c ------ Graphite Plugs ------
c --------- Ring 1 ---------
12401 29 8.8245E-02  -2401 1201 -1202 imp:n=1  $ Position 1
12402 29 8.8245E-02  -2402 1201 -1202 imp:n=1  $ Position 2
c    *Coolant Channel (No Plug)   $ Position 3
12404 29 8.8245E-02  -2404 1201 -1202 imp:n=1  $ Position 4
12405 29 8.8245E-02  -2405 1201 -1202 imp:n=1  $ Position 5
c    *Coolant Channel (No Plug)   $ Position 6
12407 29 8.8245E-02  -2407 1201 -1202 imp:n=1  $ Position 7
12408 29 8.8245E-02  -2408 1201 -1202 imp:n=1  $ Position 8
c    *Coolant Channel (No Plug)   $ Position 9
12410 29 8.8245E-02  -2410 1201 -1202 imp:n=1  $ Position 10
12411 29 8.8245E-02  -2411 1201 -1202 imp:n=1  $ Position 11
c    *Coolant Channel (No Plug)   $ Position 12
12413 29 8.8245E-02  -2413 1201 -1202 imp:n=1  $ Position 13
12414 29 8.8245E-02  -2414 1201 -1202 imp:n=1  $ Position 14
c    *Coolant Channel (No Plug)   $ Position 15
12416 29 8.8245E-02  -2416 1201 -1202 imp:n=1  $ Position 16
12417 29 8.8245E-02  -2417 1201 -1202 imp:n=1  $ Position 17
c    *Coolant Channel (No Plug)   $ Position 18
12419 29 8.8245E-02  -2419 1201 -1202 imp:n=1  $ Position 19
12420 29 8.8245E-02  -2420 1201 -1202 imp:n=1  $ Position 20
c    *Coolant Channel (No Plug)   $ Position 21
12422 29 8.8245E-02  -2422 1201 -1202 imp:n=1  $ Position 22
12423 29 8.8245E-02  -2423 1201 -1202 imp:n=1  $ Position 23
c    *Coolant Channel (No Plug)   $ Position 24
12425 29 8.8245E-02  -2425 1201 -1202 imp:n=1  $ Position 25
12426 29 8.8245E-02  -2426 1201 -1202 imp:n=1  $ Position 26
c    *Coolant Channel (No Plug)   $ Position 27
12428 29 8.8245E-02  -2428 1201 -1202 imp:n=1  $ Position 28
c    *Coolant Channel (No Plug)   $ Position 29
12430 29 8.8245E-02  -2430 1201 -1202 imp:n=1  $ Position 30
12431 29 8.8245E-02  -2431 1201 -1202 imp:n=1  $ Position 31
c    *Coolant Channel (No Plug)   $ Position 32
c
c --------- Ring 2 ---------
12501 29 8.8245E-02  -2501 1201 -1202 imp:n=1  $ Position 1
12502 29 8.8245E-02  -2502 1201 -1202 imp:n=1  $ Position 2
12503 29 8.8245E-02  -2503 1201 -1202 imp:n=1  $ Position 3
12504 29 8.8245E-02  -2504 1201 -1202 imp:n=1  $ Position 4
12505 29 8.8245E-02  -2505 1201 -1202 imp:n=1  $ Position 5
12506 29 8.8245E-02  -2506 1201 -1202 imp:n=1  $ Position 6
12507 29 8.8245E-02  -2507 1201 -1202 imp:n=1  $ Position 7
```

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12508 29 8.8245E-02  -2508 1201 -1202 imp:n=1  $ Position 8
12509 29 8.8245E-02  -2509 1201 -1202 imp:n=1  $ Position 9
12510 29 8.8245E-02  -2510 1201 -1202 imp:n=1  $ Position 10
12511 29 8.8245E-02  -2511 1201 -1202 imp:n=1  $ Position 11
12512 29 8.8245E-02  -2512 1201 -1202 imp:n=1  $ Position 12
12513 29 8.8245E-02  -2513 1201 -1202 imp:n=1  $ Position 13
12514 29 8.8245E-02  -2514 1201 -1202 imp:n=1  $ Position 14
12515 29 8.8245E-02  -2515 1201 -1202 imp:n=1  $ Position 15
12516 29 8.8245E-02  -2516 1201 -1202 imp:n=1  $ Position 16
12517 29 8.8245E-02  -2517 1201 -1202 imp:n=1  $ Position 17
12518 29 8.8245E-02  -2518 1201 -1202 imp:n=1  $ Position 18
12519 29 8.8245E-02  -2519 1201 -1202 imp:n=1  $ Position 19
12520 29 8.8245E-02  -2520 1201 -1202 imp:n=1  $ Position 20
12521 29 8.8245E-02  -2521 1201 -1202 imp:n=1  $ Position 21
12522 29 8.8245E-02  -2522 1201 -1202 imp:n=1  $ Position 22
12523 29 8.8245E-02  -2523 1201 -1202 imp:n=1  $ Position 23
12524 29 8.8245E-02  -2524 1201 -1202 imp:n=1  $ Position 24
12525 29 8.8245E-02  -2525 1201 -1202 imp:n=1  $ Position 25
12526 29 8.8245E-02  -2526 1201 -1202 imp:n=1  $ Position 26
12527 29 8.8245E-02  -2527 1201 -1202 imp:n=1  $ Position 27
12528 29 8.8245E-02  -2528 1201 -1202 imp:n=1  $ Position 28
12529 29 8.8245E-02  -2529 1201 -1202 imp:n=1  $ Position 29
12530 29 8.8245E-02  -2530 1201 -1202 imp:n=1  $ Position 30
12531 29 8.8245E-02  -2531 1201 -1202 imp:n=1  $ Position 31
12532 29 8.8245E-02  -2532 1201 -1202 imp:n=1  $ Position 32
c
c --------- Ring 3 ---------
12601 29 8.8245E-02  -2601 1201 -1202 imp:n=1  $ Position 1
c    *Coolant Channel (No Plug)   $ Position 2
12603 29 8.8245E-02  -2603 1201 -1202 imp:n=1  $ Position 3
12604 29 8.8245E-02  -2604 1201 -1202 imp:n=1  $ Position 4
c    *Coolant Channel (No Plug)   $ Position 5
12606 29 8.8245E-02  -2606 1201 -1202 imp:n=1  $ Position 6
12607 29 8.8245E-02  -2607 1201 -1202 imp:n=1  $ Position 7
c    *Coolant Channel (No Plug)   $ Position 8
12609 29 8.8245E-02  -2609 1201 -1202 imp:n=1  $ Position 9
12610 29 8.8245E-02  -2610 1201 -1202 imp:n=1  $ Position 10
c    *Coolant Channel (No Plug)   $ Position 11
12612 29 8.8245E-02  -2612 1201 -1202 imp:n=1  $ Position 12
12613 29 8.8245E-02  -2613 1201 -1202 imp:n=1  $ Position 13
c    *Coolant Channel (No Plug)   $ Position 14
12615 29 8.8245E-02  -2615 1201 -1202 imp:n=1  $ Position 15
12616 29 8.8245E-02  -2616 1201 -1202 imp:n=1  $ Position 16
c    *Coolant Channel (No Plug)   $ Position 17
12618 29 8.8245E-02  -2618 1201 -1202 imp:n=1  $ Position 18
12619 29 8.8245E-02  -2619 1201 -1202 imp:n=1  $ Position 19
c    *Coolant Channel (No Plug)   $ Position 20
12621 29 8.8245E-02  -2621 1201 -1202 imp:n=1  $ Position 21
12622 29 8.8245E-02  -2622 1201 -1202 imp:n=1  $ Position 22
c    *Coolant Channel (No Plug)   $ Position 23
12624 29 8.8245E-02  -2624 1201 -1202 imp:n=1  $ Position 24
12625 29 8.8245E-02  -2625 1201 -1202 imp:n=1  $ Position 25
c    *Coolant Channel (No Plug)   $ Position 26
12627 29 8.8245E-02  -2627 1201 -1202 imp:n=1  $ Position 27
c    *Coolant Channel (No Plug)   $ Position 28
12629 29 8.8245E-02  -2629 1201 -1202 imp:n=1  $ Position 29
12630 29 8.8245E-02  -2630 1201 -1202 imp:n=1  $ Position 30
c    *Coolant Channel (No Plug)   $ Position 31
12632 29 8.8245E-02  -2632 1201 -1202 imp:n=1  $ Position 32
c
c --------- Ring 4 ---------
12701 29 8.8245E-02  -2701 1201 -1202 imp:n=1  $ Position 1
12702 29 8.8245E-02  -2702 1201 -1202 imp:n=1  $ Position 2
12703 29 8.8245E-02  -2703 1201 -1202 imp:n=1  $ Position 3
12704 29 8.8245E-02  -2704 1201 -1202 imp:n=1  $ Position 4
12705 29 8.8245E-02  -2705 1201 -1202 imp:n=1  $ Position 5
12706 29 8.8245E-02  -2706 1201 -1202 imp:n=1  $ Position 6
12707 29 8.8245E-02  -2707 1201 -1202 imp:n=1  $ Position 7
12708 29 8.8245E-02  -2708 1201 -1202 imp:n=1  $ Position 8
12709 29 8.8245E-02  -2709 1201 -1202 imp:n=1  $ Position 9
12710 29 8.8245E-02  -2710 1201 -1202 imp:n=1  $ Position 10
12711 29 8.8245E-02  -2711 1201 -1202 imp:n=1  $ Position 11
12712 29 8.8245E-02  -2712 1201 -1202 imp:n=1  $ Position 12
12713 29 8.8245E-02  -2713 1201 -1202 imp:n=1  $ Position 13
12714 29 8.8245E-02  -2714 1201 -1202 imp:n=1  $ Position 14
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12715 29 8.8245E-02  -2715 1201 -1202 imp:n=1  $ Position 15
12716 29 8.8245E-02  -2716 1201 -1202 imp:n=1  $ Position 16
12717 29 8.8245E-02  -2717 1201 -1202 imp:n=1  $ Position 17
12718 29 8.8245E-02  -2718 1201 -1202 imp:n=1  $ Position 18
12719 29 8.8245E-02  -2719 1201 -1202 imp:n=1  $ Position 19
12720 29 8.8245E-02  -2720 1201 -1202 imp:n=1  $ Position 20
12721 29 8.8245E-02  -2721 1201 -1202 imp:n=1  $ Position 21
12722 29 8.8245E-02  -2722 1201 -1202 imp:n=1  $ Position 22
12723 29 8.8245E-02  -2723 1201 -1202 imp:n=1  $ Position 23
12724 29 8.8245E-02  -2724 1201 -1202 imp:n=1  $ Position 24
12725 29 8.8245E-02  -2725 1201 -1202 imp:n=1  $ Position 25
12726 29 8.8245E-02  -2726 1201 -1202 imp:n=1  $ Position 26
12727 29 8.8245E-02  -2727 1201 -1202 imp:n=1  $ Position 27
12728 29 8.8245E-02  -2728 1201 -1202 imp:n=1  $ Position 28
12729 29 8.8245E-02  -2729 1201 -1202 imp:n=1  $ Position 29
12730 29 8.8245E-02  -2730 1201 -1202 imp:n=1  $ Position 30
12731 29 8.8245E-02  -2731 1201 -1202 imp:n=1  $ Position 31
12732 29 8.8245E-02  -2732 1201 -1202 imp:n=1  $ Position 32
c
c --------- Ring 5 ---------
c    *Coolant Channel (No Plug)   $ Position 1
12802 29 8.8245E-02  -2802 1201 -1202 imp:n=1  $ Position 2
12803 29 8.8245E-02  -2803 1201 -1202 imp:n=1  $ Position 3
c    *Coolant Channel (No Plug)   $ Position 4
12805 29 8.8245E-02  -2805 1201 -1202 imp:n=1  $ Position 5
12806 29 8.8245E-02  -2806 1201 -1202 imp:n=1  $ Position 6
c    *Coolant Channel (No Plug)   $ Position 7
12808 29 8.8245E-02  -2808 1201 -1202 imp:n=1  $ Position 8
12809 29 8.8245E-02  -2809 1201 -1202 imp:n=1  $ Position 9
c    *Coolant Channel (No Plug)   $ Position 10
12811 29 8.8245E-02  -2811 1201 -1202 imp:n=1  $ Position 11
12812 29 8.8245E-02  -2812 1201 -1202 imp:n=1  $ Position 12
c    *Coolant Channel (No Plug)   $ Position 13
12814 29 8.8245E-02  -2814 1201 -1202 imp:n=1  $ Position 14
12815 29 8.8245E-02  -2815 1201 -1202 imp:n=1  $ Position 15
c    *Coolant Channel (No Plug)   $ Position 16
12817 29 8.8245E-02  -2817 1201 -1202 imp:n=1  $ Position 17
12818 29 8.8245E-02  -2818 1201 -1202 imp:n=1  $ Position 18
c    *Coolant Channel (No Plug)   $ Position 19
12820 29 8.8245E-02  -2820 1201 -1202 imp:n=1  $ Position 20
12821 29 8.8245E-02  -2821 1201 -1202 imp:n=1  $ Position 21
c    *Coolant Channel (No Plug)   $ Position 22
12823 29 8.8245E-02  -2823 1201 -1202 imp:n=1  $ Position 23
12824 29 8.8245E-02  -2824 1201 -1202 imp:n=1  $ Position 24
c    *Coolant Channel (No Plug)   $ Position 25
12826 29 8.8245E-02  -2826 1201 -1202 imp:n=1  $ Position 26
c    *Coolant Channel (No Plug)   $ Position 27
12828 29 8.8245E-02  -2828 1201 -1202 imp:n=1  $ Position 28
12829 29 8.8245E-02  -2829 1201 -1202 imp:n=1  $ Position 29
c    *Coolant Channel (No Plug)   $ Position 30
12831 29 8.8245E-02  -2831 1201 -1202 imp:n=1  $ Position 31
12832 29 8.8245E-02  -2832 1201 -1202 imp:n=1  $ Position 32
c
c ------ Aluminum Tank ------
1800   9 5.9018E-02  1801 -1201 -1221       imp:n=1  $ Bottom Center
1803   9 5.9018E-02  1801 -1201  1222 -1223 imp:n=1  $ Bottom Annulus
1804  10 4.8492E-05  1201 -1202  1204 -1221 imp:n=1  $ Air Gap
1805   9 5.9018E-02  1801 -1202  1221 -1222 imp:n=1  $ Inner Vertical Liner
1806  10 4.8492E-05  1201 -1202  1222 -1211 imp:n=1  $ Air Gap
1807  10 4.8492E-05  1201 -1202  1212 -1223 imp:n=1  $ Air Gap
1808   9 5.9018E-02  1801 -1202  1223 -1802 imp:n=1  $ Outer Vertical Liner
1819  10 4.8492E-05  1801 -1202  1802 -33 imp:n=1  $ Air Gap
c
c --- Lower Axial Reflector ----------------------------------------------------
1820  4 8.7744E-02  31 -1811 -1812 (1821:1823) imp:n=1  $ Inner Cylinder
1821  30 8.8245E-02  31 -1821 -1823 imp:n=1  $ Graphite Plug
c
c ------ Graphite Annulus ------
1831  10 4.8492E-05  31 -1811 1812 -1831 imp:n=1  $ Air Gap
1832  5 8.8245E-02  31 -1811 -1333 1831
          (1901 1902 1903 1904 1905 1906 1907 1908 1909 1910 1911 1912 1913
           1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926
           1927 1928 1929 1930 1931 1932)
           imp:n=1  $ Ring 1 Region
1833  5 8.8245E-02  31 -1811 1333 -1433
```

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          (2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
           2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026
           2027 2028 2029 2030 2031 2032)
           imp:n=1  $ Ring 2 Region
1834  5 8.8245E-02  31 -1811 1433 -1533
          (2101 2102 2103 2104 2105 2106 2107 2108 2109 2110 2111 2112 2113
           2114 2115 2116 2117 2118 2119 2120 2121 2122 2123 2124 2125 2126
           2127 2128 2129 2130 2131 2132)
           imp:n=1  $ Ring 3 Region
1835  5 8.8245E-02  31 -1811 1533 -1633
          (2201 2202 2203 2204 2205 2206 2207 2208 2209 2210 2211 2212 2213
           2214 2215 2216 2217 2218 2219 2220 2221 2222 2223 2224 2225 2226
           2227 2228 2229 2230 2231 2232)
           imp:n=1  $ Ring 4 Region
1836  5 8.8245E-02  31 -1811 1633 -1832
           (2301 2302 2303 2304 2305 2306 2307 2308 2309 2310 2311 2312 2313
           2314 2315 2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326
           2327 2328 2329 2330 2331 2332)
           imp:n=1  $ Ring 5 Region
1837  10 4.8492E-05  31 -1811 1832 -33 imp:n=1  $ Air Gap
c
c ------ Coolant Channels ------
c --------- Ring 1 ---------
1901 10 4.8492E-05  2401 -1901 31 -1811 imp:n=1  $ Position 1
1902 10 4.8492E-05  2402 -1902 31 -1811 imp:n=1  $ Position 2
1903 10 4.8492E-05  2403 -1903 31 -1811 imp:n=1  $ Position 3
1904 10 4.8492E-05  2404 -1904 31 -1811 imp:n=1  $ Position 4
1905 10 4.8492E-05  2405 -1905 31 -1811 imp:n=1  $ Position 5
1906 10 4.8492E-05  2406 -1906 31 -1811 imp:n=1  $ Position 6
1907 10 4.8492E-05  2407 -1907 31 -1811 imp:n=1  $ Position 7
1908 10 4.8492E-05  2408 -1908 31 -1811 imp:n=1  $ Position 8
1909 10 4.8492E-05  2409 -1909 31 -1811 imp:n=1  $ Position 9
1910 10 4.8492E-05  2410 -1910 31 -1811 imp:n=1  $ Position 10
1911 10 4.8492E-05  2411 -1911 31 -1811 imp:n=1  $ Position 11
1912 10 4.8492E-05  2412 -1912 31 -1811 imp:n=1  $ Position 12
1913 10 4.8492E-05  2413 -1913 31 -1811 imp:n=1  $ Position 13
1914 10 4.8492E-05  2414 -1914 31 -1811 imp:n=1  $ Position 14
1915 10 4.8492E-05  2415 -1915 31 -1811 imp:n=1  $ Position 15
1916 10 4.8492E-05  2416 -1916 31 -1811 imp:n=1  $ Position 16
1917 10 4.8492E-05  2417 -1917 31 -1811 imp:n=1  $ Position 17
1918 10 4.8492E-05  2418 -1918 31 -1811 imp:n=1  $ Position 18
1919 10 4.8492E-05  2419 -1919 31 -1811 imp:n=1  $ Position 19
1920 10 4.8492E-05  2420 -1920 31 -1811 imp:n=1  $ Position 20
1921 10 4.8492E-05  2421 -1921 31 -1811 imp:n=1  $ Position 21
1922 10 4.8492E-05  2422 -1922 31 -1811 imp:n=1  $ Position 22
1923 10 4.8492E-05  2423 -1923 31 -1811 imp:n=1  $ Position 23
1924 10 4.8492E-05  2424 -1924 31 -1811 imp:n=1  $ Position 24
1925 10 4.8492E-05  2425 -1925 31 -1811 imp:n=1  $ Position 25
1926 10 4.8492E-05  2426 -1926 31 -1811 imp:n=1  $ Position 26
1927 10 4.8492E-05  2427 -1927 31 -1811 imp:n=1  $ Position 27
1928 10 4.8492E-05  2428 -1928 31 -1811 imp:n=1  $ Position 28
1929 10 4.8492E-05  2429 -1929 31 -1811 imp:n=1  $ Position 29
1930 10 4.8492E-05  2430 -1930 31 -1811 imp:n=1  $ Position 30
1931 10 4.8492E-05  2431 -1931 31 -1811 imp:n=1  $ Position 31
1932 10 4.8492E-05  2432 -1932 31 -1811 imp:n=1  $ Position 32
c
c --------- Ring 2 ---------
2001 10 4.8492E-05  2501 -2001 31 -1811 imp:n=1  $ Position 1
2002 10 4.8492E-05  2502 -2002 31 -1811 imp:n=1  $ Position 2
2003 10 4.8492E-05  2503 -2003 31 -1811 imp:n=1  $ Position 3
2004 10 4.8492E-05  2504 -2004 31 -1811 imp:n=1  $ Position 4
2005 10 4.8492E-05  2505 -2005 31 -1811 imp:n=1  $ Position 5
2006 10 4.8492E-05  2506 -2006 31 -1811 imp:n=1  $ Position 6
2007 10 4.8492E-05  2507 -2007 31 -1811 imp:n=1  $ Position 7
2008 10 4.8492E-05  2508 -2008 31 -1811 imp:n=1  $ Position 8
2009 10 4.8492E-05  2509 -2009 31 -1811 imp:n=1  $ Position 9
2010 10 4.8492E-05  2510 -2010 31 -1811 imp:n=1  $ Position 10
2011 10 4.8492E-05  2511 -2011 31 -1811 imp:n=1  $ Position 11
2012 10 4.8492E-05  2512 -2012 31 -1811 imp:n=1  $ Position 12
2013 10 4.8492E-05  2513 -2013 31 -1811 imp:n=1  $ Position 13
2014 10 4.8492E-05  2514 -2014 31 -1811 imp:n=1  $ Position 14
2015 10 4.8492E-05  2515 -2015 31 -1811 imp:n=1  $ Position 15
2016 10 4.8492E-05  2516 -2016 31 -1811 imp:n=1  $ Position 16
2017 10 4.8492E-05  2517 -2017 31 -1811 imp:n=1  $ Position 17
2018 10 4.8492E-05  2518 -2018 31 -1811 imp:n=1  $ Position 18
```

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2019 10 4.8492E-05  2519 -2019 31 -1811 imp:n=1  $ Position 19
2020 10 4.8492E-05  2520 -2020 31 -1811 imp:n=1  $ Position 20
2021 10 4.8492E-05  2521 -2021 31 -1811 imp:n=1  $ Position 21
2022 10 4.8492E-05  2522 -2022 31 -1811 imp:n=1  $ Position 22
2023 10 4.8492E-05  2523 -2023 31 -1811 imp:n=1  $ Position 23
2024 10 4.8492E-05  2524 -2024 31 -1811 imp:n=1  $ Position 24
2025 10 4.8492E-05  2525 -2025 31 -1811 imp:n=1  $ Position 25
2026 10 4.8492E-05  2526 -2026 31 -1811 imp:n=1  $ Position 26
2027 10 4.8492E-05  2527 -2027 31 -1811 imp:n=1  $ Position 27
2028 10 4.8492E-05  2528 -2028 31 -1811 imp:n=1  $ Position 28
2029 10 4.8492E-05  2529 -2029 31 -1811 imp:n=1  $ Position 29
2030 10 4.8492E-05  2530 -2030 31 -1811 imp:n=1  $ Position 30
2031 10 4.8492E-05  2531 -2031 31 -1811 imp:n=1  $ Position 31
2032 10 4.8492E-05  2532 -2032 31 -1811 imp:n=1  $ Position 32
c
c --------- Ring 3 ---------
2101 10 4.8492E-05  2601 -2101 31 -1811 imp:n=1  $ Position 1
2102 10 4.8492E-05  2602 -2102 31 -1811 imp:n=1  $ Position 2
2103 10 4.8492E-05  2603 -2103 31 -1811 imp:n=1  $ Position 3
2104 10 4.8492E-05  2604 -2104 31 -1811 imp:n=1  $ Position 4
2105 10 4.8492E-05  2605 -2105 31 -1811 imp:n=1  $ Position 5
2106 10 4.8492E-05  2606 -2106 31 -1811 imp:n=1  $ Position 6
2107 10 4.8492E-05  2607 -2107 31 -1811 imp:n=1  $ Position 7
2108 10 4.8492E-05  2608 -2108 31 -1811 imp:n=1  $ Position 8
2109 10 4.8492E-05  2609 -2109 31 -1811 imp:n=1  $ Position 9
2110 10 4.8492E-05  2610 -2110 31 -1811 imp:n=1  $ Position 10
2111 10 4.8492E-05  2611 -2111 31 -1811 imp:n=1  $ Position 11
2112 10 4.8492E-05  2612 -2112 31 -1811 imp:n=1  $ Position 12
2113 10 4.8492E-05  2613 -2113 31 -1811 imp:n=1  $ Position 13
2114 10 4.8492E-05  2614 -2114 31 -1811 imp:n=1  $ Position 14
2115 10 4.8492E-05  2615 -2115 31 -1811 imp:n=1  $ Position 15
2116 10 4.8492E-05  2616 -2116 31 -1811 imp:n=1  $ Position 16
2117 10 4.8492E-05  2617 -2117 31 -1811 imp:n=1  $ Position 17
2118 10 4.8492E-05  2618 -2118 31 -1811 imp:n=1  $ Position 18
2119 10 4.8492E-05  2619 -2119 31 -1811 imp:n=1  $ Position 19
2120 10 4.8492E-05  2620 -2120 31 -1811 imp:n=1  $ Position 20
2121 10 4.8492E-05  2621 -2121 31 -1811 imp:n=1  $ Position 21
2122 10 4.8492E-05  2622 -2122 31 -1811 imp:n=1  $ Position 22
2123 10 4.8492E-05  2623 -2123 31 -1811 imp:n=1  $ Position 23
2124 10 4.8492E-05  2624 -2124 31 -1811 imp:n=1  $ Position 24
2125 10 4.8492E-05  2625 -2125 31 -1811 imp:n=1  $ Position 25
2126 10 4.8492E-05  2626 -2126 31 -1811 imp:n=1  $ Position 26
2127 10 4.8492E-05  2627 -2127 31 -1811 imp:n=1  $ Position 27
2128 10 4.8492E-05  2628 -2128 31 -1811 imp:n=1  $ Position 28
2129 10 4.8492E-05  2629 -2129 31 -1811 imp:n=1  $ Position 29
2130 10 4.8492E-05  2630 -2130 31 -1811 imp:n=1  $ Position 30
2131 10 4.8492E-05  2631 -2131 31 -1811 imp:n=1  $ Position 31
2132 10 4.8492E-05  2632 -2132 31 -1811 imp:n=1  $ Position 32
c
c --------- Ring 4 ---------
2201 10 4.8492E-05  2701 -2201 31 -1811 imp:n=1  $ Position 1
2202 10 4.8492E-05  2702 -2202 31 -1811 imp:n=1  $ Position 2
2203 10 4.8492E-05  2703 -2203 31 -1811 imp:n=1  $ Position 3
2204 10 4.8492E-05  2704 -2204 31 -1811 imp:n=1  $ Position 4
2205 10 4.8492E-05  2705 -2205 31 -1811 imp:n=1  $ Position 5
2206 10 4.8492E-05  2706 -2206 31 -1811 imp:n=1  $ Position 6
2207 10 4.8492E-05  2707 -2207 31 -1811 imp:n=1  $ Position 7
2208 10 4.8492E-05  2708 -2208 31 -1811 imp:n=1  $ Position 8
2209 10 4.8492E-05  2709 -2209 31 -1811 imp:n=1  $ Position 9
2210 10 4.8492E-05  2710 -2210 31 -1811 imp:n=1  $ Position 10
2211 10 4.8492E-05  2711 -2211 31 -1811 imp:n=1  $ Position 11
2212 10 4.8492E-05  2712 -2212 31 -1811 imp:n=1  $ Position 12
2213 10 4.8492E-05  2713 -2213 31 -1811 imp:n=1  $ Position 13
2214 10 4.8492E-05  2714 -2214 31 -1811 imp:n=1  $ Position 14
2215 10 4.8492E-05  2715 -2215 31 -1811 imp:n=1  $ Position 15
2216 10 4.8492E-05  2716 -2216 31 -1811 imp:n=1  $ Position 16
2217 10 4.8492E-05  2717 -2217 31 -1811 imp:n=1  $ Position 17
2218 10 4.8492E-05  2718 -2218 31 -1811 imp:n=1  $ Position 18
2219 10 4.8492E-05  2719 -2219 31 -1811 imp:n=1  $ Position 19
2220 10 4.8492E-05  2720 -2220 31 -1811 imp:n=1  $ Position 20
2221 10 4.8492E-05  2721 -2221 31 -1811 imp:n=1  $ Position 21
2222 10 4.8492E-05  2722 -2222 31 -1811 imp:n=1  $ Position 22
2223 10 4.8492E-05  2723 -2223 31 -1811 imp:n=1  $ Position 23
2224 10 4.8492E-05  2724 -2224 31 -1811 imp:n=1  $ Position 24
2225 10 4.8492E-05  2725 -2225 31 -1811 imp:n=1  $ Position 25
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2226 10 4.8492E-05  2726 -2226 31 -1811 imp:n=1  $ Position 26
2227 10 4.8492E-05  2727 -2227 31 -1811 imp:n=1  $ Position 27
2228 10 4.8492E-05  2728 -2228 31 -1811 imp:n=1  $ Position 28
2229 10 4.8492E-05  2729 -2229 31 -1811 imp:n=1  $ Position 29
2230 10 4.8492E-05  2730 -2230 31 -1811 imp:n=1  $ Position 30
2231 10 4.8492E-05  2731 -2231 31 -1811 imp:n=1  $ Position 31
2232 10 4.8492E-05  2732 -2232 31 -1811 imp:n=1  $ Position 32
c
c --------- Ring 5 ---------
2301 10 4.8492E-05  2801 -2301 31 -1811 imp:n=1  $ Position 1
2302 10 4.8492E-05  2802 -2302 31 -1811 imp:n=1  $ Position 2
2303 10 4.8492E-05  2803 -2303 31 -1811 imp:n=1  $ Position 3
2304 10 4.8492E-05  2804 -2304 31 -1811 imp:n=1  $ Position 4
2305 10 4.8492E-05  2805 -2305 31 -1811 imp:n=1  $ Position 5
2306 10 4.8492E-05  2806 -2306 31 -1811 imp:n=1  $ Position 6
2307 10 4.8492E-05  2807 -2307 31 -1811 imp:n=1  $ Position 7
2308 10 4.8492E-05  2808 -2308 31 -1811 imp:n=1  $ Position 8
2309 10 4.8492E-05  2809 -2309 31 -1811 imp:n=1  $ Position 9
2310 10 4.8492E-05  2810 -2310 31 -1811 imp:n=1  $ Position 10
2311 10 4.8492E-05  2811 -2311 31 -1811 imp:n=1  $ Position 11
2312 10 4.8492E-05  2812 -2312 31 -1811 imp:n=1  $ Position 12
2313 10 4.8492E-05  2813 -2313 31 -1811 imp:n=1  $ Position 13
2314 10 4.8492E-05  2814 -2314 31 -1811 imp:n=1  $ Position 14
2315 10 4.8492E-05  2815 -2315 31 -1811 imp:n=1  $ Position 15
2316 10 4.8492E-05  2816 -2316 31 -1811 imp:n=1  $ Position 16
2317 10 4.8492E-05  2817 -2317 31 -1811 imp:n=1  $ Position 17
2318 10 4.8492E-05  2818 -2318 31 -1811 imp:n=1  $ Position 18
2319 10 4.8492E-05  2819 -2319 31 -1811 imp:n=1  $ Position 19
2320 10 4.8492E-05  2820 -2320 31 -1811 imp:n=1  $ Position 20
2321 10 4.8492E-05  2821 -2321 31 -1811 imp:n=1  $ Position 21
2322 10 4.8492E-05  2822 -2322 31 -1811 imp:n=1  $ Position 22
2323 10 4.8492E-05  2823 -2323 31 -1811 imp:n=1  $ Position 23
2324 10 4.8492E-05  2824 -2324 31 -1811 imp:n=1  $ Position 24
2325 10 4.8492E-05  2825 -2325 31 -1811 imp:n=1  $ Position 25
2326 10 4.8492E-05  2826 -2326 31 -1811 imp:n=1  $ Position 26
2327 10 4.8492E-05  2827 -2327 31 -1811 imp:n=1  $ Position 27
2328 10 4.8492E-05  2828 -2328 31 -1811 imp:n=1  $ Position 28
2329 10 4.8492E-05  2829 -2329 31 -1811 imp:n=1  $ Position 29
2330 10 4.8492E-05  2830 -2330 31 -1811 imp:n=1  $ Position 30
2331 10 4.8492E-05  2831 -2331 31 -1811 imp:n=1  $ Position 31
2332 10 4.8492E-05  2832 -2332 31 -1811 imp:n=1  $ Position 32
c
c ------ Graphite Plugs ------
c --------- Ring 1 ---------
2401 29 8.8245E-02  -2401 31 -1811 imp:n=1  $ Position 1
2402 29 8.8245E-02  -2402 31 -1811 imp:n=1  $ Position 2
2403 29 8.8245E-02  -2403 31 -1811 imp:n=1  $ Position 3 (Cores 5, 6, & 7)
c 2403 10 4.8648E-05  -2403 31 -1811 imp:n=1  $ Position 3 (Core 8, i.e. No Plug)
2404 29 8.8245E-02  -2404 31 -1811 imp:n=1  $ Position 4
2405 29 8.8245E-02  -2405 31 -1811 imp:n=1  $ Position 5
2406 29 8.8245E-02  -2406 31 -1811 imp:n=1  $ Position 6 (Cores 5, 6, & 7)
c 2406 10 4.8648E-05  -2406 31 -1811 imp:n=1  $ Position 6 (Core 8, i.e. No Plug)
2407 29 8.8245E-02  -2407 31 -1811 imp:n=1  $ Position 7
2408 29 8.8245E-02  -2408 31 -1811 imp:n=1  $ Position 8
2409 29 8.8245E-02  -2409 31 -1811 imp:n=1  $ Position 9 (Cores 5, 6, & 7)
c 2409 10 4.8648E-05  -2409 31 -1811 imp:n=1  $ Position 9 (Core 8, i.e. No Plug)
2410 29 8.8245E-02  -2410 31 -1811 imp:n=1  $ Position 10
2411 29 8.8245E-02  -2411 31 -1811 imp:n=1  $ Position 11
2412 29 8.8245E-02  -2412 31 -1811 imp:n=1  $ Position 12 (Cores 5, 6, & 7)
c 2412 10 4.8648E-05  -2412 31 -1811 imp:n=1  $ Position 12 (Core 8, i.e. No Plug)
2413 29 8.8245E-02  -2413 31 -1811 imp:n=1  $ Position 13
2414 29 8.8245E-02  -2414 31 -1811 imp:n=1  $ Position 14
2415 29 8.8245E-02  -2415 31 -1811 imp:n=1  $ Position 15 (Cores 5, 6, & 7)
c 2415 10 4.8648E-05  -2415 31 -1811 imp:n=1  $ Position 15 (Core 8, i.e. No Plug)
2416 29 8.8245E-02  -2416 31 -1811 imp:n=1  $ Position 16
2417 29 8.8245E-02  -2417 31 -1811 imp:n=1  $ Position 17
2418 29 8.8245E-02  -2418 31 -1811 imp:n=1  $ Position 18 (Cores 5, 6, & 7)
c 2418 10 4.8648E-05  -2418 31 -1811 imp:n=1  $ Position 18 (Core 8, i.e. No Plug)
2419 29 8.8245E-02  -2419 31 -1811 imp:n=1  $ Position 19
2420 29 8.8245E-02  -2420 31 -1811 imp:n=1  $ Position 20
2421 29 8.8245E-02  -2421 31 -1811 imp:n=1  $ Position 21 (Cores 5, 6, & 7)
c 2421 10 4.8648E-05  -2421 31 -1811 imp:n=1  $ Position 21 (Core 8, i.e. No Plug)
2422 29 8.8245E-02  -2422 31 -1811 imp:n=1  $ Position 22
2423 29 8.8245E-02  -2423 31 -1811 imp:n=1  $ Position 23
2424 29 8.8245E-02  -2424 31 -1811 imp:n=1  $ Position 24 (Cores 5, 6, & 7)
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c 2424 10 4.8648E-05  -2424 31 -1811 imp:n=1  $ Position 24 (Core 8, i.e. No Plug)
2425 29 8.8245E-02  -2425 31 -1811 imp:n=1  $ Position 25
2426 29 8.8245E-02  -2426 31 -1811 imp:n=1  $ Position 26
2427 29 8.8245E-02  -2427 31 -1811 imp:n=1  $ Position 27 (Cores 5, 6, & 7)
c 2427 10 4.8648E-05  -2427 31 -1811 imp:n=1  $ Position 27 (Core 8, i.e. No Plug)
2428 29 8.8245E-02  -2428 31 -1811 imp:n=1  $ Position 28
2429 29 8.8245E-02  -2429 31 -1811 imp:n=1  $ Position 29 (Cores 5, 6, & 7)
c 2429 10 4.8648E-05  -2429 31 -1811 imp:n=1  $ Position 29 (Core 8, i.e. No Plug)
2430 29 8.8245E-02  -2430 31 -1811 imp:n=1  $ Position 30
2431 29 8.8245E-02  -2431 31 -1811 imp:n=1  $ Position 31
2432 29 8.8245E-02  -2432 31 -1811 imp:n=1  $ Position 32 (Cores 5, 6, & 7)
c 2432 10 4.8648E-05  -2432 31 -1811 imp:n=1  $ Position 32 (Core 8, i.e. No Plug)
c
c --------- Ring 2 ---------
2501 29 8.8245E-02  -2501 31 -1811 imp:n=1  $ Position 1
2502 29 8.8245E-02  -2502 31 -1811 imp:n=1  $ Position 2
2503 29 8.8245E-02  -2503 31 -1811 imp:n=1  $ Position 3
2504 29 8.8245E-02  -2504 31 -1811 imp:n=1  $ Position 4
2505 29 8.8245E-02  -2505 31 -1811 imp:n=1  $ Position 5
2506 29 8.8245E-02  -2506 31 -1811 imp:n=1  $ Position 6
2507 29 8.8245E-02  -2507 31 -1811 imp:n=1  $ Position 7
2508 29 8.8245E-02  -2508 31 -1811 imp:n=1  $ Position 8
2509 29 8.8245E-02  -2509 31 -1811 imp:n=1  $ Position 9
2510 29 8.8245E-02  -2510 31 -1811 imp:n=1  $ Position 10
2511 29 8.8245E-02  -2511 31 -1811 imp:n=1  $ Position 11
2512 29 8.8245E-02  -2512 31 -1811 imp:n=1  $ Position 12
2513 29 8.8245E-02  -2513 31 -1811 imp:n=1  $ Position 13
2514 29 8.8245E-02  -2514 31 -1811 imp:n=1  $ Position 14
2515 29 8.8245E-02  -2515 31 -1811 imp:n=1  $ Position 15
2516 29 8.8245E-02  -2516 31 -1811 imp:n=1  $ Position 16
2517 29 8.8245E-02  -2517 31 -1811 imp:n=1  $ Position 17
2518 29 8.8245E-02  -2518 31 -1811 imp:n=1  $ Position 18
2519 29 8.8245E-02  -2519 31 -1811 imp:n=1  $ Position 19
2520 29 8.8245E-02  -2520 31 -1811 imp:n=1  $ Position 20
2521 29 8.8245E-02  -2521 31 -1811 imp:n=1  $ Position 21
2522 29 8.8245E-02  -2522 31 -1811 imp:n=1  $ Position 22
2523 29 8.8245E-02  -2523 31 -1811 imp:n=1  $ Position 23
2524 29 8.8245E-02  -2524 31 -1811 imp:n=1  $ Position 24
2525 29 8.8245E-02  -2525 31 -1811 imp:n=1  $ Position 25
2526 29 8.8245E-02  -2526 31 -1811 imp:n=1  $ Position 26
2527 29 8.8245E-02  -2527 31 -1811 imp:n=1  $ Position 27
2528 29 8.8245E-02  -2528 31 -1811 imp:n=1  $ Position 28
2529 29 8.8245E-02  -2529 31 -1811 imp:n=1  $ Position 29
2530 29 8.8245E-02  -2530 31 -1811 imp:n=1  $ Position 30
2531 29 8.8245E-02  -2531 31 -1811 imp:n=1  $ Position 31
2532 29 8.8245E-02  -2532 31 -1811 imp:n=1  $ Position 32
c
c --------- Ring 3 ---------
2601 29 8.8245E-02  -2601 31 -1811 imp:n=1  $ Position 1
2602 29 8.8245E-02  -2602 31 -1811 imp:n=1  $ Position 2 (Cores 5, 6, & 7)
c 2602 10 4.8648E-05  -2602 31 -1811 imp:n=1  $ Position 2 (Core 8, i.e. No Plug)
2603 29 8.8245E-02  -2603 31 -1811 imp:n=1  $ Position 3
2604 29 8.8245E-02  -2604 31 -1811 imp:n=1  $ Position 4
2605 29 8.8245E-02  -2605 31 -1811 imp:n=1  $ Position 5 (Cores 5, 6, & 7)
c 2605 10 4.8648E-05  -2605 31 -1811 imp:n=1  $ Position 5 (Core 8, i.e. No Plug)
2606 29 8.8245E-02  -2606 31 -1811 imp:n=1  $ Position 6
2607 29 8.8245E-02  -2607 31 -1811 imp:n=1  $ Position 7
2608 29 8.8245E-02  -2608 31 -1811 imp:n=1  $ Position 8 (Cores 5, 6, & 7)
c 2608 10 4.8648E-05  -2608 31 -1811 imp:n=1  $ Position 8 (Core 8, i.e. No Plug)
2609 29 8.8245E-02  -2609 31 -1811 imp:n=1  $ Position 9
2610 29 8.8245E-02  -2610 31 -1811 imp:n=1  $ Position 10
2611 29 8.8245E-02  -2611 31 -1811 imp:n=1  $ Position 11 (Cores 5, 6, & 7)
c 2611 10 4.8648E-05  -2611 31 -1811 imp:n=1  $ Position 11 (Core 8, i.e. No Plug)
2612 29 8.8245E-02  -2612 31 -1811 imp:n=1  $ Position 12
2613 29 8.8245E-02  -2613 31 -1811 imp:n=1  $ Position 13
2614 29 8.8245E-02  -2614 31 -1811 imp:n=1  $ Position 14 (Cores 5, 6, & 7)
c 2614 10 4.8648E-05  -2614 31 -1811 imp:n=1  $ Position 14 (Core 8, i.e. No Plug)
2615 29 8.8245E-02  -2615 31 -1811 imp:n=1  $ Position 15
2616 29 8.8245E-02  -2616 31 -1811 imp:n=1  $ Position 16
2617 29 8.8245E-02  -2617 31 -1811 imp:n=1  $ Position 17 (Cores 5, 6, & 7)
c 2617 10 4.8648E-05  -2617 31 -1811 imp:n=1  $ Position 17 (Core 8, i.e. No Plug)
2618 29 8.8245E-02  -2618 31 -1811 imp:n=1  $ Position 18
2619 29 8.8245E-02  -2619 31 -1811 imp:n=1  $ Position 19
2620 29 8.8245E-02  -2620 31 -1811 imp:n=1  $ Position 20 (Cores 5, 6, & 7)
c 2620 10 4.8648E-05  -2620 31 -1811 imp:n=1  $ Position 20 (Core 8, i.e. No Plug)
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2621 29 8.8245E-02  -2621 31 -1811 imp:n=1  $ Position 21
2622 29 8.8245E-02  -2622 31 -1811 imp:n=1  $ Position 22
2623 29 8.8245E-02  -2623 31 -1811 imp:n=1  $ Position 23 (Cores 5, 6, & 7)
c 2623 10 4.8648E-05  -2623 31 -1811 imp:n=1  $ Position 23 (Core 8, i.e. No Plug)
2624 29 8.8245E-02  -2624 31 -1811 imp:n=1  $ Position 24
2625 29 8.8245E-02  -2625 31 -1811 imp:n=1  $ Position 25
2626 29 8.8245E-02  -2626 31 -1811 imp:n=1  $ Position 26 (Cores 5, 6, & 7)
c 2626 10 4.8648E-05  -2626 31 -1811 imp:n=1  $ Position 26 (Core 8, i.e. No Plug)
2627 29 8.8245E-02  -2627 31 -1811 imp:n=1  $ Position 27
2628 29 8.8245E-02  -2628 31 -1811 imp:n=1  $ Position 28 (Cores 5, 6, & 7)
c 2628 10 4.8648E-05  -2628 31 -1811 imp:n=1  $ Position 28 (Core 8, i.e. No Plug)
2629 29 8.8245E-02  -2629 31 -1811 imp:n=1  $ Position 29
2630 29 8.8245E-02  -2630 31 -1811 imp:n=1  $ Position 30
2631 29 8.8245E-02  -2631 31 -1811 imp:n=1  $ Position 31 (Cores 5, 6, & 7)
c 2631 10 4.8648E-05  -2631 31 -1811 imp:n=1  $ Position 31 (Core 8, i.e. No Plug)
2632 29 8.8245E-02  -2632 31 -1811 imp:n=1  $ Position 32
c
c --------- Ring 4 ---------
2701 29 8.8245E-02  -2701 31 -1811 imp:n=1  $ Position 1
2702 29 8.8245E-02  -2702 31 -1811 imp:n=1  $ Position 2
2703 29 8.8245E-02  -2703 31 -1811 imp:n=1  $ Position 3
2704 29 8.8245E-02  -2704 31 -1811 imp:n=1  $ Position 4
2705 29 8.8245E-02  -2705 31 -1811 imp:n=1  $ Position 5
2706 29 8.8245E-02  -2706 31 -1811 imp:n=1  $ Position 6
2707 29 8.8245E-02  -2707 31 -1811 imp:n=1  $ Position 7
2708 29 8.8245E-02  -2708 31 -1811 imp:n=1  $ Position 8
2709 29 8.8245E-02  -2709 31 -1811 imp:n=1  $ Position 9
2710 29 8.8245E-02  -2710 31 -1811 imp:n=1  $ Position 10
2711 29 8.8245E-02  -2711 31 -1811 imp:n=1  $ Position 11
2712 29 8.8245E-02  -2712 31 -1811 imp:n=1  $ Position 12
2713 29 8.8245E-02  -2713 31 -1811 imp:n=1  $ Position 13
2714 29 8.8245E-02  -2714 31 -1811 imp:n=1  $ Position 14
2715 29 8.8245E-02  -2715 31 -1811 imp:n=1  $ Position 15
2716 29 8.8245E-02  -2716 31 -1811 imp:n=1  $ Position 16
2717 29 8.8245E-02  -2717 31 -1811 imp:n=1  $ Position 17
2718 29 8.8245E-02  -2718 31 -1811 imp:n=1  $ Position 18
2719 29 8.8245E-02  -2719 31 -1811 imp:n=1  $ Position 19
2720 29 8.8245E-02  -2720 31 -1811 imp:n=1  $ Position 20
2721 29 8.8245E-02  -2721 31 -1811 imp:n=1  $ Position 21
2722 29 8.8245E-02  -2722 31 -1811 imp:n=1  $ Position 22
2723 29 8.8245E-02  -2723 31 -1811 imp:n=1  $ Position 23
2724 29 8.8245E-02  -2724 31 -1811 imp:n=1  $ Position 24
2725 29 8.8245E-02  -2725 31 -1811 imp:n=1  $ Position 25
2726 29 8.8245E-02  -2726 31 -1811 imp:n=1  $ Position 26
2727 29 8.8245E-02  -2727 31 -1811 imp:n=1  $ Position 27
2728 29 8.8245E-02  -2728 31 -1811 imp:n=1  $ Position 28
2729 29 8.8245E-02  -2729 31 -1811 imp:n=1  $ Position 29
2730 29 8.8245E-02  -2730 31 -1811 imp:n=1  $ Position 30
2731 29 8.8245E-02  -2731 31 -1811 imp:n=1  $ Position 31
2732 29 8.8245E-02  -2732 31 -1811 imp:n=1  $ Position 32
c
c --------- Ring 5 ---------
2801 29 8.8245E-02  -2801 31 -1811 imp:n=1  $ Position 1 (Cores 5, 6, & 7)
c 2801 10 4.8648E-05  -2801 31 -1811 imp:n=1  $ Position 1 (Core 8, i.e. No Plug)
2802 29 8.8245E-02  -2802 31 -1811 imp:n=1  $ Position 2
2803 29 8.8245E-02  -2803 31 -1811 imp:n=1  $ Position 3
2804 29 8.8245E-02  -2804 31 -1811 imp:n=1  $ Position 4 (Cores 5, 6, & 7)
c 2804 10 4.8648E-05  -2804 31 -1811 imp:n=1  $ Position 4 (Core 8, i.e. No Plug)
2805 29 8.8245E-02  -2805 31 -1811 imp:n=1  $ Position 5
2806 29 8.8245E-02  -2806 31 -1811 imp:n=1  $ Position 6
2807 29 8.8245E-02  -2807 31 -1811 imp:n=1  $ Position 7 (Cores 5, 6, & 7)
c 2807 10 4.8648E-05  -2807 31 -1811 imp:n=1  $ Position 7 (Core 8, i.e. No Plug)
2808 29 8.8245E-02  -2808 31 -1811 imp:n=1  $ Position 8
2809 29 8.8245E-02  -2809 31 -1811 imp:n=1  $ Position 9
2810 29 8.8245E-02  -2810 31 -1811 imp:n=1  $ Position 10 (Cores 5, 6, & 7)
c 2810 10 4.8648E-05  -2810 31 -1811 imp:n=1  $ Position 10 (Core 8, i.e. No Plug)
2811 29 8.8245E-02  -2811 31 -1811 imp:n=1  $ Position 11
2812 29 8.8245E-02  -2812 31 -1811 imp:n=1  $ Position 12
2813 29 8.8245E-02  -2813 31 -1811 imp:n=1  $ Position 13 (Cores 5, 6, & 7)
c 2813 10 4.8648E-05  -2813 31 -1811 imp:n=1  $ Position 13 (Core 8, i.e. No Plug)
2814 29 8.8245E-02  -2814 31 -1811 imp:n=1  $ Position 14
2815 29 8.8245E-02  -2815 31 -1811 imp:n=1  $ Position 15
2816 29 8.8245E-02  -2816 31 -1811 imp:n=1  $ Position 16 (Cores 5, 6, & 7)
c 2816 10 4.8648E-05  -2816 31 -1811 imp:n=1  $ Position 16 (Core 8, i.e. No Plug)
2817 29 8.8245E-02  -2817 31 -1811 imp:n=1  $ Position 17
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2818 29 8.8245E-02  -2818 31 -1811 imp:n=1  $ Position 18
2819 29 8.8245E-02  -2819 31 -1811 imp:n=1  $ Position 19 (Cores 5, 6, & 7)
c 2819 10 4.8648E-05  -2819 31 -1811 imp:n=1  $ Position 19 (Core 8, i.e. No Plug)
2820 29 8.8245E-02  -2820 31 -1811 imp:n=1  $ Position 20
2821 29 8.8245E-02  -2821 31 -1811 imp:n=1  $ Position 21
2822 29 8.8245E-02  -2822 31 -1811 imp:n=1  $ Position 22 (Cores 5, 6, & 7)
c 2822 10 4.8648E-05  -282 31 -1811 imp:n=1  $ Position 22 (Core 8, i.e. No Plug)
2823 29 8.8245E-02  -2823 31 -1811 imp:n=1  $ Position 23
2824 29 8.8245E-02  -2824 31 -1811 imp:n=1  $ Position 24
2825 29 8.8245E-02  -2825 31 -1811 imp:n=1  $ Position 25 (Cores 5, 6, & 7)
c 2825 10 4.8648E-05  -2825 31 -1811 imp:n=1  $ Position 25 (Core 8, i.e. No Plug)
2826 29 8.8245E-02  -2826 31 -1811 imp:n=1  $ Position 26
2827 29 8.8245E-02  -2827 31 -1811 imp:n=1  $ Position 27 (Cores 5, 6, & 7)
c 2827 10 4.8648E-05  -2827 31 -1811 imp:n=1  $ Position 27 (Core 8, i.e. No Plug)
2828 29 8.8245E-02  -2828 31 -1811 imp:n=1  $ Position 28
2829 29 8.8245E-02  -2829 31 -1811 imp:n=1  $ Position 29
2830 29 8.8245E-02  -2830 31 -1811 imp:n=1  $ Position 30 (Cores 5, 6, & 7)
c 2830 10 4.8648E-05  -2830 31 -1811 imp:n=1  $ Position 30 (Core 8, i.e. No Plug)
2831 29 8.8245E-02  -2831 31 -1811 imp:n=1  $ Position 31
2832 29 8.8245E-02  -2832 31 -1811 imp:n=1  $ Position 32
c
c --- Control Rods ---------------------------------------------------------------
c ------ Autorod ------
3031 13 8.4303E-02  3031 -3032 -3033 -3034 -3035 imp:n=1 u=10  $ Copper Plate
3032 10 4.8492E-05  -3031:3032:3033:3034:3035 imp:n=1 u=10  $ Air
c
c ****** Autorod Fully Inserted @ z=0 and Withdrawn @ z=100 **************************
c ****** Autorod Withdrawn to z=88.7 for Core 5,            **************************
c ******                     z=22.5 for Core 6,            **************************
c ******                     z=17.0 for Core 7, and        **************************
c ******                     z=50.6 for Core 8,            **************************
c
3033 0    -3036 imp:n=1 u=11 fill=10 (0 0 88.7)
3034 113 5.9746E-02  3036 -3037 31 -32 imp:n=1 u=11  $ Aluminum Tube
3035 10 4.8492E-05  3037:(3036 -31):(3036 32) imp:n=1 u=11  $ Air
c
c ------ Withdrawable Control Rods ------
3091 10 4.8492E-05  3083 -3084 -3087 imp:n=1 u=17  $ Air
3092 17 8.6477E-02  3082 -3085 3087 -3088 imp:n=1 u=17 $ Inner Tube
3093 10 4.8492E-05  3082 -3085 3088 -3089 imp:n=1 u=17 $ Air Gap
3094 18 8.6499E-02  3082 -3085 3089 -3090 imp:n=1 u=17 $ Outer Tube
3095 18 8.6499E-02  (3081 -3082 -3090):(3082 -3083 -3087) imp:n=1 u=17  $ Bottom End Plug
3096 18 8.6499E-02  (3084 -3085 -3087):(3085 -3086 -3090) imp:n=1 u=17  $ Top End Plug
3097 10 4.8492E-05  -3081:3086:3090 imp:n=1 u=17  $ Air
c
c ****** Control Rods Fully Inserted @ z=0 and Withdrawn @ z=249.4           **********
c ****** Opposite of Reported Values Inserted @ z=250 and Withdrawn @ z=0.6 **********
c ****** Control Rods Withdrawn to z=55.5 for Core 5,                        **********
c ****** Control Rods Withdrawn to z=50.0 for Core 6,                        **********
c ****** Control Rods Withdrawn to z=54.0 for Core 7, and                    **********
c ****** Control Rods Withdrawn to z= 0.0 for Core 8                         **********
c
3098 0  -3095 imp:n=1 u=18 fill=17 (0 0 55.5)  $ Rod 1
3099 0  -3095 imp:n=1 u=19 fill=17 (0 0 55.5)  $ Rod 2
3100 0  -3095 imp:n=1 u=20 fill=17 (0 0 55.5)  $ Rod 3
3101 0  -3095 imp:n=1 u=21 fill=17 (0 0 55.5)  $ Rod 4
c
c --- Pebbles --------------------------------------------------------------------
c ------ TRISO ------
3111 19 7.2917E-02  -3111 imp:n=1 u=22  $ UO2 Kernel
3112 20 5.2640E-02  3111 -3112 imp:n=1 u=22  $ Buffer Coating
3113 21 9.5254E-02  3112 -3113 imp:n=1 u=22  $ IPyC Coating
3114 22 9.6110E-02  3113 -3114 imp:n=1 u=22  $ SiC Coating
3115 23 9.4772E-02  3114 -3115 imp:n=1 u=22  $ OPyC Coating
3116 24 8.6859E-02  3115 imp:n=1 u=22  $ Fueled Zone Graphite
c
3117 24 8.6859E-02  -9999 imp:n=1 u=23  $ Fueled Zone Graphite
c
c ------ TRISO Lattice ------
3121 24 8.6859E-02  -3121 imp:n=1 u=98 lat=1 fill=-14:14 -14:14 -14:14
c
     23 840r
c
     23 405r
     23 12r 22 2r 23 12r
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     23 405r
c
     23 260r
     23 12r 22 2r 23 12r
     23 10r 22 6r 23 10r
     23 9r 22 8r 23 9r
     23 9r 22 8r 23 9r
     23 8r 22 10r 23 8r
     23 8r 22 10r 23 8r
     23 8r 22 10r 23 8r
     23 9r 22 8r 23 9r
     23 9r 22 8r 23 9r
     23 10r 22 6r 23 10r
     23 12r 22 2r 23 12r
     23 260r
c
     23 202r
     23 12r 22 2r 23 12r
     23 10r 22 6r 23 10r
     23 8r 22 10r 23 8r
     23 8r 22 10r 23 8r
     23 7r 22 12r 23 7r
     23 7r 22 12r 23 7r
     23 6r 22 14r 23 6r
     23 6r 22 14r 23 6r
     23 6r 22 14r 23 6r
     23 7r 22 12r 23 7r
     23 7r 22 12r 23 7r
     23 8r 22 10r 23 8r
     23 8r 22 10r 23 8r
     23 10r 22 6r 23 10r
     23 12r 22 2r 23 12r
     23 202r
c
     23 173r
     23 11r 22 4r 23 11r
     23 9r 22 8r 23 9r
     23 8r 22 10r 23 8r
     23 7r 22 12r 23 7r
     23 6r 22 14r 23 6r
     23 6r 22 14r 23 6r
     23 5r 22 16r 23 5r
     23 5r 22 16r 23 5r
     23 5r 22 16r 23 5r
     23 5r 22 16r 23 5r
     23 5r 22 16r 23 5r
     23 6r 22 14r 23 6r
     23 6r 22 14r 23 6r
     23 7r 22 12r 23 7r
     23 8r 22 10r 23 8r
     23 9r 22 8r 23 9r
     23 11r 22 4r 23 11r
     23 173r
c
     23 144r
     23 10r 22 6r 23 10r
     23 8r 22 10r 23 8r
     23 7r 22 12r 23 7r
     23 6r 22 14r 23 6r
     23 5r 22 16r 23 5r
     23 5r 22 16r 23 5r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
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     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 5r 22 16r 23 5r
     23 5r 22 16r 23 5r
     23 6r 22 14r 23 6r
     23 7r 22 12r 23 7r
     23 8r 22 10r 23 8r
     23 10r 22 6r 23 10r
     23 144r
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c
     23 115r
     23 11r 22 4r 23 11r
     23 8r 22 10r 23 8r
     23 7r 22 12r 23 7r
     23 6r 22 14r 23 6r
     23 5r 22 16r 23 5r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 5r 22 16r 23 5r
     23 6r 22 14r 23 6r
     23 7r 22 12r 23 7r
     23 8r 22 10r 23 8r
     23 11r 22 4r 23 11r
     23 115r
c
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     23 9r 22 8r 23 9r
     23 7r 22 12r 23 7r
     23 6r 22 14r 23 6r
     23 5r 22 16r 23 5r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
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     23 7r 22 12r 23 7r
     23 9r 22 8r 23 9r
     23 12r 22 2r 23 12r
     23 86r
c
     23 86r
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     23 8r 22 10r 23 8r
     23 6r 22 14r 23 6r
     23 5r 22 16r 23 5r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 3r 22 20r 23 3r
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     23 5r 22 16r 23 5r
     23 6r 22 14r 23 6r
     23 8r 22 10r 23 8r
     23 10r 22 6r 23 10r
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     23 86r
c
     23 57r
     23 12r 22 2r 23 12r
     23 8r 22 10r 23 8r
     23 7r 22 12r 23 7r
     23 5r 22 16r 23 5r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 3r 22 20r 23 3r
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     23 7r 22 12r 23 7r
     23 8r 22 10r 23 8r
     23 12r 22 2r 23 12r
     23 57r
c
     23 57r
     23 10r 22 6r 23 10r
     23 8r 22 10r 23 8r
     23 6r 22 14r 23 6r
     23 5r 22 16r 23 5r
     23 4r 22 18r 23 4r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
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     23 1r 22 24r 23 1r
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     23 1r 22 24r 23 1r
     23 2r 22 22r 23 2r
     23 2r 22 22r 23 2r
     23 3r 22 20r 23 3r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
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     23 8r 22 10r 23 8r
     23 6r 22 14r 23 6r
     23 5r 22 16r 23 5r
     23 4r 22 18r 23 4r
     23 3r 22 20r 23 3r
     23 2r 22 22r 23 2r
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     23 2r 22 22r 23 2r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 11r 23 22 11r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 2r 22 22r 23 2r
     23 2r 22 22r 23 2r
     23 3r 22 20r 23 3r
     23 4r 22 18r 23 4r
     23 5r 22 16r 23 5r
     23 6r 22 14r 23 6r
     23 8r 22 10r 23 8r
     23 12r 22 23 22 23 12r
     23 28r
c
     23 57r
     23 8r 22 10r 23 8r
     23 6r 22 14r 23 6r
     23 5r 22 16r 23 5r
     23 4r 22 18r 23 4r
     23 3r 22 20r 23 3r
     23 2r 22 22r 23 2r
     23 2r 22 22r 23 2r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 22 26r 23
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 2r 22 22r 23 2r
     23 2r 22 22r 23 2r
     23 3r 22 20r 23 3r
     23 4r 22 18r 23 4r
     23 5r 22 16r 23 5r
     23 6r 22 14r 23 6r
     23 8r 22 10r 23 8r
     23 57r
c
     23 57r
     23 9r 22 8r 23 9r
     23 7r 22 12r 23 7r
     23 5r 22 16r 23 5r
     23 4r 22 18r 23 4r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
     23 2r 22 22r 23 2r
     23 2r 22 22r 23 2r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
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     23 1r 22 24r 23 1r
     23 2r 22 22r 23 2r
     23 2r 22 22r 23 2r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
     23 4r 22 18r 23 4r
     23 5r 22 16r 23 5r
     23 7r 22 12r 23 7r
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     23 9r 22 8r 23 9r
     23 57r
c
     23 57r
     23 9r 22 8r 23 9r
     23 7r 22 12r 23 7r
     23 6r 22 14r 23 6r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 3r 22 20r 23 3r
     23 2r 22 22r 23 2r
     23 2r 22 22r 23 2r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
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     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 2r 22 22r 23 2r
     23 2r 22 22r 23 2r
     23 3r 22 20r 23 3r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 6r 22 14r 23 6r
     23 7r 22 12r 23 7r
     23 9r 22 8r 23 9r
     23 57r
c
     23 57r
     23 10r 22 6r 23 10r
     23 8r 22 10r 23 8r
     23 6r 22 14r 23 6r
     23 5r 22 16r 23 5r
     23 4r 22 18r 23 4r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
     23 2r 22 22r 23 2r
     23 2r 22 22r 23 2r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
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     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 2r 22 22r 23 2r
     23 2r 22 22r 23 2r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
     23 4r 22 18r 23 4r
     23 5r 22 16r 23 5r
     23 6r 22 14r 23 6r
     23 8r 22 10r 23 8r
     23 10r 22 6r 23 10r
     23 57r
c
     23 57r
     23 12r 22 2r 23 12r
     23 8r 22 10r 23 8r
     23 7r 22 12r 23 7r
     23 5r 22 16r 23 5r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 3r 22 20r 23 3r
     23 2r 22 22r 23 2r
     23 2r 22 22r 23 2r
     23 2r 22 22r 23 2r
     23 2r 22 22r 23 2r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 1r 22 24r 23 1r
     23 2r 22 22r 23 2r
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     23 2r 22 22r 23 2r
     23 2r 22 22r 23 2r
     23 2r 22 22r 23 2r
     23 3r 22 20r 23 3r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 5r 22 16r 23 5r
     23 7r 22 12r 23 7r
     23 8r 22 10r 23 8r
     23 12r 22 2r 23 12r
     23 57r
c
     23 86r
     23 10r 22 6r 23 10r
     23 8r 22 10r 23 8r
     23 6r 22 14r 23 6r
     23 5r 22 16r 23 5r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
     23 2r 22 22r 23 2r
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     23 2r 22 22r 23 2r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 5r 22 16r 23 5r
     23 6r 22 14r 23 6r
     23 8r 22 10r 23 8r
     23 10r 22 6r 23 10r
     23 86r
c
     23 86r
     23 12r 22 2r 23 12r
     23 9r 22 8r 23 9r
     23 7r 22 12r 23 7r
     23 6r 22 14r 23 6r
     23 5r 22 16r 23 5r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
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     23 2r 22 22r 23 2r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 5r 22 16r 23 5r
     23 6r 22 14r 23 6r
     23 7r 22 12r 23 7r
     23 9r 22 8r 23 9r
     23 12r 22 2r 23 12r
     23 86r
c
     23 115r
     23 11r 22 4r 23 11r
     23 8r 22 10r 23 8r
     23 7r 22 12r 23 7r
     23 6r 22 14r 23 6r
     23 5r 22 16r 23 5r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
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     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
     23 3r 22 20r 23 3r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 5r 22 16r 23 5r
     23 6r 22 14r 23 6r
     23 7r 22 12r 23 7r
     23 8r 22 10r 23 8r
     23 11r 22 4r 23 11r
     23 115r
c
     23 144r
     23 10r 22 6r 23 10r
     23 8r 22 10r 23 8r
     23 7r 22 12r 23 7r
     23 6r 22 14r 23 6r
     23 5r 22 16r 23 5r
     23 5r 22 16r 23 5r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 4r 22 18r 23 4r
     23 5r 22 16r 23 5r
     23 5r 22 16r 23 5r
     23 6r 22 14r 23 6r
     23 7r 22 12r 23 7r
     23 8r 22 10r 23 8r
     23 10r 22 6r 23 10r
     23 144r
c
     23 173r
     23 11r 22 4r 23 11r
     23 9r 22 8r 23 9r
     23 8r 22 10r 23 8r
     23 7r 22 12r 23 7r
     23 6r 22 14r 23 6r
     23 6r 22 14r 23 6r
     23 5r 22 16r 23 5r
     23 5r 22 16r 23 5r
     23 5r 22 16r 23 5r
     23 5r 22 16r 23 5r
     23 5r 22 16r 23 5r
     23 6r 22 14r 23 6r
     23 6r 22 14r 23 6r
     23 7r 22 12r 23 7r
     23 8r 22 10r 23 8r
     23 9r 22 8r 23 9r
     23 11r 22 4r 23 11r
     23 173r
c
     23 202r
     23 12r 22 2r 23 12r
     23 10r 22 6r 23 10r
     23 8r 22 10r 23 8r
     23 8r 22 10r 23 8r
     23 7r 22 12r 23 7r
     23 7r 22 12r 23 7r
     23 6r 22 14r 23 6r
     23 6r 22 14r 23 6r
     23 6r 22 14r 23 6r
     23 7r 22 12r 23 7r
     23 7r 22 12r 23 7r
     23 8r 22 10r 23 8r
     23 8r 22 10r 23 8r
     23 10r 22 6r 23 10r
     23 12r 22 2r 23 12r
     23 202r
c
     23 260r
     23 12r 22 2r 23 12r
```

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     23 10r 22 6r 23 10r
     23 9r 22 8r 23 9r
     23 9r 22 8r 23 9r
     23 8r 22 10r 23 8r
     23 8r 22 10r 23 8r
     23 8r 22 10r 23 8r
     23 9r 22 8r 23 9r
     23 9r 22 8r 23 9r
     23 10r 22 6r 23 10r
     23 12r 22 2r 23 12r
     23 260r
c
     23 405r
     23 12r 22 2r 23 12r
     23 405r
c
     23 840r
c
c ------ Fuel Pebbles ------
3131 24 8.6859E-02  -3131       imp:n=1 u=24 fill=98 $ Fuel Zone
3132 24 8.6859E-02   3131 -3132 imp:n=1 u=24         $ Pebble Shell (Unfueled Zone)
3133 10 4.8492E-05   3132       imp:n=1 u=24         $ Air
c
c ------ Moderator Pebbles ------
4131 26 8.4461E-02  -3132       imp:n=1 u=25  $ Moderator Pebble
4132 10 4.8492E-05   3132       imp:n=1 u=25  $ Air
c
c ------ Air ------
5001 10 4.8492E-05  -9999 imp:n=1 u=26  $ Air
c
c ------ Pebble Stacks ---------------------------------------------------------
c --------- Standard Stacks ---------
c ------------ Stack 0 (Cores 5 & 8) ------------
6001 10 4.8492E-05  -6001 imp:n=1 u=27 lat=2 fill=-1:1 -1:1 0:44
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
```

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     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
c
c ------------ Stack 1 (Cores 5 & 8) ------------
6002 10 4.8492E-05  -6001 imp:n=1 u=28 lat=2 fill=-1:1 -1:1 0:44
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
c
c ------------ Stack 2 (Cores 5 & 8) ------------
6003 10 4.8492E-05  -6001 imp:n=1 u=29 lat=2 fill=-1:1 -1:1 0:44
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
```

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c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
c
c ------------ Stack 0* (Cores 5 & 8) ------------
6004 10 4.8492E-05  -6001 imp:n=1 u=30 lat=2 fill=-1:1 -1:1 0:44
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
```

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     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
c
c ------------ Stack 2* (Cores 5 & 8) ------------
6005 10 4.8492E-05  -6001 imp:n=1 u=32 lat=2 fill=-1:1 -1:1 0:44
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
```

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     26 26 26  26 26 26  26 26 26
c
c
c ------------ Stack 0 (Core 6) ------------
c 6001 10 4.8492E-05  -6001 imp:n=1 u=27 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c c ------------ Stack 1 (Core 6) ------------
c 6002 10 4.8492E-05  -6001 imp:n=1 u=28 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
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c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c c ------------ Stack 2 (Core 6) ------------
c 6003 10 4.8492E-05  -6001 imp:n=1 u=29 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
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c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c c ------------ Stack 1* (Core 6) ------------
c 6004 10 4.8492E-05  -6001 imp:n=1 u=31 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c c ------------ Stack 2* (Core 6) ------------
c 6005 10 4.8492E-05  -6001 imp:n=1 u=32 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
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c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c
c
c ------------ Stack 0 (Core 7) ------------
c 6001 10 4.8492E-05  -6001 imp:n=1 u=27 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
```

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c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c c ------------ Stack 1 (Core 7) ------------
c 6002 10 4.8492E-05  -6001 imp:n=1 u=28 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
```

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c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c c ------------ Stack 2 (Core 7) ------------
c 6003 10 4.8492E-05  -6001 imp:n=1 u=29 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c c ------------ Stack 0* (Core 7) ------------
c 6004 10 4.8492E-05  -6001 imp:n=1 u=30 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
```

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c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c c ------------ Stack 1* (Core 7) ------------
c 6005 10 4.8492E-05  -6001 imp:n=1 u=31 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
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c      26 26 26  26 26 26  26 26 26
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c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
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c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c
c ------ Stacks with Polyethylene Rods (Full Set) ------
c    *Polyethylene Rods Not Used in Configuration 5
c
c ------------ Stack 0 - NW, N, NE, SE, S, SW (Core 6) ------------
c 5100 35 8.4678E-02  -7221 -6003 -7227 imp:n=1 u=34  $ NW Cu Wire
c 5101 10 4.8492E-05   7221 -7121 -6003 -7127 imp:n=1 u=34  $ NW Hole
c 5102 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7127 imp:n=1 u=34  $ NW Rod
c 5103 35 8.4678E-02  -7222 -6003 -7227 imp:n=1 u=34  $ N Cu Wire
c 5104 10 4.8492E-05   7222 -7122 -6003 -7127 imp:n=1 u=34  $ N Hole
c 5105 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7127 imp:n=1 u=34  $ N Rod
c 5106 35 8.4678E-02  -7223 -6003 -7227 imp:n=1 u=34  $ NE Cu Wire
c 5107 10 4.8492E-05   7223 -7123 -6003 -7127 imp:n=1 u=34  $ NE Hole
c 5108 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7127 imp:n=1 u=34  $ NE Rod
c 5109 35 8.4678E-02  -7224 -6003 -7227 imp:n=1 u=34  $ SE Cu Wire
c 5110 10 4.8492E-05   7224 -7124 -6003 -7127 imp:n=1 u=34  $ SE Hole
c 5111 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7127 imp:n=1 u=34  $ SE Rod
c 5112 35 8.4678E-02  -7225 -6003 -7227 imp:n=1 u=34  $ S Cu Wire
c 5113 10 4.8492E-05   7225 -7125 -6003 -7127 imp:n=1 u=34  $ S Hole
c 5114 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7127 imp:n=1 u=34  $ S Rod
c 5115 35 8.4678E-02  -7226 -6003 -7227 imp:n=1 u=34  $ SW Cu Wire
c 5116 10 4.8492E-05   7226 -7126 -6003 -7127 imp:n=1 u=34  $ SW Hole
c 5117 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7127 imp:n=1 u=34  $ SW Rod
c 5118 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c           (7135:7136:-7137:7127) (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c           (7144:7145:-7146:7127) (7221:7227) (7222:7227) (7223:7227)
c           (7224:7227) (7225:7227) (7226:7227) imp:n=1 u=34 fill=27
c c
c c ------------ Stack 1 - NW, N, NE, SE, S, SW (Core 6) ------------
c 5119 35 8.4678E-02  -7221 -6003 -7227 imp:n=1 u=35  $ NW Cu Wire
c 5120 10 4.8492E-05   7221 -7121 -6003 -7127 imp:n=1 u=35  $ NW Hole
c 5121 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7127 imp:n=1 u=35  $ NW Rod
c 5122 35 8.4678E-02  -7222 -6003 -7227 imp:n=1 u=35  $ N Cu Wire
c 5123 10 4.8492E-05   7222 -7122 -6003 -7127 imp:n=1 u=35  $ N Hole
c 5124 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7127 imp:n=1 u=35  $ N Rod
c 5125 35 8.4678E-02  -7223 -6003 -7227 imp:n=1 u=35  $ NE Cu Wire
c 5126 10 4.8492E-05   7223 -7123 -6003 -7127 imp:n=1 u=35  $ NE Hole
c 5127 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7127 imp:n=1 u=35  $ NE Rod
c 5128 35 8.4678E-02  -7224 -6003 -7227 imp:n=1 u=35  $ SE Cu Wire
c 5129 10 4.8492E-05   7224 -7124 -6003 -7127 imp:n=1 u=35  $ SE Hole
c 5130 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7127 imp:n=1 u=35  $ SE Rod
c 5131 35 8.4678E-02  -7225 -6003 -7227 imp:n=1 u=35  $ S Cu Wire
c 5132 10 4.8492E-05   7225 -7125 -6003 -7127 imp:n=1 u=35  $ S Hole
c 5133 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7127 imp:n=1 u=35  $ S Rod
c 5134 35 8.4678E-02  -7226 -6003 -7227 imp:n=1 u=35  $ SW Cu Wire
c 5135 10 4.8492E-05   7226 -7126 -6003 -7127 imp:n=1 u=35  $ SW Hole
c 5136 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7127 imp:n=1 u=35  $ SW Rod
c 5137 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c           (7135:7136:-7137:7127) (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c           (7144:7145:-7146:7127) (7221:7227) (7222:7227) (7223:7227)
c           (7224:7227) (7225:7227) (7226:7227) imp:n=1 u=35 fill=28
c c
c c ------------ Stack 2 - NW, N, NE, SE, S, SW (Core 6) ------------
c 5138 35 8.4678E-02  -7221 -6003 -7227 imp:n=1 u=36  $ NW Cu Wire
c 5139 10 4.8492E-05   7221 -7121 -6003 -7127 imp:n=1 u=36  $ NW Hole
c 5140 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7127 imp:n=1 u=36  $ NW Rod
c 5141 35 8.4678E-02  -7222 -6003 -7227 imp:n=1 u=36  $ N Cu Wire
c 5142 10 4.8492E-05   7222 -7122 -6003 -7127 imp:n=1 u=36  $ N Hole
c 5143 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7127 imp:n=1 u=36  $ N Rod
c 5144 35 8.4678E-02  -7223 -6003 -7227 imp:n=1 u=36  $ NE Cu Wire
c 5145 10 4.8492E-05   7223 -7123 -6003 -7127 imp:n=1 u=36  $ NE Hole
c 5146 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7127 imp:n=1 u=36  $ NE Rod
c 5147 35 8.4678E-02  -7224 -6003 -7227 imp:n=1 u=36  $ SE Cu Wire
c 5148 10 4.8492E-05   7224 -7124 -6003 -7127 imp:n=1 u=36  $ SE Hole
c 5149 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7127 imp:n=1 u=36  $ SE Rod
c 5150 35 8.4678E-02  -7225 -6003 -7227 imp:n=1 u=36  $ S Cu Wire
c 5151 10 4.8492E-05   7225 -7125 -6003 -7127 imp:n=1 u=36  $ S Hole
```

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c 5152 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7127 imp:n=1 u=36  $ S Rod
c 5153 35 8.4678E-02  -7226 -6003 -7227 imp:n=1 u=36  $ SW Cu Wire
c 5154 10 4.8492E-05   7226 -7126 -6003 -7127 imp:n=1 u=36  $ SW Hole
c 5155 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7127 imp:n=1 u=36  $ SW Rod
c 5156 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c           (7135:7136:-7137:7127) (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c           (7144:7145:-7146:7127) (7221:7227) (7222:7227) (7223:7227)
c           (7224:7227) (7225:7227) (7226:7227) imp:n=1 u=36 fill=29
c c
c c ------------ Stack 1* - NW, N, NE, SE, S, SW (Core 6) ------------
c 5157 35 8.4678E-02  -7221 -6003 -7227 imp:n=1 u=38  $ NW Cu Wire
c 5158 10 4.8492E-05   7221 -7121 -6003 -7127 imp:n=1 u=38  $ NW Hole
c 5159 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7127 imp:n=1 u=38  $ NW Rod
c 5160 35 8.4678E-02  -7222 -6003 -7227 imp:n=1 u=38  $ N Cu Wire
c 5161 10 4.8492E-05   7222 -7122 -6003 -7127 imp:n=1 u=38  $ N Hole
c 5162 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7127 imp:n=1 u=38  $ N Rod
c 5163 35 8.4678E-02  -7223 -6003 -7227 imp:n=1 u=38  $ NE Cu Wire
c 5164 10 4.8492E-05   7223 -7123 -6003 -7127 imp:n=1 u=38  $ NE Hole
c 5165 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7127 imp:n=1 u=38  $ NE Rod
c 5166 35 8.4678E-02  -7224 -6003 -7227 imp:n=1 u=38  $ SE Cu Wire
c 5167 10 4.8492E-05   7224 -7124 -6003 -7127 imp:n=1 u=38  $ SE Hole
c 5168 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7127 imp:n=1 u=38  $ SE Rod
c 5169 35 8.4678E-02  -7225 -6003 -7227 imp:n=1 u=38  $ S Cu Wire
c 5170 10 4.8492E-05   7225 -7125 -6003 -7127 imp:n=1 u=38  $ S Hole
c 5171 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7127 imp:n=1 u=38  $ S Rod
c 5172 35 8.4678E-02  -7226 -6003 -7227 imp:n=1 u=38  $ SW Cu Wire
c 5173 10 4.8492E-05   7226 -7126 -6003 -7127 imp:n=1 u=38  $ SW Hole
c 5174 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7127 imp:n=1 u=38  $ SW Rod
c 5175 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c           (7135:7136:-7137:7127) (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c           (7144:7145:-7146:7127) (7221:7227) (7222:7227) (7223:7227)
c           (7224:7227) (7225:7227) (7226:7227) imp:n=1 u=38 fill=31
c c
c c ------------ Stack 2* - NW, N, NE, SE, S, SW (Core 6) ------------
c 5176 35 8.4678E-02  -7221 -6003 -7227 imp:n=1 u=39  $ NW Cu Wire
c 5177 10 4.8492E-05   7221 -7121 -6003 -7127 imp:n=1 u=39  $ NW Hole
c 5178 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7127 imp:n=1 u=39  $ NW Rod
c 5179 35 8.4678E-02  -7222 -6003 -7227 imp:n=1 u=39  $ N Cu Wire
c 5180 10 4.8492E-05   7222 -7122 -6003 -7127 imp:n=1 u=39  $ N Hole
c 5181 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7127 imp:n=1 u=39  $ N Rod
c 5182 35 8.4678E-02  -7223 -6003 -7227 imp:n=1 u=39  $ NE Cu Wire
c 5183 10 4.8492E-05   7223 -7123 -6003 -7127 imp:n=1 u=39  $ NE Hole
c 5184 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7127 imp:n=1 u=39  $ NE Rod
c 5185 35 8.4678E-02  -7224 -6003 -7227 imp:n=1 u=39  $ SE Cu Wire
c 5186 10 4.8492E-05   7224 -7124 -6003 -7127 imp:n=1 u=39  $ SE Hole
c 5187 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7127 imp:n=1 u=39  $ SE Rod
c 5188 35 8.4678E-02  -7225 -6003 -7227 imp:n=1 u=39  $ S Cu Wire
c 5189 10 4.8492E-05   7225 -7125 -6003 -7127 imp:n=1 u=39  $ S Hole
c 5190 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7127 imp:n=1 u=39  $ S Rod
c 5191 35 8.4678E-02  -7226 -6003 -7227 imp:n=1 u=39  $ SW Cu Wire
c 5192 10 4.8492E-05   7226 -7126 -6003 -7127 imp:n=1 u=39  $ SW Hole
c 5193 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7127 imp:n=1 u=39  $ SW Rod
c 5194 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c           (7135:7136:-7137:7127) (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c           (7144:7145:-7146:7127) (7221:7227) (7222:7227) (7223:7227)
c           (7224:7227) (7225:7227) (7226:7227) imp:n=1 u=39 fill=32
c
c
c ------------ Stack 0 - NW, N, NE, SE, S, SW (Core 7) ------------
c 5101 34 1.2204E-01  -7021 -6003 -7027 imp:n=1 u=34  $ NW Rod
c 5102 34 1.2204E-01  -7022 -6003 -7027 imp:n=1 u=34  $ N Rod
c 5103 34 1.2204E-01  -7023 -6003 -7027 imp:n=1 u=34  $ NE Rod
c 5104 34 1.2204E-01  -7024 -6003 -7027 imp:n=1 u=34  $ SE Rod
c 5105 34 1.2204E-01  -7025 -6003 -7027 imp:n=1 u=34  $ S Rod
c 5106 34 1.2204E-01  -7026 -6003 -7027 imp:n=1 u=34  $ SW Rod
c 5107 34 1.2204E-01  -6003 (7021:7027) (7022:7027) (7023:7027)
c           (7024:7027) (7025:7027) (7026:7027) imp:n=1 u=34 fill=27
c c
c c ------------ Stack 1 - NW, N, NE, SE, S, SW (Core 7) ------------
c 5108 34 1.2204E-01  -7021 -6003 -7027 imp:n=1 u=35  $ NW Rod
c 5109 34 1.2204E-01  -7022 -6003 -7027 imp:n=1 u=35  $ N Rod
c 5110 34 1.2204E-01  -7023 -6003 -7027 imp:n=1 u=35  $ NE Rod
c 5111 34 1.2204E-01  -7024 -6003 -7027 imp:n=1 u=35  $ SE Rod
c 5112 34 1.2204E-01  -7025 -6003 -7027 imp:n=1 u=35  $ S Rod
c 5113 34 1.2204E-01  -7026 -6003 -7027 imp:n=1 u=35  $ SW Rod
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c 5114 34 1.2204E-01  -6003 (7021:7027) (7022:7027) (7023:7027)
c           (7024:7027) (7025:7027) (7026:7027) imp:n=1 u=35 fill=28
c c
c c ------------ Stack 2 - NW, N, NE, SE, S, SW (Core 7) ------------
c 5115 34 1.2204E-01  -7021 -6003 -7027 imp:n=1 u=36  $ NW Rod
c 5116 34 1.2204E-01  -7022 -6003 -7027 imp:n=1 u=36  $ N Rod
c 5117 34 1.2204E-01  -7023 -6003 -7027 imp:n=1 u=36  $ NE Rod
c 5118 34 1.2204E-01  -7024 -6003 -7027 imp:n=1 u=36  $ SE Rod
c 5119 34 1.2204E-01  -7025 -6003 -7027 imp:n=1 u=36  $ S Rod
c 5120 34 1.2204E-01  -7026 -6003 -7027 imp:n=1 u=36  $ SW Rod
c 5121 34 1.2204E-01  -6003 (7021:7027) (7022:7027) (7023:7027)
c           (7024:7027) (7025:7027) (7026:7027) imp:n=1 u=36 fill=29
c c
c c ------------ Stack 0* - NW, N, NE, SE, S, SW (Core 7) ------------
c 5122 34 1.2204E-01  -7021 -6003 -7027 imp:n=1 u=37  $ NW Rod
c 5123 34 1.2204E-01  -7022 -6003 -7027 imp:n=1 u=37  $ N Rod
c 5124 34 1.2204E-01  -7023 -6003 -7027 imp:n=1 u=37  $ NE Rod
c 5125 34 1.2204E-01  -7024 -6003 -7027 imp:n=1 u=37  $ SE Rod
c 5126 34 1.2204E-01  -7025 -6003 -7027 imp:n=1 u=37  $ S Rod
c 5127 34 1.2204E-01  -7026 -6003 -7027 imp:n=1 u=37  $ SW Rod
c 5128 34 1.2204E-01  -6003 (7021:7027) (7022:7027) (7023:7027)
c           (7024:7027) (7025:7027) (7026:7027) imp:n=1 u=37 fill=30
c c
c c ------------ Stack 1* - NW, N, NE, SE, S, SW (Core 7) ------------
c 5129 34 1.2204E-01  -7021 -6003 -7027 imp:n=1 u=38  $ NW Rod
c 5130 34 1.2204E-01  -7022 -6003 -7027 imp:n=1 u=38  $ N Rod
c 5131 34 1.2204E-01  -7023 -6003 -7027 imp:n=1 u=38  $ NE Rod
c 5132 34 1.2204E-01  -7024 -6003 -7027 imp:n=1 u=38  $ SE Rod
c 5133 34 1.2204E-01  -7025 -6003 -7027 imp:n=1 u=38  $ S Rod
c 5134 34 1.2204E-01  -7026 -6003 -7027 imp:n=1 u=38  $ SW Rod
c 5135 34 1.2204E-01  -6003 (7021:7027) (7022:7027) (7023:7027)
c           (7024:7027) (7025:7027) (7026:7027) imp:n=1 u=38 fill=31
c
c
c ------------ Stack 0 - NW, N, NE, SE, S, SW (Core 8) ------------
c 5101 10 4.8492E-05  -7121 -6003 -7128 imp:n=1 u=34  $ NW Hole
c 5102 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7128 imp:n=1 u=34  $ NW Rod
c 5104 10 4.8492E-05  -7122 -6003 -7128 imp:n=1 u=34  $ N Hole
c 5105 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7128 imp:n=1 u=34  $ N Rod
c 5107 10 4.8492E-05  -7123 -6003 -7128 imp:n=1 u=34  $ NE Hole
c 5108 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7128 imp:n=1 u=34  $ NE Rod
c 5110 10 4.8492E-05  -7124 -6003 -7128 imp:n=1 u=34  $ SE Hole
c 5111 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7128 imp:n=1 u=34  $ SE Rod
c 5113 10 4.8492E-05  -7125 -6003 -7128 imp:n=1 u=34  $ S Hole
c 5114 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7128 imp:n=1 u=34  $ S Rod
c 5116 10 4.8492E-05  -7126 -6003 -7128 imp:n=1 u=34  $ SW Hole
c 5117 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7128 imp:n=1 u=34  $ SW Rod
c 5118 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c           (7135:7136:-7137:7128) (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c           (7144:7145:-7146:7128) imp:n=1 u=34 fill=27
c c
c c ------------ Stack 1 - NW, N, NE, SE, S, SW (Core 8) ------------
c 5120 10 4.8492E-05  -7121 -6003 -7128 imp:n=1 u=35  $ NW Hole
c 5121 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7128 imp:n=1 u=35  $ NW Rod
c 5123 10 4.8492E-05  -7122 -6003 -7128 imp:n=1 u=35  $ N Hole
c 5124 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7128 imp:n=1 u=35  $ N Rod
c 5126 10 4.8492E-05  -7123 -6003 -7128 imp:n=1 u=35  $ NE Hole
c 5127 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7128 imp:n=1 u=35  $ NE Rod
c 5129 10 4.8492E-05  -7124 -6003 -7128 imp:n=1 u=35  $ SE Hole
c 5130 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7128 imp:n=1 u=35  $ SE Rod
c 5132 10 4.8492E-05  -7125 -6003 -7128 imp:n=1 u=35  $ S Hole
c 5133 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7128 imp:n=1 u=35  $ S Rod
c 5135 10 4.8492E-05  -7126 -6003 -7128 imp:n=1 u=35  $ SW Hole
c 5136 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7128 imp:n=1 u=35  $ SW Rod
c 5137 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c           (7135:7136:-7137:7128) (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c           (7144:7145:-7146:7128) imp:n=1 u=35 fill=28
c c
c c ------------ Stack 2 - NW, N, NE, SE, S, SW (Core 8) ------------
c 5139 10 4.8492E-05  -7121 -6003 -7128 imp:n=1 u=36  $ NW Hole
c 5140 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7128 imp:n=1 u=36  $ NW Rod
c 5142 10 4.8492E-05  -7122 -6003 -7128 imp:n=1 u=36  $ N Hole
c 5143 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7128 imp:n=1 u=36  $ N Rod
c 5145 10 4.8492E-05  -7123 -6003 -7128 imp:n=1 u=36  $ NE Hole
c 5146 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7128 imp:n=1 u=36  $ NE Rod
```

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c 5148 10 4.8492E-05  -7124 -6003 -7128 imp:n=1 u=36  $ SE Hole
c 5149 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7128 imp:n=1 u=36  $ SE Rod
c 5151 10 4.8492E-05  -7125 -6003 -7128 imp:n=1 u=36  $ S Hole
c 5152 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7128 imp:n=1 u=36  $ S Rod
c 5154 10 4.8492E-05  -7126 -6003 -7128 imp:n=1 u=36  $ SW Hole
c 5155 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7128 imp:n=1 u=36  $ SW Rod
c 5156 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c           (7135:7136:-7137:7128) (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c           (7144:7145:-7146:7128) imp:n=1 u=36 fill=29
c c
c c ------------ Stack 0* - NW, N, NE, SE, S, SW (Core 8) ------------
c 5158 10 4.8492E-05  -7121 -6003 -7128 imp:n=1 u=37  $ NW Hole
c 5159 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7128 imp:n=1 u=37  $ NW Rod
c 5161 10 4.8492E-05  -7122 -6003 -7128 imp:n=1 u=37  $ N Hole
c 5162 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7128 imp:n=1 u=37  $ N Rod
c 5164 10 4.8492E-05  -7123 -6003 -7128 imp:n=1 u=37  $ NE Hole
c 5165 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7128 imp:n=1 u=37  $ NE Rod
c 5167 10 4.8492E-05  -7124 -6003 -7128 imp:n=1 u=37  $ SE Hole
c 5168 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7128 imp:n=1 u=37  $ SE Rod
c 5170 10 4.8492E-05  -7125 -6003 -7128 imp:n=1 u=37  $ S Hole
c 5171 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7128 imp:n=1 u=37  $ S Rod
c 5173 10 4.8492E-05  -7126 -6003 -7128 imp:n=1 u=37  $ SW Hole
c 5174 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7128 imp:n=1 u=37  $ SW Rod
c 5175 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c           (7135:7136:-7137:7128) (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c           (7144:7145:-7146:7128) imp:n=1 u=37 fill=30
c c
c c ------------ Stack 2* - NW, N, NE, SE, S, SW (Core 8) ------------
c 5177 10 4.8492E-05  -7121 -6003 -7128 imp:n=1 u=39  $ NW Hole
c 5178 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7128 imp:n=1 u=39  $ NW Rod
c 5180 10 4.8492E-05  -7122 -6003 -7128 imp:n=1 u=39  $ N Hole
c 5181 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7128 imp:n=1 u=39  $ N Rod
c 5183 10 4.8492E-05  -7123 -6003 -7128 imp:n=1 u=39  $ NE Hole
c 5184 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7128 imp:n=1 u=39  $ NE Rod
c 5186 10 4.8492E-05  -7124 -6003 -7128 imp:n=1 u=39  $ SE Hole
c 5187 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7128 imp:n=1 u=39  $ SE Rod
c 5189 10 4.8492E-05  -7125 -6003 -7128 imp:n=1 u=39  $ S Hole
c 5190 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7128 imp:n=1 u=39  $ S Rod
c 5192 10 4.8492E-05  -7126 -6003 -7128 imp:n=1 u=39  $ SW Hole
c 5193 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7128 imp:n=1 u=39  $ SW Rod
c 5194 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c           (7135:7136:-7137:7128) (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c           (7144:7145:-7146:7128) imp:n=1 u=39 fill=32
c
c
c ------ Stacks with Polyethylene Rods (Partial Sets) ------
c c ------------ Stack 2* - NE, SE (Core 6) ------------
c 5200 like 5106 but u=40  $ NE Cu Wire
c 5201 like 5107 but u=40  $ NE Hole
c 5202 like 5108 but u=40  $ NE Rod
c 5203 like 5109 but u=40  $ SE Cu Wire
c 5204 like 5110 but u=40  $ SE Hole
c 5205 like 5111 but u=40  $ SE Rod
c 5206 10 4.8492E-05  -6003 (7135:7136:-7137:7127) (7138:7139:-7140:7127)
c           (7223:7227) (7224:7227) imp:n=1 u=40 fill=32
c c
c c ------------ Stack 1* - N, NE, SE, S (Core 6) ------------
c 5207 like 5103 but u=41  $ N Cu Wire
c 5208 like 5104 but u=41  $ N Hole
c 5209 like 5105 but u=41  $ N Rod
c 5210 like 5106 but u=41  $ NE Cu Wire
c 5211 like 5107 but u=41  $ NE Hole
c 5212 like 5108 but u=41  $ NE Rod
c 5213 like 5109 but u=41  $ SE Cu Wire
c 5214 like 5110 but u=41  $ SE Hole
c 5215 like 5111 but u=41  $ SE Rod
c 5216 like 5112 but u=41  $ S Cu Wire
c 5217 like 5113 but u=41  $ S Hole
c 5218 like 5114 but u=41  $ S Rod
c 5219 10 4.8492E-05  -6003 (7132:-7133:7134:7127) (7135:7136:-7137:7127)
c           (7138:7139:-7140:7127) (7141:-7142:7143:7127) (7222:7227)
c           (7223:7227) (7224:7227) (7225:7227) imp:n=1 u=41 fill=31
c c
c c ------------ Stack 1* - NE, SE, S (Core 6) ------------
c 5220 like 5106 but u=42  $ NE Cu Wire
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c 5221 like 5107 but u=42  $ NE Hole
c 5222 like 5108 but u=42  $ NE Rod
c 5223 like 5109 but u=42  $ SE Cu Wire
c 5224 like 5110 but u=42  $ SE Hole
c 5225 like 5111 but u=42  $ SE Rod
c 5226 like 5112 but u=42  $ S Cu Wire
c 5227 like 5113 but u=42  $ S Hole
c 5228 like 5114 but u=42  $ S Rod
c 5229 10 4.8492E-05  -6003 (7135:7136:-7137:7127) (7138:7139:-7140:7127)
c           (7141:-7142:7143:7127) (7223:7227) (7224:7227)
c           (7225:7227) imp:n=1 u=42 fill=31
c c
c c ------------ Stack 0 - NE, SE, S (Core 6) ------------
c 5230 like 5106 but u=43  $ NE Cu Wire
c 5231 like 5107 but u=43  $ NE Hole
c 5232 like 5108 but u=43  $ NE Rod
c 5233 like 5109 but u=43  $ SE Cu Wire
c 5234 like 5110 but u=43  $ SE Hole
c 5235 like 5111 but u=43  $ SE Rod
c 5236 like 5112 but u=43  $ S Cu Wire
c 5237 like 5113 but u=43  $ S Hole
c 5238 like 5114 but u=43  $ S Rod
c 5239 10 4.8492E-05  -6003 (7135:7136:-7137:7127) (7138:7139:-7140:7127)
c           (7141:-7142:7143:7127) (7223:7227) (7224:7227)
c           (7225:7227) imp:n=1 u=43 fill=27
c c
c c ------------ Stack 2* - NE, SE, S (Core 6) ------------
c 5240 like 5106 but u=44  $ NE Cu Wire
c 5241 like 5107 but u=44  $ NE Hole
c 5242 like 5108 but u=44  $ NE Rod
c 5243 like 5109 but u=44  $ SE Cu Wire
c 5244 like 5110 but u=44  $ SE Hole
c 5245 like 5111 but u=44  $ SE Rod
c 5246 like 5112 but u=44  $ S Cu Wire
c 5247 like 5113 but u=44  $ S Hole
c 5248 like 5114 but u=44  $ S Rod
c 5249 10 4.8492E-05  -6003 (7135:7136:-7137:7127) (7138:7139:-7140:7127)
c           (7141:-7142:7143:7127) (7223:7227) (7224:7227)
c           (7225:7227) imp:n=1 u=44 fill=32
c c
c c ------------ Stack 0 - SE, S (Core 6) ------------
c 5250 like 5109 but u=45  $ SE Cu Wire
c 5251 like 5110 but u=45  $ SE Hole
c 5252 like 5111 but u=45  $ SE Rod
c 5253 like 5112 but u=45  $ S Cu Wire
c 5254 like 5113 but u=45  $ S Hole
c 5255 like 5114 but u=45  $ S Rod
c 5256 10 4.8492E-05  -6003 (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c           (7224:7227) (7225:7227) imp:n=1 u=45 fill=27
c c
c c ------------ Stack 1* - NE, SE, S, SW (Core 6) ------------
c 5257 like 5106 but u=46  $ NE Cu Wire
c 5258 like 5107 but u=46  $ NE Hole
c 5259 like 5108 but u=46  $ NE Rod
c 5260 like 5109 but u=46  $ SE Cu Wire
c 5261 like 5110 but u=46  $ SE Hole
c 5262 like 5111 but u=46  $ SE Rod
c 5263 like 5112 but u=46  $ S Cu Wire
c 5264 like 5113 but u=46  $ S Hole
c 5265 like 5114 but u=46  $ S Rod
c 5266 like 5115 but u=46  $ SW Cu Wire
c 5267 like 5116 but u=46  $ SW Hole
c 5268 like 5117 but u=46  $ SW Rod
c 5269 10 4.8492E-05  -6003 (7135:7136:-7137:7127) (7138:7139:-7140:7127)
c           (7141:-7142:7143:7127) (7144:7145:-7146:7127) (7223:7227)
c           (7224:7227) (7225:7227) (7226:7227) imp:n=1 u=46 fill=31
c c
c c ------------ Stack 1* - SE, S, SW (Core 6) ------------
c 5270 like 5109 but u=47  $ SE Cu Wire
c 5271 like 5110 but u=47  $ SE Hole
c 5272 like 5111 but u=47  $ SE Rod
c 5273 like 5112 but u=47  $ S Cu Wire
c 5274 like 5113 but u=47  $ S Hole
c 5275 like 5114 but u=47  $ S Rod
c 5276 like 5115 but u=47  $ SW Cu Wire
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c 5277 like 5116 but u=47  $ SW Hole
c 5278 like 5117 but u=47  $ SW Rod
c 5279 10 4.8492E-05  -6003 (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c            (7144:7145:-7146:7127) (7224:7227) (7225:7227)
c            (7226:7227) imp:n=1 u=47 fill=31
c c
c c ------------ Stack 2* - SE, S, SW (Core 6) ------------
c 5280 like 5109 but u=48  $ SE Cu Wire
c 5281 like 5110 but u=48  $ SE Hole
c 5282 like 5111 but u=48  $ SE Rod
c 5283 like 5112 but u=48  $ S Cu Wire
c 5284 like 5113 but u=48  $ S Hole
c 5285 like 5114 but u=48  $ S Rod
c 5286 like 5115 but u=48  $ SW Cu Wire
c 5287 like 5116 but u=48  $ SW Hole
c 5288 like 5117 but u=48  $ SW Rod
c 5289 10 4.8492E-05  -6003 (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c            (7144:7145:-7146:7127) (7224:7227) (7225:7227)
c            (7226:7227) imp:n=1 u=48 fill=32
c c
c c ------------ Stack 0 - SE, S, SW (Core 6) ------------
c 5290 like 5109 but u=49  $ SE Cu Wire
c 5291 like 5110 but u=49  $ SE Hole
c 5292 like 5111 but u=49  $ SE Rod
c 5293 like 5112 but u=49  $ S Cu Wire
c 5294 like 5113 but u=49  $ S Hole
c 5295 like 5114 but u=49  $ S Rod
c 5296 like 5115 but u=49  $ SW Cu Wire
c 5297 like 5116 but u=49  $ SW Hole
c 5298 like 5117 but u=49  $ SW Rod
c 5299 10 4.8492E-05  -6003 (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c            (7144:7145:-7146:7127) (7224:7227) (7225:7227)
c            (7226:7227) imp:n=1 u=49 fill=27
c c
c c ------------ Stack 2* - S, SW (Core 6) ------------
c 5300 like 5112 but u=50  $ S Cu Wire
c 5301 like 5113 but u=50  $ S Hole
c 5302 like 5114 but u=50  $ S Rod
c 5303 like 5115 but u=50  $ SW Cu Wire
c 5304 like 5116 but u=50  $ SW Hole
c 5305 like 5117 but u=50  $ SW Rod
c 5306 10 4.8492E-05  -6003 (7141:-7142:7143:7127) (7144:7145:-7146:7127)
c            (7225:7227) (7226:7227) imp:n=1 u=50 fill=32
c c
c c ------------ Stack 1* - NW, SE, S, SW (Core 6) ------------
c 5307 like 5100 but u=51  $ NW Cu Wire
c 5308 like 5101 but u=51  $ NW Hole
c 5309 like 5102 but u=51  $ NW Rod
c 5310 like 5109 but u=51  $ SE Cu Wire
c 5311 like 5110 but u=51  $ SE Hole
c 5312 like 5111 but u=51  $ SE Rod
c 5313 like 5112 but u=51  $ S Cu Wire
c 5314 like 5113 but u=51  $ S Hole
c 5315 like 5114 but u=51  $ S Rod
c 5316 like 5115 but u=51  $ SW Cu Wire
c 5317 like 5116 but u=51  $ SW Hole
c 5318 like 5117 but u=51  $ SW Rod
c 5319 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7138:7139:-7140:7127)
c            (7141:-7142:7143:7127) (7144:7145:-7146:7127) (7221:7227)
c            (7224:7227) (7225:7227) (7226:7227) imp:n=1 u=51 fill=31
c c
c c ------------ Stack 1* - NW, S, SW (Core 6) ------------
c 5320 like 5100 but u=52  $ NW Cu Wire
c 5321 like 5101 but u=52  $ NW Hole
c 5322 like 5102 but u=52  $ NW Rod
c 5323 like 5112 but u=52  $ S Cu Wire
c 5324 like 5113 but u=52  $ S Hole
c 5325 like 5114 but u=52  $ S Rod
c 5326 like 5115 but u=52  $ SW Cu Wire
c 5327 like 5116 but u=52  $ SW Hole
c 5328 like 5117 but u=52  $ SW Rod
c 5329 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7141:-7142:7143:7127)
c            (7144:7145:-7146:7127) (7221:7227) (7225:7227)
c            (7226:7227) imp:n=1 u=52 fill=31
c c
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c c ------------ Stack 0 - NW, S, SW (Core 6) ------------
c 5330 like 5100 but u=53  $ NW Cu Wire
c 5331 like 5101 but u=53  $ NW Hole
c 5332 like 5102 but u=53  $ NW Rod
c 5333 like 5112 but u=53  $ S Cu Wire
c 5334 like 5113 but u=53  $ S Hole
c 5335 like 5114 but u=53  $ S Rod
c 5336 like 5115 but u=53  $ SW Cu Wire
c 5337 like 5116 but u=53  $ SW Hole
c 5338 like 5117 but u=53  $ SW Rod
c 5339 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7141:-7142:7143:7127)
c            (7144:7145:-7146:7127) (7221:7227) (7225:7227)
c            (7226:7227) imp:n=1 u=53 fill=27
c c
c c ------------ Stack 2* - NW, S, SW (Core 6) ------------
c 5340 like 5100 but u=54  $ NW Cu Wire
c 5341 like 5101 but u=54  $ NW Hole
c 5342 like 5102 but u=54  $ NW Rod
c 5343 like 5112 but u=54  $ S Cu Wire
c 5344 like 5113 but u=54  $ S Hole
c 5345 like 5114 but u=54  $ S Rod
c 5346 like 5115 but u=54  $ SW Cu Wire
c 5347 like 5116 but u=54  $ SW Hole
c 5348 like 5117 but u=54  $ SW Rod
c 5349 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7141:-7142:7143:7127)
c            (7144:7145:-7146:7127) (7221:7227) (7225:7227)
c            (7226:7227) imp:n=1 u=54 fill=32
c c
c c ------------ Stack 0 - NW, SW (Core 6) ------------
c 5350 like 5100 but u=55  $ NW Cu Wire
c 5351 like 5101 but u=55  $ NW Hole
c 5352 like 5102 but u=55  $ NW Rod
c 5356 like 5115 but u=55  $ SW Cu Wire
c 5357 like 5116 but u=55  $ SW Hole
c 5358 like 5117 but u=55  $ SW Rod
c 5359 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7144:7145:-7146:7127)
c            (7221:7227) (7226:7227) imp:n=1 u=55 fill=27
c c
c c ------------ Stack 1* - NW, N, S, SW (Core 6) ------------
c 5360 like 5100 but u=56  $ NW Cu Wire
c 5361 like 5101 but u=56  $ NW Hole
c 5362 like 5102 but u=56  $ NW Rod
c 5363 like 5103 but u=56  $ N Cu Wire
c 5364 like 5104 but u=56  $ N Hole
c 5365 like 5105 but u=56  $ N Rod
c 5366 like 5112 but u=56  $ S Cu Wire
c 5367 like 5113 but u=56  $ S Hole
c 5368 like 5114 but u=56  $ S Rod
c 5369 like 5115 but u=56  $ SW Cu Wire
c 5370 like 5116 but u=56  $ SW Hole
c 5371 like 5117 but u=56  $ SW Rod
c 5372 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7141:-7142:7143:7127) (7144:7145:-7146:7127) (7221:7227)
c            (7222:7227) (7225:7227) (7226:7227) imp:n=1 u=56 fill=31
c c
c c ------------ Stack 1* - NW, N, SW (Core 6) ------------
c 5373 like 5100 but u=57  $ NW Cu Wire
c 5374 like 5101 but u=57  $ NW Hole
c 5375 like 5102 but u=57  $ NW Rod
c 5376 like 5103 but u=57  $ N Cu Wire
c 5377 like 5104 but u=57  $ N Hole
c 5378 like 5105 but u=57  $ N Rod
c 5379 like 5115 but u=57  $ SW Cu Wire
c 5380 like 5116 but u=57  $ SW Hole
c 5381 like 5117 but u=57  $ SW Rod
c 5382 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7144:7145:-7146:7127) (7221:7227) (7222:7227)
c            (7226:7227) imp:n=1 u=57 fill=31
c c
c c ------------ Stack 2* - NW, N, SW (Core 6) ------------
c 5383 like 5100 but u=58  $ NW Cu Wire
c 5384 like 5101 but u=58  $ NW Hole
c 5385 like 5102 but u=58  $ NW Rod
c 5386 like 5103 but u=58  $ N Cu Wire
c 5387 like 5104 but u=58  $ N Hole
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c 5388 like 5105 but u=58  $ N Rod
c 5389 like 5115 but u=58  $ SW Cu Wire
c 5390 like 5116 but u=58  $ SW Hole
c 5391 like 5117 but u=58  $ SW Rod
c 5392 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7144:7145:-7146:7127) (7221:7227) (7222:7227)
c            (7226:7227) imp:n=1 u=58 fill=32
c c
c c ------------ Stack 0 - NW, N, SW (Core 6) ------------
c 5393 like 5100 but u=59  $ NW Cu Wire
c 5394 like 5101 but u=59  $ NW Hole
c 5395 like 5102 but u=59  $ NW Rod
c 5396 like 5103 but u=59  $ N Cu Wire
c 5397 like 5104 but u=59  $ N Hole
c 5398 like 5105 but u=59  $ N Rod
c 5399 like 5115 but u=59  $ SW Cu Wire
c 5400 like 5116 but u=59  $ SW Hole
c 5401 like 5117 but u=59  $ SW Rod
c 5402 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7144:7145:-7146:7127) (7221:7227) (7222:7227)
c            (7226:7227) imp:n=1 u=59 fill=27
c c
c c ------------ Stack 2* - NW, N (Core 6) ------------
c 5403 like 5100 but u=60  $ NW Cu Wire
c 5404 like 5101 but u=60  $ NW Hole
c 5405 like 5102 but u=60  $ NW Rod
c 5406 like 5103 but u=60  $ N Cu Wire
c 5407 like 5104 but u=60  $ N Hole
c 5408 like 5105 but u=60  $ N Rod
c 5409 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7221:7227) (7222:7227) imp:n=1 u=60 fill=32
c c
c c ------------ Stack 1* - NW, N, NE, SW (Core 6) ------------
c 5410 like 5100 but u=61  $ NW Cu Wire
c 5411 like 5101 but u=61  $ NW Hole
c 5412 like 5102 but u=61  $ NW Rod
c 5413 like 5103 but u=61  $ N Cu Wire
c 5414 like 5104 but u=61  $ N Hole
c 5415 like 5105 but u=61  $ N Rod
c 5416 like 5106 but u=61  $ NE Cu Wire
c 5417 like 5107 but u=61  $ NE Hole
c 5418 like 5108 but u=61  $ NE Rod
c 5419 like 5115 but u=61  $ SW Cu Wire
c 5420 like 5116 but u=61  $ SW Hole
c 5421 like 5117 but u=61  $ SW Rod
c 5422 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7135:7136:-7137:7127) (7144:7145:-7146:7127) (7221:7227)
c            (7222:7227) (7223:7227) (7226:7227) imp:n=1 u=61 fill=31
c c
c c ------------ Stack 1* - NW, N, NE (Core 6) ------------
c 5423 like 5100 but u=62  $ NW Cu Wire
c 5424 like 5101 but u=62  $ NW Hole
c 5425 like 5102 but u=62  $ NW Rod
c 5426 like 5103 but u=62  $ N Cu Wire
c 5427 like 5104 but u=62  $ N Hole
c 5428 like 5105 but u=62  $ N Rod
c 5429 like 5106 but u=62  $ NE Cu Wire
c 5430 like 5107 but u=62  $ NE Hole
c 5431 like 5108 but u=62  $ NE Rod
c 5432 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7135:7136:-7137:7127) (7221:7227) (7222:7227)
c            (7223:7227) imp:n=1 u=62 fill=31
c c
c c ------------ Stack 0 - NW, N, NE (Core 6) ------------
c 5433 like 5100 but u=63  $ NW Cu Wire
c 5434 like 5101 but u=63  $ NW Hole
c 5435 like 5102 but u=63  $ NW Rod
c 5436 like 5103 but u=63  $ N Cu Wire
c 5437 like 5104 but u=63  $ N Hole
c 5438 like 5105 but u=63  $ N Rod
c 5439 like 5106 but u=63  $ NE Cu Wire
c 5440 like 5107 but u=63  $ NE Hole
c 5441 like 5108 but u=63  $ NE Rod
c 5442 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7135:7136:-7137:7127) (7221:7227) (7222:7227)
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c            (7223:7227) imp:n=1 u=63 fill=27
c c
c c ------------ Stack 2* - NW, N, NE (Core 6) ------------
c 5443 like 5100 but u=64  $ NW Cu Wire
c 5444 like 5101 but u=64  $ NW Hole
c 5445 like 5102 but u=64  $ NW Rod
c 5446 like 5103 but u=64  $ N Cu Wire
c 5447 like 5104 but u=64  $ N Hole
c 5448 like 5105 but u=64  $ N Rod
c 5449 like 5106 but u=64  $ NE Cu Wire
c 5450 like 5107 but u=64  $ NE Hole
c 5451 like 5108 but u=64  $ NE Rod
c 5452 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7135:7136:-7137:7127) (7221:7227) (7222:7227)
c            (7223:7227) imp:n=1 u=64 fill=32
c c
c c ------------ Stack 0 - N, NE (Core 6) ------------
c 5453 like 5103 but u=65  $ N Cu Wire
c 5454 like 5104 but u=65  $ N Hole
c 5455 like 5105 but u=65  $ N Rod
c 5456 like 5106 but u=65  $ NE Cu Wire
c 5457 like 5107 but u=65  $ NE Hole
c 5458 like 5108 but u=65  $ NE Rod
c 5459 10 4.8492E-05  -6003 (7132:-7133:7134:7127) (7135:7136:-7137:7127)
c            (7222:7227) (7223:7227) imp:n=1 u=65 fill=27
c c
c c ------------ Stack 1* - NW, N, NE, SE (Core 6) ------------
c 5460 like 5100 but u=66  $ NW Cu Wire
c 5461 like 5101 but u=66  $ NW Hole
c 5462 like 5102 but u=66  $ NW Rod
c 5463 like 5103 but u=66  $ N Cu Wire
c 5464 like 5104 but u=66  $ N Hole
c 5465 like 5105 but u=66  $ N Rod
c 5466 like 5106 but u=66  $ NE Cu Wire
c 5467 like 5107 but u=66  $ NE Hole
c 5468 like 5108 but u=66  $ NE Rod
c 5469 like 5109 but u=66  $ SE Cu Wire
c 5470 like 5110 but u=66  $ SE Hole
c 5471 like 5111 but u=66  $ SE Rod
c 5472 10 4.8492E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7135:7136:-7137:7127) (7138:7139:-7140:7127) (7221:7227)
c            (7222:7227) (7223:7227) (7224:7227) imp:n=1 u=66 fill=31
c c
c c ------------ Stack 1* - N, NE, SE (Core 6) ------------
c 5473 like 5103 but u=67  $ N Cu Wire
c 5474 like 5104 but u=67  $ N Hole
c 5475 like 5105 but u=67  $ N Rod
c 5476 like 5106 but u=67  $ NE Cu Wire
c 5477 like 5107 but u=67  $ NE Hole
c 5478 like 5108 but u=67  $ NE Rod
c 5479 like 5109 but u=67  $ SE Cu Wire
c 5480 like 5110 but u=67  $ SE Hole
c 5481 like 5111 but u=67  $ SE Rod
c 5482 10 4.8492E-05  -6003 (7132:-7133:7134:7127) (7135:7136:-7137:7127)
c            (7138:7139:-7140:7127) (7222:7227) (7223:7227)
c            (7224:7227) imp:n=1 u=67 fill=31
c c
c c ------------ Stack 2* - N, NE, SE (Core 6) ------------
c 5483 like 5103 but u=68  $ N Cu Wire
c 5484 like 5104 but u=68  $ N Hole
c 5485 like 5105 but u=68  $ N Rod
c 5486 like 5106 but u=68  $ NE Cu Wire
c 5487 like 5107 but u=68  $ NE Hole
c 5488 like 5108 but u=68  $ NE Rod
c 5489 like 5109 but u=68  $ SE Cu Wire
c 5490 like 5110 but u=68  $ SE Hole
c 5491 like 5111 but u=68  $ SE Rod
c 5492 10 4.8492E-05  -6003 (7132:-7133:7134:7127) (7135:7136:-7137:7127)
c            (7138:7139:-7140:7127) (7222:7227) (7223:7227)
c            (7224:7227) imp:n=1 u=68 fill=32
c c
c c ------------ Stack 0 - N, NE, SE (Core 6) ------------
c 5493 like 5103 but u=69  $ N Cu Wire
c 5494 like 5104 but u=69  $ N Hole
c 5495 like 5105 but u=69  $ N Rod
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c 5496 like 5106 but u=69  $ NE Cu Wire
c 5497 like 5107 but u=69  $ NE Hole
c 5498 like 5108 but u=69  $ NE Rod
c 5499 like 5109 but u=69  $ SE Cu Wire
c 5500 like 5110 but u=69  $ SE Hole
c 5501 like 5111 but u=69  $ SE Rod
c 5502 10 4.8492E-05  -6003 (7132:-7133:7134:7127) (7135:7136:-7137:7127)
c            (7138:7139:-7140:7127) (7222:7227) (7223:7227)
c            (7224:7227) imp:n=1 u=69 fill=27
c
c
c c ------------ Stack 2 - NE, SE (Core 7) ------------
c 5201 like 5103 but u=40  $ NE Rod
c 5202 like 5104 but u=40  $ SE Rod
c 5203 10 4.8492E-05  -6003 (7023:7027) (7024:7027) imp:n=1 u=40 fill=29
c c
c c ------------ Stack 1* - N, NE, SE, S (Core 7) ------------
c 5204 like 5102 but u=41  $ N Rod
c 5205 like 5103 but u=41  $ NE Rod
c 5206 like 5104 but u=41  $ SE Rod
c 5207 like 5105 but u=41  $ S Rod
c 5208 10 4.8492E-05  -6003 (7022:7027) (7023:7027) (7024:7027)
c           (7025:7027) imp:n=1 u=41 fill=31
c c
c c ------------ Stack 1* - NE, SE, S (Core 7) ------------
c 5209 like 5103 but u=42  $ NE Rod
c 5210 like 5104 but u=42  $ SE Rod
c 5211 like 5105 but u=42  $ S Rod
c 5212 10 4.8492E-05  -6003  (7023:7027) (7024:7027)
c           (7025:7027) imp:n=1 u=42 fill=31
c c
c c ------------ Stack 0* - NE, SE, S (Core 7) ------------
c 5213 like 5103 but u=43  $ NE Rod
c 5214 like 5104 but u=43  $ SE Rod
c 5215 like 5105 but u=43  $ S Rod
c 5216 10 4.8492E-05  -6003 (7023:7027) (7024:7027)
c           (7025:7027) imp:n=1 u=43 fill=30
c c
c c ------------ Stack 2 - NE, SE, S (Core 7) ------------
c 5217 like 5103 but u=44  $ NE Rod
c 5218 like 5104 but u=44  $ SE Rod
c 5219 like 5105 but u=44  $ S Rod
c 5220 10 4.8492E-05  -6003 (7023:7027) (7024:7027)
c           (7025:7027) imp:n=1 u=44 fill=29
c c
c c ------------ Stack 0* - SE, S (Core 7) ------------
c 5221 like 5104 but u=45  $ SE Rod
c 5222 like 5105 but u=45  $ S Rod
c 5223 10 4.8492E-05  -6003 (7024:7027) (7025:7027) imp:n=1 u=45 fill=30
c c
c c ------------ Stack 1* - NE, SE, S, SW (Core 7) ------------
c 5224 like 5103 but u=46  $ NE Rod
c 5225 like 5104 but u=46  $ SE Rod
c 5226 like 5105 but u=46  $ S Rod
c 5227 like 5106 but u=46  $ SW Rod
c 5228 10 4.8492E-05  -6003 (7023:7027) (7024:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=46 fill=31
c c
c c ------------ Stack 1* - SE, S, SW (Core 7) ------------
c 5229 like 5104 but u=47  $ SE Rod
c 5230 like 5105 but u=47  $ S Rod
c 5231 like 5106 but u=47  $ SW Rod
c 5232 10 4.8492E-05  -6003 (7024:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=47 fill=31
c c
c c ------------ Stack 2 - SE, S, SW (Core 7) ------------
c 5233 like 5104 but u=48  $ SE Rod
c 5234 like 5105 but u=48  $ S Rod
c 5235 like 5106 but u=48  $ SW Rod
c 5236 10 4.8492E-05  -6003 (7024:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=48 fill=29
c c
c c ------------ Stack 0* - SE, S, SW (Core 7) ------------
c 5237 like 5104 but u=49  $ SE Rod
c 5238 like 5105 but u=49  $ S Rod
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c 5239 like 5106 but u=49  $ SW Rod
c 5240 10 4.8492E-05  -6003 (7024:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=49 fill=30
c c
c c ------------ Stack 2 - S, SW (Core 7) ------------
c 5241 like 5105 but u=50  $ S Rod
c 5242 like 5106 but u=50  $ SW Rod
c 5243 10 4.8492E-05  -6003 (7025:7027) (7026:7027) imp:n=1 u=50 fill=29
c c
c c ------------ Stack 1* - NW, SE, S, SW (Core 7) ------------
c 5244 like 5101 but u=51  $ NW Rod
c 5245 like 5104 but u=51  $ SE Rod
c 5246 like 5105 but u=51  $ S Rod
c 5247 like 5106 but u=51  $ SW Rod
c 5248 10 4.8492E-05  -6003 (7021:7027) (7024:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=51 fill=31
c c
c c ------------ Stack 1* - NW, S, SW (Core 7) ------------
c 5249 like 5101 but u=52  $ NW Rod
c 5250 like 5105 but u=52  $ S Rod
c 5251 like 5106 but u=52  $ SW Rod
c 5252 10 4.8492E-05  -6003 (7021:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=52 fill=31
c c
c c ------------ Stack 0* - NW, S, SW (Core 7) ------------
c 5253 like 5101 but u=53  $ NW Rod
c 5254 like 5105 but u=53  $ S Rod
c 5255 like 5106 but u=53  $ SW Rod
c 5256 10 4.8492E-05  -6003 (7021:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=53 fill=30
c c
c c ------------ Stack 2 - NW, S, SW (Core 7) ------------
c 5257 like 5101 but u=54  $ NW Rod
c 5258 like 5105 but u=54  $ S Rod
c 5259 like 5106 but u=54  $ SW Rod
c 5260 10 4.8492E-05  -6003 (7021:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=54 fill=29
c c
c c ------------ Stack 0* - NW, SW (Core 7) ------------
c 5261 like 5101 but u=55  $ NW Rod
c 5262 like 5106 but u=55  $ SW Rod
c 5263 10 4.8492E-05  -6003 (7021:7027) (7026:7027) imp:n=1 u=55 fill=30
c c
c c ------------ Stack 1* - NW, N, S, SW (Core 7) ------------
c 5264 like 5101 but u=56  $ NW Rod
c 5265 like 5102 but u=56  $ N Rod
c 5266 like 5105 but u=56  $ S Rod
c 5267 like 5106 but u=56  $ SW Rod
c 5268 10 4.8492E-05  -6003 (7021:7027) (7022:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=56 fill=31
c c
c c ------------ Stack 1* - NW, N, SW (Core 7) ------------
c 5269 like 5101 but u=57  $ NW Rod
c 5270 like 5102 but u=57  $ N Rod
c 5271 like 5106 but u=57  $ SW Rod
c 5272 10 4.8492E-05  -6003 (7021:7027) (7022:7027)
c           (7026:7027) imp:n=1 u=57 fill=31
c c
c c ------------ Stack 2 - NW, N, SW (Core 7) ------------
c 5273 like 5101 but u=58  $ NW Rod
c 5274 like 5102 but u=58  $ N Rod
c 5275 like 5106 but u=58  $ SW Rod
c 5276 10 4.8492E-05  -6003 (7021:7027) (7022:7027)
c           (7026:7027) imp:n=1 u=58 fill=29
c c
c c ------------ Stack 0* - NW, N, SW (Core 7) ------------
c 5277 like 5101 but u=59  $ NW Rod
c 5278 like 5102 but u=59  $ N Rod
c 5279 like 5106 but u=59  $ SW Rod
c 5280 10 4.8492E-05  -6003 (7021:7027) (7022:7027)
c           (7026:7027) imp:n=1 u=59 fill=30
c c
c c ------------ Stack 2 - NW, N (Core 7) ------------
c 5281 like 5101 but u=60  $ NW Rod
c 5282 like 5102 but u=60  $ N Rod
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c 5283 10 4.8492E-05  -6003 (7021:7027) (7022:7027)  imp:n=1 u=60 fill=29
c c
c c ------------ Stack 1* - NW, N, NE, SW (Core 7) ------------
c 5284 like 5101 but u=61  $ NW Rod
c 5285 like 5102 but u=61  $ N Rod
c 5286 like 5103 but u=61  $ NE Rod
c 5287 like 5106 but u=61  $ SW Rod
c 5288 10 4.8492E-05  -6003 (7021:7027) (7022:7027) (7023:7027)
c           (7026:7027) imp:n=1 u=61 fill=31
c c
c c ------------ Stack 1* - NW, N, NE (Core 7) ------------
c 5289 like 5101 but u=62  $ NW Rod
c 5290 like 5102 but u=62  $ N Rod
c 5291 like 5103 but u=62  $ NE Rod
c 5292 10 4.8492E-05  -6003 (7021:7027) (7022:7027) (7023:7027)
c           imp:n=1 u=62 fill=31
c c
c c ------------ Stack 0* - NW, N, NE (Core 7) ------------
c 5293 like 5101 but u=63  $ NW Rod
c 5294 like 5102 but u=63  $ N Rod
c 5295 like 5103 but u=63  $ NE Rod
c 5296 10 4.8492E-05  -6003 (7021:7027) (7022:7027) (7023:7027)
c           imp:n=1 u=63 fill=30
c c
c c ------------ Stack 2 - NW, N, NE (Core 7) ------------
c 5297 like 5101 but u=64  $ NW Rod
c 5298 like 5102 but u=64  $ N Rod
c 5299 like 5103 but u=64  $ NE Rod
c 5300 10 4.8492E-05  -6003 (7021:7027) (7022:7027) (7023:7027)
c           imp:n=1 u=64 fill=29
c c
c c ------------ Stack 0* - N, NE (Core 7) ------------
c 5301 like 5102 but u=65  $ N Rod
c 5302 like 5103 but u=65  $ NE Rod
c 5303 10 4.8492E-05  -6003 (7022:7027) (7023:7027) imp:n=1 u=65 fill=30
c c
c c ------------ Stack 1* - NW, N, NE, SE (Core 7) ------------
c 5304 like 5101 but u=66  $ NW Rod
c 5305 like 5102 but u=66  $ N Rod
c 5306 like 5103 but u=66  $ NE Rod
c 5307 like 5104 but u=66  $ SE Rod
c 5308 10 4.8492E-05  -6003 (7021:7027) (7022:7027) (7023:7027) (7024:7027)
c           imp:n=1 u=66 fill=31
c c
c c ------------ Stack 1* - N, NE, SE (Core 7) ------------
c 5309 like 5102 but u=67  $ N Rod
c 5310 like 5103 but u=67  $ NE Rod
c 5311 like 5104 but u=67  $ SE Rod
c 5312 10 4.8492E-05  -6003 (7022:7027) (7023:7027) (7024:7027)
c           imp:n=1 u=67 fill=31
c c
c c ------------ Stack 2 - N, NE, SE (Core 7) ------------
c 5313 like 5102 but u=68  $ N Rod
c 5314 like 5103 but u=68  $ NE Rod
c 5315 like 5104 but u=68  $ SE Rod
c 5316 10 4.8492E-05  -6003 (7022:7027) (7023:7027) (7024:7027)
c           imp:n=1 u=68 fill=29
c c
c c ------------ Stack 0* - N, NE, SE (Core 7) ------------
c 5317 like 5102 but u=69  $ N Rod
c 5318 like 5103 but u=69  $ NE Rod
c 5319 like 5104 but u=69  $ SE Rod
c 5320 10 4.8492E-05  -6003 (7022:7027) (7023:7027) (7024:7027)
c           imp:n=1 u=69 fill=30
c
c
c ------------ Stack 2* - NE, SE (Core 8) ------------
c 5201 like 5107 but u=40  $ NE Hole
c 5202 like 5108 but u=40  $ NE Rod
c 5204 like 5110 but u=40  $ SE Hole
c 5205 like 5111 but u=40  $ SE Rod
c 5206 10 4.8492E-05  -6003 (7135:7136:-7137:7128) (7138:7139:-7140:7128)
c           imp:n=1 u=40 fill=32
c c
c c ------------ Stack 1 - N, NE, SE, S (Core 8) ------------
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c 5208 like 5104 but u=41  $ N Hole
c 5209 like 5105 but u=41  $ N Rod
c 5211 like 5107 but u=41  $ NE Hole
c 5212 like 5108 but u=41  $ NE Rod
c 5214 like 5110 but u=41  $ SE Hole
c 5215 like 5111 but u=41  $ SE Rod
c 5217 like 5113 but u=41  $ S Hole
c 5218 like 5114 but u=41  $ S Rod
c 5219 10 4.8492E-05  -6003 (7132:-7133:7134:7128) (7135:7136:-7137:7128)
c            (7138:7139:-7140:7128) (7141:-7142:7143:7128) imp:n=1 u=41 fill=28
c c
c c ------------ Stack 1 - NE, SE, S (Core 8) ------------
c 5221 like 5107 but u=42  $ NE Hole
c 5222 like 5108 but u=42  $ NE Rod
c 5224 like 5110 but u=42  $ SE Hole
c 5225 like 5111 but u=42  $ SE Rod
c 5227 like 5113 but u=42  $ S Hole
c 5228 like 5114 but u=42  $ S Rod
c 5229 10 4.8492E-05  -6003 (7135:7136:-7137:7128) (7138:7139:-7140:7128)
c            (7141:-7142:7143:7128) imp:n=1 u=42 fill=28
c c
c c ------------ Stack 0* - NE, SE, S (Core 8) ------------
c 5231 like 5107 but u=43  $ NE Hole
c 5232 like 5108 but u=43  $ NE Rod
c 5234 like 5110 but u=43  $ SE Hole
c 5235 like 5111 but u=43  $ SE Rod
c 5237 like 5113 but u=43  $ S Hole
c 5238 like 5114 but u=43  $ S Rod
c 5239 10 4.8492E-05  -6003 (7135:7136:-7137:7128) (7138:7139:-7140:7128)
c            (7141:-7142:7143:7128) imp:n=1 u=43 fill=30
c c
c c ------------ Stack 2* - NE, SE, S (Core 8) ------------
c 5241 like 5107 but u=44  $ NE Hole
c 5242 like 5108 but u=44  $ NE Rod
c 5244 like 5110 but u=44  $ SE Hole
c 5245 like 5111 but u=44  $ SE Rod
c 5247 like 5113 but u=44  $ S Hole
c 5248 like 5114 but u=44  $ S Rod
c 5249 10 4.8492E-05  -6003 (7135:7136:-7137:7128) (7138:7139:-7140:7128)
c            (7141:-7142:7143:7128) imp:n=1 u=44 fill=32
c c
c c ------------ Stack 0* - SE, S (Core 8) ------------
c 5251 like 5110 but u=45  $ SE Hole
c 5252 like 5111 but u=45  $ SE Rod
c 5254 like 5113 but u=45  $ S Hole
c 5255 like 5114 but u=45  $ S Rod
c 5256 10 4.8492E-05  -6003 (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c            imp:n=1 u=45 fill=30
c c
c c ------------ Stack 1 - NE, SE, S, SW (Core 8) ------------
c 5258 like 5107 but u=46  $ NE Hole
c 5259 like 5108 but u=46  $ NE Rod
c 5261 like 5110 but u=46  $ SE Hole
c 5262 like 5111 but u=46  $ SE Rod
c 5264 like 5113 but u=46  $ S Hole
c 5265 like 5114 but u=46  $ S Rod
c 5267 like 5116 but u=46  $ SW Hole
c 5268 like 5117 but u=46  $ SW Rod
c 5269 10 4.8492E-05  -6003 (7135:7136:-7137:7128) (7138:7139:-7140:7128)
c            (7141:-7142:7143:7128) (7144:7145:-7146:7128) imp:n=1 u=46 fill=28
c c
c c ------------ Stack 1 - SE, S, SW (Core 8) ------------
c 5271 like 5110 but u=47  $ SE Hole
c 5272 like 5111 but u=47  $ SE Rod
c 5274 like 5113 but u=47  $ S Hole
c 5275 like 5114 but u=47  $ S Rod
c 5277 like 5116 but u=47  $ SW Hole
c 5278 like 5117 but u=47  $ SW Rod
c 5279 10 4.8492E-05  -6003 (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c             (7144:7145:-7146:7128) imp:n=1 u=47 fill=28
c c
c c ------------ Stack 2* - SE, S, SW (Core 8) ------------
c 5281 like 5110 but u=48  $ SE Hole
c 5282 like 5111 but u=48  $ SE Rod
c 5284 like 5113 but u=48  $ S Hole
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c 5285 like 5114 but u=48  $ S Rod
c 5287 like 5116 but u=48  $ SW Hole
c 5288 like 5117 but u=48  $ SW Rod
c 5289 10 4.8492E-05  -6003 (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=48 fill=32
c c
c c ------------ Stack 0* - SE, S, SW (Core 8) ------------
c 5291 like 5110 but u=49  $ SE Hole
c 5292 like 5111 but u=49  $ SE Rod
c 5294 like 5113 but u=49  $ S Hole
c 5295 like 5114 but u=49  $ S Rod
c 5297 like 5116 but u=49  $ SW Hole
c 5298 like 5117 but u=49  $ SW Rod
c 5299 10 4.8492E-05  -6003 (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=49 fill=30
c c
c c ------------ Stack 2* - S, SW (Core 8) ------------
c 5301 like 5113 but u=50  $ S Hole
c 5302 like 5114 but u=50  $ S Rod
c 5304 like 5116 but u=50  $ SW Hole
c 5305 like 5117 but u=50  $ SW Rod
c 5306 10 4.8492E-05  -6003 (7141:-7142:7143:7128) (7144:7145:-7146:7128)
c            imp:n=1 u=50 fill=32
c c
c c ------------ Stack 1 - NW, SE, S, SW (Core 8) ------------
c 5308 like 5101 but u=51  $ NW Hole
c 5309 like 5102 but u=51  $ NW Rod
c 5311 like 5110 but u=51  $ SE Hole
c 5312 like 5111 but u=51  $ SE Rod
c 5314 like 5113 but u=51  $ S Hole
c 5315 like 5114 but u=51  $ S Rod
c 5317 like 5116 but u=51  $ SW Hole
c 5318 like 5117 but u=51  $ SW Rod
c 5319 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7138:7139:-7140:7128)
c            (7141:-7142:7143:7128) (7144:7145:-7146:7128) imp:n=1 u=51 fill=28
c c
c c ------------ Stack 1 - NW, S, SW (Core 8) ------------
c 5321 like 5101 but u=52  $ NW Hole
c 5322 like 5102 but u=52  $ NW Rod
c 5324 like 5113 but u=52  $ S Hole
c 5325 like 5114 but u=52  $ S Rod
c 5327 like 5116 but u=52  $ SW Hole
c 5328 like 5117 but u=52  $ SW Rod
c 5329 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7141:-7142:7143:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=52 fill=28
c c
c c ------------ Stack 0* - NW, S, SW (Core 8) ------------
c 5331 like 5101 but u=53  $ NW Hole
c 5332 like 5102 but u=53  $ NW Rod
c 5334 like 5113 but u=53  $ S Hole
c 5335 like 5114 but u=53  $ S Rod
c 5337 like 5116 but u=53  $ SW Hole
c 5338 like 5117 but u=53  $ SW Rod
c 5339 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7141:-7142:7143:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=53 fill=30
c c
c c ------------ Stack 2* - NW, S, SW (Core 8) ------------
c 5341 like 5101 but u=54  $ NW Hole
c 5342 like 5102 but u=54  $ NW Rod
c 5344 like 5113 but u=54  $ S Hole
c 5345 like 5114 but u=54  $ S Rod
c 5347 like 5116 but u=54  $ SW Hole
c 5348 like 5117 but u=54  $ SW Rod
c 5349 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7141:-7142:7143:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=54 fill=32
c c
c c ------------ Stack 0* - NW, SW (Core 8) ------------
c 5351 like 5101 but u=55  $ NW Hole
c 5352 like 5102 but u=55  $ NW Rod
c 5357 like 5116 but u=55  $ SW Hole
c 5358 like 5117 but u=55  $ SW Rod
c 5359 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7144:7145:-7146:7128)
c            imp:n=1 u=55 fill=30
c c
c c ------------ Stack 1 - NW, N, S, SW (Core 8) ------------
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c 5361 like 5101 but u=56  $ NW Hole
c 5362 like 5102 but u=56  $ NW Rod
c 5364 like 5104 but u=56  $ N Hole
c 5365 like 5105 but u=56  $ N Rod
c 5367 like 5113 but u=56  $ S Hole
c 5368 like 5114 but u=56  $ S Rod
c 5370 like 5116 but u=56  $ SW Hole
c 5371 like 5117 but u=56  $ SW Rod
c 5372 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7141:-7142:7143:7128) (7144:7145:-7146:7128) imp:n=1 u=56 fill=28
c c
c c ------------ Stack 1 - NW, N, SW (Core 8) ------------
c 5374 like 5101 but u=57  $ NW Hole
c 5375 like 5102 but u=57  $ NW Rod
c 5377 like 5104 but u=57  $ N Hole
c 5378 like 5105 but u=57  $ N Rod
c 5380 like 5116 but u=57  $ SW Hole
c 5381 like 5117 but u=57  $ SW Rod
c 5382 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=57 fill=28
c c
c c ------------ Stack 2* - NW, N, SW (Core 8) ------------
c 5384 like 5101 but u=58  $ NW Hole
c 5385 like 5102 but u=58  $ NW Rod
c 5387 like 5104 but u=58  $ N Hole
c 5388 like 5105 but u=58  $ N Rod
c 5390 like 5116 but u=58  $ SW Hole
c 5391 like 5117 but u=58  $ SW Rod
c 5392 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=58 fill=32
c c
c c ------------ Stack 0* - NW, N, SW (Core 8) ------------
c 5394 like 5101 but u=59  $ NW Hole
c 5395 like 5102 but u=59  $ NW Rod
c 5397 like 5104 but u=59  $ N Hole
c 5398 like 5105 but u=59  $ N Rod
c 5400 like 5116 but u=59  $ SW Hole
c 5401 like 5117 but u=59  $ SW Rod
c 5402 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=59 fill=30
c c
c c ------------ Stack 2* - NW, N (Core 8) ------------
c 5404 like 5101 but u=60  $ NW Hole
c 5405 like 5102 but u=60  $ NW Rod
c 5407 like 5104 but u=60  $ N Hole
c 5408 like 5105 but u=60  $ N Rod
c 5409 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            imp:n=1 u=60 fill=32
c c
c c ------------ Stack 1 - NW, N, NE, SW (Core 8) ------------
c 5411 like 5101 but u=61  $ NW Hole
c 5412 like 5102 but u=61  $ NW Rod
c 5414 like 5104 but u=61  $ N Hole
c 5415 like 5105 but u=61  $ N Rod
c 5417 like 5107 but u=61  $ NE Hole
c 5418 like 5108 but u=61  $ NE Rod
c 5420 like 5116 but u=61  $ SW Hole
c 5421 like 5117 but u=61  $ SW Rod
c 5422 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7135:7136:-7137:7128) (7144:7145:-7146:7128) imp:n=1 u=61 fill=28
c c
c c ------------ Stack 1 - NW, N, NE (Core 8) ------------
c 5424 like 5101 but u=62  $ NW Hole
c 5425 like 5102 but u=62  $ NW Rod
c 5427 like 5104 but u=62  $ N Hole
c 5428 like 5105 but u=62  $ N Rod
c 5430 like 5107 but u=62  $ NE Hole
c 5431 like 5108 but u=62  $ NE Rod
c 5432 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7135:7136:-7137:7128) imp:n=1 u=62 fill=28
c c
c c ------------ Stack 0* - NW, N, NE (Core 8) ------------
c 5434 like 5101 but u=63  $ NW Hole
c 5435 like 5102 but u=63  $ NW Rod
c 5437 like 5104 but u=63  $ N Hole
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c 5438 like 5105 but u=63  $ N Rod
c 5440 like 5107 but u=63  $ NE Hole
c 5441 like 5108 but u=63  $ NE Rod
c 5442 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7135:7136:-7137:7128) imp:n=1 u=63 fill=30
c c
c c ------------ Stack 2* - NW, N, NE (Core 8) ------------
c 5444 like 5101 but u=64  $ NW Hole
c 5445 like 5102 but u=64  $ NW Rod
c 5447 like 5104 but u=64  $ N Hole
c 5448 like 5105 but u=64  $ N Rod
c 5450 like 5107 but u=64  $ NE Hole
c 5451 like 5108 but u=64  $ NE Rod
c 5452 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7135:7136:-7137:7128) imp:n=1 u=64 fill=32
c c
c c ------------ Stack 0* - N, NE (Core 8) ------------
c 5454 like 5104 but u=65  $ N Hole
c 5455 like 5105 but u=65  $ N Rod
c 5457 like 5107 but u=65  $ NE Hole
c 5458 like 5108 but u=65  $ NE Rod
c 5459 10 4.8492E-05  -6003 (7132:-7133:7134:7128) (7135:7136:-7137:7128)
c            imp:n=1 u=65 fill=30
c c
c c ------------ Stack 1 - NW, N, NE, SE (Core 8) ------------
c 5461 like 5101 but u=66  $ NW Hole
c 5462 like 5102 but u=66  $ NW Rod
c 5464 like 5104 but u=66  $ N Hole
c 5465 like 5105 but u=66  $ N Rod
c 5467 like 5107 but u=66  $ NE Hole
c 5468 like 5108 but u=66  $ NE Rod
c 5470 like 5110 but u=66  $ SE Hole
c 5471 like 5111 but u=66  $ SE Rod
c 5472 10 4.8492E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7135:7136:-7137:7128) (7138:7139:-7140:7128) imp:n=1 u=66 fill=28
c c
c c ------------ Stack 1 - N, NE, SE (Core 8) ------------
c 5474 like 5104 but u=67  $ N Hole
c 5475 like 5105 but u=67  $ N Rod
c 5477 like 5107 but u=67  $ NE Hole
c 5478 like 5108 but u=67  $ NE Rod
c 5480 like 5110 but u=67  $ SE Hole
c 5481 like 5111 but u=67  $ SE Rod
c 5482 10 4.8492E-05  -6003 (7132:-7133:7134:7128) (7135:7136:-7137:7128)
c            (7138:7139:-7140:7128) imp:n=1 u=67 fill=28
c c
c c ------------ Stack 2* - N, NE, SE (Core 8) ------------
c 5484 like 5104 but u=68  $ N Hole
c 5485 like 5105 but u=68  $ N Rod
c 5487 like 5107 but u=68  $ NE Hole
c 5488 like 5108 but u=68  $ NE Rod
c 5490 like 5110 but u=68  $ SE Hole
c 5491 like 5111 but u=68  $ SE Rod
c 5492 10 4.8492E-05  -6003 (7132:-7133:7134:7128) (7135:7136:-7137:7128)
c            (7138:7139:-7140:7128)  imp:n=1 u=68 fill=32
c c
c c ------------ Stack 0* - N, NE, SE (Core 8) ------------
c 5494 like 5104 but u=69  $ N Hole
c 5495 like 5105 but u=69  $ N Rod
c 5497 like 5107 but u=69  $ NE Hole
c 5498 like 5108 but u=69  $ NE Rod
c 5500 like 5110 but u=69  $ SE Hole
c 5501 like 5111 but u=69  $ SE Rod
c 5502 10 4.8492E-05  -6003 (7132:-7133:7134:7128) (7135:7136:-7137:7128)
c            (7138:7139:-7140:7128) imp:n=1 u=69 fill=30
c
c
c ------ Core Arrangement ----------------------------------------------------
c --------- Core 5 Lattice Description ---------
7001 10 4.8492E-05  -6002 imp:n=1 u=100 lat=2 fill=-12:12 -12:12 0:0
      26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
      26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 30 28 32 30 28 32 26 26 26 26
      26 26 26 26 26 26 26 26 26 26 26 26 26 30 28 32 30 28 32 30 28 32 26 26 26
      26 26 26 26 26 26 26 26 26 26 26 30 28 32 30 28 32 30 28 32 30 28 32 26 26
      26 26 26 26 26 26 26 26 26 30 28 32 30 28 29 27 28 29 27 28 32 30 28 32 26
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      26 26 26 26 26 26 26 26 28 32 30 28 29 27 28 29 27 28 29 27 28 32 30 28 26
      26 26 26 26 26 26 26 32 30 28 29 27 28 29 27 28 29 27 28 29 27 28 32 30 26
      26 26 26 26 26 26 30 28 32 27 28 29 27 28 29 27 28 29 27 28 29 30 28 32 26
      26 26 26 26 26 28 32 30 28 29 27 28 29 27 28 29 27 28 29 27 28 32 30 28 26
      26 26 26 26 32 30 28 29 27 28 29 27 28 29 27 28 29 27 28 29 27 28 32 30 26
      26 26 26 26 28 32 27 28 29 27 28 29 27 28 29 27 28 29 27 28 29 30 28 26 26
      26 26 26 32 30 28 29 27 28 29 27 28 29 27 28 29 27 28 29 27 28 32 30 26 26
c
      26 26 26 28 32 27 28 29 27 28 29 27 28 29 27 28 29 27 28 29 30 28 26 26 26
c
      26 26 32 30 28 29 27 28 29 27 28 29 27 28 29 27 28 29 27 28 32 30 26 26 26
      26 26 28 32 27 28 29 27 28 29 27 28 29 27 28 29 27 28 29 30 28 26 26 26 26
      26 32 30 28 29 27 28 29 27 28 29 27 28 29 27 28 29 27 28 32 30 26 26 26 26
      26 28 32 30 28 29 27 28 29 27 28 29 27 28 29 27 28 32 30 28 26 26 26 26 26
      26 30 28 32 27 28 29 27 28 29 27 28 29 27 28 29 30 28 32 26 26 26 26 26 26
      26 32 30 28 29 27 28 29 27 28 29 27 28 29 27 28 32 30 26 26 26 26 26 26 26
      26 28 32 30 28 29 27 28 29 27 28 29 27 28 32 30 28 26 26 26 26 26 26 26 26
      26 30 28 32 30 28 29 27 28 29 27 28 32 30 28 32 26 26 26 26 26 26 26 26 26
      26 26 30 28 32 30 28 32 30 28 32 30 28 32 26 26 26 26 26 26 26 26 26 26 26
      26 26 26 30 28 32 30 28 32 30 28 32 26 26 26 26 26 26 26 26 26 26 26 26 26
      26 26 26 26 30 28 32 30 28 32 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
      26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c
c --------- Core 6 Lattice Description ---------
c 7001 10 4.8492E-05  -6002 imp:n=1 u=100 lat=2 fill=-12:12 -12:12 0:0
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 65 62 64 63 62 60 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 26 65 66 39 34 38 39 34 61 60 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 65 66 39 34 38 39 34 38 39 34 61 60 26 26
c       26 26 26 26 26 26 26 26 26 65 66 39 34 38 36 34 35 36 34 38 39 34 61 60 26
c       26 26 26 26 26 26 26 26 67 39 34 38 36 34 35 36 34 35 36 34 38 39 34 57 26
c       26 26 26 26 26 26 26 68 34 38 36 34 35 36 34 35 36 34 35 36 34 38 39 59 26
c       26 26 26 26 26 26 69 38 39 34 35 36 34 35 36 34 35 36 34 35 36 34 38 58 26
c       26 26 26 26 26 67 39 34 35 36 34 35 36 34 35 36 34 35 36 34 35 39 34 57 26
c       26 26 26 26 40 34 38 36 34 35 36 34 35 36 34 35 36 34 35 36 34 38 39 55 26
c       26 26 26 26 41 39 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 34 56 26 26
c       26 26 26 40 34 38 36 34 35 36 34 35 36 34 35 36 34 35 36 34 38 39 55 26 26
c c
c       26 26 26 41 39 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 34 56 26 26 26
c c
c       26 26 40 34 38 36 34 35 36 34 35 36 34 35 36 34 35 36 34 38 39 55 26 26 26
c       26 26 41 39 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 34 56 26 26 26 26
c       26 40 34 38 36 34 35 36 34 35 36 34 35 36 34 35 36 34 38 39 55 26 26 26 26
c       26 42 39 34 35 36 34 35 36 34 35 36 34 35 36 34 35 39 34 52 26 26 26 26 26
c       26 43 38 39 34 35 36 34 35 36 34 35 36 34 35 36 34 38 54 26 26 26 26 26 26
c       26 44 34 38 36 34 35 36 34 35 36 34 35 36 34 38 39 53 26 26 26 26 26 26 26
c       26 42 39 34 38 36 34 35 36 34 35 36 34 38 39 34 52 26 26 26 26 26 26 26 26
c       26 45 46 39 34 38 36 34 35 36 34 38 39 34 51 50 26 26 26 26 26 26 26 26 26
c       26 26 45 46 39 34 38 39 34 38 39 34 51 50 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 45 46 39 34 38 39 34 51 50 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 45 47 48 49 47 50 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c
c --------- Core 7 Lattice Description ---------
c 7001 10 4.8492E-05  -6002 imp:n=1 u=100 lat=2 fill=-12:12 -12:12 0:0
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 65 62 64 63 62 60 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 26 65 66 36 37 38 36 37 61 60 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 65 66 36 37 38 36 37 38 36 37 61 60 26 26
c       26 26 26 26 26 26 26 26 26 65 66 36 37 38 36 34 35 36 34 38 36 37 61 60 26
c       26 26 26 26 26 26 26 26 67 36 37 38 36 34 35 36 34 35 36 34 38 36 37 57 26
c       26 26 26 26 26 26 26 68 37 38 36 34 35 36 34 35 36 34 35 36 34 38 36 59 26
c       26 26 26 26 26 26 69 38 36 34 35 36 34 35 36 34 35 36 34 35 36 37 38 58 26
c       26 26 26 26 26 67 36 37 35 36 34 35 36 34 35 36 34 35 36 34 35 36 37 57 26
c       26 26 26 26 40 37 38 36 34 35 36 34 35 36 34 35 36 34 35 36 34 38 36 55 26
c       26 26 26 26 41 36 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 37 56 26 26
c       26 26 26 40 37 38 36 34 35 36 34 35 36 34 35 36 34 35 36 34 38 36 55 26 26
c c
c       26 26 26 41 36 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 37 56 26 26 26
c c
c       26 26 40 37 38 36 34 35 36 34 35 36 34 35 36 34 35 36 34 38 36 55 26 26 26
c       26 26 41 36 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 37 56 26 26 26 26
c       26 40 37 38 36 34 35 36 34 35 36 34 35 36 34 35 36 34 38 36 55 26 26 26 26
c       26 42 36 37 35 36 34 35 36 34 35 36 34 35 36 34 35 36 37 52 26 26 26 26 26
c       26 43 38 36 34 35 36 34 35 36 34 35 36 34 35 36 37 38 54 26 26 26 26 26 26
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c       26 44 37 38 36 34 35 36 34 35 36 34 35 36 34 38 36 53 26 26 26 26 26 26 26
c       26 42 36 37 38 36 34 35 36 34 35 36 34 38 36 37 52 26 26 26 26 26 26 26 26
c       26 45 46 36 37 38 36 34 35 36 34 38 36 37 51 50 26 26 26 26 26 26 26 26 26
c       26 26 45 46 36 37 38 36 37 38 36 37 51 50 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 45 46 36 37 38 36 37 51 50 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 45 47 48 49 47 50 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c
c --------- Core 8 Lattice Description ---------
c 7001 10 4.8492E-05  -6002 imp:n=1 u=100 lat=2 fill=-12:12 -12:12 0:0
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 65 62 64 63 62 60 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 65 66 39 37 35 39 37 61 60 26 26 26
c       26 26 26 26 26 26 26 26 26 26 65 66 39 37 35 39 37 35 39 37 61 60 26 26
c       26 26 26 26 26 26 26 26 65 66 39 37 35 36 34 35 36 34 35 39 37 61 60 26
c       26 26 26 26 26 26 26 67 39 37 35 36 34 35 36 34 35 36 34 35 39 37 57 26
c       26 26 26 26 26 26 68 37 35 36 34 35 36 34 35 36 34 35 36 34 35 39 59 26
c       26 26 26 26 26 69 35 39 34 35 36 34 35 36 34 35 36 34 35 36 37 35 58 26
c       26 26 26 26 67 39 37 35 36 34 35 36 34 35 36 34 35 36 34 35 39 37 57 26
c       26 26 26 40 37 35 36 34 35 36 34 35 36 34 35 36 34 35 36 34 35 39 55 26
c       26 26 26 41 39 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 37 56 26 26
c       26 26 40 37 35 36 34 35 36 34 35 36 34 35 36 34 35 36 34 35 39 55 26 26
c c
c       26 26 26 41 39 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 37 56 26 26 26
c c
c       26 26 40 37 35 36 34 35 36 34 35 36 34 35 36 34 35 36 34 35 39 55 26 26 26
c       26 26 41 39 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 37 56 26 26 26 26
c       26 40 37 35 36 34 35 36 34 35 36 34 35 36 34 35 36 34 35 39 55 26 26 26 26
c       26 42 39 37 35 36 34 35 36 34 35 36 34 35 36 34 35 39 37 52 26 26 26 26 26
c       26 43 35 39 34 35 36 34 35 36 34 35 36 34 35 36 37 35 54 26 26 26 26 26 26
c       26 44 37 35 36 34 35 36 34 35 36 34 35 36 34 35 39 53 26 26 26 26 26 26 26
c       26 42 39 37 35 36 34 35 36 34 35 36 34 35 39 37 52 26 26 26 26 26 26 26 26
c       26 45 46 39 37 35 36 34 35 36 34 35 39 37 51 50 26 26 26 26 26 26 26 26 26
c       26 26 45 46 39 37 35 39 37 35 39 37 51 50 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 45 46 39 37 35 39 37 51 50 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 45 47 48 49 47 50 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c
c --------- Pebble-Filled Core Cavity ---------
7101 10 4.8492E-05  -7001 -7002 -7003 imp:n=1 fill=100 (0 0 75)
c
c --- Model Boundary -----------------------------------------------------------
9999  0  -31:1202:34 imp:n=0  $ The Great Void
c

c Surface Cards ****************************************************************
c --- Radial Reflector ---------------------------------------------------------
c ------ Graphite Annulus ------
31    pz     0.0   $ Bottom of Reflector
32    pz   330.4   $ Top of Reflector
33    cz    62.83398  $ Inside Radial Equivalent-Area Cavity Surface
34    cz   163.76986  $ Outside Radial Equivalent-Area Surface
c
c ------ Safety/Shutdown Rod Holes ------
1101  c/z  -38.45  56.57  2.25  $ Rod 1
1102  c/z   32.74 -60.05  2.25  $ Rod 2
1103  c/z   57.17  37.55  2.25  $ Rod 3
1104  c/z  -53.23 -42.95  2.25  $ Rod 4
1105  c/z   67.19 -12.82  2.25  $ Rod 5
1106  c/z  -66.98  13.87  2.25  $ Rod 6
1107  c/z   19.31  65.62  2.25  $ Rod 7
1108  c/z  -13.87 -66.98  2.25  $ Rod 8
c
c ------ Withdrawable Control Rod Holes ------
503   c/z  -83.70  34.67  1.3715  $ Position 3 Hole
519   c/z   34.67  83.70  1.3715  $ Position 19 Hole
535   c/z   83.70 -34.67  1.3715  $ Position 35 Hole
551   c/z  -34.67 -83.70  1.3715  $ Position 51 Hole
1003  c/z  -83.70  34.67  1.325  $ Position 3 Plug
1019  c/z   34.67  83.70  1.325  $ Position 19 Plug
1035  c/z   83.70 -34.67  1.325  $ Position 35 Plug
1051  c/z  -34.67 -83.70  1.325  $ Position 51 Plug
c
c ------ Autorod Hole ------
1113  c/z   17.36 -87.29  2.75
```

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c
c --- Upper Axial Reflector ----------------------------------------------------
c ------ Central Cylinder ------
1201  pz   267.3     $ Bottom of Graphite
1202  pz   345.3     $ Top of Graphite
1203  cz     1.3715  $ Central Coolant Channel
1204  cz    19.7     $ Outer Radius
c
c ------ Graphite Annulus ------
1211  cz    20.93    $ Inner Radius
1212  cz    61.7     $ Outer Radius
c
c ------ Air Gaps ------
1221  cz    19.8     $ Outside of Central Cylinder
1222  cz    20.5     $ Inside of Annulus
1223  cz    61.8     $ Outside of Annulus
c
c ------ Coolant Channels ------
c --------- Ring 1 ---------
1301  c/z  -29.86   2.94  1.3715  $ Position 1
1302  c/z  -28.71   8.71  1.3715  $ Position 2
1303  c/z  -26.46  14.14  1.3715  $ Position 3
1304  c/z  -23.19  19.03  1.3715  $ Position 4
1305  c/z  -19.03  23.19  1.3715  $ Position 5
1306  c/z  -14.14  26.46  1.3715  $ Position 6
1307  c/z   -8.71  28.71  1.3715  $ Position 7
1308  c/z   -2.94  29.86  1.3715  $ Position 8
1309  c/z    2.94  29.86  1.3715  $ Position 9
1310  c/z    8.71  28.71  1.3715  $ Position 10
1311  c/z   14.14  26.46  1.3715  $ Position 11
1312  c/z   19.03  23.19  1.3715  $ Position 12
1313  c/z   23.19  19.03  1.3715  $ Position 13
1314  c/z   26.46  14.14  1.3715  $ Position 14
1315  c/z   28.71   8.71  1.3715  $ Position 15
1316  c/z   29.86   2.94  1.3715  $ Position 16
1317  c/z   29.86  -2.94  1.3715  $ Position 17
1318  c/z   28.71  -8.71  1.3715  $ Position 18
1319  c/z   26.46 -14.14  1.3715  $ Position 19
1320  c/z   23.19 -19.03  1.3715  $ Position 20
1321  c/z   19.03 -23.19  1.3715  $ Position 21
1322  c/z   14.14 -26.46  1.3715  $ Position 22
1323  c/z    8.71 -28.71  1.3715  $ Position 23
1324  c/z    2.94 -29.86  1.3715  $ Position 24
1325  c/z   -2.94 -29.86  1.3715  $ Position 25
1326  c/z   -8.71 -28.71  1.3715  $ Position 26
1327  c/z  -14.14 -26.46  1.3715  $ Position 27
1328  c/z  -19.03 -23.19  1.3715  $ Position 28
1329  c/z  -23.19 -19.03  1.3715  $ Position 29
1330  c/z  -26.46 -14.14  1.3715  $ Position 30
1331  c/z  -28.71  -8.71  1.3715  $ Position 31
1332  c/z  -29.86  -2.94  1.3715  $ Position 32
c
1333  cz    32.75  $ Ring Divider for Modeling Simplification
c
c --------- Ring 2 ---------
1401  c/z  -34.82   6.93  1.3715  $ Position 1
1402  c/z  -32.80  13.59  1.3715  $ Position 2
1403  c/z  -29.52  19.72  1.3715  $ Position 3
1404  c/z  -25.10  25.10  1.3715  $ Position 4
1405  c/z  -19.72  29.52  1.3715  $ Position 5
1406  c/z  -13.59  32.80  1.3715  $ Position 6
1407  c/z   -6.93  34.82  1.3715  $ Position 7
1408  c/z    0.00  35.50  1.3715  $ Position 8
1409  c/z    6.93  34.82  1.3715  $ Position 9
1410  c/z   13.59  32.80  1.3715  $ Position 10
1411  c/z   19.72  29.52  1.3715  $ Position 11
1412  c/z   25.10  25.10  1.3715  $ Position 12
1413  c/z   29.52  19.72  1.3715  $ Position 13
1414  c/z   32.80  13.59  1.3715  $ Position 14
1415  c/z   34.82   6.93  1.3715  $ Position 15
1416  c/z   35.50   0.00  1.3715  $ Position 16
1417  c/z   34.82  -6.93  1.3715  $ Position 17
1418  c/z   32.80 -13.59  1.3715  $ Position 18
1419  c/z   29.52 -19.72  1.3715  $ Position 19
1420  c/z   25.10 -25.10  1.3715  $ Position 20
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1421  c/z   19.72 -29.52  1.3715  $ Position 21
1422  c/z   13.59 -32.80  1.3715  $ Position 22
1423  c/z    6.93 -34.82  1.3715  $ Position 23
1424  c/z    0.00 -35.50  1.3715  $ Position 24
1425  c/z   -6.93 -34.82  1.3715  $ Position 25
1426  c/z  -13.59 -32.80  1.3715  $ Position 26
1427  c/z  -19.72 -29.52  1.3715  $ Position 27
1428  c/z  -25.10 -25.10  1.3715  $ Position 28
1429  c/z  -29.52 -19.72  1.3715  $ Position 29
1430  c/z  -32.80 -13.59  1.3715  $ Position 30
1431  c/z  -34.82  -6.93  1.3715  $ Position 31
1432  c/z  -35.50   0.00  1.3715  $ Position 32
c
1433  cz    38.25  $ Ring Divider for Modeling Simplification
c
c --------- Ring 3 ---------
1501  c/z  -39.23  11.90  1.3715  $ Position 1
1502  c/z  -36.16  19.33  1.3715  $ Position 2
1503  c/z  -31.69  26.01  1.3715  $ Position 3
1504  c/z  -26.01  31.69  1.3715  $ Position 4
1505  c/z  -19.33  36.16  1.3715  $ Position 5
1506  c/z  -11.90  39.23  1.3715  $ Position 6
1507  c/z   -4.02  40.80  1.3715  $ Position 7
1508  c/z    4.02  40.80  1.3715  $ Position 8
1509  c/z   11.90  39.23  1.3715  $ Position 9
1510  c/z   19.33  36.16  1.3715  $ Position 10
1511  c/z   26.01  31.69  1.3715  $ Position 11
1512  c/z   31.69  26.01  1.3715  $ Position 12
1513  c/z   36.16  19.33  1.3715  $ Position 13
1514  c/z   39.23  11.90  1.3715  $ Position 14
1515  c/z   40.80   4.02  1.3715  $ Position 15
1516  c/z   40.80  -4.02  1.3715  $ Position 16
1517  c/z   39.23 -11.90  1.3715  $ Position 17
1518  c/z   36.16 -19.33  1.3715  $ Position 18
1519  c/z   31.69 -26.01  1.3715  $ Position 19
1520  c/z   26.01 -31.69  1.3715  $ Position 20
1521  c/z   19.33 -36.16  1.3715  $ Position 21
1522  c/z   11.90 -39.23  1.3715  $ Position 22
1523  c/z    4.02 -40.80  1.3715  $ Position 23
1524  c/z   -4.02 -40.80  1.3715  $ Position 24
1525  c/z  -11.90 -39.23  1.3715  $ Position 25
1526  c/z  -19.33 -36.16  1.3715  $ Position 26
1527  c/z  -26.01 -31.69  1.3715  $ Position 27
1528  c/z  -31.69 -26.01  1.3715  $ Position 28
1529  c/z  -36.16 -19.33  1.3715  $ Position 29
1530  c/z  -39.23 -11.90  1.3715  $ Position 30
1531  c/z  -40.80  -4.02  1.3715  $ Position 31
1532  c/z  -40.80   4.02  1.3715  $ Position 32
c
1533  cz    43.625  $ Ring Divider for Modeling Simplification
c
c --------- Ring 4 ---------
1601  c/z  -42.73  17.70  1.3715  $ Position 1
1602  c/z  -38.46  25.70  1.3715  $ Position 2
1603  c/z  -32.70  32.70  1.3715  $ Position 3
1604  c/z  -25.70  38.46  1.3715  $ Position 4
1605  c/z  -17.70  42.73  1.3715  $ Position 5
1606  c/z   -9.02  45.36  1.3715  $ Position 6
1607  c/z    0.00  46.25  1.3715  $ Position 7
1608  c/z    9.02  45.36  1.3715  $ Position 8
1609  c/z   17.70  42.73  1.3715  $ Position 9
1610  c/z   25.70  38.46  1.3715  $ Position 10
1611  c/z   32.70  32.70  1.3715  $ Position 11
1612  c/z   38.46  25.70  1.3715  $ Position 12
1613  c/z   42.73  17.70  1.3715  $ Position 13
1614  c/z   45.36   9.02  1.3715  $ Position 14
1615  c/z   46.25   0.00  1.3715  $ Position 15
1616  c/z   45.36  -9.02  1.3715  $ Position 16
1617  c/z   42.73 -17.70  1.3715  $ Position 17
1618  c/z   38.46 -25.70  1.3715  $ Position 18
1619  c/z   32.70 -32.70  1.3715  $ Position 19
1620  c/z   25.70 -38.46  1.3715  $ Position 20
1621  c/z   17.70 -42.73  1.3715  $ Position 21
1622  c/z    9.02 -45.36  1.3715  $ Position 22
1623  c/z    0.00 -46.25  1.3715  $ Position 23
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1624  c/z   -9.02 -45.36  1.3715  $ Position 24
1625  c/z  -17.70 -42.73  1.3715  $ Position 25
1626  c/z  -25.70 -38.46  1.3715  $ Position 26
1627  c/z  -32.70 -32.70  1.3715  $ Position 27
1628  c/z  -38.46 -25.70  1.3715  $ Position 28
1629  c/z  -42.73 -17.70  1.3715  $ Position 29
1630  c/z  -45.36  -9.02  1.3715  $ Position 30
1631  c/z  -46.25   0.00  1.3715  $ Position 31
1632  c/z  -45.36   9.02  1.3715  $ Position 32
c
1633  cz    48.875  $ Ring Divider for Modeling Simplification
c
c --------- Ring 5 ---------
1701  c/z  -45.42  24.28  1.3715  $ Position 1
1702  c/z  -39.81  32.67  1.3715  $ Position 2
1703  c/z  -32.67  39.81  1.3715  $ Position 3
1704  c/z  -24.28  45.42  1.3715  $ Position 4
1705  c/z  -14.95  49.28  1.3715  $ Position 5
1706  c/z   -5.05  51.25  1.3715  $ Position 6
1707  c/z    5.05  51.25  1.3715  $ Position 7
1708  c/z   14.95  49.28  1.3715  $ Position 8
1709  c/z   24.28  45.42  1.3715  $ Position 9
1710  c/z   32.67  39.81  1.3715  $ Position 10
1711  c/z   39.81  32.67  1.3715  $ Position 11
1712  c/z   45.42  24.28  1.3715  $ Position 12
1713  c/z   49.28  14.95  1.3715  $ Position 13
1714  c/z   51.25   5.05  1.3715  $ Position 14
1715  c/z   51.25  -5.05  1.3715  $ Position 15
1716  c/z   49.28 -14.95  1.3715  $ Position 16
1717  c/z   45.42 -24.28  1.3715  $ Position 17
1718  c/z   39.81 -32.67  1.3715  $ Position 18
1719  c/z   32.67 -39.81  1.3715  $ Position 19
1720  c/z   24.28 -45.42  1.3715  $ Position 20
1721  c/z   14.95 -49.28  1.3715  $ Position 21
1722  c/z    5.05 -51.25  1.3715  $ Position 22
1723  c/z   -5.05 -51.25  1.3715  $ Position 23
1724  c/z  -14.95 -49.28  1.3715  $ Position 24
1725  c/z  -24.28 -45.42  1.3715  $ Position 25
1726  c/z  -32.67 -39.81  1.3715  $ Position 26
1727  c/z  -39.81 -32.67  1.3715  $ Position 27
1728  c/z  -45.42 -24.28  1.3715  $ Position 28
1729  c/z  -49.28 -14.95  1.3715  $ Position 29
1730  c/z  -51.25  -5.05  1.3715  $ Position 30
1731  c/z  -51.25   5.05  1.3715  $ Position 31
1732  c/z  -49.28  14.95  1.3715  $ Position 32
c
c ------ Aluminum Tank ------
1801  pz   266.3             $ Bottom of Aluminum
1802  cz    62.1             $ Outer Radius
c
c --- Lower Axial Reflector ---------------------------------------------------
c ------ Inner Cylinder ------
1811  pz    78.0   $ Inside Bottom of Cavity
1812  cz    24.75  $ Outer Radius
c
c ------ Graphite Plug ------
1821  pz    25.0
1823  cz     6.0
c
c ------ Graphite Annulus ------
1831  cz    25.05171  $ Inner Radial Equivalent-Area Surface
1832  cz    62.71754  $ Outer Radial Equivalent-Area Surface
c
c ------ Coolant Channels ------
c --------- Ring 1 ---------
1901  c/z  -29.86   2.94  1.371  $ Position 1
1902  c/z  -28.71   8.71  1.371  $ Position 2
1903  c/z  -26.46  14.14  1.371  $ Position 3
1904  c/z  -23.19  19.03  1.371  $ Position 4
1905  c/z  -19.03  23.19  1.371  $ Position 5
1906  c/z  -14.14  26.46  1.371  $ Position 6
1907  c/z   -8.71  28.71  1.371  $ Position 7
1908  c/z   -2.94  29.86  1.371  $ Position 8
1909  c/z    2.94  29.86  1.371  $ Position 9
1910  c/z    8.71  28.71  1.371  $ Position 10
```

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1911  c/z   14.14  26.46  1.371  $ Position 11
1912  c/z   19.03  23.19  1.371  $ Position 12
1913  c/z   23.19  19.03  1.371  $ Position 13
1914  c/z   26.46  14.14  1.371  $ Position 14
1915  c/z   28.71   8.71  1.371  $ Position 15
1916  c/z   29.86   2.94  1.371  $ Position 16
1917  c/z   29.86  -2.94  1.371  $ Position 17
1918  c/z   28.71  -8.71  1.371  $ Position 18
1919  c/z   26.46 -14.14  1.371  $ Position 19
1920  c/z   23.19 -19.03  1.371  $ Position 20
1921  c/z   19.03 -23.19  1.371  $ Position 21
1922  c/z   14.14 -26.46  1.371  $ Position 22
1923  c/z    8.71 -28.71  1.371  $ Position 23
1924  c/z    2.94 -29.86  1.371  $ Position 24
1925  c/z   -2.94 -29.86  1.371  $ Position 25
1926  c/z   -8.71 -28.71  1.371  $ Position 26
1927  c/z  -14.14 -26.46  1.371  $ Position 27
1928  c/z  -19.03 -23.19  1.371  $ Position 28
1929  c/z  -23.19 -19.03  1.371  $ Position 29
1930  c/z  -26.46 -14.14  1.371  $ Position 30
1931  c/z  -28.71 -8.71   1.371  $ Position 31
1932  c/z  -29.86 -2.94   1.371  $ Position 32
c
c --------- Ring 2 ---------
2001  c/z  -34.82   6.93  1.371  $ Position 1
2002  c/z  -32.80  13.59  1.371  $ Position 2
2003  c/z  -29.52  19.72  1.371  $ Position 3
2004  c/z  -25.10  25.10  1.371  $ Position 4
2005  c/z  -19.72  29.52  1.371  $ Position 5
2006  c/z  -13.59  32.80  1.371  $ Position 6
2007  c/z   -6.93  34.82  1.371  $ Position 7
2008  c/z    0.00  35.50  1.371  $ Position 8
2009  c/z    6.93  34.82  1.371  $ Position 9
2010  c/z   13.59  32.80  1.371  $ Position 10
2011  c/z   19.72  29.52  1.371  $ Position 11
2012  c/z   25.10  25.10  1.371  $ Position 12
2013  c/z   29.52  19.72  1.371  $ Position 13
2014  c/z   32.80  13.59  1.371  $ Position 14
2015  c/z   34.82   6.93  1.371  $ Position 15
2016  c/z   35.50   0.00  1.371  $ Position 16
2017  c/z   34.82  -6.93  1.371  $ Position 17
2018  c/z   32.80 -13.59  1.371  $ Position 18
2019  c/z   29.52 -19.72  1.371  $ Position 19
2020  c/z   25.10 -25.10  1.371  $ Position 20
2021  c/z   19.72 -29.52  1.371  $ Position 21
2022  c/z   13.59 -32.80  1.371  $ Position 22
2023  c/z    6.93 -34.82  1.371  $ Position 23
2024  c/z    0.00 -35.50  1.371  $ Position 24
2025  c/z   -6.93 -34.82  1.371  $ Position 25
2026  c/z  -13.59 -32.80  1.371  $ Position 26
2027  c/z  -19.72 -29.52  1.371  $ Position 27
2028  c/z  -25.10 -25.10  1.371  $ Position 28
2029  c/z  -29.52 -19.72  1.371  $ Position 29
2030  c/z  -32.80 -13.59  1.371  $ Position 30
2031  c/z  -34.82  -6.93  1.371  $ Position 31
2032  c/z  -35.50   0.00  1.371  $ Position 32
c
c --------- Ring 3 ---------
2101  c/z  -39.23  11.90  1.371  $ Position 1
2102  c/z  -36.16  19.33  1.371  $ Position 2
2103  c/z  -31.69  26.01  1.371  $ Position 3
2104  c/z  -26.01  31.69  1.371  $ Position 4
2105  c/z  -19.33  36.16  1.371  $ Position 5
2106  c/z  -11.90  39.23  1.371  $ Position 6
2107  c/z   -4.02  40.80  1.371  $ Position 7
2108  c/z    4.02  40.80  1.371  $ Position 8
2109  c/z   11.90  39.23  1.371  $ Position 9
2110  c/z   19.33  36.16  1.371  $ Position 10
2111  c/z   26.01  31.69  1.371  $ Position 11
2112  c/z   31.69  26.01  1.371  $ Position 12
2113  c/z   36.16  19.33  1.371  $ Position 13
2114  c/z   39.23  11.90  1.371  $ Position 14
2115  c/z   40.80   4.02  1.371  $ Position 15
2116  c/z   40.80  -4.02  1.371  $ Position 16
2117  c/z   39.23 -11.90  1.371  $ Position 17
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2118  c/z   36.16 -19.33  1.371  $ Position 18
2119  c/z   31.69 -26.01  1.371  $ Position 19
2120  c/z   26.01 -31.69  1.371  $ Position 20
2121  c/z   19.33 -36.16  1.371  $ Position 21
2122  c/z   11.90 -39.23  1.371  $ Position 22
2123  c/z    4.02 -40.80  1.371  $ Position 23
2124  c/z   -4.02 -40.80  1.371  $ Position 24
2125  c/z  -11.90 -39.23  1.371  $ Position 25
2126  c/z  -19.33 -36.16  1.371  $ Position 26
2127  c/z  -26.01 -31.69  1.371  $ Position 27
2128  c/z  -31.69 -26.01  1.371  $ Position 28
2129  c/z  -36.16 -19.33  1.371  $ Position 29
2130  c/z  -39.23 -11.90  1.371  $ Position 30
2131  c/z  -40.80  -4.02  1.371  $ Position 31
2132  c/z  -40.80   4.02  1.371  $ Position 32
c
c --------- Ring 4 ---------
2201  c/z  -42.73  17.70  1.371  $ Position 1
2202  c/z  -38.46  25.70  1.371  $ Position 2
2203  c/z  -32.70  32.70  1.371  $ Position 3
2204  c/z  -25.70  38.46  1.371  $ Position 4
2205  c/z  -17.70  42.73  1.371  $ Position 5
2206  c/z   -9.02  45.36  1.371  $ Position 6
2207  c/z    0.00  46.25  1.371  $ Position 7
2208  c/z    9.02  45.36  1.371  $ Position 8
2209  c/z   17.70  42.73  1.371  $ Position 9
2210  c/z   25.70  38.46  1.371  $ Position 10
2211  c/z   32.70  32.70  1.371  $ Position 11
2212  c/z   38.46  25.70  1.371  $ Position 12
2213  c/z   42.73  17.70  1.371  $ Position 13
2214  c/z   45.36   9.02  1.371  $ Position 14
2215  c/z   46.25   0.00  1.371  $ Position 15
2216  c/z   45.36  -9.02  1.371  $ Position 16
2217  c/z   42.73 -17.70  1.371  $ Position 17
2218  c/z   38.46 -25.70  1.371  $ Position 18
2219  c/z   32.70 -32.70  1.371  $ Position 19
2220  c/z   25.70 -38.46  1.371  $ Position 20
2221  c/z   17.70 -42.73  1.371  $ Position 21
2222  c/z    9.02 -45.36  1.371  $ Position 22
2223  c/z    0.00 -46.25  1.371  $ Position 23
2224  c/z   -9.02 -45.36  1.371  $ Position 24
2225  c/z  -17.70 -42.73  1.371  $ Position 25
2226  c/z  -25.70 -38.46  1.371  $ Position 26
2227  c/z  -32.70 -32.70  1.371  $ Position 27
2228  c/z  -38.46 -25.70  1.371  $ Position 28
2229  c/z  -42.73 -17.70  1.371  $ Position 29
2230  c/z  -45.36  -9.02  1.371  $ Position 30
2231  c/z  -46.25   0.00  1.371  $ Position 31
2232  c/z  -45.36   9.02  1.371  $ Position 32
c
c --------- Ring 5 ---------
2301  c/z  -45.42  24.28  1.371  $ Position 1
2302  c/z  -39.81  32.67  1.371  $ Position 2
2303  c/z  -32.67  39.81  1.371  $ Position 3
2304  c/z  -24.28  45.42  1.371  $ Position 4
2305  c/z  -14.95  49.28  1.371  $ Position 5
2306  c/z   -5.05  51.25  1.371  $ Position 6
2307  c/z    5.05  51.25  1.371  $ Position 7
2308  c/z   14.95  49.28  1.371  $ Position 8
2309  c/z   24.28  45.42  1.371  $ Position 9
2310  c/z   32.67  39.81  1.371  $ Position 10
2311  c/z   39.81  32.67  1.371  $ Position 11
2312  c/z   45.42  24.28  1.371  $ Position 12
2313  c/z   49.28  14.95  1.371  $ Position 13
2314  c/z   51.25   5.05  1.371  $ Position 14
2315  c/z   51.25  -5.05  1.371  $ Position 15
2316  c/z   49.28 -14.95  1.371  $ Position 16
2317  c/z   45.42 -24.28  1.371  $ Position 17
2318  c/z   39.81 -32.67  1.371  $ Position 18
2319  c/z   32.67 -39.81  1.371  $ Position 19
2320  c/z   24.28 -45.42  1.371  $ Position 20
2321  c/z   14.95 -49.28  1.371  $ Position 21
2322  c/z    5.05 -51.25  1.371  $ Position 22
2323  c/z   -5.05 -51.25  1.371  $ Position 23
2324  c/z  -14.95 -49.28  1.371  $ Position 24
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2325  c/z  -24.28 -45.42  1.371  $ Position 25
2326  c/z  -32.67 -39.81  1.371  $ Position 26
2327  c/z  -39.81 -32.67  1.371  $ Position 27
2328  c/z  -45.42 -24.28  1.371  $ Position 28
2329  c/z  -49.28 -14.95  1.371  $ Position 29
2330  c/z  -51.25  -5.05  1.371  $ Position 30
2331  c/z  -51.25   5.05  1.371  $ Position 31
2332  c/z  -49.28  14.95  1.371  $ Position 32
c
c ------ Graphite Plugs ------
c --------- Ring 1 ---------
2401  c/z  -29.86   2.94  1.325  $ Position 1
2402  c/z  -28.71   8.71  1.325  $ Position 2
2403  c/z  -26.46  14.14  1.325  $ Position 3
2404  c/z  -23.19  19.03  1.325  $ Position 4
2405  c/z  -19.03  23.19  1.325  $ Position 5
2406  c/z  -14.14  26.46  1.325  $ Position 6
2407  c/z   -8.71  28.71  1.325  $ Position 7
2408  c/z   -2.94  29.86  1.325  $ Position 8
2409  c/z    2.94  29.86  1.325  $ Position 9
2410  c/z    8.71  28.71  1.325  $ Position 10
2411  c/z   14.14  26.46  1.325  $ Position 11
2412  c/z   19.03  23.19  1.325  $ Position 12
2413  c/z   23.19  19.03  1.325  $ Position 13
2414  c/z   26.46  14.14  1.325  $ Position 14
2415  c/z   28.71   8.71  1.325  $ Position 15
2416  c/z   29.86   2.94  1.325  $ Position 16
2417  c/z   29.86  -2.94  1.325  $ Position 17
2418  c/z   28.71  -8.71  1.325  $ Position 18
2419  c/z   26.46 -14.14  1.325  $ Position 19
2420  c/z   23.19 -19.03  1.325  $ Position 20
2421  c/z   19.03 -23.19  1.325  $ Position 21
2422  c/z   14.14 -26.46  1.325  $ Position 22
2423  c/z    8.71 -28.71  1.325  $ Position 23
2424  c/z    2.94 -29.86  1.325  $ Position 24
2425  c/z   -2.94 -29.86  1.325  $ Position 25
2426  c/z   -8.71 -28.71  1.325  $ Position 26
2427  c/z  -14.14 -26.46  1.325  $ Position 27
2428  c/z  -19.03 -23.19  1.325  $ Position 28
2429  c/z  -23.19 -19.03  1.325  $ Position 29
2430  c/z  -26.46 -14.14  1.325  $ Position 30
2431  c/z  -28.71  -8.71  1.325  $ Position 31
2432  c/z  -29.86  -2.94  1.325  $ Position 32
c
c --------- Ring 2 ---------
2501  c/z  -34.82   6.93  1.325  $ Position 1
2502  c/z  -32.80  13.59  1.325  $ Position 2
2503  c/z  -29.52  19.72  1.325  $ Position 3
2504  c/z  -25.10  25.10  1.325  $ Position 4
2505  c/z  -19.72  29.52  1.325  $ Position 5
2506  c/z  -13.59  32.80  1.325  $ Position 6
2507  c/z   -6.93  34.82  1.325  $ Position 7
2508  c/z    0.00  35.50  1.325  $ Position 8
2509  c/z    6.93  34.82  1.325  $ Position 9
2510  c/z   13.59  32.80  1.325  $ Position 10
2511  c/z   19.72  29.52  1.325  $ Position 11
2512  c/z   25.10  25.10  1.325  $ Position 12
2513  c/z   29.52  19.72  1.325  $ Position 13
2514  c/z   32.80  13.59  1.325  $ Position 14
2515  c/z   34.82   6.93  1.325  $ Position 15
2516  c/z   35.50   0.00  1.325  $ Position 16
2517  c/z   34.82  -6.93  1.325  $ Position 17
2518  c/z   32.80 -13.59  1.325  $ Position 18
2519  c/z   29.52 -19.72  1.325  $ Position 19
2520  c/z   25.10 -25.10  1.325  $ Position 20
2521  c/z   19.72 -29.52  1.325  $ Position 21
2522  c/z   13.59 -32.80  1.325  $ Position 22
2523  c/z    6.93 -34.82  1.325  $ Position 23
2524  c/z    0.00 -35.50  1.325  $ Position 24
2525  c/z   -6.93 -34.82  1.325  $ Position 25
2526  c/z  -13.59 -32.80  1.325  $ Position 26
2527  c/z  -19.72 -29.52  1.325  $ Position 27
2528  c/z  -25.10 -25.10  1.325  $ Position 28
2529  c/z  -29.52 -19.72  1.325  $ Position 29
2530  c/z  -32.80 -13.59  1.325  $ Position 30
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2531  c/z  -34.82  -6.93  1.325  $ Position 31
2532  c/z  -35.50   0.00  1.325  $ Position 32
c
c --------- Ring 3 ---------
2601  c/z  -39.23  11.90  1.325  $ Position 1
2602  c/z  -36.16  19.33  1.325  $ Position 2
2603  c/z  -31.69  26.01  1.325  $ Position 3
2604  c/z  -26.01  31.69  1.325  $ Position 4
2605  c/z  -19.33  36.16  1.325  $ Position 5
2606  c/z  -11.90  39.23  1.325  $ Position 6
2607  c/z   -4.02  40.80  1.325  $ Position 7
2608  c/z    4.02  40.80  1.325  $ Position 8
2609  c/z   11.90  39.23  1.325  $ Position 9
2610  c/z   19.33  36.16  1.325  $ Position 10
2611  c/z   26.01  31.69  1.325  $ Position 11
2612  c/z   31.69  26.01  1.325  $ Position 12
2613  c/z   36.16  19.33  1.325  $ Position 13
2614  c/z   39.23  11.90  1.325  $ Position 14
2615  c/z   40.80   4.02  1.325  $ Position 15
2616  c/z   40.80  -4.02  1.325  $ Position 16
2617  c/z   39.23 -11.90  1.325  $ Position 17
2618  c/z   36.16 -19.33  1.325  $ Position 18
2619  c/z   31.69 -26.01  1.325  $ Position 19
2620  c/z   26.01 -31.69  1.325  $ Position 20
2621  c/z   19.33 -36.16  1.325  $ Position 21
2622  c/z   11.90 -39.23  1.325  $ Position 22
2623  c/z    4.02 -40.80  1.325  $ Position 23
2624  c/z   -4.02 -40.80  1.325  $ Position 24
2625  c/z  -11.90 -39.23  1.325  $ Position 25
2626  c/z  -19.33 -36.16  1.325  $ Position 26
2627  c/z  -26.01 -31.69  1.325  $ Position 27
2628  c/z  -31.69 -26.01  1.325  $ Position 28
2629  c/z  -36.16 -19.33  1.325  $ Position 29
2630  c/z  -39.23 -11.90  1.325  $ Position 30
2631  c/z  -40.80  -4.02  1.325  $ Position 31
2632  c/z  -40.80   4.02  1.325  $ Position 32
c
c --------- Ring 4 ---------
2701  c/z  -42.73  17.70  1.325  $ Position 1
2702  c/z  -38.46  25.70  1.325  $ Position 2
2703  c/z  -32.70  32.70  1.325  $ Position 3
2704  c/z  -25.70  38.46  1.325  $ Position 4
2705  c/z  -17.70  42.73  1.325  $ Position 5
2706  c/z   -9.02  45.36  1.325  $ Position 6
2707  c/z    0.00  46.25  1.325  $ Position 7
2708  c/z    9.02  45.36  1.325  $ Position 8
2709  c/z   17.70  42.73  1.325  $ Position 9
2710  c/z   25.70  38.46  1.325  $ Position 10
2711  c/z   32.70  32.70  1.325  $ Position 11
2712  c/z   38.46  25.70  1.325  $ Position 12
2713  c/z   42.73  17.70  1.325  $ Position 13
2714  c/z   45.36   9.02  1.325  $ Position 14
2715  c/z   46.25   0.00  1.325  $ Position 15
2716  c/z   45.36  -9.02  1.325  $ Position 16
2717  c/z   42.73 -17.70  1.325  $ Position 17
2718  c/z   38.46 -25.70  1.325  $ Position 18
2719  c/z   32.70 -32.70  1.325  $ Position 19
2720  c/z   25.70 -38.46  1.325  $ Position 20
2721  c/z   17.70 -42.73  1.325  $ Position 21
2722  c/z    9.02 -45.36  1.325  $ Position 22
2723  c/z    0.00 -46.25  1.325  $ Position 23
2724  c/z   -9.02 -45.36  1.325  $ Position 24
2725  c/z  -17.70 -42.73  1.325  $ Position 25
2726  c/z  -25.70 -38.46  1.325  $ Position 26
2727  c/z  -32.70 -32.70  1.325  $ Position 27
2728  c/z  -38.46 -25.70  1.325  $ Position 28
2729  c/z  -42.73 -17.70  1.325  $ Position 29
2730  c/z  -45.36  -9.02  1.325  $ Position 30
2731  c/z  -46.25   0.00  1.325  $ Position 31
2732  c/z  -45.36   9.02  1.325  $ Position 32
c
c --------- Ring 5 ---------
2801  c/z  -45.42  24.28  1.325  $ Position 1
2802  c/z  -39.81  32.67  1.325  $ Position 2
2803  c/z  -32.67  39.81  1.325  $ Position 3
```

```
2804  c/z  -24.28  45.42  1.325  $ Position 4
2805  c/z  -14.95  49.28  1.325  $ Position 5
2806  c/z   -5.05  51.25  1.325  $ Position 6
2807  c/z    5.05  51.25  1.325  $ Position 7
2808  c/z   14.95  49.28  1.325  $ Position 8
2809  c/z   24.28  45.42  1.325  $ Position 9
2810  c/z   32.67  39.81  1.325  $ Position 10
2811  c/z   39.81  32.67  1.325  $ Position 11
2812  c/z   45.42  24.28  1.325  $ Position 12
2813  c/z   49.28  14.95  1.325  $ Position 13
2814  c/z   51.25   5.05  1.325  $ Position 14
2815  c/z   51.25  -5.05  1.325  $ Position 15
2816  c/z   49.28 -14.95  1.325  $ Position 16
2817  c/z   45.42 -24.28  1.325  $ Position 17
2818  c/z   39.81 -32.67  1.325  $ Position 18
2819  c/z   32.67 -39.81  1.325  $ Position 19
2820  c/z   24.28 -45.42  1.325  $ Position 20
2821  c/z   14.95 -49.28  1.325  $ Position 21
2822  c/z    5.05 -51.25  1.325  $ Position 22
2823  c/z   -5.05 -51.25  1.325  $ Position 23
2824  c/z  -14.95 -49.28  1.325  $ Position 24
2825  c/z  -24.28 -45.42  1.325  $ Position 25
2826  c/z  -32.67 -39.81  1.325  $ Position 26
2827  c/z  -39.81 -32.67  1.325  $ Position 27
2828  c/z  -45.42 -24.28  1.325  $ Position 28
2829  c/z  -49.28 -14.95  1.325  $ Position 29
2830  c/z  -51.25  -5.05  1.325  $ Position 30
2831  c/z  -51.25   5.05  1.325  $ Position 31
2832  c/z  -49.28  14.95  1.325  $ Position 32
c
c --- Control Rods --------------------------------------------------------------
c ------ Autorod ------
3031  px   -0.15  $ Coreside Copper Plate Face
3032  px    0.15  $ Farside Copper Plate Face
3033  pz  222.5   $ Top Surface of Plate
3034  p    -0.15 0 -7.5  0.15 0 -7.5  -0.15 -1.95 222.5 $ Angled Plate Surface
3035  p    -0.15 0 -7.5  0.15 0 -7.5  -0.15 1.95 222.5  $ Angled Plate Surface
3036  cz    2     $ Aluminum Tube Inner Radius
3037  cz    2.2   $ Aluminum Tube Outer Radius
c
c ------ Withdrawable Control Rods ------
3081  pz   75.5    $ Bottom of Bottom End Plug
3082  pz   77.0    $ Bottom of Tubes
3083  pz   78.0    $ Top of Bottom End Plug
3084  pz  287.0    $ Bottom of Top End Plug
3085  pz  292.0    $ Top of Tubes
3086  pz  294.5    $ Top of Top End Plug
3087  cz    0.475  $ Inner Tube Inner Radius
3088  cz    0.675  $ Inner Tube Outer Radius
3089  cz    0.7    $ Outer Tube Inner Radius
3090  cz    1.1    $ Outer Tube Outer Radius
c
3091  pz   73.0    $ Top of Graphite Plug
3092  cz    1.325  $ Radius of Graphite Plug
c
3095  so 1000      $ A Very Large Sphere
c
c --- Pebbles -------------------------------------------------------------------
c ------ TRISO ------
3111  so  0.0251   $ UO2 Kernel
3112  so  0.03425  $ Buffer Coating
3113  so  0.03824  $ IPyC Coating
3114  so  0.04177  $ SiC Coating
3115  so  0.04577  $ OPyC Coating
c
c ------ TRISO Lattice ------
3121  rpp -0.0879 0.0879 -0.0879 0.0879 -0.0879 0.0879
c
c ------ Fuel Pebble ------
3131  s   0 0 0  2.35  $ Fuel Zone
3132  s   0 0 0  3.00  $ Pebble Shell (Unfueled Zone)
c
c ------ Moderator Pebble ------
c    *Same dimension as Fuel Pebble Shell
c
```

```
c ------ CHPOP Pebble Lattice ------
6001  hex  0 0 -3.00  0 0 6.00  3.00 0 0
c
c ------ CHPOP Pebble Stack Lattice ------
6002  hex  0 0 -9.00  0 0 264.  3.00 0 0  $ Core Lattice
6003  hex  0 0 -9.00  0 0 264.  3.4  0 0  $ Adding Poly Rods
c
c --- Graphite Fillers -------------------------------------------------------
c ------ Axial Modifiers ------
7001  hex  0 0 78  0 0 172.9  60.15 0 0
7002  hex  0 0 78  0 0 172.9  0 60.3 0
7003  pz  250.9  $ Top Surface
c
c --- Water Ingress Simulation -----------------------------------------------
c    *Polyethylene Rods Not Used in Configuration 5
c
c ------ Polyethylene Rods (Cores 6 & 8) ------
7121  c/z  -3.0  1.732050808 0.300  $ NW Hole
7122  c/z   0.0  3.464101615 0.300  $ N Hole
7123  c/z   3.0  1.732050808 0.300  $ NE Hole
7124  c/z   3.0 -1.732050808 0.300  $ SE Hole
7125  c/z   0.0 -3.464101615 0.300  $ S Hole
7126  c/z  -3.0 -1.732050808 0.300  $ SW Hole
c
7127  pz    142                     $ Top of Rods (Core 6)
7128  pz     18                     $ Top of Rods (Core 8)
c
7129  p -3.0 0.866025404 1  -3.75 2.16506351 1  -3.75 2.16506351 -1  $ NW Rod Side 1
7130  p -3.75 2.16506351 1  -2.25 2.16506351 1  -2.25 2.16506351 -1  $ NW Rod Side 2
7131  p -2.25 2.16506351 1  -3.0 0.866025404 1  -3.0 0.866025404 -1  $ NW Rod Side 3
c
7132  p  0.0 4.330127019 1  -0.75 3.031088913 1  -0.75 3.031088913 -1  $ N Rod Side 1
7133  p -0.75 3.031088913 1  0.75 3.031088913 1  0.75 3.031088913 -1   $ N Rod Side 2
7134  p  0.75 3.031088913 1  0.0 4.330127019 1  0.0 4.330127019 -1     $ N Rod Side 3
c
7135  p  3.0 0.866025404 1  3.75 2.16506351 1  3.75 2.16506351 -1  $ NE Rod Side 1
7136  p  3.75 2.16506351 1  2.25 2.16506351 1  2.25 2.16506351 -1  $ NE Rod Side 2
7137  p  2.25 2.16506351 1  3.0 0.866025404 1  3.0 0.866025404 -1  $ NE Rod Side 3
c
7138  p  3.0 -0.866025404 1  3.75 -2.16506351 1  3.75 -2.16506351 -1  $ SE Rod Side 1
7139  p  3.75 -2.16506351 1  2.25 -2.16506351 1  2.25 -2.16506351 -1  $ SE Rod Side 2
7140  p  2.25 -2.16506351 1  3.0 -0.866025404 1  3.0 -0.866025404 -1  $ SE Rod Side 3
c
7141  p  0.0 -4.330127019 1  -0.75 -3.031088913 1  -0.75 -3.031088913 -1  $ S Rod Side 1
7142  p -0.75 -3.031088913 1  0.75 -3.031088913 1  0.75 -3.031088913 -1   $ S Rod Side 2
7143  p  0.75 -3.031088913 1  0.0 -4.330127019 1  0.0 -4.330127019 -1     $ S Rod Side 3
c
7144  p -3.0 -0.866025404 1  -3.75 -2.16506351 1  -3.75 -2.16506351 -1  $ SW Rod Side 1
7145  p -3.75 -2.16506351 1  -2.25 -2.16506351 1  -2.25 -2.16506351 -1  $ SW Rod Side 2
7146  p -2.25 -2.16506351 1  -3.0 -0.866025404 1  -3.0 -0.866025404 -1  $ SW Rod Side 3
c
c ------ Polyethylene Rods (Core 7) ------
7021  c/z  -3.0  1.732050808 0.415  $ NW Rod
7022  c/z   0.0  3.464101615 0.415  $ N Rod
7023  c/z   3.0  1.732050808 0.415  $ NE Rod
7024  c/z   3.0 -1.732050808 0.415  $ SE Rod
7025  c/z   0.0 -3.464101615 0.415  $ S Rod
7026  c/z  -3.0 -1.732050808 0.415  $ SW Rod
7027  pz    112                     $ Top of Rods
c
c ------ Copper Wire ------
c    Copper Wire Only Used in Configuration 6
c
7221  c/z  -3.0  1.732050808 0.0892  $ NW Hole
7222  c/z   0.0  3.464101615 0.0892  $ N Hole
7223  c/z   3.0  1.732050808 0.0892  $ NE Hole
7224  c/z   3.0 -1.732050808 0.0892  $ SE Hole
7225  c/z   0.0 -3.464101615 0.0892  $ S Hole
7226  c/z  -3.0 -1.732050808 0.0892  $ SW Hole
c
7227  pz    143                     $ Top of Wire
c
c ------ Very Large Sphere ------
9999  so  1000  $ For Modeling Purposes Only
c
```

```
c Data Cards ******************************************************************
c
c *** Material Cards **********************************************************
c ------ Graphite (Radial Reflector) ------
m3     5010.70c 2.3253E-08   5011.70c 9.3597E-08   6000.70c 8.7858E-02
c         Total 8.7858E-02
mt3   grph.10t
c
c ------ Graphite (Lower Axial Reflector Cylinder) ------
m4     5010.70c 2.3223E-08   5011.70c 9.3476E-08   6000.70c 8.7744E-02
c         Total 8.7744E-02
mt4   grph.10t
c
c ------ Graphite (Lower Axial Reflector Annulus) ------
m5     5010.70c 2.3356E-08   5011.70c 9.4011E-08   6000.70c 8.8245E-02
c         Total 8.8245E-02
mt5   grph.10t
c
c ------ Graphite (Upper Axial Reflector Cylinder) ------
m6     5010.70c 2.3235E-08   5011.70c 9.3524E-08   6000.70c 8.7789E-02
c         Total 8.7789E-02
mt6   grph.10t
c
c ------ Graphite (Upper Axial Reflector Annulus) ------
m7     5010.70c 2.3368E-08   5011.70c 9.4059E-08   6000.70c 8.8291E-02
c         Total 8.8291E-02
mt7   grph.10t
c
c ------ Peraluman-300 (Upper Axial Reflector) ------
m9     5010.70c 1.4688E-07   5011.70c 5.9119E-07  12024.70c 8.0390E-04
      12025.70c 1.0177E-04  12026.70c 1.1205E-04  13027.70c 5.7575E-02
      14028.70c 2.0962E-04  14029.70c 1.0644E-05  14030.70c 7.0168E-06
      25055.70c 7.2621E-05  26054.70c 5.0109E-06  26056.70c 7.8660E-05
      26057.70c 1.8166E-06  26058.70c 2.4176E-07  29063.70c 8.6855E-06
      29065.70c 3.8712E-06  30000.70c 2.4398E-05  31069.70c 6.8789E-07
      31071.70c 4.5653E-07  48106.70c 8.8729E-10  48108.70c 6.3175E-10
      48110.70c 8.8658E-09  48111.70c 9.0858E-09  48112.70c 1.7128E-08
      48113.70c 8.6741E-09  48114.70c 2.0393E-08  48116.70c 5.3166E-09
c         Total 5.9018E-02
mt9   al27.12t fe56.12t
c
c ------ Air ------
m10    1001.70c 5.7091E-07   1002.70c 6.5663E-11   7014.70c 3.7225E-05
       7015.70c 1.3749E-07   8016.70c 1.0322E-05   8017.70c 3.9239E-09
      18036.70c 7.5192E-10  18038.70c 1.4122E-10  18040.70c 2.2256E-07
       6000.70c 9.1319E-09
c         Total 4.8492E-05
mt10  lwtr.10t hwtr.10t
c
c --- Control Rods ------------------------------------------------------------
c ------ Copper Autorod (i.e. C110) ------
m13   29063.70c 5.8245E-02  29065.70c 2.5961E-02   8016.70c 6.6898E-05
       8017.70c 2.5431E-08  47107.70c 1.9296E-06  47109.70c 1.7927E-06
      16032.70c 1.1887E-05  16033.70c 9.5169E-08  16034.70c 5.3720E-07
      16036.70c 2.5044E-09  28058.70c 4.6572E-06  28060.70c 1.7939E-06
      28061.70c 7.7981E-08  28062.70c 2.4864E-07  28064.70c 6.3321E-08
      26054.70c 4.2025E-07  26056.70c 6.5971E-06  26057.70c 1.5236E-07
      26058.70c 2.0276E-08
c         Total 8.4303E-02
mt13  fe56.12t
c
c ------ Pure Aluminum Autorod Guide Tube (i.e. AL 1100) ------
m113  14028.70c 2.6697E-04  14029.70c 1.3556E-05  14030.70c 8.9364E-06
      26054.70c 8.5091E-06  26056.70c 1.3357E-04  26057.70c 3.0848E-06
      26058.70c 4.1053E-07  29063.70c 2.2123E-05  29065.70c 9.8607E-06
      25055.70c 7.3991E-06  30000.70c 1.2429E-05  27059.70c 6.8975E-05
      28058.70c 4.7148E-05  28060.70c 1.8161E-05  28061.70c 7.8946E-07
      28062.70c 2.5171E-06  28064.70c 6.4104E-07  50112.70c 3.3215E-07
      50114.70c 2.2600E-07  50115.70c 1.1642E-07  50116.70c 4.9788E-06
      50117.70c 2.6298E-06  50118.70c 8.2935E-06  50119.70c 2.9414E-06
      50120.70c 1.1156E-05  50122.70c 1.5854E-06  50124.70c 1.9826E-06
      13027.70c 5.9087E-02
c         Total 5.9746E-02
mt113  al27.12t fe56.12t
```

```
c
c ------ St1.4301 Stainless Steel (Inner Tube) ------
m17    6000.70c 1.3864E-04  14028.70c 7.8115E-04  14029.70c 3.9665E-05
      14030.70c 2.6147E-05  25055.70c 8.6597E-04  24050.70c 7.3547E-04
      24052.70c 1.4183E-02  24053.70c 1.6082E-03  24054.70c 4.0032E-04
      28058.70c 5.6560E-03  28060.70c 2.1787E-03  28061.70c 9.4706E-05
      28062.70c 3.0196E-04  28064.70c 7.6901E-05  26054.70c 3.4714E-03
      26056.70c 5.4493E-02  26057.70c 1.2585E-03  26058.70c 1.6748E-04
c         Total 8.6477E-02
mt17  fe56.12t
c
c ------ St1.4541 Stainless Steel (Outer Tube) ------
m18     6000.70c 1.9805E-04  14028.70c 7.8115E-04  14029.70c 3.9665E-05
       14030.70c 2.6147E-05  25055.70c 8.6597E-04  24050.70c 7.1559E-04
       24052.70c 1.3800E-02  24053.70c 1.5648E-03  24054.70c 3.8950E-04
       28058.70c 5.6560E-03  28060.70c 2.1787E-03  28061.70c 9.4706E-05
       28062.70c 3.0196E-04  28064.70c 7.6901E-05  22046.70c 4.0998E-06
       22047.70c 3.6973E-06  22048.70c 3.6635E-05  22049.70c 2.6885E-06
       22050.70c 2.5742E-06  26054.70c 3.4930E-03  26056.70c 5.4833E-02
       26057.70c 1.2663E-03  26058.70c 1.6853E-04
c         Total 8.6499E-02
mt18  fe56.12t
c
c --- Pebbles -----------------------------------------------------------------
c ------ UO2 ------
m19    8016.70c 4.8593E-02   8017.70c 1.8472E-05  92234.70c 3.3079E-05
      92235.70c 4.1172E-03  92236.70c 2.0499E-05  92238.70c 2.0135E-02
c         Total 7.2917E-02
mt19  o2/u.10t u/o2.10t
c
c ------ Buffer ------
m20    6000.70c 5.2640E-02
c         Total 5.2640E-02
mt20  grph.10t
c
c ------ IPyC ------
m21    6000.70c 9.5254E-02
c         Total 9.5254E-02
mt21  grph.10t
c
c ------ SiC ------
m22   14028.70c 4.4321E-02  14029.70c 2.2505E-03  14030.70c 1.4836E-03
       6000.70c 4.8055E-02
c         Total 9.6110E-02
mt22  grph.10t
c
c ------ OPyC ------
m23    6000.70c 9.4752E-02
c         Total 9.4772E-02
mt23  grph.10t
c
c ------ Fuel Pebbles ------
m24    6000.70c 8.6842E-02  47107.70c 5.0131E-10  47109.70c 4.6575E-10
       5010.70c 1.9393E-09   5011.70c 7.8061E-09  20040.70c 2.3415E-07
      20042.70c 1.5628E-09  20043.70c 3.2608E-10  20044.70c 5.0385E-09
      20046.70c 9.6616E-12  20048.70c 4.5168E-10  48106.70c 5.9739E-12
      48108.70c 4.2534E-12  48110.70c 5.9691E-11  48111.70c 6.1172E-11
      48112.70c 1.1532E-10  48113.70c 5.8401E-11  48114.70c 1.3730E-10
      48116.70c 3.5795E-11  17035.70c 3.3446E-08  17037.70c 1.0690E-08
      27059.70c 1.1505E-09  24050.70c 1.5778E-09  24052.70c 3.0426E-08
      24053.70c 3.4500E-09  24054.70c 8.5879E-10  66156.70c 1.9258E-14
      66158.70c 3.2097E-14  66160.70c 7.5107E-13  66161.70c 6.0695E-12
      66162.70c 8.1879E-12  66163.70c 7.9921E-12  66164.70c 9.0449E-12
      63151.70c 1.6409E-11  63153.70c 1.7913E-11  26054.70c 3.2208E-09
      26056.70c 5.0560E-08  26057.70c 1.1677E-09  26058.70c 1.5539E-10
      64152.70c 6.6337E-14  64154.70c 7.2307E-13  64155.70c 4.9089E-12
      64156.70c 6.7896E-12  64157.70c 5.1909E-12  64158.70c 8.2391E-12
      64160.70c 7.2506E-12   3006.70c 5.7034E-09   3007.70c 6.9441E-08
      25055.70c 8.1647E-09  28058.70c 6.0496E-09  28060.70c 2.3303E-09
      28061.70c 1.0130E-10  28062.70c 3.2298E-10  28064.70c 8.2253E-11
      16032.70c 1.6986E-10  16033.70c 1.3599E-12  16034.70c 7.6760E-12
      16036.70c 3.5786E-14  22046.70c 8.9355E-10  22047.70c 8.0582E-10
      22048.70c 7.9846E-09  22049.70c 5.8596E-10  22050.70c 5.6104E-10
      23000.70c 4.4334E-09   1001.70c 1.1579E-05   1002.70c 1.3318E-09
       8016.70c 5.7882E-06   8017.70c 2.2003E-09
```

```
c         Total 8.6859E-02
mt24  grph.10t lwtr.10t hwtr.10t
c
c ------ Moderator Pebbles ------
m26    6000.70c 8.4434E-02   5010.70c 1.4193E-08   5011.70c 5.7130E-08
      20040.70c 3.1657E-06  20042.70c 2.1129E-08  20043.70c 4.4086E-09
      20044.70c 6.8121E-08  20046.70c 1.3062E-10  20048.70c 6.1067E-09
      48106.70c 3.3846E-11  48108.70c 2.4098E-11  48110.70c 3.3819E-10
      48111.70c 3.4658E-10  48112.70c 6.5336E-10  48113.70c 3.3088E-10
      48114.70c 7.7791E-10  48116.70c 2.0280E-10  17035.70c 4.0423E-07
      17037.70c 1.2920E-07  66156.70c 2.4350E-13  66158.70c 4.0583E-13
      66160.70c 9.4964E-12  66161.70c 7.6742E-11  66162.70c 1.0353E-10
      66163.70c 1.0105E-10  66164.70c 1.1436E-10  63151.70c 4.1496E-10
      63153.70c 4.5297E-10  26054.70c 6.2652E-09  26056.70c 9.8350E-08
      26057.70c 2.2713E-09  26058.70c 3.0227E-10  64152.70c 5.1616E-13
      64154.70c 5.6261E-12  64155.70c 3.8196E-11  64156.70c 5.2829E-11
      64157.70c 4.0389E-11  64158.70c 6.4107E-11  64160.70c 5.6416E-11
       3006.70c 9.7630E-09   3007.70c 1.1887E-07  28058.70c 9.1788E-09
      28060.70c 3.5357E-09  28061.70c 1.5369E-10  28062.70c 4.9004E-10
      28064.70c 1.2480E-10  16032.70c 4.2052E-06  16033.70c 3.3666E-08
      16034.70c 1.9004E-07  16036.70c 8.8595E-10  14028.70c 1.1661E-06
      14029.70c 5.9212E-08  14030.70c 3.9033E-08  62144.70c 1.7815E-11
      62147.70c 8.6986E-11  62148.70c 6.5225E-11  62149.70c 8.0197E-11
      62150.70c 4.2826E-11  62152.70c 1.5523E-10  62154.70c 1.3202E-10
      22046.70c 1.7486E-08  22047.70c 1.5770E-08  22048.70c 1.5625E-07
      22049.70c 1.1467E-08  22050.70c 1.0979E-08  23000.70c 2.5891E-07
       1001.70c 1.1262E-05   1002.70c 1.2953E-09   8016.70c 5.6296E-06
       8017.70c 2.1401E-09
c         Total 8.4461E-02
mt26  grph.10t lwtr.10t hwtr.10t
c
c --- Graphite Fillers -----------------------------------------------------
c ------ Short Plugs/Rods (Axial Reflectors) ------
m29    5010.70c 2.3356E-08   5011.70c 9.4011E-08   6000.70c 8.8245E-02
c         Total 8.8245E-02
mt29  grph.10t
c
c ------ Source Plug (Lower Axial Reflector) ------
m30    5010.70c 2.3356E-08   5011.70c 9.4011E-08   6000.70c 8.8245E-02
c         Total 8.8245E-02
mt30  grph.10t
c
c --- Water Ingress Simulation ---------------------------------------------
c ------ Polyethylene Rods (Cores 6 & 8) ------
m34    5010.70c 5.1775E-09   5011.70c 2.0840E-08   1001.70c 8.1231E-02
       1002.70c 9.3427E-06   6000.70c 4.0020E-02
c         Total 1.2126E-01
c
c ------ Polyethylene Rods (Core 7) ------
c m34    5010.70c 5.2110E-09   5011.70c 2.0975E-08   1001.70c 8.1756E-02
c        1002.70c 9.4031E-06   6000.70c 4.0279E-02
c         Total 1.2204E-01
c
mt34  poly.10t
c
c ------ Copper Wire (Core 6) ------
m35   29063.70c 5.8504E-02  29065.70c 2.6076E-02   8016.70c 6.7195E-05
       8017.70c 2.5544E-08  47107.70c 1.9382E-06  47109.70c 1.8007E-06
      16032.70c 1.1940E-05  16033.70c 9.5591E-08  16034.70c 5.3959E-07
      16036.70c 2.5156E-09  28058.70c 4.6778E-06  28060.70c 1.8019E-06
      28061.70c 7.8327E-08  28062.70c 2.4974E-07  28064.70c 6.3602E-08
      26054.70c 4.2212E-07  26056.70c 6.6264E-06  26057.70c 1.5303E-07
      26058.70c 2.0366E-08
c         Total 8.4678E-02
mt35  fe56.12t
c
c *** Control Cards ********************************************************
mode  n
kcode 100000 1 150 1650
ksrc  0 0  80  40 40  80  40 -40  80  -40 -40  80  -40 40  80
      0 0  90  40 40  90  40 -40  90  -40 -40  90  -40 40  90
      0 0 100  40 40 100  40 -40 100  -40 -40 100  -40 40 100
      0 0 110  40 40 110  40 -40 110  -40 -40 110  -40 40 110
      0 0 120  40 40 120  40 -40 120  -40 -40 120  -40 40 120
      0 0 130  40 40 130  40 -40 130  -40 -40 130  -40 40 130
```

```
      0 0 140  40 40 140  40 -40 140  -40 -40 140  -40 40 140
      0 0 150  40 40 150  40 -40 150  -40 -40 150  -40 40 150
      0 20  80  20 0  80  -20 0  80  0 -20  80
      0 20  90  20 0  90  -20 0  90  0 -20  90
      0 20 100  20 0 100  -20 0 100  0 -20 100
      0 20 110  20 0 110  -20 0 110  0 -20 110
      0 20 120  20 0 120  -20 0 120  0 -20 120
      0 20 130  20 0 130  -20 0 130  0 -20 130
      0 20 140  20 0 140  -20 0 140  0 -20 140
      0 20 150  20 0 150  -20 0 150  0 -20 150
      0 50  80  50 0  80  -50 0  80  0 -50  80
      0 50  90  50 0  90  -50 0  90  0 -50  90
      0 50 100  50 0 100  -50 0 100  0 -50 100
      0 50 110  50 0 110  -50 0 110  0 -50 110
      0 50 120  50 0 120  -50 0 120  0 -50 120
      0 50 130  50 0 130  -50 0 130  0 -50 130
      0 50 140  50 0 140  -50 0 140  0 -50 140
      0 50 150  50 0 150  -50 0 150  0 -50 150
c
kopts  blocksize=10 kinetics=yes precursor=yes
c print
c
```

A.2 Buckling and Extrapolation Length Configurations

Buckling and extrapolation length measurements were made but have not yet been evaluated.

A.3 Spectral-Characteristics Configurations

Spectral characteristics measurements were not made.

A.4 Reactivity-Effects Configurations

Reactivity effects measurements were made but have not yet been evaluated.

A.5 Reactivity Coefficient Configurations

Reactivity coefficient measurements were made but have not yet been evaluated.

A.6 Kinetics Parameter Configurations

Kinetics measurements were made but have not yet been evaluated.

A.7 Reaction-Rate Configurations

Reaction-rate distribution measurements were made but have not yet been evaluated.

A.8 Power Distribution Configurations

Power distribution measurements were not made.

A.9 Isotopic Configurations

Isotopic measurements were not made.

A.10 Configurations of Other Miscellaneous Types of Measurements

Other miscellaneous types of measurements were not made.

APPENDIX B: CALCULATED SPECTRAL DATA

The neutron spectral calculations provided below were obtained from the output files for the input decks used to obtain the results in Section 4.1. Spectral data using the ENDF/B-VII.0 neutron cross section library is provided here for the MCNP5 analysis.

B.1 MCNP-Calculated Spectral Data

A summary of the computed neutron spectral data using MCNP5 for the benchmark model is provided in Tables B.1-1 through B.1-4 for Cases 1 through 4 (Cores 5 through 8), respectively.

Table B.1-1. Neutron Spectral Data for Benchmark Model for Case 1 (Core 5).

Neutron Cross Section Library		ENDF/B-VII.0
k_{eff}		1.00714
$\pm\sigma_k$		0.00007
Neutron Leakage (%)[(a)]		15.66
Fission Fraction, by Energy (%)	**Thermal (<0.625 eV)**	93.85
	Intermediate	5.75
	Fast (>100 keV)	0.40
Average Number of Neutrons Produced per Fission		2.437
Energy of Average Neutron Lethargy Causing Fission (eV)		0.062926
Neutron Generation Time, Λ (msec)		1.85934
Rossi-α ($msec^{-1}$)		-3.76712E-03
β_{eff}		0.00700

(a) The neutron leakage is calculated using the neutron balance tables provided in the MCNP output file. The weight fraction of neutrons lost due to escaping the boundaries of the benchmark model are divided by the total weight fraction of neutron loss.

Table B.1-2. Neutron Spectral Data for Benchmark Model for Case 2 (Core 6).

Neutron Cross Section Library		ENDF/B-VII.0
k_{eff}		1.00650
$\pm\sigma_k$		0.00006
Neutron Leakage (%)[(a)]		10.90
Fission Fraction, by Energy (%)	**Thermal (<0.625 eV)**	96.48
	Intermediate	3.19
	Fast (>100 keV)	0.33
Average Number of Neutrons Produced per Fission		2.437
Energy of Average Neutron Lethargy Causing Fission (eV)		0.044045
Neutron Generation Time, Λ (msec)		1.19579
Rossi-α ($msec^{-1}$)		-5.78850E-03
β_{eff}		0.00692

(a) The neutron leakage is calculated using the neutron balance tables provided in the MCNP output file. The weight fraction of neutrons lost due to escaping the boundaries of the benchmark model are divided by the total weight fraction of neutron loss.

Table B.1-3. Neutron Spectral Data for Benchmark Model for Case 3 (Core 7).

Neutron Cross Section Library		ENDF/B-VII.0
k_{eff}		1.00863
$\pm\sigma_k$		0.00006
Neutron Leakage (%)[(a)]		13.33
Fission Fraction, by Energy (%)	**Thermal (<0.625 eV)**	96.32
	Intermediate	3.34
	Fast (>100 keV)	0.34
Average Number of Neutrons Produced per Fission		2.438
Energy of Average Neutron Lethargy Causing Fission (eV)		0.045353
Neutron Generation Time, Λ (msec)		1.40717
Rossi-α ($msec^{-1}$)		-5.08680E-03
β_{eff}		0.00716

(a) The neutron leakage is calculated using the neutron balance tables provided in the MCNP output file. The weight fraction of neutrons lost due to escaping the boundaries of the benchmark model are divided by the total weight fraction of neutron loss.

Table B.1-4. Neutron Spectral Data for Benchmark Model for Case 4 (Core 8).

Neutron Cross Section Library		ENDF/B-VII.0
k_{eff}		1.00812
$\pm\sigma_k$		0.00007
Neutron Leakage (%)[(a)]		14.93
Fission Fraction, by Energy (%)	Thermal (<0.625 eV)	94.19
	Intermediate	5.42
	Fast (>100 keV)	0.39
Average Number of Neutrons Produced per Fission		2.437
Energy of Average Neutron Lethargy Causing Fission (eV)		0.059943
Neutron Generation Time, Λ (msec)		1.74313
Rossi-α ($msec^{-1}$)		-4.05134E-03
β_{eff}		0.00706

(a) The neutron leakage is calculated using the neutron balance tables provided in the MCNP output file. The weight fraction of neutrons lost due to escaping the boundaries of the benchmark model are divided by the total weight fraction of neutron loss.

APPENDIX C: DETAILED MODELS OF HTR-PROTEUS

C.1 Detailed MCNP Models of the HTR-PROTEUS (NOT BENCHMARKED)

Detailed models of HTR-PROTEUS core configurations 5, 6, 7, and 8 were prepared to evaluate biases in the benchmark model. Because the effects of many of the model simplifications produced small or otherwise negligible biases (in regards to criticality) in the benchmark model, development of a detailed benchmark model was unnecessary. An example MCNP5 input deck, using ENDF/B-VII.0 neutron cross section data, is preserved in this appendix for future use. Calculations were performed with 1,650 generations with 100,000 neutrons per generation. The k_{eff} estimates (with the first 150 generations skipped) are the result of 150,000,000 neutron histories. Calculated results obtained with this input deck are provided in Tables C.1-1 through C.1-4 for each core, respectively.

The input deck provided below is for core configuration 5. The following portions of the code need reconfigured for core configuration 6 through 8:

- Autorod position,
- Withdrawable control rod positions,
- All closed (Cores 5, 6, and 7) or 33 open coolant channels (Core 8) in the lower axial reflector,
- Core cavity filled with correct pebble configuration (including polyethylene rods), and
- Change air composition and atom density.

Table C.1-1. Neutron Spectral Data for Detailed Model (Core 5).

Neutron Cross Section Library		ENDF/B-VII.0
$\mathbf{k_{eff}}$		1.00576
$\pm\sigma_k$		0.00007
Neutron Leakage (%)[(a)]		1.60
Fission Fraction, by Energy (%)	**Thermal (<0.625 eV)**	93.84
	Intermediate	5.76
	Fast (>100 keV)	0.40
Average Number of Neutrons Produced per Fission		2.437
Energy of Average Neutron Lethargy Causing Fission (eV)		0.062978
Neutron Generation Time, Λ (msec)		1.87321
Rossi-α ($\mathbf{msec^{-1}}$)		-3.82794E-03
β_{eff}		0.00717

(a) The neutron leakage is calculated using the neutron balance tables provided in the MCNP output file. The weight fraction of neutrons lost due to escaping the boundaries of the benchmark model are divided by the total weight fraction of neutron loss.

Table C.1-2. Neutron Spectral Data for Detailed Model (Core 6).

Neutron Cross Section Library		ENDF/B-VII.0
k_{eff}		1.00585
$\pm\sigma_k$		0.00006
Neutron Leakage (%)[(a)]		1.05
Fission Fraction, by Energy (%)	Thermal (<0.625 eV)	96.48
	Intermediate	3.18
	Fast (>100 keV)	0.33
Average Number of Neutrons Produced per Fission		2.437
Energy of Average Neutron Lethargy Causing Fission (eV)		0.044049
Neutron Generation Time, Λ (msec)		1.20833
Rossi-α ($msec^{-1}$)		-5.74457E-03
β_{eff}		0.00694

(a) The neutron leakage is calculated using the neutron balance tables provided in the MCNP output file. The weight fraction of neutrons lost due to escaping the boundaries of the benchmark model are divided by the total weight fraction of neutron loss.

Table C.1-3. Neutron Spectral Data for Detailed Model (Core 7).

Neutron Cross Section Library		ENDF/B-VII.0
k_{eff}		1.00769
$\pm\sigma_k$		0.00006
Neutron Leakage (%)[(a)]		1.27
Fission Fraction, by Energy (%)	Thermal (<0.625 eV)	96.32
	Intermediate	3.34
	Fast (>100 keV)	0.34
Average Number of Neutrons Produced per Fission		2.437
Energy of Average Neutron Lethargy Causing Fission (eV)		0.045367
Neutron Generation Time, Λ (msec)		1.41459
Rossi-α ($msec^{-1}$)		-4.92322E-03
β_{eff}		0.00696

(a) The neutron leakage is calculated using the neutron balance tables provided in the MCNP output file. The weight fraction of neutrons lost due to escaping the boundaries of the benchmark model are divided by the total weight fraction of neutron loss.

Table C.1-4. Neutron Spectral Data for Detailed Model (Core 8).

Neutron Cross Section Library		ENDF/B-VII.0
k_{eff}		1.00677
$\pm\sigma_k$		0.00007
Neutron Leakage (%)[(a)]		1.56
Fission Fraction, by Energy (%)	**Thermal (<0.625 eV)**	94.19
	Intermediate	5.42
	Fast (>100 keV)	0.39
Average Number of Neutrons Produced per Fission		2.438
Energy of Average Neutron Lethargy Causing Fission (eV)		0.059959
Neutron Generation Time, Λ (msec)		1.75832
Rossi-α ($msec^{-1}$)		-3.98480E-03
β_{eff}		0.00701

(a) The neutron leakage is calculated using the neutron balance tables provided in the MCNP output file. The weight fraction of neutrons lost due to escaping the boundaries of the benchmark model are divided by the total weight fraction of neutron loss.

C.2 Input Listing for Detailed Models

MCNP5 Input Deck for Core 5 (can be modified for Cores 6 through 8):

```
HTR-PROTEUS :: Cores 5, 6, 7 & 8
c Pebble Bed Experimental Program
c Columnar Hexagonal Point-On-Point Packing with a 1:2 Moderator to Fuel Pebble Ratio
c
c John Darrell Bess - Idaho National Laboratory
c Last Updated: July 23, 2012
c
c Cell Cards ******************************************************************
c --- Structural Surroundings ---------------------------------------------------
c ------ Concrete ------
1    1 6.1726E-02  (-1:3:-5:7) 2 -4 6 -8 15 -9 imp:n=1
c
c ------ Steel Plate Pedestal ------
2    2 8.6882E-02  1 -3 5 -7 15 -31
          (1101 1102 1103 1104 1105 1106 1107 1108 1109 1110 1111 1112 1113)
          imp:n=1
c
c ------ Thermal Column ------
3    3 8.8245E-02  21 -22 23 -24 1 (7545:7546:7547:7548) imp:n=1
c
c ------ Air ------
4    10 4.8648E-05  (1 -3 5 -7 31 -9 #3)
          (7531:7532:7533:7534:7535:7536:7537:7538:7539:7540:7541:
          7542:7543:7544:7545:7546:7547:7548:7549:7550:7551:7552) imp:n=1
5    10 4.8648E-05  32 -9
          (7501:7502:7503:7504:7505:7506:7507:7508:7509:7510:7511:
          7512:7513:7514:7515:7516:7517:7518:7519:7520:7521:7522)
          -7531 -7532 -7533 -7534 -7535 -7536 -7537 -7538 -7539 -7540 -7541
          -7542 -7543 -7544 -7545 -7546 -7547 -7548 -7549 -7550 -7551 -7552
          (1101 1102 1103 1104 1105 1106 1107 1108)
          (1109 1110 1111 1112 1113) (503 519 535 551) imp:n=1
6    10 4.8648E-05  1202 -9
          -7501 -7502 -7503 -7504 -7505 -7506 -7507 -7508 -7509 -7510 -7511
          -7512 -7513 -7514 -7515 -7516 -7517 -7518 -7519 -7520 -7521 -7522
          imp:n=1
c
c --- Radial Reflector ---------------------------------------------------------
11   3 8.8245E-02  (7501:7502:7503:7504:7505:7506:7507:7508:7509:7510:7511:
          7512:7513:7514:7515:7516:7517:7518:7519:7520:7521:7522)
          -165 31 -32 #21
          (1101 1102 1103 1104 1105 1106 1107 1108)
          (101 102     104 105 106 107 108 109 110     112 113 114 115 116
           117 118 119     121 122 123 124 125 126     128 129 130 131 132
           133 134     136 137 138 139 140 141 142 143     145 146 147 148
           149 150     152 153 154 155 156 157     159 160 161 162 163 164)
           imp:n=1  $ Ring 1 Region
12   3 8.8245E-02  165 -265 31 -32
          (1101 1102 1103 1104 1105 1106 1107 1108)
          (201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216
           217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232
           233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248
           249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264)
           imp:n=1  $ Ring 2 Region
13   3 8.8245E-02  265 -365 31 -32
          (301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316
           317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332
           333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348
           349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364)
           imp:n=1  $ Ring 3 Region
14   3 8.8245E-02  365 -465 31 -32
          (1109 1110 1111 1112 1113)
          (401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416
           417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432
           433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448
           449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464)
           imp:n=1  $ Ring 4 Region
15   3 8.8245E-02  465  31 -32
          -7531 -7532 -7533 -7534 -7535 -7536 -7537 -7538 -7539 -7540 -7541
          -7542 -7543 -7544 -7545 -7546 -7547 -7548 -7549 -7550 -7551 -7552
          (1109 1110 1111 1112 1113)
```

```
          (501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516
           517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532
           533 534 535 536 537 538 539 540 541 542 543 544     546 547 548
           549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564)
           imp:n=1  $ Ring 5 Region
c
c ------ Safety Ring ------
21   8 5.9018E-02  41 -42 43 -44
          (101 102     104 105 106 107 108 109 110     112 113 114 115 116
           117 118 119     121 122 123 124 125 126     128 129 130 131 132
           133 134     136 137 138 139 140 141 142 143     145 146 147 148
           149 150     152 153 154 155 156 157     159 160 161 162 163 164)
          (1101 1102 1103 1104 1105 1106 1107 1108)
           imp:n=1
c
c ------ Air Gap ------
22   10 4.8492E-05  7003 -1801 (-1804:1805:1802) #21
          -7501 -7502 -7503 -7504 -7505 -7506 -7507 -7508 -7509 -7510 -7511
          -7512 -7513 -7514 -7515 -7516 -7517 -7518 -7519 -7520 -7521 -7522
          imp:n=1
c
c ------ C-Driver Channels ------
c --------- Ring 1 ---------
101  10 4.8648E-05  -101 601 31 -32 imp:n=1  $ Position 1
102  10 4.8648E-05  -102 602 31 -32 imp:n=1  $ Position 2
c    *Replaced by Safety/Shutdown Rod  $ Position 3
104  10 4.8648E-05  -104 604 31 -32 imp:n=1  $ Position 4
105  10 4.8648E-05  -105 605 31 -32 imp:n=1  $ Position 5
106  10 4.8648E-05  -106 606 31 -32 imp:n=1  $ Position 6
107  10 4.8648E-05  -107 607 31 -32 imp:n=1  $ Position 7
108  10 4.8648E-05  -108 608 31 -32 imp:n=1  $ Position 8
109  10 4.8648E-05  -109 609 31 -32 imp:n=1  $ Position 9
110  10 4.8648E-05  -110 610 31 -32 imp:n=1  $ Position 10
c    *Replaced by Safety/Shutdown Rod  $ Position 11
112  10 4.8648E-05  -112 612 31 -32 imp:n=1  $ Position 12
113  10 4.8648E-05  -113 613 31 -32 imp:n=1  $ Position 13
114  10 4.8648E-05  -114 614 31 -32 imp:n=1  $ Position 14
115  10 4.8648E-05  -115 615 31 -32 imp:n=1  $ Position 15
116  10 4.8648E-05  -116 616 31 -32 imp:n=1  $ Position 16
117  10 4.8648E-05  -117 617 31 -32 imp:n=1  $ Position 17
118  10 4.8648E-05  -118 618 31 -32 imp:n=1  $ Position 18
119  10 4.8648E-05  -119 619 31 -32 imp:n=1  $ Position 19
c    *Replaced by Safety/Shutdown Rod  $ Position 20
121  10 4.8648E-05  -121 621 31 -32 imp:n=1  $ Position 21
122  10 4.8648E-05  -122 622 31 -32 imp:n=1  $ Position 22
123  10 4.8648E-05  -123 623 31 -32 imp:n=1  $ Position 23
124  10 4.8648E-05  -124 624 31 -32 imp:n=1  $ Position 24
125  10 4.8648E-05  -125 625 31 -32 imp:n=1  $ Position 25
126  10 4.8648E-05  -126 626 31 -32 imp:n=1  $ Position 26
c    *Replaced by Safety/Shutdown Rod  $ Position 27
128  10 4.8648E-05  -128 628 31 -32 imp:n=1  $ Position 28
129  10 4.8648E-05  -129 629 31 -32 imp:n=1  $ Position 29
130  10 4.8648E-05  -130 630 31 -32 imp:n=1  $ Position 30
131  10 4.8648E-05  -131 631 31 -32 imp:n=1  $ Position 31
132  10 4.8648E-05  -132 632 31 -32 imp:n=1  $ Position 32
133  10 4.8648E-05  -133 633 31 -32 imp:n=1  $ Position 33
134  10 4.8648E-05  -134 634 31 -32 imp:n=1  $ Position 34
c    *Replaced by Safety/Shutdown Rod  $ Position 35
136  10 4.8648E-05   -136 636 31 -32 imp:n=1  $ Position 36
137  10 4.8648E-05   -137 637 31 -32 imp:n=1  $ Position 37
138  10 4.8648E-05   -138 638 31 -32 imp:n=1  $ Position 38
139  10 4.8648E-05   -139 639 31 -32 imp:n=1  $ Position 39
140  10 4.8648E-05   -140 640 31 -32 imp:n=1  $ Position 40
141  10 4.8648E-05   -141 641 31 -32 imp:n=1  $ Position 41
142  10 4.8648E-05   -142 642 31 -32 imp:n=1  $ Position 42
143  10 4.8648E-05   -143 643 31 -32 imp:n=1  $ Position 43
c    *Replaced by Safety/Shutdown Rod  $ Position 44
145  10 4.8648E-05   -145 645 31 -32 imp:n=1  $ Position 45
146  10 4.8648E-05   -146 646 31 -32 imp:n=1  $ Position 46
147  10 4.8648E-05   -147 647 31 -32 imp:n=1  $ Position 47
148  10 4.8648E-05   -148 648 31 -32 imp:n=1  $ Position 48
149  10 4.8648E-05   -149 649 31 -32 imp:n=1  $ Position 49
150  10 4.8648E-05   -150 650 31 -32 imp:n=1  $ Position 50
c    *Replaced by Safety/Shutdown Rod  $ Position 51
152  10 4.8648E-05   -152 652 31 -32 imp:n=1  $ Position 52
```

```
153  10 4.8648E-05   -153 653 31 -32 imp:n=1  $ Position 53
154  10 4.8648E-05   -154 654 31 -32 imp:n=1  $ Position 54
155  10 4.8648E-05   -155 655 31 -32 imp:n=1  $ Position 55
156  10 4.8648E-05   -156 656 31 -32 imp:n=1  $ Position 56
157  10 4.8648E-05   -157 657 31 -32 imp:n=1  $ Position 57
c    *Replaced by Safety/Shutdown Rod  $ Position 58
159  10 4.8648E-05   -159 659 31 -32 imp:n=1  $ Position 59
160  10 4.8648E-05   -160 660 31 -32 imp:n=1  $ Position 60
161  10 4.8648E-05   -161 661 31 -32 imp:n=1  $ Position 61
162  10 4.8648E-05   -162 662 31 -32 imp:n=1  $ Position 62
163  10 4.8648E-05   -163 663 31 -32 imp:n=1  $ Position 63
164  10 4.8648E-05   -164 664 31 -32 imp:n=1  $ Position 64
c
c --------- Ring 2 ---------
201  10 4.8648E-05   -201 701 31 -32 imp:n=1  $ Position 1
202  10 4.8648E-05   -202 702 31 -32 imp:n=1  $ Position 2
203  10 4.8648E-05   -203 703 31 -32 imp:n=1  $ Position 3
204  10 4.8648E-05   -204 704 31 -32 imp:n=1  $ Position 4
205  10 4.8648E-05   -205 705 31 -32 imp:n=1  $ Position 5
206  10 4.8648E-05   -206 706 31 -32 imp:n=1  $ Position 6
207  10 4.8648E-05   -207 707 31 -32 imp:n=1  $ Position 7
208  10 4.8648E-05   -208 708 31 -32 imp:n=1  $ Position 8
209  10 4.8648E-05   -209 709 31 -32 imp:n=1  $ Position 9
210  10 4.8648E-05   -210 710 31 -32 imp:n=1  $ Position 10
211  10 4.8648E-05   -211 711 31 -32 imp:n=1  $ Position 11
212  10 4.8648E-05   -212 712 31 -32 imp:n=1  $ Position 12
213  10 4.8648E-05   -213 713 31 -32 imp:n=1  $ Position 13
214  10 4.8648E-05   -214 714 31 -32 imp:n=1  $ Position 14
215  10 4.8648E-05   -215 715 31 -32 imp:n=1  $ Position 15
216  10 4.8648E-05   -216 716 31 -32 imp:n=1  $ Position 16
217  10 4.8648E-05   -217 717 31 -32 imp:n=1  $ Position 17
218  10 4.8648E-05   -218 718 31 -32 imp:n=1  $ Position 18
219  10 4.8648E-05   -219 719 31 -32 imp:n=1  $ Position 19
220  10 4.8648E-05   -220 720 31 -32 imp:n=1  $ Position 20
221  10 4.8648E-05   -221 721 31 -32 imp:n=1  $ Position 21
222  10 4.8648E-05   -222 722 31 -32 imp:n=1  $ Position 22
223  10 4.8648E-05   -223 723 31 -32 imp:n=1  $ Position 23
224  10 4.8648E-05   -224 724 31 -32 imp:n=1  $ Position 24
225  10 4.8648E-05   -225 725 31 -32 imp:n=1  $ Position 25
226  10 4.8648E-05   -226 726 31 -32 imp:n=1  $ Position 26
227  10 4.8648E-05   -227 727 31 -32 imp:n=1  $ Position 27
228  10 4.8648E-05   -228 728 31 -32 imp:n=1  $ Position 28
229  10 4.8648E-05   -229 729 31 -32 imp:n=1  $ Position 29
230  10 4.8648E-05   -230 730 31 -32 imp:n=1  $ Position 30
231  10 4.8648E-05   -231 731 31 -32 imp:n=1  $ Position 31
232  10 4.8648E-05   -232 732 31 -32 imp:n=1  $ Position 32
233  10 4.8648E-05   -233 733 31 -32 imp:n=1  $ Position 33
234  10 4.8648E-05   -234 734 31 -32 imp:n=1  $ Position 34
235  10 4.8648E-05   -235 735 31 -32 imp:n=1  $ Position 35
236  10 4.8648E-05   -236 736 31 -32 imp:n=1  $ Position 36
237  10 4.8648E-05   -237 737 31 -32 imp:n=1  $ Position 37
238  10 4.8648E-05   -238 738 31 -32 imp:n=1  $ Position 38
239  10 4.8648E-05   -239 739 31 -32 imp:n=1  $ Position 39
240  10 4.8648E-05   -240 740 31 -32 imp:n=1  $ Position 40
241  10 4.8648E-05   -241 741 31 -32 imp:n=1  $ Position 41
242  10 4.8648E-05   -242 742 31 -32 imp:n=1  $ Position 42
243  10 4.8648E-05   -243 743 31 -32 imp:n=1  $ Position 43
244  10 4.8648E-05   -244 744 31 -32 imp:n=1  $ Position 44
245  10 4.8648E-05   -245 745 31 -32 imp:n=1  $ Position 45
246  10 4.8648E-05   -246 746 31 -32 imp:n=1  $ Position 46
247  10 4.8648E-05   -247 747 31 -32 imp:n=1  $ Position 47
248  10 4.8648E-05   -248 748 31 -32 imp:n=1  $ Position 48
249  10 4.8648E-05   -249 749 31 -32 imp:n=1  $ Position 49
250  10 4.8648E-05   -250 750 31 -32 imp:n=1  $ Position 50
251  10 4.8648E-05   -251 751 31 -32 imp:n=1  $ Position 51
252  10 4.8648E-05   -252 752 31 -32 imp:n=1  $ Position 52
253  10 4.8648E-05   -253 753 31 -32 imp:n=1  $ Position 53
254  10 4.8648E-05   -254 754 31 -32 imp:n=1  $ Position 54
255  10 4.8648E-05   -255 755 31 -32 imp:n=1  $ Position 55
256  10 4.8648E-05   -256 756 31 -32 imp:n=1  $ Position 56
257  10 4.8648E-05   -257 757 31 -32 imp:n=1  $ Position 57
258  10 4.8648E-05   -258 758 31 -32 imp:n=1  $ Position 58
259  10 4.8648E-05   -259 759 31 -32 imp:n=1  $ Position 59
260  10 4.8648E-05   -260 760 31 -32 imp:n=1  $ Position 60
261  10 4.8648E-05   -261 761 31 -32 imp:n=1  $ Position 61
```

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262  10 4.8648E-05   -262 762 31 -32 imp:n=1  $ Position 62
263  10 4.8648E-05   -263 763 31 -32 imp:n=1  $ Position 63
264  10 4.8648E-05   -264 764 31 -32 imp:n=1  $ Position 64
c
c --------- Ring 3 ---------
301  10 4.8648E-05   -301 801 31 -32 imp:n=1  $ Position 1
302  10 4.8648E-05   -302 802 31 -32 imp:n=1  $ Position 2
303  10 4.8648E-05   -303 803 31 -32 imp:n=1  $ Position 3
304  10 4.8648E-05   -304 804 31 -32 imp:n=1  $ Position 4
305  10 4.8648E-05   -305 805 31 -32 imp:n=1  $ Position 5
306  10 4.8648E-05   -306 806 31 -32 imp:n=1  $ Position 6
307  10 4.8648E-05   -307 807 31 -32 imp:n=1  $ Position 7
308  10 4.8648E-05   -308 808 31 -32 imp:n=1  $ Position 8
309  10 4.8648E-05   -309 809 31 -32 imp:n=1  $ Position 9
310  10 4.8648E-05   -310 810 31 -32 imp:n=1  $ Position 10
311  10 4.8648E-05   -311 811 31 -32 imp:n=1  $ Position 11
312  10 4.8648E-05   -312 812 31 -32 imp:n=1  $ Position 12
313  10 4.8648E-05   -313 813 31 -32 imp:n=1  $ Position 13
314  10 4.8648E-05   -314 814 31 -32 imp:n=1  $ Position 14
315  10 4.8648E-05   -315 815 31 -32 imp:n=1  $ Position 15
316  10 4.8648E-05   -316 816 31 -32 imp:n=1  $ Position 16
317  10 4.8648E-05   -317 817 31 -32 imp:n=1  $ Position 17
318  10 4.8648E-05   -318 818 31 -32 imp:n=1  $ Position 18
319  10 4.8648E-05   -319 819 31 -32 imp:n=1  $ Position 19
320  10 4.8648E-05   -320 820 31 -32 imp:n=1  $ Position 20
321  10 4.8648E-05   -321 821 31 -32 imp:n=1  $ Position 21
322  10 4.8648E-05   -322 822 31 -32 imp:n=1  $ Position 22
323  10 4.8648E-05   -323 823 31 -32 imp:n=1  $ Position 23
324  10 4.8648E-05   -324 824 31 -32 imp:n=1  $ Position 24
325  10 4.8648E-05   -325 825 31 -32 imp:n=1  $ Position 25
326  10 4.8648E-05   -326 826 31 -32 imp:n=1  $ Position 26
327  10 4.8648E-05   -327 827 31 -32 imp:n=1  $ Position 27
328  10 4.8648E-05   -328 828 31 -32 imp:n=1  $ Position 28
329  10 4.8648E-05   -329 829 31 -32 imp:n=1  $ Position 29
330  10 4.8648E-05   -330 830 31 -32 imp:n=1  $ Position 30
331  10 4.8648E-05   -331 831 31 -32 imp:n=1  $ Position 31
332  10 4.8648E-05   -332 832 31 -32 imp:n=1  $ Position 32
333  10 4.8648E-05   -333 833 31 -32 imp:n=1  $ Position 33
334  10 4.8648E-05   -334 834 31 -32 imp:n=1  $ Position 34
335  10 4.8648E-05   -335 835 31 -32 imp:n=1  $ Position 35
336  10 4.8648E-05   -336 836 31 -32 imp:n=1  $ Position 36
337  10 4.8648E-05   -337 837 31 -32 imp:n=1  $ Position 37
338  10 4.8648E-05   -338 838 31 -32 imp:n=1  $ Position 38
339  10 4.8648E-05   -339 839 31 -32 imp:n=1  $ Position 39
340  10 4.8648E-05   -340 840 31 -32 imp:n=1  $ Position 40
341  10 4.8648E-05   -341 841 31 -32 imp:n=1  $ Position 41
342  10 4.8648E-05   -342 842 31 -32 imp:n=1  $ Position 42
343  10 4.8648E-05   -343 843 31 -32 imp:n=1  $ Position 43
344  10 4.8648E-05   -344 844 31 -32 imp:n=1  $ Position 44
345  10 4.8648E-05   -345 845 31 -32 imp:n=1  $ Position 45
346  10 4.8648E-05   -346 846 31 -32 imp:n=1  $ Position 46
347  10 4.8648E-05   -347 847 31 -32 imp:n=1  $ Position 47
348  10 4.8648E-05   -348 848 31 -32 imp:n=1  $ Position 48
349  10 4.8648E-05   -349 849 31 -32 imp:n=1  $ Position 49
350  10 4.8648E-05   -350 850 31 -32 imp:n=1  $ Position 50
351  10 4.8648E-05   -351 851 31 -32 imp:n=1  $ Position 51
352  10 4.8648E-05   -352 852 31 -32 imp:n=1  $ Position 52
353  10 4.8648E-05   -353 853 31 -32 imp:n=1  $ Position 53
354  10 4.8648E-05   -354 854 31 -32 imp:n=1  $ Position 54
355  10 4.8648E-05   -355 855 31 -32 imp:n=1  $ Position 55
356  10 4.8648E-05   -356 856 31 -32 imp:n=1  $ Position 56
357  10 4.8648E-05   -357 857 31 -32 imp:n=1  $ Position 57
358  10 4.8648E-05   -358 858 31 -32 imp:n=1  $ Position 58
359  10 4.8648E-05   -359 859 31 -32 imp:n=1  $ Position 59
360  10 4.8648E-05   -360 860 31 -32 imp:n=1  $ Position 60
361  10 4.8648E-05   -361 861 31 -32 imp:n=1  $ Position 61
362  10 4.8648E-05   -362 862 31 -32 imp:n=1  $ Position 62
363  10 4.8648E-05   -363 863 31 -32 imp:n=1  $ Position 63
364  10 4.8648E-05   -364 864 31 -32 imp:n=1  $ Position 64
c
c --------- Ring 4 ---------
401  10 4.8648E-05   -401 901 31 -32 imp:n=1  $ Position 1
402  10 4.8648E-05   -402 902 31 -32 imp:n=1  $ Position 2
403  10 4.8648E-05   -403 903 31 -32 imp:n=1  $ Position 3
404  10 4.8648E-05   -404 904 31 -32 imp:n=1  $ Position 4
```

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405  10 4.8648E-05   -405 905 31 -32 imp:n=1  $ Position 5
406  10 4.8648E-05   -406 906 31 -32 imp:n=1  $ Position 6
407  10 4.8648E-05   -407 907 31 -32 imp:n=1  $ Position 7
408  10 4.8648E-05   -408 908 31 -32 imp:n=1  $ Position 8
409  10 4.8648E-05   -409 909 31 -32 imp:n=1  $ Position 9
410  10 4.8648E-05   -410 910 31 -32 imp:n=1  $ Position 10
411  10 4.8648E-05   -411 911 31 -32 imp:n=1  $ Position 11
412  10 4.8648E-05   -412 912 31 -32 imp:n=1  $ Position 12
413  10 4.8648E-05   -413 913 31 -32 imp:n=1  $ Position 13
414  10 4.8648E-05   -414 914 31 -32 imp:n=1  $ Position 14
415  10 4.8648E-05   -415 915 31 -32 imp:n=1  $ Position 15
416  10 4.8648E-05   -416 916 31 -32 imp:n=1  $ Position 16
417  10 4.8648E-05   -417 917 31 -32 imp:n=1  $ Position 17
418  10 4.8648E-05   -418 918 31 -32 imp:n=1  $ Position 18
419  10 4.8648E-05   -419 919 31 -32 imp:n=1  $ Position 19
420  10 4.8648E-05   -420 920 31 -32 imp:n=1  $ Position 20
421  10 4.8648E-05   -421 921 31 -32 imp:n=1  $ Position 21
422  10 4.8648E-05   -422 922 31 -32 imp:n=1  $ Position 22
423  10 4.8648E-05   -423 923 31 -32 imp:n=1  $ Position 23
424  10 4.8648E-05   -424 924 31 -32 imp:n=1  $ Position 24
425  10 4.8648E-05   -425 925 31 -32 imp:n=1  $ Position 25
426  10 4.8648E-05   -426 926 31 -32 imp:n=1  $ Position 26
427  10 4.8648E-05   -427 927 31 -32 imp:n=1  $ Position 27
428  10 4.8648E-05   -428 928 31 -32 imp:n=1  $ Position 28
429  10 4.8648E-05   -429 929 31 -32 imp:n=1  $ Position 29
430  10 4.8648E-05   -430 930 31 -32 imp:n=1  $ Position 30
431  10 4.8648E-05   -431 931 31 -32 imp:n=1  $ Position 31
432  10 4.8648E-05   -432 932 31 -32 imp:n=1  $ Position 32
433  10 4.8648E-05   -433 933 31 -32 imp:n=1  $ Position 33
434  10 4.8648E-05   -434 934 31 -32 imp:n=1  $ Position 34
435  10 4.8648E-05   -435 935 31 -32 imp:n=1  $ Position 35
436  10 4.8648E-05   -436 936 31 -32 imp:n=1  $ Position 36
437  10 4.8648E-05   -437 937 31 -32 imp:n=1  $ Position 37
438  10 4.8648E-05   -438 938 31 -32 imp:n=1  $ Position 38
439  10 4.8648E-05   -439 939 31 -32 imp:n=1  $ Position 39
440  10 4.8648E-05   -440 940 31 -32 imp:n=1  $ Position 40
441  10 4.8648E-05   -441 941 31 -32 imp:n=1  $ Position 41
442  10 4.8648E-05   -442 942 31 -32 imp:n=1  $ Position 42
443  10 4.8648E-05   -443 943 31 -32 imp:n=1  $ Position 43
444  10 4.8648E-05   -444 944 31 -32 imp:n=1  $ Position 44
445  10 4.8648E-05   -445 945 31 -32 imp:n=1  $ Position 45
446  10 4.8648E-05   -446 946 31 -32 imp:n=1  $ Position 46
447  10 4.8648E-05   -447 947 31 -32 imp:n=1  $ Position 47
448  10 4.8648E-05   -448 948 31 -32 imp:n=1  $ Position 48
449  10 4.8648E-05   -449 949 31 -32 imp:n=1  $ Position 49
450  10 4.8648E-05   -450 950 31 -32 imp:n=1  $ Position 50
451  10 4.8648E-05   -451 951 31 -32 imp:n=1  $ Position 51
452  10 4.8648E-05   -452 952 31 -32 imp:n=1  $ Position 52
453  10 4.8648E-05   -453 953 31 -32 imp:n=1  $ Position 53
454  10 4.8648E-05   -454 954 31 -32 imp:n=1  $ Position 54
455  10 4.8648E-05   -455 955 31 -32 imp:n=1  $ Position 55
456  10 4.8648E-05   -456 956 31 -32 imp:n=1  $ Position 56
457  10 4.8648E-05   -457 957 31 -32 imp:n=1  $ Position 57
458  10 4.8648E-05   -458 958 31 -32 imp:n=1  $ Position 58
459  10 4.8648E-05   -459 959 31 -32 imp:n=1  $ Position 59
460  10 4.8648E-05   -460 960 31 -32 imp:n=1  $ Position 60
461  10 4.8648E-05   -461 961 31 -32 imp:n=1  $ Position 61
462  10 4.8648E-05   -462 962 31 -32 imp:n=1  $ Position 62
463  10 4.8648E-05   -463 963 31 -32 imp:n=1  $ Position 63
464  10 4.8648E-05   -464 964 31 -32 imp:n=1  $ Position 64
c
c --------- Ring 5 ---------
501  10 4.8648E-05   -501 1001 31 -32 imp:n=1  $ Position 1
502  10 4.8648E-05   -502 1002 31 -32 imp:n=1  $ Position 2
503  10 4.8648E-05   -503 1003 31 -3091 imp:n=1  $ Position 3
3105 0    -503 3091 -9 imp:n=1 fill=21 (-83.70  34.67 0)  $ Control Rod 4
504  10 4.8648E-05   -504 1004 31 -32 imp:n=1  $ Position 4
505  10 4.8648E-05   -505 1005 31 -32 imp:n=1  $ Position 5
506  10 4.8648E-05   -506 1006 31 -32 imp:n=1  $ Position 6
507  10 4.8648E-05   -507 1007 31 -32 imp:n=1  $ Position 7
508  10 4.8648E-05   -508 1008 31 -32 imp:n=1  $ Position 8
509  10 4.8648E-05   -509 1009 31 -32 imp:n=1  $ Position 9
510  10 4.8648E-05   -510 1010 31 -32 imp:n=1  $ Position 10
511  10 4.8648E-05   -511 1011 31 -32 imp:n=1  $ Position 11
512  10 4.8648E-05   -512 1012 31 -32 imp:n=1  $ Position 12
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513  10 4.8648E-05   -513 1013 31 -32 imp:n=1  $ Position 13
514  10 4.8648E-05   -514 1014 31 -32 imp:n=1  $ Position 14
515  10 4.8648E-05   -515 1015 31 -32 imp:n=1  $ Position 15
516  10 4.8648E-05   -516 1016 31 -32 imp:n=1  $ Position 16
517  10 4.8648E-05   -517 1017 31 -32 imp:n=1  $ Position 17
518  10 4.8648E-05   -518 1018 31 -32 imp:n=1  $ Position 18
519  10 4.8648E-05   -519 1019 31 -3091 imp:n=1  $ Position 19
3102 0    -519 3091 -9 imp:n=1 fill=18 ( 34.67  83.70 0)  $ Control Rod 1
520  10 4.8648E-05   -520 1020 31 -32 imp:n=1  $ Position 20
521  10 4.8648E-05   -521 1021 31 -32 imp:n=1  $ Position 21
522  10 4.8648E-05   -522 1022 31 -32 imp:n=1  $ Position 22
523  10 4.8648E-05   -523 1023 31 -32 imp:n=1  $ Position 23
524  10 4.8648E-05   -524 1024 31 -32 imp:n=1  $ Position 24
525  10 4.8648E-05   -525 1025 31 -32 imp:n=1  $ Position 25
526  10 4.8648E-05   -526 1026 31 -32 imp:n=1  $ Position 26
527  10 4.8648E-05   -527 1027 31 -32 imp:n=1  $ Position 27
528  10 4.8648E-05   -528 1028 31 -32 imp:n=1  $ Position 28
529  10 4.8648E-05   -529 1029 31 -32 imp:n=1  $ Position 29
530  10 4.8648E-05   -530 1030 31 -32 imp:n=1  $ Position 30
531  10 4.8648E-05   -531 1031 31 -32 imp:n=1  $ Position 31
532  10 4.8648E-05   -532 1032 31 -32 imp:n=1  $ Position 32
533  10 4.8648E-05   -533 1033 31 -32 imp:n=1  $ Position 33
534  10 4.8648E-05   -534 1034 31 -32 imp:n=1  $ Position 34
535  10 4.8648E-05   -535 1035 31 -3091 imp:n=1  $ Position 35
3103 0    -535 3091 -9 imp:n=1 fill=19 ( 83.70 -34.67 0)  $ Control Rod 2
536  10 4.8648E-05   -536 1036 31 -32 imp:n=1  $ Position 36
537  10 4.8648E-05   -537 1037 31 -32 imp:n=1  $ Position 37
538  10 4.8648E-05   -538 1038 31 -32 imp:n=1  $ Position 38
539  10 4.8648E-05   -539 1039 31 -32 imp:n=1  $ Position 39
540  10 4.8648E-05   -540 1040 31 -32 imp:n=1  $ Position 40
541  10 4.8648E-05   -541 1041 31 -32 imp:n=1  $ Position 41
542  10 4.8648E-05   -542 1042 31 -32 imp:n=1  $ Position 42
543  10 4.8648E-05   -543 1043 31 -32 imp:n=1  $ Position 43
544  10 4.8648E-05   -544 1044 31 -32 imp:n=1  $ Position 44
c    *Replaced by Autorod  $ Position 45
546  10 4.8648E-05   -546 1046 31 -32 imp:n=1  $ Position 46
547  10 4.8648E-05   -547 1047 31 -32 imp:n=1  $ Position 47
548  10 4.8648E-05   -548 1048 31 -32 imp:n=1  $ Position 48
549  10 4.8648E-05   -549 1049 31 -32 imp:n=1  $ Position 49
550  10 4.8648E-05   -550 1050 31 -32 imp:n=1  $ Position 50
551  10 4.8648E-05   -551 1051 31 -3091 imp:n=1  $ Position 51
3104 0    -551 3091 -9 imp:n=1 fill=20 (-34.67 -83.70 0)  $ Control Rod 3
552  10 4.8648E-05   -552 1052 31 -32 imp:n=1  $ Position 52
553  10 4.8648E-05   -553 1053 31 -32 imp:n=1  $ Position 53
554  10 4.8648E-05   -554 1054 31 -32 imp:n=1  $ Position 54
555  10 4.8648E-05   -555 1055 31 -32 imp:n=1  $ Position 55
556  10 4.8648E-05   -556 1056 31 -32 imp:n=1  $ Position 56
557  10 4.8648E-05   -557 1057 31 -32 imp:n=1  $ Position 57
558  10 4.8648E-05   -558 1058 31 -32 imp:n=1  $ Position 58
559  10 4.8648E-05   -559 1059 31 -32 imp:n=1  $ Position 59
560  10 4.8648E-05   -560 1060 31 -32 imp:n=1  $ Position 60
561  10 4.8648E-05   -561 1061 31 -32 imp:n=1  $ Position 61
562  10 4.8648E-05   -562 1062 31 -32 imp:n=1  $ Position 62
563  10 4.8648E-05   -563 1063 31 -32 imp:n=1  $ Position 63
564  10 4.8648E-05   -564 1064 31 -32 imp:n=1  $ Position 64
c
c ------ Graphite Plugs ------
c --------- Ring 1 ---------
601  27 8.8496E-02  -601 31 -32 imp:n=1  $ Position 1
602  27 8.8496E-02  -602 31 -32 imp:n=1  $ Position 2
c    *Replaced by Safety/Shutdown Rod  $ Position 3
604  27 8.8496E-02  -604 31 -32 imp:n=1  $ Position 4
605  27 8.8496E-02  -605 31 -32 imp:n=1  $ Position 5
606  27 8.8496E-02  -606 31 -32 imp:n=1  $ Position 6
607  27 8.8496E-02  -607 31 -32 imp:n=1  $ Position 7
608  27 8.8496E-02  -608 31 -32 imp:n=1  $ Position 8
609  27 8.8496E-02  -609 31 -32 imp:n=1  $ Position 9
610  27 8.8496E-02  -610 31 -32 imp:n=1  $ Position 10
c    *Replaced by Safety/Shutdown Rod  $ Position 11
612  27 8.8496E-02  -612 31 -32 imp:n=1  $ Position 12
613  27 8.8496E-02  -613 31 -32 imp:n=1  $ Position 13
614  27 8.8496E-02  -614 31 -32 imp:n=1  $ Position 14
615  27 8.8496E-02  -615 31 -32 imp:n=1  $ Position 15
616  27 8.8496E-02  -616 31 -32 imp:n=1  $ Position 16
617  27 8.8496E-02  -617 31 -32 imp:n=1  $ Position 17
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618  27 8.8496E-02  -618 31 -32 imp:n=1  $ Position 18
619  27 8.8496E-02  -619 31 -32 imp:n=1  $ Position 19
c    *Replaced by Safety/Shutdown Rod  $ Position 20
621  27 8.8496E-02  -621 31 -32 imp:n=1  $ Position 21
622  27 8.8496E-02  -622 31 -32 imp:n=1  $ Position 22
623  27 8.8496E-02  -623 31 -32 imp:n=1  $ Position 23
624  27 8.8496E-02  -624 31 -32 imp:n=1  $ Position 24
625  27 8.8496E-02  -625 31 -32 imp:n=1  $ Position 25
626  27 8.8496E-02  -626 31 -32 imp:n=1  $ Position 26
c    *Replaced by Safety/Shutdown Rod  $ Position 27
628  27 8.8496E-02  -628 31 -32 imp:n=1  $ Position 28
629  27 8.8496E-02  -629 31 -32 imp:n=1  $ Position 29
630  27 8.8496E-02  -630 31 -32 imp:n=1  $ Position 30
631  27 8.8496E-02  -631 31 -32 imp:n=1  $ Position 31
632  27 8.8496E-02  -632 31 -32 imp:n=1  $ Position 32
633  27 8.8496E-02  -633 31 -32 imp:n=1  $ Position 33
634  27 8.8496E-02  -634 31 -32 imp:n=1  $ Position 34
c    *Replaced by Safety/Shutdown Rod  $ Position 35
636  27 8.8496E-02  -636 31 -32 imp:n=1  $ Position 36
637  27 8.8496E-02  -637 31 -32 imp:n=1  $ Position 37
638  27 8.8496E-02  -638 31 -32 imp:n=1  $ Position 38
639  27 8.8496E-02  -639 31 -32 imp:n=1  $ Position 39
640  27 8.8496E-02  -640 31 -32 imp:n=1  $ Position 40
641  27 8.8496E-02  -641 31 -32 imp:n=1  $ Position 41
642  27 8.8496E-02  -642 31 -32 imp:n=1  $ Position 42
643  27 8.8496E-02  -643 31 -32 imp:n=1  $ Position 43
c    *Replaced by Safety/Shutdown Rod  $ Position 44
645  27 8.8496E-02  -645 31 -32 imp:n=1  $ Position 45
646  27 8.8496E-02  -646 31 -32 imp:n=1  $ Position 46
647  27 8.8496E-02  -647 31 -32 imp:n=1  $ Position 47
648  27 8.8496E-02  -648 31 -32 imp:n=1  $ Position 48
649  27 8.8496E-02  -649 31 -32 imp:n=1  $ Position 49
650  27 8.8496E-02  -650 31 -32 imp:n=1  $ Position 50
c    *Replaced by Safety/Shutdown Rod  $ Position 51
652  27 8.8496E-02  -652 31 -32 imp:n=1  $ Position 52
653  27 8.8496E-02  -653 31 -32 imp:n=1  $ Position 53
654  27 8.8496E-02  -654 31 -32 imp:n=1  $ Position 54
655  27 8.8496E-02  -655 31 -32 imp:n=1  $ Position 55
656  27 8.8496E-02  -656 31 -32 imp:n=1  $ Position 56
657  27 8.8496E-02  -657 31 -32 imp:n=1  $ Position 57
c    *Replaced by Safety/Shutdown Rod  $ Position 58
659  27 8.8496E-02  -659 31 -32 imp:n=1  $ Position 59
660  27 8.8496E-02  -660 31 -32 imp:n=1  $ Position 60
661  27 8.8496E-02  -661 31 -32 imp:n=1  $ Position 61
662  27 8.8496E-02  -662 31 -32 imp:n=1  $ Position 62
663  27 8.8496E-02  -663 31 -32 imp:n=1  $ Position 63
664  27 8.8496E-02  -664 31 -32 imp:n=1  $ Position 64
c
c --------- Ring 2 ---------
701  27 8.8496E-02  -701 31 -32 imp:n=1  $ Position 1
702  27 8.8496E-02  -702 31 -32 imp:n=1  $ Position 2
703  27 8.8496E-02  -703 31 -32 imp:n=1  $ Position 3
704  27 8.8496E-02  -704 31 -32 imp:n=1  $ Position 4
705  27 8.8496E-02  -705 31 -32 imp:n=1  $ Position 5
706  27 8.8496E-02  -706 31 -32 imp:n=1  $ Position 6
707  27 8.8496E-02  -707 31 -32 imp:n=1  $ Position 7
708  27 8.8496E-02  -708 31 -32 imp:n=1  $ Position 8
709  27 8.8496E-02  -709 31 -32 imp:n=1  $ Position 9
710  27 8.8496E-02  -710 31 -32 imp:n=1  $ Position 10
711  27 8.8496E-02  -711 31 -32 imp:n=1  $ Position 11
712  27 8.8496E-02  -712 31 -32 imp:n=1  $ Position 12
713  27 8.8496E-02  -713 31 -32 imp:n=1  $ Position 13
714  27 8.8496E-02  -714 31 -32 imp:n=1  $ Position 14
715  27 8.8496E-02  -715 31 -32 imp:n=1  $ Position 15
716  27 8.8496E-02  -716 31 -32 imp:n=1  $ Position 16
717  27 8.8496E-02  -717 31 -32 imp:n=1  $ Position 17
718  27 8.8496E-02  -718 31 -32 imp:n=1  $ Position 18
719  27 8.8496E-02  -719 31 -32 imp:n=1  $ Position 19
720  27 8.8496E-02  -720 31 -32 imp:n=1  $ Position 20
721  27 8.8496E-02  -721 31 -32 imp:n=1  $ Position 21
722  27 8.8496E-02  -722 31 -32 imp:n=1  $ Position 22
723  27 8.8496E-02  -723 31 -32 imp:n=1  $ Position 23
724  27 8.8496E-02  -724 31 -32 imp:n=1  $ Position 24
725  27 8.8496E-02  -725 31 -32 imp:n=1  $ Position 25
726  27 8.8496E-02  -726 31 -32 imp:n=1  $ Position 26
```

```
727  27 8.8496E-02  -727 31 -32 imp:n=1  $ Position 27
728  27 8.8496E-02  -728 31 -32 imp:n=1  $ Position 28
729  27 8.8496E-02  -729 31 -32 imp:n=1  $ Position 29
730  27 8.8496E-02  -730 31 -32 imp:n=1  $ Position 30
731  27 8.8496E-02  -731 31 -32 imp:n=1  $ Position 31
732  27 8.8496E-02  -732 31 -32 imp:n=1  $ Position 32
733  27 8.8496E-02  -733 31 -32 imp:n=1  $ Position 33
734  27 8.8496E-02  -734 31 -32 imp:n=1  $ Position 34
735  27 8.8496E-02  -735 31 -32 imp:n=1  $ Position 35
736  27 8.8496E-02  -736 31 -32 imp:n=1  $ Position 36
737  27 8.8496E-02  -737 31 -32 imp:n=1  $ Position 37
738  27 8.8496E-02  -738 31 -32 imp:n=1  $ Position 38
739  27 8.8496E-02  -739 31 -32 imp:n=1  $ Position 39
740  27 8.8496E-02  -740 31 -32 imp:n=1  $ Position 40
741  27 8.8496E-02  -741 31 -32 imp:n=1  $ Position 41
742  27 8.8496E-02  -742 31 -32 imp:n=1  $ Position 42
743  27 8.8496E-02  -743 31 -32 imp:n=1  $ Position 43
744  27 8.8496E-02  -744 31 -32 imp:n=1  $ Position 44
745  27 8.8496E-02  -745 31 -32 imp:n=1  $ Position 45
746  27 8.8496E-02  -746 31 -32 imp:n=1  $ Position 46
747  27 8.8496E-02  -747 31 -32 imp:n=1  $ Position 47
748  27 8.8496E-02  -748 31 -32 imp:n=1  $ Position 48
749  27 8.8496E-02  -749 31 -32 imp:n=1  $ Position 49
750  27 8.8496E-02  -750 31 -32 imp:n=1  $ Position 50
751  27 8.8496E-02  -751 31 -32 imp:n=1  $ Position 51
752  27 8.8496E-02  -752 31 -32 imp:n=1  $ Position 52
753  27 8.8496E-02  -753 31 -32 imp:n=1  $ Position 53
754  27 8.8496E-02  -754 31 -32 imp:n=1  $ Position 54
755  27 8.8496E-02  -755 31 -32 imp:n=1  $ Position 55
756  27 8.8496E-02  -756 31 -32 imp:n=1  $ Position 56
757  27 8.8496E-02  -757 31 -32 imp:n=1  $ Position 57
758  27 8.8496E-02  -758 31 -32 imp:n=1  $ Position 58
759  27 8.8496E-02  -759 31 -32 imp:n=1  $ Position 59
760  27 8.8496E-02  -760 31 -32 imp:n=1  $ Position 60
761  27 8.8496E-02  -761 31 -32 imp:n=1  $ Position 61
762  27 8.8496E-02  -762 31 -32 imp:n=1  $ Position 62
763  27 8.8496E-02  -763 31 -32 imp:n=1  $ Position 63
764  27 8.8496E-02  -764 31 -32 imp:n=1  $ Position 64
c
c --------- Ring 3 ---------
801  27 8.8496E-02  -801 31 -32 imp:n=1  $ Position 1
802  27 8.8496E-02  -802 31 -32 imp:n=1  $ Position 2
803  27 8.8496E-02  -803 31 -32 imp:n=1  $ Position 3
804  27 8.8496E-02  -804 31 -32 imp:n=1  $ Position 4
805  27 8.8496E-02  -805 31 -32 imp:n=1  $ Position 5
806  27 8.8496E-02  -806 31 -32 imp:n=1  $ Position 6
807  27 8.8496E-02  -807 31 -32 imp:n=1  $ Position 7
808  27 8.8496E-02  -808 31 -32 imp:n=1  $ Position 8
809  27 8.8496E-02  -809 31 -32 imp:n=1  $ Position 9
810  27 8.8496E-02  -810 31 -32 imp:n=1  $ Position 10
811  27 8.8496E-02  -811 31 -32 imp:n=1  $ Position 11
812  27 8.8496E-02  -812 31 -32 imp:n=1  $ Position 12
813  27 8.8496E-02  -813 31 -32 imp:n=1  $ Position 13
814  27 8.8496E-02  -814 31 -32 imp:n=1  $ Position 14
815  27 8.8496E-02  -815 31 -32 imp:n=1  $ Position 15
816  27 8.8496E-02  -816 31 -32 imp:n=1  $ Position 16
817  27 8.8496E-02  -817 31 -32 imp:n=1  $ Position 17
818  27 8.8496E-02  -818 31 -32 imp:n=1  $ Position 18
819  27 8.8496E-02  -819 31 -32 imp:n=1  $ Position 19
820  27 8.8496E-02  -820 31 -32 imp:n=1  $ Position 20
821  27 8.8496E-02  -821 31 -32 imp:n=1  $ Position 21
822  27 8.8496E-02  -822 31 -32 imp:n=1  $ Position 22
823  27 8.8496E-02  -823 31 -32 imp:n=1  $ Position 23
824  27 8.8496E-02  -824 31 -32 imp:n=1  $ Position 24
825  27 8.8496E-02  -825 31 -32 imp:n=1  $ Position 25
826  27 8.8496E-02  -826 31 -32 imp:n=1  $ Position 26
827  27 8.8496E-02  -827 31 -32 imp:n=1  $ Position 27
828  27 8.8496E-02  -828 31 -32 imp:n=1  $ Position 28
829  27 8.8496E-02  -829 31 -32 imp:n=1  $ Position 29
830  27 8.8496E-02  -830 31 -32 imp:n=1  $ Position 30
831  27 8.8496E-02  -831 31 -32 imp:n=1  $ Position 31
832  27 8.8496E-02  -832 31 -32 imp:n=1  $ Position 32
833  27 8.8496E-02  -833 31 -32 imp:n=1  $ Position 33
834  27 8.8496E-02  -834 31 -32 imp:n=1  $ Position 34
835  27 8.8496E-02  -835 31 -32 imp:n=1  $ Position 35
```

```
836  27 8.8496E-02  -836 31 -32 imp:n=1  $ Position 36
837  27 8.8496E-02  -837 31 -32 imp:n=1  $ Position 37
838  27 8.8496E-02  -838 31 -32 imp:n=1  $ Position 38
839  27 8.8496E-02  -839 31 -32 imp:n=1  $ Position 39
840  27 8.8496E-02  -840 31 -32 imp:n=1  $ Position 40
841  27 8.8496E-02  -841 31 -32 imp:n=1  $ Position 41
842  27 8.8496E-02  -842 31 -32 imp:n=1  $ Position 42
843  27 8.8496E-02  -843 31 -32 imp:n=1  $ Position 43
844  27 8.8496E-02  -844 31 -32 imp:n=1  $ Position 44
845  27 8.8496E-02  -845 31 -32 imp:n=1  $ Position 45
846  27 8.8496E-02  -846 31 -32 imp:n=1  $ Position 46
847  27 8.8496E-02  -847 31 -32 imp:n=1  $ Position 47
848  27 8.8496E-02  -848 31 -32 imp:n=1  $ Position 48
849  27 8.8496E-02  -849 31 -32 imp:n=1  $ Position 49
850  27 8.8496E-02  -850 31 -32 imp:n=1  $ Position 50
851  27 8.8496E-02  -851 31 -32 imp:n=1  $ Position 51
852  27 8.8496E-02  -852 31 -32 imp:n=1  $ Position 52
853  27 8.8496E-02  -853 31 -32 imp:n=1  $ Position 53
854  27 8.8496E-02  -854 31 -32 imp:n=1  $ Position 54
855  27 8.8496E-02  -855 31 -32 imp:n=1  $ Position 55
856  27 8.8496E-02  -856 31 -32 imp:n=1  $ Position 56
857  27 8.8496E-02  -857 31 -32 imp:n=1  $ Position 57
858  27 8.8496E-02  -858 31 -32 imp:n=1  $ Position 58
859  27 8.8496E-02  -859 31 -32 imp:n=1  $ Position 59
860  27 8.8496E-02  -860 31 -32 imp:n=1  $ Position 60
861  27 8.8496E-02  -861 31 -32 imp:n=1  $ Position 61
862  27 8.8496E-02  -862 31 -32 imp:n=1  $ Position 62
863  27 8.8496E-02  -863 31 -32 imp:n=1  $ Position 63
864  27 8.8496E-02  -864 31 -32 imp:n=1  $ Position 64
c
c --------- Ring 4 ---------
901  27 8.8496E-02  -901 31 -32 imp:n=1  $ Position 1
902  27 8.8496E-02  -902 31 -32 imp:n=1  $ Position 2
903  27 8.8496E-02  -903 31 -32 imp:n=1  $ Position 3
904  27 8.8496E-02  -904 31 -32 imp:n=1  $ Position 4
905  27 8.8496E-02  -905 31 -32 imp:n=1  $ Position 5
906  27 8.8496E-02  -906 31 -32 imp:n=1  $ Position 6
907  27 8.8496E-02  -907 31 -32 imp:n=1  $ Position 7
908  27 8.8496E-02  -908 31 -32 imp:n=1  $ Position 8
909  27 8.8496E-02  -909 31 -32 imp:n=1  $ Position 9
910  27 8.8496E-02  -910 31 -32 imp:n=1  $ Position 10
911  27 8.8496E-02  -911 31 -32 imp:n=1  $ Position 11
912  27 8.8496E-02  -912 31 -32 imp:n=1  $ Position 12
913  27 8.8496E-02  -913 31 -32 imp:n=1  $ Position 13
914  27 8.8496E-02  -914 31 -32 imp:n=1  $ Position 14
915  27 8.8496E-02  -915 31 -32 imp:n=1  $ Position 15
916  27 8.8496E-02  -916 31 -32 imp:n=1  $ Position 16
917  27 8.8496E-02  -917 31 -32 imp:n=1  $ Position 17
918  27 8.8496E-02  -918 31 -32 imp:n=1  $ Position 18
919  27 8.8496E-02  -919 31 -32 imp:n=1  $ Position 19
920  27 8.8496E-02  -920 31 -32 imp:n=1  $ Position 20
921  27 8.8496E-02  -921 31 -32 imp:n=1  $ Position 21
922  27 8.8496E-02  -922 31 -32 imp:n=1  $ Position 22
923  27 8.8496E-02  -923 31 -32 imp:n=1  $ Position 23
924  27 8.8496E-02  -924 31 -32 imp:n=1  $ Position 24
925  27 8.8496E-02  -925 31 -32 imp:n=1  $ Position 25
926  27 8.8496E-02  -926 31 -32 imp:n=1  $ Position 26
927  27 8.8496E-02  -927 31 -32 imp:n=1  $ Position 27
928  27 8.8496E-02  -928 31 -32 imp:n=1  $ Position 28
929  27 8.8496E-02  -929 31 -32 imp:n=1  $ Position 29
930  27 8.8496E-02  -930 31 -32 imp:n=1  $ Position 30
931  27 8.8496E-02  -931 31 -32 imp:n=1  $ Position 31
932  27 8.8496E-02  -932 31 -32 imp:n=1  $ Position 32
933  27 8.8496E-02  -933 31 -32 imp:n=1  $ Position 33
934  27 8.8496E-02  -934 31 -32 imp:n=1  $ Position 34
935  27 8.8496E-02  -935 31 -32 imp:n=1  $ Position 35
936  27 8.8496E-02  -936 31 -32 imp:n=1  $ Position 36
937  27 8.8496E-02  -937 31 -32 imp:n=1  $ Position 37
938  27 8.8496E-02  -938 31 -32 imp:n=1  $ Position 38
939  27 8.8496E-02  -939 31 -32 imp:n=1  $ Position 39
940  27 8.8496E-02  -940 31 -32 imp:n=1  $ Position 40
941  27 8.8496E-02  -941 31 -32 imp:n=1  $ Position 41
942  27 8.8496E-02  -942 31 -32 imp:n=1  $ Position 42
943  27 8.8496E-02  -943 31 -32 imp:n=1  $ Position 43
944  27 8.8496E-02  -944 31 -32 imp:n=1  $ Position 44
```

```
945  27 8.8496E-02  -945 31 -32 imp:n=1  $ Position 45
946  27 8.8496E-02  -946 31 -32 imp:n=1  $ Position 46
947  27 8.8496E-02  -947 31 -32 imp:n=1  $ Position 47
948  27 8.8496E-02  -948 31 -32 imp:n=1  $ Position 48
949  27 8.8496E-02  -949 31 -32 imp:n=1  $ Position 49
950  27 8.8496E-02  -950 31 -32 imp:n=1  $ Position 50
951  27 8.8496E-02  -951 31 -32 imp:n=1  $ Position 51
952  27 8.8496E-02  -952 31 -32 imp:n=1  $ Position 52
953  27 8.8496E-02  -953 31 -32 imp:n=1  $ Position 53
954  27 8.8496E-02  -954 31 -32 imp:n=1  $ Position 54
955  27 8.8496E-02  -955 31 -32 imp:n=1  $ Position 55
956  27 8.8496E-02  -956 31 -32 imp:n=1  $ Position 56
957  27 8.8496E-02  -957 31 -32 imp:n=1  $ Position 57
958  27 8.8496E-02  -958 31 -32 imp:n=1  $ Position 58
959  27 8.8496E-02  -959 31 -32 imp:n=1  $ Position 59
960  27 8.8496E-02  -960 31 -32 imp:n=1  $ Position 60
961  27 8.8496E-02  -961 31 -32 imp:n=1  $ Position 61
962  27 8.8496E-02  -962 31 -32 imp:n=1  $ Position 62
963  27 8.8496E-02  -963 31 -32 imp:n=1  $ Position 63
964  27 8.8496E-02  -964 31 -32 imp:n=1  $ Position 64
c
c --------- Ring 5 ---------
1001 27 8.8496E-02  -1001 31 -32 imp:n=1  $ Position 1
1002 27 8.8496E-02  -1002 31 -32 imp:n=1  $ Position 2
1003 27 8.8496E-02  -1003 31 -3091 imp:n=1  $ Position 3
1004 27 8.8496E-02  -1004 31 -32 imp:n=1  $ Position 4
1005 27 8.8496E-02  -1005 31 -32 imp:n=1  $ Position 5
1006 27 8.8496E-02  -1006 31 -32 imp:n=1  $ Position 6
1007 27 8.8496E-02  -1007 31 -32 imp:n=1  $ Position 7
1008 27 8.8496E-02  -1008 31 -32 imp:n=1  $ Position 8
1009 27 8.8496E-02  -1009 31 -32 imp:n=1  $ Position 9
1010 27 8.8496E-02  -1010 31 -32 imp:n=1  $ Position 10
1011 27 8.8496E-02  -1011 31 -32 imp:n=1  $ Position 11
1012 27 8.8496E-02  -1012 31 -32 imp:n=1  $ Position 12
1013 27 8.8496E-02  -1013 31 -32 imp:n=1  $ Position 13
1014 27 8.8496E-02  -1014 31 -32 imp:n=1  $ Position 14
1015 27 8.8496E-02  -1015 31 -32 imp:n=1  $ Position 15
1016 27 8.8496E-02  -1016 31 -32 imp:n=1  $ Position 16
1017 27 8.8496E-02  -1017 31 -32 imp:n=1  $ Position 17
1018 27 8.8496E-02  -1018 31 -32 imp:n=1  $ Position 18
1019 27 8.8496E-02  -1019 31 -3091 imp:n=1  $ Position 19
1020 27 8.8496E-02  -1020 31 -32 imp:n=1  $ Position 20
1021 27 8.8496E-02  -1021 31 -32 imp:n=1  $ Position 21
1022 27 8.8496E-02  -1022 31 -32 imp:n=1  $ Position 22
1023 27 8.8496E-02  -1023 31 -32 imp:n=1  $ Position 23
1024 27 8.8496E-02  -1024 31 -32 imp:n=1  $ Position 24
1025 27 8.8496E-02  -1025 31 -32 imp:n=1  $ Position 25
1026 27 8.8496E-02  -1026 31 -32 imp:n=1  $ Position 26
1027 27 8.8496E-02  -1027 31 -32 imp:n=1  $ Position 27
1028 27 8.8496E-02  -1028 31 -32 imp:n=1  $ Position 28
1029 27 8.8496E-02  -1029 31 -32 imp:n=1  $ Position 29
1030 27 8.8496E-02  -1030 31 -32 imp:n=1  $ Position 30
1031 27 8.8496E-02  -1031 31 -32 imp:n=1  $ Position 31
1032 27 8.8496E-02  -1032 31 -32 imp:n=1  $ Position 32
1033 27 8.8496E-02  -1033 31 -32 imp:n=1  $ Position 33
1034 27 8.8496E-02  -1034 31 -32 imp:n=1  $ Position 34
1035 27 8.8496E-02  -1035 31 -3091 imp:n=1  $ Position 35
1036 27 8.8496E-02  -1036 31 -32 imp:n=1  $ Position 36
1037 27 8.8496E-02  -1037 31 -32 imp:n=1  $ Position 37
1038 27 8.8496E-02  -1038 31 -32 imp:n=1  $ Position 38
1039 27 8.8496E-02  -1039 31 -32 imp:n=1  $ Position 39
1040 27 8.8496E-02  -1040 31 -32 imp:n=1  $ Position 40
1041 27 8.8496E-02  -1041 31 -32 imp:n=1  $ Position 41
1042 27 8.8496E-02  -1042 31 -32 imp:n=1  $ Position 42
1043 27 8.8496E-02  -1043 31 -32 imp:n=1  $ Position 43
1044 27 8.8496E-02  -1044 31 -32 imp:n=1  $ Position 44
c    *Replaced by Autorod  $ Position 45
1046 27 8.8496E-02  -1046 31 -32 imp:n=1  $ Position 46
1047 27 8.8496E-02  -1047 31 -32 imp:n=1  $ Position 47
1048 27 8.8496E-02  -1048 31 -32 imp:n=1  $ Position 48
1049 27 8.8496E-02  -1049 31 -32 imp:n=1  $ Position 49
1050 27 8.8496E-02  -1050 31 -32 imp:n=1  $ Position 50
1051 27 8.8496E-02  -1051 31 -3091 imp:n=1  $ Position 51
1052 27 8.8496E-02  -1052 31 -32 imp:n=1  $ Position 52
1053 27 8.8496E-02  -1053 31 -32 imp:n=1  $ Position 53
```

```
1054 27 8.8496E-02  -1054 31 -32 imp:n=1  $ Position 54
1055 27 8.8496E-02  -1055 31 -32 imp:n=1  $ Position 55
1056 27 8.8496E-02  -1056 31 -32 imp:n=1  $ Position 56
1057 27 8.8496E-02  -1057 31 -32 imp:n=1  $ Position 57
1058 27 8.8496E-02  -1058 31 -32 imp:n=1  $ Position 58
1059 27 8.8496E-02  -1059 31 -32 imp:n=1  $ Position 59
1060 27 8.8496E-02  -1060 31 -32 imp:n=1  $ Position 60
1061 27 8.8496E-02  -1061 31 -32 imp:n=1  $ Position 61
1062 27 8.8496E-02  -1062 31 -32 imp:n=1  $ Position 62
1063 27 8.8496E-02  -1063 31 -32 imp:n=1  $ Position 63
1064 27 8.8496E-02  -1064 31 -32 imp:n=1  $ Position 64
c
c ------ Safety/Shutdown Rod Holes ------
1101 0  -1101 15 -9 imp:n=1 fill=2 (-38.45  56.57 0)  $ Rod 1
1102 0  -1102 15 -9 imp:n=1 fill=3 ( 32.74 -60.05 0)  $ Rod 2
1103 0  -1103 15 -9 imp:n=1 fill=4 ( 57.17  37.55 0)  $ Rod 3
1104 0  -1104 15 -9 imp:n=1 fill=5 (-53.23 -42.95 0)  $ Rod 4
1105 0  -1105 15 -9 imp:n=1 fill=6 ( 67.19 -12.82 0)  $ Rod 5
1106 0  -1106 15 -9 imp:n=1 fill=7 (-66.98  13.87 0)  $ Rod 6
1107 0  -1107 15 -9 imp:n=1 fill=8 ( 19.31  65.62 0)  $ Rod 7
1108 0  -1108 15 -9 imp:n=1 fill=9 (-13.87 -66.98 0)  $ Rod 8
c
c ------ ZEBRA Control Rod Holes ------
c    *There were no ZEBRA Control Rods in the Core
c
1109 10 4.8648E-05  (11109 -1109 15 -9):(-11109 32 -9) imp:n=1  $ Air
11109 28 8.9248E-02 -11109 15 -32 imp:n=1  $ Graphite Filler
1110 10 4.8648E-05  (11110 -1110 15 -9):(-11110 32 -9) imp:n=1  $ Air
11110 28 8.9248E-02 -11110 15 -32 imp:n=1  $ Graphite Filler
1111 10 4.8648E-05  (11111 -1111 15 -9):(-11111 32 -9) imp:n=1  $ Air
11111 28 8.9248E-02 -11111 15 -32 imp:n=1  $ Graphite Filler
1112 10 4.8648E-05  (11112 -1112 15 -9):(-11112 32 -9) imp:n=1  $ Air
11112 28 8.9248E-02 -11112 15 -32 imp:n=1  $ Graphite Filler
c
c ------ Withdrawable Control Rod Holes ------
c    *Same as Ring 5 Position 19 $ Rod 1
c    *Same as Ring 5 Position 35 $ Rod 2
c    *Same as Ring 5 Position 51 $ Rod 3
c    *Same as Ring 5 Position 3  $ Rod 4
c
c ------ Autorod Hole ------
1113 0  -1113 15 -9 imp:n=1 fill=11 (17.36 -87.29 0)
c
c --- Upper Axial Reflector ---------------------------------------------------
c ------ Central Cylinder ------
1201 10 4.8648E-05  1201 -1202 -1203 imp:n=1  $ Central Coolant Channel
1202 6 8.7789E-02  1201 -1202 1203 -1204 imp:n=1  $ Graphite
c
c ------ Graphite Annulus ------
1211 7 8.8291E-02  1201 -1202 1211 -1333
          (1301 1302 1303 1304 1305 1306 1307 1308 1309 1310 1311 1312 1313
           1314 1315 1316 1317 1318 1319 1320 1321 1322 1323 1324 1325 1326
           1327 1328 1329 1330 1331 1332)
           imp:n=1  $ Ring 1 Region
1212 7 8.8291E-02  1201 -1202 1333 -1433
          (1401 1402 1403 1404 1405 1406 1407 1408 1409 1410 1411 1412 1413
           1414 1415 1416 1417 1418 1419 1420 1421 1422 1423 1424 1425 1426
           1427 1428 1429 1430 1431 1432)
           imp:n=1  $ Ring 2 Region
1213 7 8.8291E-02  1201 -1202 1433 -1533
          (1501 1502 1503 1504 1505 1506 1507 1508 1509 1510 1511 1512 1513
           1514 1515 1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526
           1527 1528 1529 1530 1531 1532)
           imp:n=1  $ Ring 3 Region
1214 7 8.8291E-02  1201 -1202 1533 -1633
          (1601 1602 1603 1604 1605 1606 1607 1608 1609 1610 1611 1612 1613
           1614 1615 1616 1617 1618 1619 1620 1621 1622 1623 1624 1625 1626
           1627 1628 1629 1630 1631 1632)
           imp:n=1  $ Ring 4 Region
1215 7 8.8291E-02  1201 -1202 1633 -1212
          (1701 1702 1703 1704 1705 1706 1707 1708 1709 1710 1711 1712 1713
           1714 1715 1716 1717 1718 1719 1720 1721 1722 1723 1724 1725 1726
           1727 1728 1729 1730 1731 1732)
           imp:n=1  $ Ring 5 Region
c
```

```
c ------ Coolant Channels ------
c --------- Ring 1 ---------
1301 10 4.8648E-05  2401 -1301 1201 -1202 imp:n=1  $ Position 1
1302 10 4.8648E-05  2402 -1302 1201 -1202 imp:n=1  $ Position 2
1303 10 4.8648E-05       -1303 1201 -1202 imp:n=1  $ Position 3
1304 10 4.8648E-05  2404 -1304 1201 -1202 imp:n=1  $ Position 4
1305 10 4.8648E-05  2405 -1305 1201 -1202 imp:n=1  $ Position 5
1306 10 4.8648E-05       -1306 1201 -1202 imp:n=1  $ Position 6
1307 10 4.8648E-05  2407 -1307 1201 -1202 imp:n=1  $ Position 7
1308 10 4.8648E-05  2408 -1308 1201 -1202 imp:n=1  $ Position 8
1309 10 4.8648E-05       -1309 1201 -1202 imp:n=1  $ Position 9
1310 10 4.8648E-05  2410 -1310 1201 -1202 imp:n=1  $ Position 10
1311 10 4.8648E-05  2411 -1311 1201 -1202 imp:n=1  $ Position 11
1312 10 4.8648E-05       -1312 1201 -1202 imp:n=1  $ Position 12
1313 10 4.8648E-05  2413 -1313 1201 -1202 imp:n=1  $ Position 13
1314 10 4.8648E-05  2414 -1314 1201 -1202 imp:n=1  $ Position 14
1315 10 4.8648E-05       -1315 1201 -1202 imp:n=1  $ Position 15
1316 10 4.8648E-05  2416 -1316 1201 -1202 imp:n=1  $ Position 16
1317 10 4.8648E-05  2417 -1317 1201 -1202 imp:n=1  $ Position 17
1318 10 4.8648E-05       -1318 1201 -1202 imp:n=1  $ Position 18
1319 10 4.8648E-05  2419 -1319 1201 -1202 imp:n=1  $ Position 19
1320 10 4.8648E-05  2420 -1320 1201 -1202 imp:n=1  $ Position 20
1321 10 4.8648E-05       -1321 1201 -1202 imp:n=1  $ Position 21
1322 10 4.8648E-05  2422 -1322 1201 -1202 imp:n=1  $ Position 22
1323 10 4.8648E-05  2423 -1323 1201 -1202 imp:n=1  $ Position 23
1324 10 4.8648E-05       -1324 1201 -1202 imp:n=1  $ Position 24
1325 10 4.8648E-05  2425 -1325 1201 -1202 imp:n=1  $ Position 25
1326 10 4.8648E-05  2426 -1326 1201 -1202 imp:n=1  $ Position 26
1327 10 4.8648E-05       -1327 1201 -1202 imp:n=1  $ Position 27
1328 10 4.8648E-05  2428 -1328 1201 -1202 imp:n=1  $ Position 28
1329 10 4.8648E-05       -1329 1201 -1202 imp:n=1  $ Position 29
1330 10 4.8648E-05  2430 -1330 1201 -1202 imp:n=1  $ Position 30
1331 10 4.8648E-05  2431 -1331 1201 -1202 imp:n=1  $ Position 31
1332 10 4.8648E-05       -1332 1201 -1202 imp:n=1  $ Position 32
c
c --------- Ring 2 ---------
1401 10 4.8648E-05  2501 -1401 1201 -1202 imp:n=1  $ Position 1
1402 10 4.8648E-05  2502 -1402 1201 -1202 imp:n=1  $ Position 2
1403 10 4.8648E-05  2503 -1403 1201 -1202 imp:n=1  $ Position 3
1404 10 4.8648E-05  2504 -1404 1201 -1202 imp:n=1  $ Position 4
1405 10 4.8648E-05  2505 -1405 1201 -1202 imp:n=1  $ Position 5
1406 10 4.8648E-05  2506 -1406 1201 -1202 imp:n=1  $ Position 6
1407 10 4.8648E-05  2507 -1407 1201 -1202 imp:n=1  $ Position 7
1408 10 4.8648E-05  2508 -1408 1201 -1202 imp:n=1  $ Position 8
1409 10 4.8648E-05  2509 -1409 1201 -1202 imp:n=1  $ Position 9
1410 10 4.8648E-05  2510 -1410 1201 -1202 imp:n=1  $ Position 10
1411 10 4.8648E-05  2511 -1411 1201 -1202 imp:n=1  $ Position 11
1412 10 4.8648E-05  2512 -1412 1201 -1202 imp:n=1  $ Position 12
1413 10 4.8648E-05  2513 -1413 1201 -1202 imp:n=1  $ Position 13
1414 10 4.8648E-05  2514 -1414 1201 -1202 imp:n=1  $ Position 14
1415 10 4.8648E-05  2515 -1415 1201 -1202 imp:n=1  $ Position 15
1416 10 4.8648E-05  2516 -1416 1201 -1202 imp:n=1  $ Position 16
1417 10 4.8648E-05  2517 -1417 1201 -1202 imp:n=1  $ Position 17
1418 10 4.8648E-05  2518 -1418 1201 -1202 imp:n=1  $ Position 18
1419 10 4.8648E-05  2519 -1419 1201 -1202 imp:n=1  $ Position 19
1420 10 4.8648E-05  2520 -1420 1201 -1202 imp:n=1  $ Position 20
1421 10 4.8648E-05  2521 -1421 1201 -1202 imp:n=1  $ Position 21
1422 10 4.8648E-05  2522 -1422 1201 -1202 imp:n=1  $ Position 22
1423 10 4.8648E-05  2523 -1423 1201 -1202 imp:n=1  $ Position 23
1424 10 4.8648E-05  2524 -1424 1201 -1202 imp:n=1  $ Position 24
1425 10 4.8648E-05  2525 -1425 1201 -1202 imp:n=1  $ Position 25
1426 10 4.8648E-05  2526 -1426 1201 -1202 imp:n=1  $ Position 26
1427 10 4.8648E-05  2527 -1427 1201 -1202 imp:n=1  $ Position 27
1428 10 4.8648E-05  2528 -1428 1201 -1202 imp:n=1  $ Position 28
1429 10 4.8648E-05  2529 -1429 1201 -1202 imp:n=1  $ Position 29
1430 10 4.8648E-05  2530 -1430 1201 -1202 imp:n=1  $ Position 30
1431 10 4.8648E-05  2531 -1431 1201 -1202 imp:n=1  $ Position 31
1432 10 4.8648E-05  2532 -1432 1201 -1202 imp:n=1  $ Position 32
c
c --------- Ring 3 ---------
1501 10 4.8648E-05  2601 -1501 1201 -1202 imp:n=1  $ Position 1
1502 10 4.8648E-05       -1502 1201 -1202 imp:n=1  $ Position 2
1503 10 4.8648E-05  2603 -1503 1201 -1202 imp:n=1  $ Position 3
1504 10 4.8648E-05  2604 -1504 1201 -1202 imp:n=1  $ Position 4
1505 10 4.8648E-05       -1505 1201 -1202 imp:n=1  $ Position 5
```

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1506 10 4.8648E-05  2606 -1506 1201 -1202 imp:n=1  $ Position 6
1507 10 4.8648E-05  2607 -1507 1201 -1202 imp:n=1  $ Position 7
1508 10 4.8648E-05       -1508 1201 -1202 imp:n=1  $ Position 8
1509 10 4.8648E-05  2609 -1509 1201 -1202 imp:n=1  $ Position 9
1510 10 4.8648E-05  2610 -1510 1201 -1202 imp:n=1  $ Position 10
1511 10 4.8648E-05       -1511 1201 -1202 imp:n=1  $ Position 11
1512 10 4.8648E-05  2612 -1512 1201 -1202 imp:n=1  $ Position 12
1513 10 4.8648E-05  2613 -1513 1201 -1202 imp:n=1  $ Position 13
1514 10 4.8648E-05       -1514 1201 -1202 imp:n=1  $ Position 14
1515 10 4.8648E-05  2615 -1515 1201 -1202 imp:n=1  $ Position 15
1516 10 4.8648E-05  2616 -1516 1201 -1202 imp:n=1  $ Position 16
1517 10 4.8648E-05       -1517 1201 -1202 imp:n=1  $ Position 17
1518 10 4.8648E-05  2618 -1518 1201 -1202 imp:n=1  $ Position 18
1519 10 4.8648E-05  2619 -1519 1201 -1202 imp:n=1  $ Position 19
1520 10 4.8648E-05       -1520 1201 -1202 imp:n=1  $ Position 20
1521 10 4.8648E-05  2621 -1521 1201 -1202 imp:n=1  $ Position 21
1522 10 4.8648E-05  2622 -1522 1201 -1202 imp:n=1  $ Position 22
1523 10 4.8648E-05       -1523 1201 -1202 imp:n=1  $ Position 23
1524 10 4.8648E-05  2624 -1524 1201 -1202 imp:n=1  $ Position 24
1525 10 4.8648E-05  2625 -1525 1201 -1202 imp:n=1  $ Position 25
1526 10 4.8648E-05       -1526 1201 -1202 imp:n=1  $ Position 26
1527 10 4.8648E-05  2627 -1527 1201 -1202 imp:n=1  $ Position 27
1528 10 4.8648E-05       -1528 1201 -1202 imp:n=1  $ Position 28
1529 10 4.8648E-05  2629 -1529 1201 -1202 imp:n=1  $ Position 29
1530 10 4.8648E-05  2630 -1530 1201 -1202 imp:n=1  $ Position 30
1531 10 4.8648E-05       -1531 1201 -1202 imp:n=1  $ Position 31
1532 10 4.8648E-05  2632 -1532 1201 -1202 imp:n=1  $ Position 32
c
c --------- Ring 4 ---------
1601 10 4.8648E-05  2701 -1601 1201 -1202 imp:n=1  $ Position 1
1602 10 4.8648E-05  2702 -1602 1201 -1202 imp:n=1  $ Position 2
1603 10 4.8648E-05  2703 -1603 1201 -1202 imp:n=1  $ Position 3
1604 10 4.8648E-05  2704 -1604 1201 -1202 imp:n=1  $ Position 4
1605 10 4.8648E-05  2705 -1605 1201 -1202 imp:n=1  $ Position 5
1606 10 4.8648E-05  2706 -1606 1201 -1202 imp:n=1  $ Position 6
1607 10 4.8648E-05  2707 -1607 1201 -1202 imp:n=1  $ Position 7
1608 10 4.8648E-05  2708 -1608 1201 -1202 imp:n=1  $ Position 8
1609 10 4.8648E-05  2709 -1609 1201 -1202 imp:n=1  $ Position 9
1610 10 4.8648E-05  2710 -1610 1201 -1202 imp:n=1  $ Position 10
1611 10 4.8648E-05  2711 -1611 1201 -1202 imp:n=1  $ Position 11
1612 10 4.8648E-05  2712 -1612 1201 -1202 imp:n=1  $ Position 12
1613 10 4.8648E-05  2713 -1613 1201 -1202 imp:n=1  $ Position 13
1614 10 4.8648E-05  2714 -1614 1201 -1202 imp:n=1  $ Position 14
1615 10 4.8648E-05  2715 -1615 1201 -1202 imp:n=1  $ Position 15
1616 10 4.8648E-05  2716 -1616 1201 -1202 imp:n=1  $ Position 16
1617 10 4.8648E-05  2717 -1617 1201 -1202 imp:n=1  $ Position 17
1618 10 4.8648E-05  2718 -1618 1201 -1202 imp:n=1  $ Position 18
1619 10 4.8648E-05  2719 -1619 1201 -1202 imp:n=1  $ Position 19
1620 10 4.8648E-05  2720 -1620 1201 -1202 imp:n=1  $ Position 20
1621 10 4.8648E-05  2721 -1621 1201 -1202 imp:n=1  $ Position 21
1622 10 4.8648E-05  2722 -1622 1201 -1202 imp:n=1  $ Position 22
1623 10 4.8648E-05  2723 -1623 1201 -1202 imp:n=1  $ Position 23
1624 10 4.8648E-05  2724 -1624 1201 -1202 imp:n=1  $ Position 24
1625 10 4.8648E-05  2725 -1625 1201 -1202 imp:n=1  $ Position 25
1626 10 4.8648E-05  2726 -1626 1201 -1202 imp:n=1  $ Position 26
1627 10 4.8648E-05  2727 -1627 1201 -1202 imp:n=1  $ Position 27
1628 10 4.8648E-05  2728 -1628 1201 -1202 imp:n=1  $ Position 28
1629 10 4.8648E-05  2729 -1629 1201 -1202 imp:n=1  $ Position 29
1630 10 4.8648E-05  2730 -1630 1201 -1202 imp:n=1  $ Position 30
1631 10 4.8648E-05  2731 -1631 1201 -1202 imp:n=1  $ Position 31
1632 10 4.8648E-05  2732 -1632 1201 -1202 imp:n=1  $ Position 32
c
c --------- Ring 5 ---------
1701 10 4.8648E-05       -1701 1201 -1202 imp:n=1  $ Position 1
1702 10 4.8648E-05  2802 -1702 1201 -1202 imp:n=1  $ Position 2
1703 10 4.8648E-05  2803 -1703 1201 -1202 imp:n=1  $ Position 3
1704 10 4.8648E-05       -1704 1201 -1202 imp:n=1  $ Position 4
1705 10 4.8648E-05  2805 -1705 1201 -1202 imp:n=1  $ Position 5
1706 10 4.8648E-05  2806 -1706 1201 -1202 imp:n=1  $ Position 6
1707 10 4.8648E-05       -1707 1201 -1202 imp:n=1  $ Position 7
1708 10 4.8648E-05  2808 -1708 1201 -1202 imp:n=1  $ Position 8
1709 10 4.8648E-05  2809 -1709 1201 -1202 imp:n=1  $ Position 9
1710 10 4.8648E-05       -1710 1201 -1202 imp:n=1  $ Position 10
1711 10 4.8648E-05  2811 -1711 1201 -1202 imp:n=1  $ Position 11
1712 10 4.8648E-05  2812 -1712 1201 -1202 imp:n=1  $ Position 12
```

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1713 10 4.8648E-05       -1713 1201 -1202 imp:n=1  $ Position 13
1714 10 4.8648E-05  2814 -1714 1201 -1202 imp:n=1  $ Position 14
1715 10 4.8648E-05  2815 -1715 1201 -1202 imp:n=1  $ Position 15
1716 10 4.8648E-05       -1716 1201 -1202 imp:n=1  $ Position 16
1717 10 4.8648E-05  2817 -1717 1201 -1202 imp:n=1  $ Position 17
1718 10 4.8648E-05  2818 -1718 1201 -1202 imp:n=1  $ Position 18
1719 10 4.8648E-05       -1719 1201 -1202 imp:n=1  $ Position 19
1720 10 4.8648E-05  2820 -1720 1201 -1202 imp:n=1  $ Position 20
1721 10 4.8648E-05  2821 -1721 1201 -1202 imp:n=1  $ Position 21
1722 10 4.8648E-05       -1722 1201 -1202 imp:n=1  $ Position 22
1723 10 4.8648E-05  2823 -1723 1201 -1202 imp:n=1  $ Position 23
1724 10 4.8648E-05  2824 -1724 1201 -1202 imp:n=1  $ Position 24
1725 10 4.8648E-05       -1725 1201 -1202 imp:n=1  $ Position 25
1726 10 4.8648E-05  2826 -1726 1201 -1202 imp:n=1  $ Position 26
1727 10 4.8648E-05       -1727 1201 -1202 imp:n=1  $ Position 27
1728 10 4.8648E-05  2828 -1728 1201 -1202 imp:n=1  $ Position 28
1729 10 4.8648E-05  2829 -1729 1201 -1202 imp:n=1  $ Position 29
1730 10 4.8648E-05       -1730 1201 -1202 imp:n=1  $ Position 30
1731 10 4.8648E-05  2831 -1731 1201 -1202 imp:n=1  $ Position 31
1732 10 4.8648E-05  2832 -1732 1201 -1202 imp:n=1  $ Position 32
c
c ------ Graphite Plugs ------
c --------- Ring 1 ---------
12401 29 8.8245E-02  -2401 1201 -1202 imp:n=1  $ Position 1
12402 29 8.8245E-02  -2402 1201 -1202 imp:n=1  $ Position 2
c    *Coolant Channel (No Plug)   $ Position 3
12404 29 8.8245E-02  -2404 1201 -1202 imp:n=1  $ Position 4
12405 29 8.8245E-02  -2405 1201 -1202 imp:n=1  $ Position 5
c    *Coolant Channel (No Plug)   $ Position 6
12407 29 8.8245E-02  -2407 1201 -1202 imp:n=1  $ Position 7
12408 29 8.8245E-02  -2408 1201 -1202 imp:n=1  $ Position 8
c    *Coolant Channel (No Plug)   $ Position 9
12410 29 8.8245E-02  -2410 1201 -1202 imp:n=1  $ Position 10
12411 29 8.8245E-02  -2411 1201 -1202 imp:n=1  $ Position 11
c    *Coolant Channel (No Plug)   $ Position 12
12413 29 8.8245E-02  -2413 1201 -1202 imp:n=1  $ Position 13
12414 29 8.8245E-02  -2414 1201 -1202 imp:n=1  $ Position 14
c    *Coolant Channel (No Plug)   $ Position 15
12416 29 8.8245E-02  -2416 1201 -1202 imp:n=1  $ Position 16
12417 29 8.8245E-02  -2417 1201 -1202 imp:n=1  $ Position 17
c    *Coolant Channel (No Plug)   $ Position 18
12419 29 8.8245E-02  -2419 1201 -1202 imp:n=1  $ Position 19
12420 29 8.8245E-02  -2420 1201 -1202 imp:n=1  $ Position 20
c    *Coolant Channel (No Plug)   $ Position 21
12422 29 8.8245E-02  -2422 1201 -1202 imp:n=1  $ Position 22
12423 29 8.8245E-02  -2423 1201 -1202 imp:n=1  $ Position 23
c    *Coolant Channel (No Plug)   $ Position 24
12425 29 8.8245E-02  -2425 1201 -1202 imp:n=1  $ Position 25
12426 29 8.8245E-02  -2426 1201 -1202 imp:n=1  $ Position 26
c    *Coolant Channel (No Plug)   $ Position 27
12428 29 8.8245E-02  -2428 1201 -1202 imp:n=1  $ Position 28
c    *Coolant Channel (No Plug)   $ Position 29
12430 29 8.8245E-02  -2430 1201 -1202 imp:n=1  $ Position 30
12431 29 8.8245E-02  -2431 1201 -1202 imp:n=1  $ Position 31
c    *Coolant Channel (No Plug)   $ Position 32
c
c --------- Ring 2 ---------
12501 29 8.8245E-02  -2501 1201 -1202 imp:n=1  $ Position 1
12502 29 8.8245E-02  -2502 1201 -1202 imp:n=1  $ Position 2
12503 29 8.8245E-02  -2503 1201 -1202 imp:n=1  $ Position 3
12504 29 8.8245E-02  -2504 1201 -1202 imp:n=1  $ Position 4
12505 29 8.8245E-02  -2505 1201 -1202 imp:n=1  $ Position 5
12506 29 8.8245E-02  -2506 1201 -1202 imp:n=1  $ Position 6
12507 29 8.8245E-02  -2507 1201 -1202 imp:n=1  $ Position 7
12508 29 8.8245E-02  -2508 1201 -1202 imp:n=1  $ Position 8
12509 29 8.8245E-02  -2509 1201 -1202 imp:n=1  $ Position 9
12510 29 8.8245E-02  -2510 1201 -1202 imp:n=1  $ Position 10
12511 29 8.8245E-02  -2511 1201 -1202 imp:n=1  $ Position 11
12512 29 8.8245E-02  -2512 1201 -1202 imp:n=1  $ Position 12
12513 29 8.8245E-02  -2513 1201 -1202 imp:n=1  $ Position 13
12514 29 8.8245E-02  -2514 1201 -1202 imp:n=1  $ Position 14
12515 29 8.8245E-02  -2515 1201 -1202 imp:n=1  $ Position 15
12516 29 8.8245E-02  -2516 1201 -1202 imp:n=1  $ Position 16
12517 29 8.8245E-02  -2517 1201 -1202 imp:n=1  $ Position 17
12518 29 8.8245E-02  -2518 1201 -1202 imp:n=1  $ Position 18
```

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12519 29 8.8245E-02  -2519 1201 -1202 imp:n=1  $ Position 19
12520 29 8.8245E-02  -2520 1201 -1202 imp:n=1  $ Position 20
12521 29 8.8245E-02  -2521 1201 -1202 imp:n=1  $ Position 21
12522 29 8.8245E-02  -2522 1201 -1202 imp:n=1  $ Position 22
12523 29 8.8245E-02  -2523 1201 -1202 imp:n=1  $ Position 23
12524 29 8.8245E-02  -2524 1201 -1202 imp:n=1  $ Position 24
12525 29 8.8245E-02  -2525 1201 -1202 imp:n=1  $ Position 25
12526 29 8.8245E-02  -2526 1201 -1202 imp:n=1  $ Position 26
12527 29 8.8245E-02  -2527 1201 -1202 imp:n=1  $ Position 27
12528 29 8.8245E-02  -2528 1201 -1202 imp:n=1  $ Position 28
12529 29 8.8245E-02  -2529 1201 -1202 imp:n=1  $ Position 29
12530 29 8.8245E-02  -2530 1201 -1202 imp:n=1  $ Position 30
12531 29 8.8245E-02  -2531 1201 -1202 imp:n=1  $ Position 31
12532 29 8.8245E-02  -2532 1201 -1202 imp:n=1  $ Position 32
c
c --------- Ring 3 ---------
12601 29 8.8245E-02  -2601 1201 -1202 imp:n=1  $ Position 1
c    *Coolant Channel (No Plug)   $ Position 2
12603 29 8.8245E-02  -2603 1201 -1202 imp:n=1  $ Position 3
12604 29 8.8245E-02  -2604 1201 -1202 imp:n=1  $ Position 4
c    *Coolant Channel (No Plug)   $ Position 5
12606 29 8.8245E-02  -2606 1201 -1202 imp:n=1  $ Position 6
12607 29 8.8245E-02  -2607 1201 -1202 imp:n=1  $ Position 7
c    *Coolant Channel (No Plug)   $ Position 8
12609 29 8.8245E-02  -2609 1201 -1202 imp:n=1  $ Position 9
12610 29 8.8245E-02  -2610 1201 -1202 imp:n=1  $ Position 10
c    *Coolant Channel (No Plug)   $ Position 11
12612 29 8.8245E-02  -2612 1201 -1202 imp:n=1  $ Position 12
12613 29 8.8245E-02  -2613 1201 -1202 imp:n=1  $ Position 13
c    *Coolant Channel (No Plug)   $ Position 14
12615 29 8.8245E-02  -2615 1201 -1202 imp:n=1  $ Position 15
12616 29 8.8245E-02  -2616 1201 -1202 imp:n=1  $ Position 16
c    *Coolant Channel (No Plug)   $ Position 17
12618 29 8.8245E-02  -2618 1201 -1202 imp:n=1  $ Position 18
12619 29 8.8245E-02  -2619 1201 -1202 imp:n=1  $ Position 19
c    *Coolant Channel (No Plug)   $ Position 20
12621 29 8.8245E-02  -2621 1201 -1202 imp:n=1  $ Position 21
12622 29 8.8245E-02  -2622 1201 -1202 imp:n=1  $ Position 22
c    *Coolant Channel (No Plug)   $ Position 23
12624 29 8.8245E-02  -2624 1201 -1202 imp:n=1  $ Position 24
12625 29 8.8245E-02  -2625 1201 -1202 imp:n=1  $ Position 25
c    *Coolant Channel (No Plug)   $ Position 26
12627 29 8.8245E-02  -2627 1201 -1202 imp:n=1  $ Position 27
c    *Coolant Channel (No Plug)   $ Position 28
12629 29 8.8245E-02  -2629 1201 -1202 imp:n=1  $ Position 29
12630 29 8.8245E-02  -2630 1201 -1202 imp:n=1  $ Position 30
c    *Coolant Channel (No Plug)   $ Position 31
12632 29 8.8245E-02  -2632 1201 -1202 imp:n=1  $ Position 32
c
c --------- Ring 4 ---------
12701 29 8.8245E-02  -2701 1201 -1202 imp:n=1  $ Position 1
12702 29 8.8245E-02  -2702 1201 -1202 imp:n=1  $ Position 2
12703 29 8.8245E-02  -2703 1201 -1202 imp:n=1  $ Position 3
12704 29 8.8245E-02  -2704 1201 -1202 imp:n=1  $ Position 4
12705 29 8.8245E-02  -2705 1201 -1202 imp:n=1  $ Position 5
12706 29 8.8245E-02  -2706 1201 -1202 imp:n=1  $ Position 6
12707 29 8.8245E-02  -2707 1201 -1202 imp:n=1  $ Position 7
12708 29 8.8245E-02  -2708 1201 -1202 imp:n=1  $ Position 8
12709 29 8.8245E-02  -2709 1201 -1202 imp:n=1  $ Position 9
12710 29 8.8245E-02  -2710 1201 -1202 imp:n=1  $ Position 10
12711 29 8.8245E-02  -2711 1201 -1202 imp:n=1  $ Position 11
12712 29 8.8245E-02  -2712 1201 -1202 imp:n=1  $ Position 12
12713 29 8.8245E-02  -2713 1201 -1202 imp:n=1  $ Position 13
12714 29 8.8245E-02  -2714 1201 -1202 imp:n=1  $ Position 14
12715 29 8.8245E-02  -2715 1201 -1202 imp:n=1  $ Position 15
12716 29 8.8245E-02  -2716 1201 -1202 imp:n=1  $ Position 16
12717 29 8.8245E-02  -2717 1201 -1202 imp:n=1  $ Position 17
12718 29 8.8245E-02  -2718 1201 -1202 imp:n=1  $ Position 18
12719 29 8.8245E-02  -2719 1201 -1202 imp:n=1  $ Position 19
12720 29 8.8245E-02  -2720 1201 -1202 imp:n=1  $ Position 20
12721 29 8.8245E-02  -2721 1201 -1202 imp:n=1  $ Position 21
12722 29 8.8245E-02  -2722 1201 -1202 imp:n=1  $ Position 22
12723 29 8.8245E-02  -2723 1201 -1202 imp:n=1  $ Position 23
12724 29 8.8245E-02  -2724 1201 -1202 imp:n=1  $ Position 24
12725 29 8.8245E-02  -2725 1201 -1202 imp:n=1  $ Position 25
```

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12726 29 8.8245E-02  -2726 1201 -1202 imp:n=1  $ Position 26
12727 29 8.8245E-02  -2727 1201 -1202 imp:n=1  $ Position 27
12728 29 8.8245E-02  -2728 1201 -1202 imp:n=1  $ Position 28
12729 29 8.8245E-02  -2729 1201 -1202 imp:n=1  $ Position 29
12730 29 8.8245E-02  -2730 1201 -1202 imp:n=1  $ Position 30
12731 29 8.8245E-02  -2731 1201 -1202 imp:n=1  $ Position 31
12732 29 8.8245E-02  -2732 1201 -1202 imp:n=1  $ Position 32
c
c --------- Ring 5 ---------
c    *Coolant Channel (No Plug)   $ Position 1
12802 29 8.8245E-02  -2802 1201 -1202 imp:n=1  $ Position 2
12803 29 8.8245E-02  -2803 1201 -1202 imp:n=1  $ Position 3
c    *Coolant Channel (No Plug)   $ Position 4
12805 29 8.8245E-02  -2805 1201 -1202 imp:n=1  $ Position 5
12806 29 8.8245E-02  -2806 1201 -1202 imp:n=1  $ Position 6
c    *Coolant Channel (No Plug)   $ Position 7
12808 29 8.8245E-02  -2808 1201 -1202 imp:n=1  $ Position 8
12809 29 8.8245E-02  -2809 1201 -1202 imp:n=1  $ Position 9
c    *Coolant Channel (No Plug)   $ Position 10
12811 29 8.8245E-02  -2811 1201 -1202 imp:n=1  $ Position 11
12812 29 8.8245E-02  -2812 1201 -1202 imp:n=1  $ Position 12
c    *Coolant Channel (No Plug)   $ Position 13
12814 29 8.8245E-02  -2814 1201 -1202 imp:n=1  $ Position 14
12815 29 8.8245E-02  -2815 1201 -1202 imp:n=1  $ Position 15
c    *Coolant Channel (No Plug)   $ Position 16
12817 29 8.8245E-02  -2817 1201 -1202 imp:n=1  $ Position 17
12818 29 8.8245E-02  -2818 1201 -1202 imp:n=1  $ Position 18
c    *Coolant Channel (No Plug)   $ Position 19
12820 29 8.8245E-02  -2820 1201 -1202 imp:n=1  $ Position 20
12821 29 8.8245E-02  -2821 1201 -1202 imp:n=1  $ Position 21
c    *Coolant Channel (No Plug)   $ Position 22
12823 29 8.8245E-02  -2823 1201 -1202 imp:n=1  $ Position 23
12824 29 8.8245E-02  -2824 1201 -1202 imp:n=1  $ Position 24
c    *Coolant Channel (No Plug)   $ Position 25
12826 29 8.8245E-02  -2826 1201 -1202 imp:n=1  $ Position 26
c    *Coolant Channel (No Plug)   $ Position 27
12828 29 8.8245E-02  -2828 1201 -1202 imp:n=1  $ Position 28
12829 29 8.8245E-02  -2829 1201 -1202 imp:n=1  $ Position 29
c    *Coolant Channel (No Plug)   $ Position 30
12831 29 8.8245E-02  -2831 1201 -1202 imp:n=1  $ Position 31
12832 29 8.8245E-02  -2832 1201 -1202 imp:n=1  $ Position 32
c
c ------ Aluminum Tank ------
1800   9 5.9018E-02  1801 -1201 -1221       imp:n=1  $ Bottom Center
1801  10 4.8648E-05  1803 -1801 -1221       imp:n=1  $ Air Gap
1802   9 5.9018E-02  1804 -1803 -1222       imp:n=1  $ Very Bottom Center
1803   9 5.9018E-02  1801 -1201  1222 -1223 imp:n=1  $ Bottom Annulus
1804  10 4.8648E-05  1201 -1202  1204 -1221 imp:n=1  $ Air Gap
1805   9 5.9018E-02  1803 -1202  1221 -1222 imp:n=1  $ Inner Vertical Liner
1806  10 4.8648E-05  1201 -1202  1222 -1211 imp:n=1  $ Air Gap
1807  10 4.8648E-05  1201 -1202  1212 -1223 imp:n=1  $ Air Gap
1808   9 5.9018E-02  1803 -1202  1223 -1802 -1806 imp:n=1  $ Outer Vertical Liner
1809  10 4.8648E-05  1803 -1801 -1806  1222 -1807 imp:n=1  $ Air Gap
1810   9 5.9018E-02  1803 -1801 -1806  1807 -1808 imp:n=1  $ Support
1811  10 4.8648E-05  1803 -1801 -1806  1808 -1223 imp:n=1  $ Air Gap
1812   9 5.9018E-02  (1806:-1803) -1805 -1801  1222 -1802 1804 imp:n=1  $ Curved Liner
1819  10 4.8648E-05  1801 -1202  1802
           -7501 -7502 -7503 -7504 -7505 -7506 -7507 -7508 -7509 -7510 -7511
           -7512 -7513 -7514 -7515 -7516 -7517 -7518 -7519 -7520 -7521 -7522
           imp:n=1  $ Air Gap
c
c --- Lower Axial Reflector ---------------------------------------------------
c ------ Inner Cylinder ------
1820  4 8.7744E-02  31 -1811 -1812 (1821:1822) imp:n=1
c
c ------ Neutron Source Position ------
1821  30 8.8245E-02  31 -1821 -1823 imp:n=1  $ Graphite Plug
1822  10 4.8648E-05  31 -1821 1823 -1822 imp:n=1  $ Neutron Source Channel
c
c ------ Graphite Annulus ------
1831  10 4.8648E-05  31 -1811 1812
           -7561 -7562 -7563 -7564 -7565 -7566 -7567 -7568 -7569 -7570 -7571
           -7572 -7573 -7574 -7575 -7576 -7577 -7578 -7579 -7580 -7581 imp:n=1  $ Air Gap
1832  5 8.8245E-02  31 -1811 -1333
           (7561:7562:7563:7564:7565:7566:7567:7568:7569:7570:7571:
```

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           7572:7573:7574:7575:7576:7577:7578:7579:7580:7581)
          (1901 1902 1903 1904 1905 1906 1907 1908 1909 1910 1911 1912 1913
           1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926
           1927 1928 1929 1930 1931 1932)
           imp:n=1  $ Ring 1 Region
1833  5 8.8245E-02  31 -1811 1333 -1433
          (2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
           2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026
           2027 2028 2029 2030 2031 2032)
           imp:n=1  $ Ring 2 Region
1834  5 8.8245E-02  31 -1811 1433 -1533
          (2101 2102 2103 2104 2105 2106 2107 2108 2109 2110 2111 2112 2113
           2114 2115 2116 2117 2118 2119 2120 2121 2122 2123 2124 2125 2126
           2127 2128 2129 2130 2131 2132)
           imp:n=1  $ Ring 3 Region
1835  5 8.8245E-02  31 -1811 1533 -1633
          (2201 2202 2203 2204 2205 2206 2207 2208 2209 2210 2211 2212 2213
           2214 2215 2216 2217 2218 2219 2220 2221 2222 2223 2224 2225 2226
           2227 2228 2229 2230 2231 2232)
           imp:n=1  $ Ring 4 Region
1836  5 8.8245E-02  31 -1811 1633
           -7601 -7602 -7603 -7604 -7605 -7606 -7607 -7608 -7609 -7610 -7611
           -7612 -7613 -7614 -7615 -7616 -7617 -7618 -7619 -7620 -7621
           (2301 2302 2303 2304 2305 2306 2307 2308 2309 2310 2311 2312 2313
           2314 2315 2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326
           2327 2328 2329 2330 2331 2332)
           imp:n=1  $ Ring 5 Region
1837  10 4.8648E-05  31 -1811
           (7601:7602:7603:7604:7605:7606:7607:7608:7609:7610:7611:
           7612:7613:7614:7615:7616:7617:7618:7619:7620:7621)
           -7501 -7502 -7503 -7504 -7505 -7506 -7507 -7508 -7509 -7510 -7511
           -7512 -7513 -7514 -7515 -7516 -7517 -7518 -7519 -7520 -7521 -7522
           imp:n=1  $ Air Gap
c
c ------ Coolant Channels ------
c --------- Ring 1 ---------
1901 10 4.8648E-05  2401 -1901 31 -1811 imp:n=1  $ Position 1
1902 10 4.8648E-05  2402 -1902 31 -1811 imp:n=1  $ Position 2
1903 10 4.8648E-05  2403 -1903 31 -1811 imp:n=1  $ Position 3
1904 10 4.8648E-05  2404 -1904 31 -1811 imp:n=1  $ Position 4
1905 10 4.8648E-05  2405 -1905 31 -1811 imp:n=1  $ Position 5
1906 10 4.8648E-05  2406 -1906 31 -1811 imp:n=1  $ Position 6
1907 10 4.8648E-05  2407 -1907 31 -1811 imp:n=1  $ Position 7
1908 10 4.8648E-05  2408 -1908 31 -1811 imp:n=1  $ Position 8
1909 10 4.8648E-05  2409 -1909 31 -1811 imp:n=1  $ Position 9
1910 10 4.8648E-05  2410 -1910 31 -1811 imp:n=1  $ Position 10
1911 10 4.8648E-05  2411 -1911 31 -1811 imp:n=1  $ Position 11
1912 10 4.8648E-05  2412 -1912 31 -1811 imp:n=1  $ Position 12
1913 10 4.8648E-05  2413 -1913 31 -1811 imp:n=1  $ Position 13
1914 10 4.8648E-05  2414 -1914 31 -1811 imp:n=1  $ Position 14
1915 10 4.8648E-05  2415 -1915 31 -1811 imp:n=1  $ Position 15
1916 10 4.8648E-05  2416 -1916 31 -1811 imp:n=1  $ Position 16
1917 10 4.8648E-05  2417 -1917 31 -1811 imp:n=1  $ Position 17
1918 10 4.8648E-05  2418 -1918 31 -1811 imp:n=1  $ Position 18
1919 10 4.8648E-05  2419 -1919 31 -1811 imp:n=1  $ Position 19
1920 10 4.8648E-05  2420 -1920 31 -1811 imp:n=1  $ Position 20
1921 10 4.8648E-05  2421 -1921 31 -1811 imp:n=1  $ Position 21
1922 10 4.8648E-05  2422 -1922 31 -1811 imp:n=1  $ Position 22
1923 10 4.8648E-05  2423 -1923 31 -1811 imp:n=1  $ Position 23
1924 10 4.8648E-05  2424 -1924 31 -1811 imp:n=1  $ Position 24
1925 10 4.8648E-05  2425 -1925 31 -1811 imp:n=1  $ Position 25
1926 10 4.8648E-05  2426 -1926 31 -1811 imp:n=1  $ Position 26
1927 10 4.8648E-05  2427 -1927 31 -1811 imp:n=1  $ Position 27
1928 10 4.8648E-05  2428 -1928 31 -1811 imp:n=1  $ Position 28
1929 10 4.8648E-05  2429 -1929 31 -1811 imp:n=1  $ Position 29
1930 10 4.8648E-05  2430 -1930 31 -1811 imp:n=1  $ Position 30
1931 10 4.8648E-05  2431 -1931 31 -1811 imp:n=1  $ Position 31
1932 10 4.8648E-05  2432 -1932 31 -1811 imp:n=1  $ Position 32
c
c --------- Ring 2 ---------
2001 10 4.8648E-05  2501 -2001 31 -1811 imp:n=1  $ Position 1
2002 10 4.8648E-05  2502 -2002 31 -1811 imp:n=1  $ Position 2
2003 10 4.8648E-05  2503 -2003 31 -1811 imp:n=1  $ Position 3
2004 10 4.8648E-05  2504 -2004 31 -1811 imp:n=1  $ Position 4
2005 10 4.8648E-05  2505 -2005 31 -1811 imp:n=1  $ Position 5
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2006 10 4.8648E-05  2506 -2006 31 -1811 imp:n=1  $ Position 6
2007 10 4.8648E-05  2507 -2007 31 -1811 imp:n=1  $ Position 7
2008 10 4.8648E-05  2508 -2008 31 -1811 imp:n=1  $ Position 8
2009 10 4.8648E-05  2509 -2009 31 -1811 imp:n=1  $ Position 9
2010 10 4.8648E-05  2510 -2010 31 -1811 imp:n=1  $ Position 10
2011 10 4.8648E-05  2511 -2011 31 -1811 imp:n=1  $ Position 11
2012 10 4.8648E-05  2512 -2012 31 -1811 imp:n=1  $ Position 12
2013 10 4.8648E-05  2513 -2013 31 -1811 imp:n=1  $ Position 13
2014 10 4.8648E-05  2514 -2014 31 -1811 imp:n=1  $ Position 14
2015 10 4.8648E-05  2515 -2015 31 -1811 imp:n=1  $ Position 15
2016 10 4.8648E-05  2516 -2016 31 -1811 imp:n=1  $ Position 16
2017 10 4.8648E-05  2517 -2017 31 -1811 imp:n=1  $ Position 17
2018 10 4.8648E-05  2518 -2018 31 -1811 imp:n=1  $ Position 18
2019 10 4.8648E-05  2519 -2019 31 -1811 imp:n=1  $ Position 19
2020 10 4.8648E-05  2520 -2020 31 -1811 imp:n=1  $ Position 20
2021 10 4.8648E-05  2521 -2021 31 -1811 imp:n=1  $ Position 21
2022 10 4.8648E-05  2522 -2022 31 -1811 imp:n=1  $ Position 22
2023 10 4.8648E-05  2523 -2023 31 -1811 imp:n=1  $ Position 23
2024 10 4.8648E-05  2524 -2024 31 -1811 imp:n=1  $ Position 24
2025 10 4.8648E-05  2525 -2025 31 -1811 imp:n=1  $ Position 25
2026 10 4.8648E-05  2526 -2026 31 -1811 imp:n=1  $ Position 26
2027 10 4.8648E-05  2527 -2027 31 -1811 imp:n=1  $ Position 27
2028 10 4.8648E-05  2528 -2028 31 -1811 imp:n=1  $ Position 28
2029 10 4.8648E-05  2529 -2029 31 -1811 imp:n=1  $ Position 29
2030 10 4.8648E-05  2530 -2030 31 -1811 imp:n=1  $ Position 30
2031 10 4.8648E-05  2531 -2031 31 -1811 imp:n=1  $ Position 31
2032 10 4.8648E-05  2532 -2032 31 -1811 imp:n=1  $ Position 32
c
c --------- Ring 3 ---------
2101 10 4.8648E-05  2601 -2101 31 -1811 imp:n=1  $ Position 1
2102 10 4.8648E-05  2602 -2102 31 -1811 imp:n=1  $ Position 2
2103 10 4.8648E-05  2603 -2103 31 -1811 imp:n=1  $ Position 3
2104 10 4.8648E-05  2604 -2104 31 -1811 imp:n=1  $ Position 4
2105 10 4.8648E-05  2605 -2105 31 -1811 imp:n=1  $ Position 5
2106 10 4.8648E-05  2606 -2106 31 -1811 imp:n=1  $ Position 6
2107 10 4.8648E-05  2607 -2107 31 -1811 imp:n=1  $ Position 7
2108 10 4.8648E-05  2608 -2108 31 -1811 imp:n=1  $ Position 8
2109 10 4.8648E-05  2609 -2109 31 -1811 imp:n=1  $ Position 9
2110 10 4.8648E-05  2610 -2110 31 -1811 imp:n=1  $ Position 10
2111 10 4.8648E-05  2611 -2111 31 -1811 imp:n=1  $ Position 11
2112 10 4.8648E-05  2612 -2112 31 -1811 imp:n=1  $ Position 12
2113 10 4.8648E-05  2613 -2113 31 -1811 imp:n=1  $ Position 13
2114 10 4.8648E-05  2614 -2114 31 -1811 imp:n=1  $ Position 14
2115 10 4.8648E-05  2615 -2115 31 -1811 imp:n=1  $ Position 15
2116 10 4.8648E-05  2616 -2116 31 -1811 imp:n=1  $ Position 16
2117 10 4.8648E-05  2617 -2117 31 -1811 imp:n=1  $ Position 17
2118 10 4.8648E-05  2618 -2118 31 -1811 imp:n=1  $ Position 18
2119 10 4.8648E-05  2619 -2119 31 -1811 imp:n=1  $ Position 19
2120 10 4.8648E-05  2620 -2120 31 -1811 imp:n=1  $ Position 20
2121 10 4.8648E-05  2621 -2121 31 -1811 imp:n=1  $ Position 21
2122 10 4.8648E-05  2622 -2122 31 -1811 imp:n=1  $ Position 22
2123 10 4.8648E-05  2623 -2123 31 -1811 imp:n=1  $ Position 23
2124 10 4.8648E-05  2624 -2124 31 -1811 imp:n=1  $ Position 24
2125 10 4.8648E-05  2625 -2125 31 -1811 imp:n=1  $ Position 25
2126 10 4.8648E-05  2626 -2126 31 -1811 imp:n=1  $ Position 26
2127 10 4.8648E-05  2627 -2127 31 -1811 imp:n=1  $ Position 27
2128 10 4.8648E-05  2628 -2128 31 -1811 imp:n=1  $ Position 28
2129 10 4.8648E-05  2629 -2129 31 -1811 imp:n=1  $ Position 29
2130 10 4.8648E-05  2630 -2130 31 -1811 imp:n=1  $ Position 30
2131 10 4.8648E-05  2631 -2131 31 -1811 imp:n=1  $ Position 31
2132 10 4.8648E-05  2632 -2132 31 -1811 imp:n=1  $ Position 32
c
c --------- Ring 4 ---------
2201 10 4.8648E-05  2701 -2201 31 -1811 imp:n=1  $ Position 1
2202 10 4.8648E-05  2702 -2202 31 -1811 imp:n=1  $ Position 2
2203 10 4.8648E-05  2703 -2203 31 -1811 imp:n=1  $ Position 3
2204 10 4.8648E-05  2704 -2204 31 -1811 imp:n=1  $ Position 4
2205 10 4.8648E-05  2705 -2205 31 -1811 imp:n=1  $ Position 5
2206 10 4.8648E-05  2706 -2206 31 -1811 imp:n=1  $ Position 6
2207 10 4.8648E-05  2707 -2207 31 -1811 imp:n=1  $ Position 7
2208 10 4.8648E-05  2708 -2208 31 -1811 imp:n=1  $ Position 8
2209 10 4.8648E-05  2709 -2209 31 -1811 imp:n=1  $ Position 9
2210 10 4.8648E-05  2710 -2210 31 -1811 imp:n=1  $ Position 10
2211 10 4.8648E-05  2711 -2211 31 -1811 imp:n=1  $ Position 11
2212 10 4.8648E-05  2712 -2212 31 -1811 imp:n=1  $ Position 12
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2213 10 4.8648E-05  2713 -2213 31 -1811 imp:n=1  $ Position 13
2214 10 4.8648E-05  2714 -2214 31 -1811 imp:n=1  $ Position 14
2215 10 4.8648E-05  2715 -2215 31 -1811 imp:n=1  $ Position 15
2216 10 4.8648E-05  2716 -2216 31 -1811 imp:n=1  $ Position 16
2217 10 4.8648E-05  2717 -2217 31 -1811 imp:n=1  $ Position 17
2218 10 4.8648E-05  2718 -2218 31 -1811 imp:n=1  $ Position 18
2219 10 4.8648E-05  2719 -2219 31 -1811 imp:n=1  $ Position 19
2220 10 4.8648E-05  2720 -2220 31 -1811 imp:n=1  $ Position 20
2221 10 4.8648E-05  2721 -2221 31 -1811 imp:n=1  $ Position 21
2222 10 4.8648E-05  2722 -2222 31 -1811 imp:n=1  $ Position 22
2223 10 4.8648E-05  2723 -2223 31 -1811 imp:n=1  $ Position 23
2224 10 4.8648E-05  2724 -2224 31 -1811 imp:n=1  $ Position 24
2225 10 4.8648E-05  2725 -2225 31 -1811 imp:n=1  $ Position 25
2226 10 4.8648E-05  2726 -2226 31 -1811 imp:n=1  $ Position 26
2227 10 4.8648E-05  2727 -2227 31 -1811 imp:n=1  $ Position 27
2228 10 4.8648E-05  2728 -2228 31 -1811 imp:n=1  $ Position 28
2229 10 4.8648E-05  2729 -2229 31 -1811 imp:n=1  $ Position 29
2230 10 4.8648E-05  2730 -2230 31 -1811 imp:n=1  $ Position 30
2231 10 4.8648E-05  2731 -2231 31 -1811 imp:n=1  $ Position 31
2232 10 4.8648E-05  2732 -2232 31 -1811 imp:n=1  $ Position 32
c
c --------- Ring 5 ---------
2301 10 4.8648E-05  2801 -2301 31 -1811 imp:n=1  $ Position 1
2302 10 4.8648E-05  2802 -2302 31 -1811 imp:n=1  $ Position 2
2303 10 4.8648E-05  2803 -2303 31 -1811 imp:n=1  $ Position 3
2304 10 4.8648E-05  2804 -2304 31 -1811 imp:n=1  $ Position 4
2305 10 4.8648E-05  2805 -2305 31 -1811 imp:n=1  $ Position 5
2306 10 4.8648E-05  2806 -2306 31 -1811 imp:n=1  $ Position 6
2307 10 4.8648E-05  2807 -2307 31 -1811 imp:n=1  $ Position 7
2308 10 4.8648E-05  2808 -2308 31 -1811 imp:n=1  $ Position 8
2309 10 4.8648E-05  2809 -2309 31 -1811 imp:n=1  $ Position 9
2310 10 4.8648E-05  2810 -2310 31 -1811 imp:n=1  $ Position 10
2311 10 4.8648E-05  2811 -2311 31 -1811 imp:n=1  $ Position 11
2312 10 4.8648E-05  2812 -2312 31 -1811 imp:n=1  $ Position 12
2313 10 4.8648E-05  2813 -2313 31 -1811 imp:n=1  $ Position 13
2314 10 4.8648E-05  2814 -2314 31 -1811 imp:n=1  $ Position 14
2315 10 4.8648E-05  2815 -2315 31 -1811 imp:n=1  $ Position 15
2316 10 4.8648E-05  2816 -2316 31 -1811 imp:n=1  $ Position 16
2317 10 4.8648E-05  2817 -2317 31 -1811 imp:n=1  $ Position 17
2318 10 4.8648E-05  2818 -2318 31 -1811 imp:n=1  $ Position 18
2319 10 4.8648E-05  2819 -2319 31 -1811 imp:n=1  $ Position 19
2320 10 4.8648E-05  2820 -2320 31 -1811 imp:n=1  $ Position 20
2321 10 4.8648E-05  2821 -2321 31 -1811 imp:n=1  $ Position 21
2322 10 4.8648E-05  2822 -2322 31 -1811 imp:n=1  $ Position 22
2323 10 4.8648E-05  2823 -2323 31 -1811 imp:n=1  $ Position 23
2324 10 4.8648E-05  2824 -2324 31 -1811 imp:n=1  $ Position 24
2325 10 4.8648E-05  2825 -2325 31 -1811 imp:n=1  $ Position 25
2326 10 4.8648E-05  2826 -2326 31 -1811 imp:n=1  $ Position 26
2327 10 4.8648E-05  2827 -2327 31 -1811 imp:n=1  $ Position 27
2328 10 4.8648E-05  2828 -2328 31 -1811 imp:n=1  $ Position 28
2329 10 4.8648E-05  2829 -2329 31 -1811 imp:n=1  $ Position 29
2330 10 4.8648E-05  2830 -2330 31 -1811 imp:n=1  $ Position 30
2331 10 4.8648E-05  2831 -2331 31 -1811 imp:n=1  $ Position 31
2332 10 4.8648E-05  2832 -2332 31 -1811 imp:n=1  $ Position 32
c
c ------ Graphite Plugs ------
c --------- Ring 1 ---------
2401 29 8.8245E-02  -2401 31 -1811 imp:n=1  $ Position 1
2402 29 8.8245E-02  -2402 31 -1811 imp:n=1  $ Position 2
2403 29 8.8245E-02  -2403 31 -1811 imp:n=1  $ Position 3 (Cores 5, 6, & 7)
c 2403 10 4.8648E-05  -2403 31 -1811 imp:n=1  $ Position 3 (Core 8, i.e. No Plug)
2404 29 8.8245E-02  -2404 31 -1811 imp:n=1  $ Position 4
2405 29 8.8245E-02  -2405 31 -1811 imp:n=1  $ Position 5
2406 29 8.8245E-02  -2406 31 -1811 imp:n=1  $ Position 6 (Cores 5, 6, & 7)
c 2406 10 4.8648E-05  -2406 31 -1811 imp:n=1  $ Position 6 (Core 8, i.e. No Plug)
2407 29 8.8245E-02  -2407 31 -1811 imp:n=1  $ Position 7
2408 29 8.8245E-02  -2408 31 -1811 imp:n=1  $ Position 8
2409 29 8.8245E-02  -2409 31 -1811 imp:n=1  $ Position 9 (Cores 5, 6, & 7)
c 2409 10 4.8648E-05  -2409 31 -1811 imp:n=1  $ Position 9 (Core 8, i.e. No Plug)
2410 29 8.8245E-02  -2410 31 -1811 imp:n=1  $ Position 10
2411 29 8.8245E-02  -2411 31 -1811 imp:n=1  $ Position 11
2412 29 8.8245E-02  -2412 31 -1811 imp:n=1  $ Position 12 (Cores 5, 6, & 7)
c 2412 10 4.8648E-05  -2412 31 -1811 imp:n=1  $ Position 12 (Core 8, i.e. No Plug)
2413 29 8.8245E-02  -2413 31 -1811 imp:n=1  $ Position 13
2414 29 8.8245E-02  -2414 31 -1811 imp:n=1  $ Position 14
```

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2415 29 8.8245E-02  -2415 31 -1811 imp:n=1  $ Position 15 (Cores 5, 6, & 7)
c 2415 10 4.8648E-05  -2415 31 -1811 imp:n=1  $ Position 15 (Core 8, i.e. No Plug)
2416 29 8.8245E-02  -2416 31 -1811 imp:n=1  $ Position 16
2417 29 8.8245E-02  -2417 31 -1811 imp:n=1  $ Position 17
2418 29 8.8245E-02  -2418 31 -1811 imp:n=1  $ Position 18 (Cores 5, 6, & 7)
c 2418 10 4.8648E-05  -2418 31 -1811 imp:n=1  $ Position 18 (Core 8, i.e. No Plug)
2419 29 8.8245E-02  -2419 31 -1811 imp:n=1  $ Position 19
2420 29 8.8245E-02  -2420 31 -1811 imp:n=1  $ Position 20
2421 29 8.8245E-02  -2421 31 -1811 imp:n=1  $ Position 21 (Cores 5, 6, & 7)
c 2421 10 4.8648E-05  -2421 31 -1811 imp:n=1  $ Position 21 (Core 8, i.e. No Plug)
2422 29 8.8245E-02  -2422 31 -1811 imp:n=1  $ Position 22
2423 29 8.8245E-02  -2423 31 -1811 imp:n=1  $ Position 23
2424 29 8.8245E-02  -2424 31 -1811 imp:n=1  $ Position 24 (Cores 5, 6, & 7)
c 2424 10 4.8648E-05  -2424 31 -1811 imp:n=1  $ Position 24 (Core 8, i.e. No Plug)
2425 29 8.8245E-02  -2425 31 -1811 imp:n=1  $ Position 25
2426 29 8.8245E-02  -2426 31 -1811 imp:n=1  $ Position 26
2427 29 8.8245E-02  -2427 31 -1811 imp:n=1  $ Position 27 (Cores 5, 6, & 7)
c 2427 10 4.8648E-05  -2427 31 -1811 imp:n=1  $ Position 27 (Core 8, i.e. No Plug)
2428 29 8.8245E-02  -2428 31 -1811 imp:n=1  $ Position 28
2429 29 8.8245E-02  -2429 31 -1811 imp:n=1  $ Position 29 (Cores 5, 6, & 7)
c 2429 10 4.8648E-05  -2429 31 -1811 imp:n=1  $ Position 29 (Core 8, i.e. No Plug)
2430 29 8.8245E-02  -2430 31 -1811 imp:n=1  $ Position 30
2431 29 8.8245E-02  -2431 31 -1811 imp:n=1  $ Position 31
2432 29 8.8245E-02  -2432 31 -1811 imp:n=1  $ Position 32 (Cores 5, 6, & 7)
c 2432 10 4.8648E-05  -2432 31 -1811 imp:n=1  $ Position 32 (Core 8, i.e. No Plug)
c
c --------- Ring 2 ---------
2501 29 8.8245E-02  -2501 31 -1811 imp:n=1  $ Position 1
2502 29 8.8245E-02  -2502 31 -1811 imp:n=1  $ Position 2
2503 29 8.8245E-02  -2503 31 -1811 imp:n=1  $ Position 3
2504 29 8.8245E-02  -2504 31 -1811 imp:n=1  $ Position 4
2505 29 8.8245E-02  -2505 31 -1811 imp:n=1  $ Position 5
2506 29 8.8245E-02  -2506 31 -1811 imp:n=1  $ Position 6
2507 29 8.8245E-02  -2507 31 -1811 imp:n=1  $ Position 7
2508 29 8.8245E-02  -2508 31 -1811 imp:n=1  $ Position 8
2509 29 8.8245E-02  -2509 31 -1811 imp:n=1  $ Position 9
2510 29 8.8245E-02  -2510 31 -1811 imp:n=1  $ Position 10
2511 29 8.8245E-02  -2511 31 -1811 imp:n=1  $ Position 11
2512 29 8.8245E-02  -2512 31 -1811 imp:n=1  $ Position 12
2513 29 8.8245E-02  -2513 31 -1811 imp:n=1  $ Position 13
2514 29 8.8245E-02  -2514 31 -1811 imp:n=1  $ Position 14
2515 29 8.8245E-02  -2515 31 -1811 imp:n=1  $ Position 15
2516 29 8.8245E-02  -2516 31 -1811 imp:n=1  $ Position 16
2517 29 8.8245E-02  -2517 31 -1811 imp:n=1  $ Position 17
2518 29 8.8245E-02  -2518 31 -1811 imp:n=1  $ Position 18
2519 29 8.8245E-02  -2519 31 -1811 imp:n=1  $ Position 19
2520 29 8.8245E-02  -2520 31 -1811 imp:n=1  $ Position 20
2521 29 8.8245E-02  -2521 31 -1811 imp:n=1  $ Position 21
2522 29 8.8245E-02  -2522 31 -1811 imp:n=1  $ Position 22
2523 29 8.8245E-02  -2523 31 -1811 imp:n=1  $ Position 23
2524 29 8.8245E-02  -2524 31 -1811 imp:n=1  $ Position 24
2525 29 8.8245E-02  -2525 31 -1811 imp:n=1  $ Position 25
2526 29 8.8245E-02  -2526 31 -1811 imp:n=1  $ Position 26
2527 29 8.8245E-02  -2527 31 -1811 imp:n=1  $ Position 27
2528 29 8.8245E-02  -2528 31 -1811 imp:n=1  $ Position 28
2529 29 8.8245E-02  -2529 31 -1811 imp:n=1  $ Position 29
2530 29 8.8245E-02  -2530 31 -1811 imp:n=1  $ Position 30
2531 29 8.8245E-02  -2531 31 -1811 imp:n=1  $ Position 31
2532 29 8.8245E-02  -2532 31 -1811 imp:n=1  $ Position 32
c
c --------- Ring 3 ---------
2601 29 8.8245E-02  -2601 31 -1811 imp:n=1  $ Position 1
2602 29 8.8245E-02  -2602 31 -1811 imp:n=1  $ Position 2 (Cores 5, 6, & 7)
c 2602 10 4.8648E-05  -2602 31 -1811 imp:n=1  $ Position 2 (Core 8, i.e. No Plug)
2603 29 8.8245E-02  -2603 31 -1811 imp:n=1  $ Position 3
2604 29 8.8245E-02  -2604 31 -1811 imp:n=1  $ Position 4
2605 29 8.8245E-02  -2605 31 -1811 imp:n=1  $ Position 5 (Cores 5, 6, & 7)
c 2605 10 4.8648E-05  -2605 31 -1811 imp:n=1  $ Position 5 (Core 8, i.e. No Plug)
2606 29 8.8245E-02  -2606 31 -1811 imp:n=1  $ Position 6
2607 29 8.8245E-02  -2607 31 -1811 imp:n=1  $ Position 7
2608 29 8.8245E-02  -2608 31 -1811 imp:n=1  $ Position 8 (Cores 5, 6, & 7)
c 2608 10 4.8648E-05  -2608 31 -1811 imp:n=1  $ Position 8 (Core 8, i.e. No Plug)
2609 29 8.8245E-02  -2609 31 -1811 imp:n=1  $ Position 9
2610 29 8.8245E-02  -2610 31 -1811 imp:n=1  $ Position 10
2611 29 8.8245E-02  -2611 31 -1811 imp:n=1  $ Position 11 (Cores 5, 6, & 7)
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c 2611 10 4.8648E-05  -2611 31 -1811 imp:n=1  $ Position 11 (Core 8, i.e. No Plug)
2612 29 8.8245E-02  -2612 31 -1811 imp:n=1  $ Position 12
2613 29 8.8245E-02  -2613 31 -1811 imp:n=1  $ Position 13
2614 29 8.8245E-02  -2614 31 -1811 imp:n=1  $ Position 14 (Cores 5, 6, & 7)
c 2614 10 4.8648E-05  -2614 31 -1811 imp:n=1  $ Position 14 (Core 8, i.e. No Plug)
2615 29 8.8245E-02  -2615 31 -1811 imp:n=1  $ Position 15
2616 29 8.8245E-02  -2616 31 -1811 imp:n=1  $ Position 16
2617 29 8.8245E-02  -2617 31 -1811 imp:n=1  $ Position 17 (Cores 5, 6, & 7)
c 2617 10 4.8648E-05  -2617 31 -1811 imp:n=1  $ Position 17 (Core 8, i.e. No Plug)
2618 29 8.8245E-02  -2618 31 -1811 imp:n=1  $ Position 18
2619 29 8.8245E-02  -2619 31 -1811 imp:n=1  $ Position 19
2620 29 8.8245E-02  -2620 31 -1811 imp:n=1  $ Position 20 (Cores 5, 6, & 7)
c 2620 10 4.8648E-05  -2620 31 -1811 imp:n=1  $ Position 20 (Core 8, i.e. No Plug)
2621 29 8.8245E-02  -2621 31 -1811 imp:n=1  $ Position 21
2622 29 8.8245E-02  -2622 31 -1811 imp:n=1  $ Position 22
2623 29 8.8245E-02  -2623 31 -1811 imp:n=1  $ Position 23 (Cores 5, 6, & 7)
c 2623 10 4.8648E-05  -2623 31 -1811 imp:n=1  $ Position 23 (Core 8, i.e. No Plug)
2624 29 8.8245E-02  -2624 31 -1811 imp:n=1  $ Position 24
2625 29 8.8245E-02  -2625 31 -1811 imp:n=1  $ Position 25
2626 29 8.8245E-02  -2626 31 -1811 imp:n=1  $ Position 26 (Cores 5, 6, & 7)
c 2626 10 4.8648E-05  -2626 31 -1811 imp:n=1  $ Position 26 (Core 8, i.e. No Plug)
2627 29 8.8245E-02  -2627 31 -1811 imp:n=1  $ Position 27
2628 29 8.8245E-02  -2628 31 -1811 imp:n=1  $ Position 28 (Cores 5, 6, & 7)
c 2628 10 4.8648E-05  -2628 31 -1811 imp:n=1  $ Position 28 (Core 8, i.e. No Plug)
2629 29 8.8245E-02  -2629 31 -1811 imp:n=1  $ Position 29
2630 29 8.8245E-02  -2630 31 -1811 imp:n=1  $ Position 30
2631 29 8.8245E-02  -2631 31 -1811 imp:n=1  $ Position 31 (Cores 5, 6, & 7)
c 2631 10 4.8648E-05  -2631 31 -1811 imp:n=1  $ Position 31 (Core 8, i.e. No Plug)
2632 29 8.8245E-02  -2632 31 -1811 imp:n=1  $ Position 32
c
c --------- Ring 4 ---------
2701 29 8.8245E-02  -2701 31 -1811 imp:n=1  $ Position 1
2702 29 8.8245E-02  -2702 31 -1811 imp:n=1  $ Position 2
2703 29 8.8245E-02  -2703 31 -1811 imp:n=1  $ Position 3
2704 29 8.8245E-02  -2704 31 -1811 imp:n=1  $ Position 4
2705 29 8.8245E-02  -2705 31 -1811 imp:n=1  $ Position 5
2706 29 8.8245E-02  -2706 31 -1811 imp:n=1  $ Position 6
2707 29 8.8245E-02  -2707 31 -1811 imp:n=1  $ Position 7
2708 29 8.8245E-02  -2708 31 -1811 imp:n=1  $ Position 8
2709 29 8.8245E-02  -2709 31 -1811 imp:n=1  $ Position 9
2710 29 8.8245E-02  -2710 31 -1811 imp:n=1  $ Position 10
2711 29 8.8245E-02  -2711 31 -1811 imp:n=1  $ Position 11
2712 29 8.8245E-02  -2712 31 -1811 imp:n=1  $ Position 12
2713 29 8.8245E-02  -2713 31 -1811 imp:n=1  $ Position 13
2714 29 8.8245E-02  -2714 31 -1811 imp:n=1  $ Position 14
2715 29 8.8245E-02  -2715 31 -1811 imp:n=1  $ Position 15
2716 29 8.8245E-02  -2716 31 -1811 imp:n=1  $ Position 16
2717 29 8.8245E-02  -2717 31 -1811 imp:n=1  $ Position 17
2718 29 8.8245E-02  -2718 31 -1811 imp:n=1  $ Position 18
2719 29 8.8245E-02  -2719 31 -1811 imp:n=1  $ Position 19
2720 29 8.8245E-02  -2720 31 -1811 imp:n=1  $ Position 20
2721 29 8.8245E-02  -2721 31 -1811 imp:n=1  $ Position 21
2722 29 8.8245E-02  -2722 31 -1811 imp:n=1  $ Position 22
2723 29 8.8245E-02  -2723 31 -1811 imp:n=1  $ Position 23
2724 29 8.8245E-02  -2724 31 -1811 imp:n=1  $ Position 24
2725 29 8.8245E-02  -2725 31 -1811 imp:n=1  $ Position 25
2726 29 8.8245E-02  -2726 31 -1811 imp:n=1  $ Position 26
2727 29 8.8245E-02  -2727 31 -1811 imp:n=1  $ Position 27
2728 29 8.8245E-02  -2728 31 -1811 imp:n=1  $ Position 28
2729 29 8.8245E-02  -2729 31 -1811 imp:n=1  $ Position 29
2730 29 8.8245E-02  -2730 31 -1811 imp:n=1  $ Position 30
2731 29 8.8245E-02  -2731 31 -1811 imp:n=1  $ Position 31
2732 29 8.8245E-02  -2732 31 -1811 imp:n=1  $ Position 32
c
c --------- Ring 5 ---------
2801 29 8.8245E-02  -2801 31 -1811 imp:n=1  $ Position 1 (Cores 5, 6, & 7)
c 2801 10 4.8648E-05  -2801 31 -1811 imp:n=1  $ Position 1 (Core 8, i.e. No Plug)
2802 29 8.8245E-02  -2802 31 -1811 imp:n=1  $ Position 2
2803 29 8.8245E-02  -2803 31 -1811 imp:n=1  $ Position 3
2804 29 8.8245E-02  -2804 31 -1811 imp:n=1  $ Position 4 (Cores 5, 6, & 7)
c 2804 10 4.8648E-05  -2804 31 -1811 imp:n=1  $ Position 4 (Core 8, i.e. No Plug)
2805 29 8.8245E-02  -2805 31 -1811 imp:n=1  $ Position 5
2806 29 8.8245E-02  -2806 31 -1811 imp:n=1  $ Position 6
2807 29 8.8245E-02  -2807 31 -1811 imp:n=1  $ Position 7 (Cores 5, 6, & 7)
c 2807 10 4.8648E-05  -2807 31 -1811 imp:n=1  $ Position 7 (Core 8, i.e. No Plug)
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2808 29 8.8245E-02  -2808 31 -1811 imp:n=1  $ Position 8
2809 29 8.8245E-02  -2809 31 -1811 imp:n=1  $ Position 9
2810 29 8.8245E-02  -2810 31 -1811 imp:n=1  $ Position 10 (Cores 5, 6, & 7)
c 2810 10 4.8648E-05  -2810 31 -1811 imp:n=1  $ Position 10 (Core 8, i.e. No Plug)
2811 29 8.8245E-02  -2811 31 -1811 imp:n=1  $ Position 11
2812 29 8.8245E-02  -2812 31 -1811 imp:n=1  $ Position 12
2813 29 8.8245E-02  -2813 31 -1811 imp:n=1  $ Position 13 (Cores 5, 6, & 7)
c 2813 10 4.8648E-05  -2813 31 -1811 imp:n=1  $ Position 13 (Core 8, i.e. No Plug)
2814 29 8.8245E-02  -2814 31 -1811 imp:n=1  $ Position 14
2815 29 8.8245E-02  -2815 31 -1811 imp:n=1  $ Position 15
2816 29 8.8245E-02  -2816 31 -1811 imp:n=1  $ Position 16 (Cores 5, 6, & 7)
c 2816 10 4.8648E-05  -2816 31 -1811 imp:n=1  $ Position 16 (Core 8, i.e. No Plug)
2817 29 8.8245E-02  -2817 31 -1811 imp:n=1  $ Position 17
2818 29 8.8245E-02  -2818 31 -1811 imp:n=1  $ Position 18
2819 29 8.8245E-02  -2819 31 -1811 imp:n=1  $ Position 19 (Cores 5, 6, & 7)
c 2819 10 4.8648E-05  -2819 31 -1811 imp:n=1  $ Position 19 (Core 8, i.e. No Plug)
2820 29 8.8245E-02  -2820 31 -1811 imp:n=1  $ Position 20
2821 29 8.8245E-02  -2821 31 -1811 imp:n=1  $ Position 21
2822 29 8.8245E-02  -2822 31 -1811 imp:n=1  $ Position 22 (Cores 5, 6, & 7)
c 2822 10 4.8648E-05  -282 31 -1811 imp:n=1  $ Position 22 (Core 8, i.e. No Plug)
2823 29 8.8245E-02  -2823 31 -1811 imp:n=1  $ Position 23
2824 29 8.8245E-02  -2824 31 -1811 imp:n=1  $ Position 24
2825 29 8.8245E-02  -2825 31 -1811 imp:n=1  $ Position 25 (Cores 5, 6, & 7)
c 2825 10 4.8648E-05  -2825 31 -1811 imp:n=1  $ Position 25 (Core 8, i.e. No Plug)
2826 29 8.8245E-02  -2826 31 -1811 imp:n=1  $ Position 26
2827 29 8.8245E-02  -2827 31 -1811 imp:n=1  $ Position 27 (Cores 5, 6, & 7)
c 2827 10 4.8648E-05  -2827 31 -1811 imp:n=1  $ Position 27 (Core 8, i.e. No Plug)
2828 29 8.8245E-02  -2828 31 -1811 imp:n=1  $ Position 28
2829 29 8.8245E-02  -2829 31 -1811 imp:n=1  $ Position 29
2830 29 8.8245E-02  -2830 31 -1811 imp:n=1  $ Position 30 (Cores 5, 6, & 7)
c 2830 10 4.8648E-05  -2830 31 -1811 imp:n=1  $ Position 30 (Core 8, i.e. No Plug)
2831 29 8.8245E-02  -2831 31 -1811 imp:n=1  $ Position 31
2832 29 8.8245E-02  -2832 31 -1811 imp:n=1  $ Position 32
c
c ------ Aluminum Plugs ------
c    *There were no aluminum plugs in the Core
c
c --- Control Rods --------------------------------------------------------------
c ------ Safety/Shutdown Rods ------
3001 11 9.1511E-02  3002 -3003 -3005 imp:n=1 u=1  $ Borated Steel Rod
3002 10 4.8648E-05  3002 -3003 3005 -3006 imp:n=1 u=1  $ Air
3003 12 8.6882E-02  3001 -3004 -3007 (-3002:3003:3006) imp:n=1 u=1  $ Steel Tube
3004 10 4.8648E-05  -3001:3004:3007 imp:n=1 u=1  $ Air
c
c ****** Safety/Shutdown Rods Fully Inserted @ z=0 and Withdrawn @ z=290   ***********
c ****** Safety/Shutdown Rods were Fully Withdrawn for Cores 1, 1A, 2, & 3 ***********
c
c --------- Rod 1 ---------
3005 10 4.8648E-05  3011 -3012 -3014 imp:n=1 u=2  $ Air
3006 14 8.1409E-02  31 -3013 -3015 (-3011:3012:3014) imp:n=1 u=2  $ Aluminum Shock Damper
3007 0    (-31:3013:3015) imp:n=1 u=2 fill=1 (0 0 290)
c
c --------- Rod 2 ---------
3008 10 4.8648E-05  3011 -3012 -3014 imp:n=1 u=3  $ Air
3009 14 8.1409E-02  31 -3013 -3015 (-3011:3012:3014) imp:n=1 u=3  $ Aluminum Shock Damper
3010 0    (-31:3013:3015) imp:n=1 u=3 fill=1 (0 0 290)
c
c --------- Rod 3 ---------
3011 10 4.8648E-05  3011 -3012 -3014 imp:n=1 u=4  $ Air
3012 14 8.1409E-02  31 -3013 -3015 (-3011:3012:3014) imp:n=1 u=4  $ Aluminum Shock Damper
3013 0    (-31:3013:3015) imp:n=1 u=4 fill=1 (0 0 290)
c
c --------- Rod 4 ---------
3014 10 4.8648E-05  3011 -3012 -3014 imp:n=1 u=5  $ Air
3015 14 8.1409E-02  31 -3013 -3015 (-3011:3012:3014) imp:n=1 u=5  $ Aluminum Shock Damper
3016 0    (-31:3013:3015) imp:n=1 u=5 fill=1 (0 0 290)
c
c --------- Rod 5 ---------
3017 10 4.8648E-05  3011 -3012 -3014 imp:n=1 u=6  $ Air
3018 14 8.1409E-02  31 -3013 -3015 (-3011:3012:3014) imp:n=1 u=6  $ Aluminum Shock Damper
3019 0    (-31:3013:3015) imp:n=1 u=6 fill=1 (0 0 290)
c
c --------- Rod 6 ---------
3020 10 4.8648E-05  3011 -3012 -3014 imp:n=1 u=7  $ Air
3021 14 8.1409E-02  31 -3013 -3015 (-3011:3012:3014) imp:n=1 u=7  $ Aluminum Shock Damper
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3022 0    (-31:3013:3015) imp:n=1 u=7 fill=1 (0 0 290)
c
c --------- Rod 7 ---------
3023 10 4.8648E-05  3011 -3012 -3014 imp:n=1 u=8  $ Air
3024 14 8.1409E-02  31 -3013 -3015 (-3011:3012:3014) imp:n=1 u=8  $ Aluminum Shock Damper
3025 0    (-31:3013:3015) imp:n=1 u=8 fill=1 (0 0 290)
c
c --------- Rod 8 ---------
3026 10 4.8648E-05  3011 -3012 -3014 imp:n=1 u=9  $ Air
3027 14 8.1409E-02  31 -3013 -3015 (-3011:3012:3014) imp:n=1 u=9  $ Aluminum Shock Damper
3028 0    (-31:3013:3015) imp:n=1 u=9 fill=1 (0 0 290)
c
c ------ Autorod ------
3031 13 8.4303E-02  3031 -3032 -3033 -3034 -3035 imp:n=1 u=10  $ Copper Plate
3032 10 4.8648E-05  -3031:3032:3033:3034:3035 imp:n=1 u=10  $ Air
c
c ****** Autorod Fully Inserted @ z=0 and Withdrawn @ z=100 **************************
c ****** Autorod Withdrawn to z=88.7 for Core 5,            **************************
c ******                      z=22.5 for Core 6,            **************************
c ******                      z=17.0 for Core 7, and        **************************
c ******                      z=50.6 for Core 8,            **************************
c
3033 0    -3036 imp:n=1 u=11 fill=10 (0 0 88.7)
3034 113 5.9746E-02  3036 -3037 15 -32 imp:n=1 u=11  $ Aluminum Tube
3035 10 4.8648E-05  3037:(3036 -15):(3036 32) imp:n=1 u=11  $ Air
c
c ------ Static Measurement Rods ------
c    *There were no Static Measurement Rods in the Core
c
c ------ ZEBRA Rods ------
c    *There were no ZEBRA Control Rods in the Core
c
c ------ Withdrawable Control Rods ------
3091 10 4.8648E-05  3083 -3084 -3087 imp:n=1 u=17  $ Air
3092 17 8.6477E-02  3082 -3085 3087 -3088 imp:n=1 u=17 $ Inner Tube
3093 10 4.8648E-05  3082 -3085 3088 -3089 imp:n=1 u=17 $ Air Gap
3094 18 8.6499E-02  3082 -3085 3089 -3090 imp:n=1 u=17 $ Outer Tube
3095 18 8.6499E-02  (3081 -3082 -3090):(3082 -3083 -3087) imp:n=1 u=17  $ Bottom End Plug
3096 18 8.6499E-02  (3084 -3085 -3087):(3085 -3086 -3090) imp:n=1 u=17  $ Top End Plug
3097 10 4.8648E-05  -3081:3086:3090 imp:n=1 u=17  $ Air
c
c ****** Control Rods Fully Inserted @ z=0 and Withdrawn @ z=249.4          **********
c ****** Opposite of Reported Values Inserted @ z=250 and Withdrawn @ z=0.6 **********
c ****** Control Rods Withdrawn to z=55.5 for Core 5,                       **********
c ****** Control Rods Withdrawn to z=50.0 for Core 6,                       **********
c ****** Control Rods Withdrawn to z=54.0 for Core 7, and                   **********
c ****** Control Rods Withdrawn to z= 0.0 for Core 8                        **********
c
3098 0  -3095 imp:n=1 u=18 fill=17 (0 0 55.5)  $ Rod 1
3099 0  -3095 imp:n=1 u=19 fill=17 (0 0 55.5)  $ Rod 2
3100 0  -3095 imp:n=1 u=20 fill=17 (0 0 55.5)  $ Rod 3
3101 0  -3095 imp:n=1 u=21 fill=17 (0 0 55.5)  $ Rod 4
c
c --- Pebbles -----------------------------------------------------------------
c ------ TRISO ------
3111 19 7.2935E-02  -3111 imp:n=1 u=22  $ UO2 Kernel
3112 20 5.2651E-02  3111 -3112 imp:n=1 u=22  $ Buffer Coating
3113 21 9.5273E-02  3112 -3113 imp:n=1 u=22  $ IPyC Coating
3114 22 9.6142E-02  3113 -3114 imp:n=1 u=22  $ SiC Coating
3115 23 9.4772E-02  3114 -3115 imp:n=1 u=22  $ OPyC Coating
3116 24 8.6859E-02  3115 imp:n=1 u=22  $ Fueled Zone Graphite
c
3117 24 8.6859E-02  -9999 imp:n=1 u=23  $ Fueled Zone Graphite
c
c ------ TRISO Lattice ------
3121 24 8.6859E-02  -3121 imp:n=1 u=98 lat=1 fill=-14:14 -14:14 -14:14
c
     23 840r
c
     23 405r
     23 12r 22 2r 23 12r
     23 405r
c
     23 260r
     23 12r 22 2r 23 12r
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     23 10r 22 6r 23 10r
     23 9r 22 8r 23 9r
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     23 9r 22 8r 23 9r
     23 9r 22 8r 23 9r
     23 10r 22 6r 23 10r
     23 12r 22 2r 23 12r
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     23 202r
     23 12r 22 2r 23 12r
     23 10r 22 6r 23 10r
     23 8r 22 10r 23 8r
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     23 7r 22 12r 23 7r
     23 8r 22 10r 23 8r
     23 9r 22 8r 23 9r
     23 11r 22 4r 23 11r
     23 173r
c
     23 202r
     23 12r 22 2r 23 12r
     23 10r 22 6r 23 10r
     23 8r 22 10r 23 8r
     23 8r 22 10r 23 8r
     23 7r 22 12r 23 7r
     23 7r 22 12r 23 7r
     23 6r 22 14r 23 6r
     23 6r 22 14r 23 6r
     23 6r 22 14r 23 6r
     23 7r 22 12r 23 7r
     23 7r 22 12r 23 7r
     23 8r 22 10r 23 8r
     23 8r 22 10r 23 8r
     23 10r 22 6r 23 10r
     23 12r 22 2r 23 12r
     23 202r
c
     23 260r
     23 12r 22 2r 23 12r
     23 10r 22 6r 23 10r
     23 9r 22 8r 23 9r
     23 9r 22 8r 23 9r
     23 8r 22 10r 23 8r
```

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     23 8r 22 10r 23 8r
     23 8r 22 10r 23 8r
     23 9r 22 8r 23 9r
     23 9r 22 8r 23 9r
     23 10r 22 6r 23 10r
     23 12r 22 2r 23 12r
     23 260r
c
     23 405r
     23 12r 22 2r 23 12r
     23 405r
c
     23 840r
c
c
c
c ------ Fuel Pebbles ------
3131 24 8.6859E-02  -3131       imp:n=1 u=24 fill=98 $ Fuel Zone
3132 25 8.6859E-02   3131 -3132 imp:n=1 u=24         $ Pebble Shell (Unfueled Zone)
3133 10 4.8648E-05   3132       imp:n=1 u=24         $ Air
c
c ------ Moderator Pebbles ------
4131 26 8.4461E-02  -3132       imp:n=1 u=25  $ Moderator Pebble
4132 10 4.8648E-05   3132       imp:n=1 u=25  $ Air
c
c ------ Air ------
5001 10 4.8648E-05  -9999 imp:n=1 u=26  $ Air
c
c ------ Pebble Stacks ------------------------------------------------------
c --------- Standard Stacks ---------
c ------------ Stack 0 (Cores 5 & 8) ------------
6001 10 4.8648E-05  -6001 imp:n=1 u=27 lat=2 fill=-1:1 -1:1 0:44
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
```

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     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
c
c ------------ Stack 1 (Cores 5 & 8) ------------
6002 10 4.8648E-05  -6001 imp:n=1 u=28 lat=2 fill=-1:1 -1:1 0:44
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
c
c ------------ Stack 2 (Cores 5 & 8) ------------
6003 10 4.8648E-05  -6001 imp:n=1 u=29 lat=2 fill=-1:1 -1:1 0:44
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
```

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     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
c
c ------------ Stack 0* (Cores 5 & 8) ------------
6004 10 4.8648E-05  -6001 imp:n=1 u=30 lat=2 fill=-1:1 -1:1 0:44
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
c
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
c
```

```
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
c
c ------------ Stack 2* (Cores 5 & 8) ------------
6005 10 4.8648E-05  -6001 imp:n=1 u=32 lat=2 fill=-1:1 -1:1 0:44
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
     26 26 26  26 24 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
     26 26 26  26 24 26  26 26 26
     26 26 26  26 25 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
c
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
     26 26 26  26 26 26  26 26 26
c
```

```
c
c ------------ Stack 0 (Core 6) ------------
c 6001 10 4.8648E-05  -6001 imp:n=1 u=27 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c c ------------ Stack 1 (Core 6) ------------
c 6002 10 4.8648E-05  -6001 imp:n=1 u=28 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
```

```
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c c
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c c
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c c
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c c
c c ------------ Stack 2 (Core 6) ------------
c 6003 10 4.8648E-05  -6001 imp:n=1 u=29 lat=2 fill=-1:1 -1:1 0:44
c       26 26 26  26 26 26  26 26 26
c c
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c c
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c c
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c c
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c c
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c c
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
```

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c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c c ------------ Stack 1* (Core 6) ------------
c 6004 10 4.8648E-05  -6001 imp:n=1 u=31 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c c ------------ Stack 2* (Core 6) ------------
c 6005 10 4.8648E-05  -6001 imp:n=1 u=32 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
```

```
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c c
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c c
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c c
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c c
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c c
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c
c
c ------------ Stack 0 (Core 7) ------------
c 6001 10 4.8648E-05  -6001 imp:n=1 u=27 lat=2 fill=-1:1 -1:1 0:44
c       26 26 26  26 26 26  26 26 26
c c
c       26 26 26  26 25 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c c
c       26 26 26  26 25 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c c
c       26 26 26  26 25 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 25 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c       26 26 26  26 24 26  26 26 26
c c
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
c       26 26 26  26 26 26  26 26 26
```

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c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c c ------------ Stack 1 (Core 7) ------------
c 6002 10 4.8648E-05  -6001 imp:n=1 u=28 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
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c c
c c ------------ Stack 2 (Core 7) ------------
c 6003 10 4.8648E-05  -6001 imp:n=1 u=29 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c c ------------ Stack 0* (Core 7) ------------
c 6004 10 4.8648E-05  -6001 imp:n=1 u=30 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
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c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
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c      26 26 26  26 26 26  26 26 26
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c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c c
c c ------------ Stack 1* (Core 7) ------------
c 6005 10 4.8648E-05  -6001 imp:n=1 u=31 lat=2 fill=-1:1 -1:1 0:44
c      26 26 26  26 26 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c c
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 24 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c      26 26 26  26 25 26  26 26 26
c c
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
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c      26 26 26  26 26 26  26 26 26
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c      26 26 26  26 26 26  26 26 26
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c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
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c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c      26 26 26  26 26 26  26 26 26
c
c ------ Stacks with Polyethylene Rods (Full Set) ------
c    *Polyethylene Rods Not Used in Configuration 5
c
c ------------ Stack 0 - NW, N, NE, SE, S, SW (Core 6) ------------
c 5100 35 8.4678E-02  -7221 -6003 -7227 imp:n=1 u=34  $ NW Cu Wire
c 5101 10 4.8648E-05   7221 -7121 -6003 -7127 imp:n=1 u=34  $ NW Hole
c 5102 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7127 imp:n=1 u=34  $ NW Rod
c 5103 35 8.4678E-02  -7222 -6003 -7227 imp:n=1 u=34  $ N Cu Wire
c 5104 10 4.8648E-05   7222 -7122 -6003 -7127 imp:n=1 u=34  $ N Hole
c 5105 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7127 imp:n=1 u=34  $ N Rod
c 5106 35 8.4678E-02  -7223 -6003 -7227 imp:n=1 u=34  $ NE Cu Wire
c 5107 10 4.8648E-05   7223 -7123 -6003 -7127 imp:n=1 u=34  $ NE Hole
c 5108 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7127 imp:n=1 u=34  $ NE Rod
c 5109 35 8.4678E-02  -7224 -6003 -7227 imp:n=1 u=34  $ SE Cu Wire
c 5110 10 4.8648E-05   7224 -7124 -6003 -7127 imp:n=1 u=34  $ SE Hole
c 5111 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7127 imp:n=1 u=34  $ SE Rod
c 5112 35 8.4678E-02  -7225 -6003 -7227 imp:n=1 u=34  $ S Cu Wire
c 5113 10 4.8648E-05   7225 -7125 -6003 -7127 imp:n=1 u=34  $ S Hole
c 5114 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7127 imp:n=1 u=34  $ S Rod
c 5115 35 8.4678E-02  -7226 -6003 -7227 imp:n=1 u=34  $ SW Cu Wire
c 5116 10 4.8648E-05   7226 -7126 -6003 -7127 imp:n=1 u=34  $ SW Hole
c 5117 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7127 imp:n=1 u=34  $ SW Rod
c 5118 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c           (7135:7136:-7137:7127) (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c           (7144:7145:-7146:7127) (7221:7227) (7222:7227) (7223:7227)
c           (7224:7227) (7225:7227) (7226:7227) imp:n=1 u=34 fill=27
c c
c c ------------ Stack 1 - NW, N, NE, SE, S, SW (Core 6) ------------
c 5119 35 8.4678E-02  -7221 -6003 -7227 imp:n=1 u=35  $ NW Cu Wire
c 5120 10 4.8648E-05   7221 -7121 -6003 -7127 imp:n=1 u=35  $ NW Hole
c 5121 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7127 imp:n=1 u=35  $ NW Rod
c 5122 35 8.4678E-02  -7222 -6003 -7227 imp:n=1 u=35  $ N Cu Wire
c 5123 10 4.8648E-05   7222 -7122 -6003 -7127 imp:n=1 u=35  $ N Hole
c 5124 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7127 imp:n=1 u=35  $ N Rod
c 5125 35 8.4678E-02  -7223 -6003 -7227 imp:n=1 u=35  $ NE Cu Wire
c 5126 10 4.8648E-05   7223 -7123 -6003 -7127 imp:n=1 u=35  $ NE Hole
c 5127 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7127 imp:n=1 u=35  $ NE Rod
c 5128 35 8.4678E-02  -7224 -6003 -7227 imp:n=1 u=35  $ SE Cu Wire
c 5129 10 4.8648E-05   7224 -7124 -6003 -7127 imp:n=1 u=35  $ SE Hole
c 5130 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7127 imp:n=1 u=35  $ SE Rod
c 5131 35 8.4678E-02  -7225 -6003 -7227 imp:n=1 u=35  $ S Cu Wire
c 5132 10 4.8648E-05   7225 -7125 -6003 -7127 imp:n=1 u=35  $ S Hole
c 5133 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7127 imp:n=1 u=35  $ S Rod
c 5134 35 8.4678E-02  -7226 -6003 -7227 imp:n=1 u=35  $ SW Cu Wire
c 5135 10 4.8648E-05   7226 -7126 -6003 -7127 imp:n=1 u=35  $ SW Hole
c 5136 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7127 imp:n=1 u=35  $ SW Rod
c 5137 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c           (7135:7136:-7137:7127) (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c           (7144:7145:-7146:7127) (7221:7227) (7222:7227) (7223:7227)
c           (7224:7227) (7225:7227) (7226:7227) imp:n=1 u=35 fill=28
c c
c c ------------ Stack 2 - NW, N, NE, SE, S, SW (Core 6) ------------
c 5138 35 8.4678E-02  -7221 -6003 -7227 imp:n=1 u=36  $ NW Cu Wire
c 5139 10 4.8648E-05   7221 -7121 -6003 -7127 imp:n=1 u=36  $ NW Hole
c 5140 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7127 imp:n=1 u=36  $ NW Rod
c 5141 35 8.4678E-02  -7222 -6003 -7227 imp:n=1 u=36  $ N Cu Wire
c 5142 10 4.8648E-05   7222 -7122 -6003 -7127 imp:n=1 u=36  $ N Hole
c 5143 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7127 imp:n=1 u=36  $ N Rod
c 5144 35 8.4678E-02  -7223 -6003 -7227 imp:n=1 u=36  $ NE Cu Wire
c 5145 10 4.8648E-05   7223 -7123 -6003 -7127 imp:n=1 u=36  $ NE Hole
c 5146 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7127 imp:n=1 u=36  $ NE Rod
c 5147 35 8.4678E-02  -7224 -6003 -7227 imp:n=1 u=36  $ SE Cu Wire
c 5148 10 4.8648E-05   7224 -7124 -6003 -7127 imp:n=1 u=36  $ SE Hole
c 5149 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7127 imp:n=1 u=36  $ SE Rod
c 5150 35 8.4678E-02  -7225 -6003 -7227 imp:n=1 u=36  $ S Cu Wire
c 5151 10 4.8648E-05   7225 -7125 -6003 -7127 imp:n=1 u=36  $ S Hole
c 5152 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7127 imp:n=1 u=36  $ S Rod
c 5153 35 8.4678E-02  -7226 -6003 -7227 imp:n=1 u=36  $ SW Cu Wire
```

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c 5154 10 4.8648E-05   7226 -7126 -6003 -7127 imp:n=1 u=36  $ SW Hole
c 5155 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7127 imp:n=1 u=36  $ SW Rod
c 5156 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c           (7135:7136:-7137:7127) (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c           (7144:7145:-7146:7127) (7221:7227) (7222:7227) (7223:7227)
c           (7224:7227) (7225:7227) (7226:7227) imp:n=1 u=36 fill=29
c c
c c ------------ Stack 1* - NW, N, NE, SE, S, SW (Core 6) ------------
c 5157 35 8.4678E-02  -7221 -6003 -7227 imp:n=1 u=38  $ NW Cu Wire
c 5158 10 4.8648E-05   7221 -7121 -6003 -7127 imp:n=1 u=38  $ NW Hole
c 5159 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7127 imp:n=1 u=38  $ NW Rod
c 5160 35 8.4678E-02  -7222 -6003 -7227 imp:n=1 u=38  $ N Cu Wire
c 5161 10 4.8648E-05   7222 -7122 -6003 -7127 imp:n=1 u=38  $ N Hole
c 5162 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7127 imp:n=1 u=38  $ N Rod
c 5163 35 8.4678E-02  -7223 -6003 -7227 imp:n=1 u=38  $ NE Cu Wire
c 5164 10 4.8648E-05   7223 -7123 -6003 -7127 imp:n=1 u=38  $ NE Hole
c 5165 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7127 imp:n=1 u=38  $ NE Rod
c 5166 35 8.4678E-02  -7224 -6003 -7227 imp:n=1 u=38  $ SE Cu Wire
c 5167 10 4.8648E-05   7224 -7124 -6003 -7127 imp:n=1 u=38  $ SE Hole
c 5168 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7127 imp:n=1 u=38  $ SE Rod
c 5169 35 8.4678E-02  -7225 -6003 -7227 imp:n=1 u=38  $ S Cu Wire
c 5170 10 4.8648E-05   7225 -7125 -6003 -7127 imp:n=1 u=38  $ S Hole
c 5171 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7127 imp:n=1 u=38  $ S Rod
c 5172 35 8.4678E-02  -7226 -6003 -7227 imp:n=1 u=38  $ SW Cu Wire
c 5173 10 4.8648E-05   7226 -7126 -6003 -7127 imp:n=1 u=38  $ SW Hole
c 5174 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7127 imp:n=1 u=38  $ SW Rod
c 5175 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c           (7135:7136:-7137:7127) (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c           (7144:7145:-7146:7127) (7221:7227) (7222:7227) (7223:7227)
c           (7224:7227) (7225:7227) (7226:7227) imp:n=1 u=38 fill=31
c c
c c ------------ Stack 2* - NW, N, NE, SE, S, SW (Core 6) ------------
c 5176 35 8.4678E-02  -7221 -6003 -7227 imp:n=1 u=39  $ NW Cu Wire
c 5177 10 4.8648E-05   7221 -7121 -6003 -7127 imp:n=1 u=39  $ NW Hole
c 5178 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7127 imp:n=1 u=39  $ NW Rod
c 5179 35 8.4678E-02  -7222 -6003 -7227 imp:n=1 u=39  $ N Cu Wire
c 5180 10 4.8648E-05   7222 -7122 -6003 -7127 imp:n=1 u=39  $ N Hole
c 5181 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7127 imp:n=1 u=39  $ N Rod
c 5182 35 8.4678E-02  -7223 -6003 -7227 imp:n=1 u=39  $ NE Cu Wire
c 5183 10 4.8648E-05   7223 -7123 -6003 -7127 imp:n=1 u=39  $ NE Hole
c 5184 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7127 imp:n=1 u=39  $ NE Rod
c 5185 35 8.4678E-02  -7224 -6003 -7227 imp:n=1 u=39  $ SE Cu Wire
c 5186 10 4.8648E-05   7224 -7124 -6003 -7127 imp:n=1 u=39  $ SE Hole
c 5187 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7127 imp:n=1 u=39  $ SE Rod
c 5188 35 8.4678E-02  -7225 -6003 -7227 imp:n=1 u=39  $ S Cu Wire
c 5189 10 4.8648E-05   7225 -7125 -6003 -7127 imp:n=1 u=39  $ S Hole
c 5190 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7127 imp:n=1 u=39  $ S Rod
c 5191 35 8.4678E-02  -7226 -6003 -7227 imp:n=1 u=39  $ SW Cu Wire
c 5192 10 4.8648E-05   7226 -7126 -6003 -7127 imp:n=1 u=39  $ SW Hole
c 5193 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7127 imp:n=1 u=39  $ SW Rod
c 5194 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c           (7135:7136:-7137:7127) (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c           (7144:7145:-7146:7127) (7221:7227) (7222:7227) (7223:7227)
c           (7224:7227) (7225:7227) (7226:7227) imp:n=1 u=39 fill=32
c
c
c ------------ Stack 0 - NW, N, NE, SE, S, SW (Core 7) ------------
c 5101 34 1.2204E-01  -7021 -6003 -7027 imp:n=1 u=34  $ NW Rod
c 5102 34 1.2204E-01  -7022 -6003 -7027 imp:n=1 u=34  $ N Rod
c 5103 34 1.2204E-01  -7023 -6003 -7027 imp:n=1 u=34  $ NE Rod
c 5104 34 1.2204E-01  -7024 -6003 -7027 imp:n=1 u=34  $ SE Rod
c 5105 34 1.2204E-01  -7025 -6003 -7027 imp:n=1 u=34  $ S Rod
c 5106 34 1.2204E-01  -7026 -6003 -7027 imp:n=1 u=34  $ SW Rod
c 5107 34 1.2204E-01  -6003 (7021:7027) (7022:7027) (7023:7027)
c           (7024:7027) (7025:7027) (7026:7027) imp:n=1 u=34 fill=27
c c
c c ------------ Stack 1 - NW, N, NE, SE, S, SW (Core 7) ------------
c 5108 34 1.2204E-01  -7021 -6003 -7027 imp:n=1 u=35  $ NW Rod
c 5109 34 1.2204E-01  -7022 -6003 -7027 imp:n=1 u=35  $ N Rod
c 5110 34 1.2204E-01  -7023 -6003 -7027 imp:n=1 u=35  $ NE Rod
c 5111 34 1.2204E-01  -7024 -6003 -7027 imp:n=1 u=35  $ SE Rod
c 5112 34 1.2204E-01  -7025 -6003 -7027 imp:n=1 u=35  $ S Rod
c 5113 34 1.2204E-01  -7026 -6003 -7027 imp:n=1 u=35  $ SW Rod
c 5114 34 1.2204E-01  -6003 (7021:7027) (7022:7027) (7023:7027)
c           (7024:7027) (7025:7027) (7026:7027) imp:n=1 u=35 fill=28
```

```
c c
c c ------------ Stack 2 - NW, N, NE, SE, S, SW (Core 7) ------------
c 5115 34 1.2204E-01  -7021 -6003 -7027 imp:n=1 u=36  $ NW Rod
c 5116 34 1.2204E-01  -7022 -6003 -7027 imp:n=1 u=36  $ N Rod
c 5117 34 1.2204E-01  -7023 -6003 -7027 imp:n=1 u=36  $ NE Rod
c 5118 34 1.2204E-01  -7024 -6003 -7027 imp:n=1 u=36  $ SE Rod
c 5119 34 1.2204E-01  -7025 -6003 -7027 imp:n=1 u=36  $ S Rod
c 5120 34 1.2204E-01  -7026 -6003 -7027 imp:n=1 u=36  $ SW Rod
c 5121 34 1.2204E-01  -6003 (7021:7027) (7022:7027) (7023:7027)
c           (7024:7027) (7025:7027) (7026:7027) imp:n=1 u=36 fill=29
c c
c c ------------ Stack 0* - NW, N, NE, SE, S, SW (Core 7) ------------
c 5122 34 1.2204E-01  -7021 -6003 -7027 imp:n=1 u=37  $ NW Rod
c 5123 34 1.2204E-01  -7022 -6003 -7027 imp:n=1 u=37  $ N Rod
c 5124 34 1.2204E-01  -7023 -6003 -7027 imp:n=1 u=37  $ NE Rod
c 5125 34 1.2204E-01  -7024 -6003 -7027 imp:n=1 u=37  $ SE Rod
c 5126 34 1.2204E-01  -7025 -6003 -7027 imp:n=1 u=37  $ S Rod
c 5127 34 1.2204E-01  -7026 -6003 -7027 imp:n=1 u=37  $ SW Rod
c 5128 34 1.2204E-01  -6003 (7021:7027) (7022:7027) (7023:7027)
c           (7024:7027) (7025:7027) (7026:7027) imp:n=1 u=37 fill=30
c c
c c ------------ Stack 1* - NW, N, NE, SE, S, SW (Core 7) ------------
c 5129 34 1.2204E-01  -7021 -6003 -7027 imp:n=1 u=38  $ NW Rod
c 5130 34 1.2204E-01  -7022 -6003 -7027 imp:n=1 u=38  $ N Rod
c 5131 34 1.2204E-01  -7023 -6003 -7027 imp:n=1 u=38  $ NE Rod
c 5132 34 1.2204E-01  -7024 -6003 -7027 imp:n=1 u=38  $ SE Rod
c 5133 34 1.2204E-01  -7025 -6003 -7027 imp:n=1 u=38  $ S Rod
c 5134 34 1.2204E-01  -7026 -6003 -7027 imp:n=1 u=38  $ SW Rod
c 5135 34 1.2204E-01  -6003 (7021:7027) (7022:7027) (7023:7027)
c           (7024:7027) (7025:7027) (7026:7027) imp:n=1 u=38 fill=31
c
c
c ------------ Stack 0 - NW, N, NE, SE, S, SW (Core 8) ------------
c 5101 10 4.8648E-05  -7121 -6003 -7128 imp:n=1 u=34  $ NW Hole
c 5102 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7128 imp:n=1 u=34  $ NW Rod
c 5104 10 4.8648E-05  -7122 -6003 -7128 imp:n=1 u=34  $ N Hole
c 5105 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7128 imp:n=1 u=34  $ N Rod
c 5107 10 4.8648E-05  -7123 -6003 -7128 imp:n=1 u=34  $ NE Hole
c 5108 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7128 imp:n=1 u=34  $ NE Rod
c 5110 10 4.8648E-05  -7124 -6003 -7128 imp:n=1 u=34  $ SE Hole
c 5111 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7128 imp:n=1 u=34  $ SE Rod
c 5113 10 4.8648E-05  -7125 -6003 -7128 imp:n=1 u=34  $ S Hole
c 5114 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7128 imp:n=1 u=34  $ S Rod
c 5116 10 4.8648E-05  -7126 -6003 -7128 imp:n=1 u=34  $ SW Hole
c 5117 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7128 imp:n=1 u=34  $ SW Rod
c 5118 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c           (7135:7136:-7137:7128) (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c           (7144:7145:-7146:7128) imp:n=1 u=34 fill=27
c c
c c ------------ Stack 1 - NW, N, NE, SE, S, SW (Core 8) ------------
c 5120 10 4.8648E-05  -7121 -6003 -7128 imp:n=1 u=35  $ NW Hole
c 5121 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7128 imp:n=1 u=35  $ NW Rod
c 5123 10 4.8648E-05  -7122 -6003 -7128 imp:n=1 u=35  $ N Hole
c 5124 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7128 imp:n=1 u=35  $ N Rod
c 5126 10 4.8648E-05  -7123 -6003 -7128 imp:n=1 u=35  $ NE Hole
c 5127 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7128 imp:n=1 u=35  $ NE Rod
c 5129 10 4.8648E-05  -7124 -6003 -7128 imp:n=1 u=35  $ SE Hole
c 5130 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7128 imp:n=1 u=35  $ SE Rod
c 5132 10 4.8648E-05  -7125 -6003 -7128 imp:n=1 u=35  $ S Hole
c 5133 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7128 imp:n=1 u=35  $ S Rod
c 5135 10 4.8648E-05  -7126 -6003 -7128 imp:n=1 u=35  $ SW Hole
c 5136 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7128 imp:n=1 u=35  $ SW Rod
c 5137 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c           (7135:7136:-7137:7128) (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c           (7144:7145:-7146:7128) imp:n=1 u=35 fill=28
c c
c c ------------ Stack 2 - NW, N, NE, SE, S, SW (Core 8) ------------
c 5139 10 4.8648E-05  -7121 -6003 -7128 imp:n=1 u=36  $ NW Hole
c 5140 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7128 imp:n=1 u=36  $ NW Rod
c 5142 10 4.8648E-05  -7122 -6003 -7128 imp:n=1 u=36  $ N Hole
c 5143 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7128 imp:n=1 u=36  $ N Rod
c 5145 10 4.8648E-05  -7123 -6003 -7128 imp:n=1 u=36  $ NE Hole
c 5146 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7128 imp:n=1 u=36  $ NE Rod
c 5148 10 4.8648E-05  -7124 -6003 -7128 imp:n=1 u=36  $ SE Hole
c 5149 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7128 imp:n=1 u=36  $ SE Rod
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c 5151 10 4.8648E-05  -7125 -6003 -7128 imp:n=1 u=36  $ S Hole
c 5152 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7128 imp:n=1 u=36  $ S Rod
c 5154 10 4.8648E-05  -7126 -6003 -7128 imp:n=1 u=36  $ SW Hole
c 5155 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7128 imp:n=1 u=36  $ SW Rod
c 5156 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7135:7136:-7137:7128) (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=36 fill=29
c c
c c ------------ Stack 0* - NW, N, NE, SE, S, SW (Core 8) ------------
c 5158 10 4.8648E-05  -7121 -6003 -7128 imp:n=1 u=37  $ NW Hole
c 5159 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7128 imp:n=1 u=37  $ NW Rod
c 5161 10 4.8648E-05  -7122 -6003 -7128 imp:n=1 u=37  $ N Hole
c 5162 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7128 imp:n=1 u=37  $ N Rod
c 5164 10 4.8648E-05  -7123 -6003 -7128 imp:n=1 u=37  $ NE Hole
c 5165 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7128 imp:n=1 u=37  $ NE Rod
c 5167 10 4.8648E-05  -7124 -6003 -7128 imp:n=1 u=37  $ SE Hole
c 5168 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7128 imp:n=1 u=37  $ SE Rod
c 5170 10 4.8648E-05  -7125 -6003 -7128 imp:n=1 u=37  $ S Hole
c 5171 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7128 imp:n=1 u=37  $ S Rod
c 5173 10 4.8648E-05  -7126 -6003 -7128 imp:n=1 u=37  $ SW Hole
c 5174 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7128 imp:n=1 u=37  $ SW Rod
c 5175 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7135:7136:-7137:7128) (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=37 fill=30
c c
c c ------------ Stack 2* - NW, N, NE, SE, S, SW (Core 8) ------------
c 5177 10 4.8648E-05  -7121 -6003 -7128 imp:n=1 u=39  $ NW Hole
c 5178 34 1.2126E-01   7121 -7129 -7130  7131 -6003 -7128 imp:n=1 u=39  $ NW Rod
c 5180 10 4.8648E-05  -7122 -6003 -7128 imp:n=1 u=39  $ N Hole
c 5181 34 1.2126E-01   7122 -7132  7133 -7134 -6003 -7128 imp:n=1 u=39  $ N Rod
c 5183 10 4.8648E-05  -7123 -6003 -7128 imp:n=1 u=39  $ NE Hole
c 5184 34 1.2126E-01   7123 -7135 -7136  7137 -6003 -7128 imp:n=1 u=39  $ NE Rod
c 5186 10 4.8648E-05  -7124 -6003 -7128 imp:n=1 u=39  $ SE Hole
c 5187 34 1.2126E-01   7124 -7138 -7139  7140 -6003 -7128 imp:n=1 u=39  $ SE Rod
c 5189 10 4.8648E-05  -7125 -6003 -7128 imp:n=1 u=39  $ S Hole
c 5190 34 1.2126E-01   7125 -7141  7142 -7143 -6003 -7128 imp:n=1 u=39  $ S Rod
c 5192 10 4.8648E-05  -7126 -6003 -7128 imp:n=1 u=39  $ SW Hole
c 5193 34 1.2126E-01   7126 -7144 -7145  7146 -6003 -7128 imp:n=1 u=39  $ SW Rod
c 5194 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7135:7136:-7137:7128) (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=39 fill=32
c
c
c ------ Stacks with Polyethylene Rods (Partial Sets) ------
c c ------------ Stack 2* - NE, SE (Core 6) ------------
c 5200 like 5106 but u=40  $ NE Cu Wire
c 5201 like 5107 but u=40  $ NE Hole
c 5202 like 5108 but u=40  $ NE Rod
c 5203 like 5109 but u=40  $ SE Cu Wire
c 5204 like 5110 but u=40  $ SE Hole
c 5205 like 5111 but u=40  $ SE Rod
c 5206 10 4.8648E-05  -6003 (7135:7136:-7137:7127) (7138:7139:-7140:7127)
c            (7223:7227) (7224:7227) imp:n=1 u=40 fill=32
c c
c c ------------ Stack 1* - N, NE, SE, S (Core 6) ------------
c 5207 like 5103 but u=41  $ N Cu Wire
c 5208 like 5104 but u=41  $ N Hole
c 5209 like 5105 but u=41  $ N Rod
c 5210 like 5106 but u=41  $ NE Cu Wire
c 5211 like 5107 but u=41  $ NE Hole
c 5212 like 5108 but u=41  $ NE Rod
c 5213 like 5109 but u=41  $ SE Cu Wire
c 5214 like 5110 but u=41  $ SE Hole
c 5215 like 5111 but u=41  $ SE Rod
c 5216 like 5112 but u=41  $ S Cu Wire
c 5217 like 5113 but u=41  $ S Hole
c 5218 like 5114 but u=41  $ S Rod
c 5219 10 4.8648E-05  -6003 (7132:-7133:7134:7127) (7135:7136:-7137:7127)
c            (7138:7139:-7140:7127) (7141:-7142:7143:7127) (7222:7227)
c            (7223:7227) (7224:7227) (7225:7227) imp:n=1 u=41 fill=31
c c
c c ------------ Stack 1* - NE, SE, S (Core 6) ------------
c 5220 like 5106 but u=42  $ NE Cu Wire
c 5221 like 5107 but u=42  $ NE Hole
c 5222 like 5108 but u=42  $ NE Rod
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c 5223 like 5109 but u=42  $ SE Cu Wire
c 5224 like 5110 but u=42  $ SE Hole
c 5225 like 5111 but u=42  $ SE Rod
c 5226 like 5112 but u=42  $ S Cu Wire
c 5227 like 5113 but u=42  $ S Hole
c 5228 like 5114 but u=42  $ S Rod
c 5229 10 4.8648E-05  -6003 (7135:7136:-7137:7127) (7138:7139:-7140:7127)
c           (7141:-7142:7143:7127) (7223:7227) (7224:7227)
c           (7225:7227) imp:n=1 u=42 fill=31
c c
c c ------------ Stack 0 - NE, SE, S (Core 6) ------------
c 5230 like 5106 but u=43  $ NE Cu Wire
c 5231 like 5107 but u=43  $ NE Hole
c 5232 like 5108 but u=43  $ NE Rod
c 5233 like 5109 but u=43  $ SE Cu Wire
c 5234 like 5110 but u=43  $ SE Hole
c 5235 like 5111 but u=43  $ SE Rod
c 5236 like 5112 but u=43  $ S Cu Wire
c 5237 like 5113 but u=43  $ S Hole
c 5238 like 5114 but u=43  $ S Rod
c 5239 10 4.8648E-05  -6003 (7135:7136:-7137:7127) (7138:7139:-7140:7127)
c           (7141:-7142:7143:7127) (7223:7227) (7224:7227)
c           (7225:7227) imp:n=1 u=43 fill=27
c c
c c ------------ Stack 2* - NE, SE, S (Core 6) ------------
c 5240 like 5106 but u=44  $ NE Cu Wire
c 5241 like 5107 but u=44  $ NE Hole
c 5242 like 5108 but u=44  $ NE Rod
c 5243 like 5109 but u=44  $ SE Cu Wire
c 5244 like 5110 but u=44  $ SE Hole
c 5245 like 5111 but u=44  $ SE Rod
c 5246 like 5112 but u=44  $ S Cu Wire
c 5247 like 5113 but u=44  $ S Hole
c 5248 like 5114 but u=44  $ S Rod
c 5249 10 4.8648E-05  -6003 (7135:7136:-7137:7127) (7138:7139:-7140:7127)
c           (7141:-7142:7143:7127) (7223:7227) (7224:7227)
c           (7225:7227) imp:n=1 u=44 fill=32
c c
c c ------------ Stack 0 - SE, S (Core 6) ------------
c 5250 like 5109 but u=45  $ SE Cu Wire
c 5251 like 5110 but u=45  $ SE Hole
c 5252 like 5111 but u=45  $ SE Rod
c 5253 like 5112 but u=45  $ S Cu Wire
c 5254 like 5113 but u=45  $ S Hole
c 5255 like 5114 but u=45  $ S Rod
c 5256 10 4.8648E-05  -6003 (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c           (7224:7227) (7225:7227) imp:n=1 u=45 fill=27
c c
c c ------------ Stack 1* - NE, SE, S, SW (Core 6) ------------
c 5257 like 5106 but u=46  $ NE Cu Wire
c 5258 like 5107 but u=46  $ NE Hole
c 5259 like 5108 but u=46  $ NE Rod
c 5260 like 5109 but u=46  $ SE Cu Wire
c 5261 like 5110 but u=46  $ SE Hole
c 5262 like 5111 but u=46  $ SE Rod
c 5263 like 5112 but u=46  $ S Cu Wire
c 5264 like 5113 but u=46  $ S Hole
c 5265 like 5114 but u=46  $ S Rod
c 5266 like 5115 but u=46  $ SW Cu Wire
c 5267 like 5116 but u=46  $ SW Hole
c 5268 like 5117 but u=46  $ SW Rod
c 5269 10 4.8648E-05  -6003 (7135:7136:-7137:7127) (7138:7139:-7140:7127)
c           (7141:-7142:7143:7127) (7144:7145:-7146:7127) (7223:7227)
c           (7224:7227) (7225:7227) (7226:7227) imp:n=1 u=46 fill=31
c c
c c ------------ Stack 1* - SE, S, SW (Core 6) ------------
c 5270 like 5109 but u=47  $ SE Cu Wire
c 5271 like 5110 but u=47  $ SE Hole
c 5272 like 5111 but u=47  $ SE Rod
c 5273 like 5112 but u=47  $ S Cu Wire
c 5274 like 5113 but u=47  $ S Hole
c 5275 like 5114 but u=47  $ S Rod
c 5276 like 5115 but u=47  $ SW Cu Wire
c 5277 like 5116 but u=47  $ SW Hole
c 5278 like 5117 but u=47  $ SW Rod
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c 5279 10 4.8648E-05  -6003 (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c            (7144:7145:-7146:7127) (7224:7227) (7225:7227)
c            (7226:7227) imp:n=1 u=47 fill=31
c c
c c ------------ Stack 2* - SE, S, SW (Core 6) ------------
c 5280 like 5109 but u=48  $ SE Cu Wire
c 5281 like 5110 but u=48  $ SE Hole
c 5282 like 5111 but u=48  $ SE Rod
c 5283 like 5112 but u=48  $ S Cu Wire
c 5284 like 5113 but u=48  $ S Hole
c 5285 like 5114 but u=48  $ S Rod
c 5286 like 5115 but u=48  $ SW Cu Wire
c 5287 like 5116 but u=48  $ SW Hole
c 5288 like 5117 but u=48  $ SW Rod
c 5289 10 4.8648E-05  -6003 (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c            (7144:7145:-7146:7127) (7224:7227) (7225:7227)
c            (7226:7227) imp:n=1 u=48 fill=32
c c
c c ------------ Stack 0 - SE, S, SW (Core 6) ------------
c 5290 like 5109 but u=49  $ SE Cu Wire
c 5291 like 5110 but u=49  $ SE Hole
c 5292 like 5111 but u=49  $ SE Rod
c 5293 like 5112 but u=49  $ S Cu Wire
c 5294 like 5113 but u=49  $ S Hole
c 5295 like 5114 but u=49  $ S Rod
c 5296 like 5115 but u=49  $ SW Cu Wire
c 5297 like 5116 but u=49  $ SW Hole
c 5298 like 5117 but u=49  $ SW Rod
c 5299 10 4.8648E-05  -6003 (7138:7139:-7140:7127) (7141:-7142:7143:7127)
c            (7144:7145:-7146:7127) (7224:7227) (7225:7227)
c            (7226:7227) imp:n=1 u=49 fill=27
c c
c c ------------ Stack 2* - S, SW (Core 6) ------------
c 5300 like 5112 but u=50  $ S Cu Wire
c 5301 like 5113 but u=50  $ S Hole
c 5302 like 5114 but u=50  $ S Rod
c 5303 like 5115 but u=50  $ SW Cu Wire
c 5304 like 5116 but u=50  $ SW Hole
c 5305 like 5117 but u=50  $ SW Rod
c 5306 10 4.8648E-05  -6003 (7141:-7142:7143:7127) (7144:7145:-7146:7127)
c            (7225:7227) (7226:7227) imp:n=1 u=50 fill=32
c c
c c ------------ Stack 1* - NW, SE, S, SW (Core 6) ------------
c 5307 like 5100 but u=51  $ NW Cu Wire
c 5308 like 5101 but u=51  $ NW Hole
c 5309 like 5102 but u=51  $ NW Rod
c 5310 like 5109 but u=51  $ SE Cu Wire
c 5311 like 5110 but u=51  $ SE Hole
c 5312 like 5111 but u=51  $ SE Rod
c 5313 like 5112 but u=51  $ S Cu Wire
c 5314 like 5113 but u=51  $ S Hole
c 5315 like 5114 but u=51  $ S Rod
c 5316 like 5115 but u=51  $ SW Cu Wire
c 5317 like 5116 but u=51  $ SW Hole
c 5318 like 5117 but u=51  $ SW Rod
c 5319 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7138:7139:-7140:7127)
c            (7141:-7142:7143:7127) (7144:7145:-7146:7127) (7221:7227)
c            (7224:7227) (7225:7227) (7226:7227) imp:n=1 u=51 fill=31
c c
c c ------------ Stack 1* - NW, S, SW (Core 6) ------------
c 5320 like 5100 but u=52  $ NW Cu Wire
c 5321 like 5101 but u=52  $ NW Hole
c 5322 like 5102 but u=52  $ NW Rod
c 5323 like 5112 but u=52  $ S Cu Wire
c 5324 like 5113 but u=52  $ S Hole
c 5325 like 5114 but u=52  $ S Rod
c 5326 like 5115 but u=52  $ SW Cu Wire
c 5327 like 5116 but u=52  $ SW Hole
c 5328 like 5117 but u=52  $ SW Rod
c 5329 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7141:-7142:7143:7127)
c            (7144:7145:-7146:7127) (7221:7227) (7225:7227)
c            (7226:7227) imp:n=1 u=52 fill=31
c c
c c ------------ Stack 0 - NW, S, SW (Core 6) ------------
c 5330 like 5100 but u=53  $ NW Cu Wire
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c 5331 like 5101 but u=53  $ NW Hole
c 5332 like 5102 but u=53  $ NW Rod
c 5333 like 5112 but u=53  $ S Cu Wire
c 5334 like 5113 but u=53  $ S Hole
c 5335 like 5114 but u=53  $ S Rod
c 5336 like 5115 but u=53  $ SW Cu Wire
c 5337 like 5116 but u=53  $ SW Hole
c 5338 like 5117 but u=53  $ SW Rod
c 5339 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7141:-7142:7143:7127)
c            (7144:7145:-7146:7127) (7221:7227) (7225:7227)
c            (7226:7227) imp:n=1 u=53 fill=27
c c
c c ------------ Stack 2* - NW, S, SW (Core 6) ------------
c 5340 like 5100 but u=54  $ NW Cu Wire
c 5341 like 5101 but u=54  $ NW Hole
c 5342 like 5102 but u=54  $ NW Rod
c 5343 like 5112 but u=54  $ S Cu Wire
c 5344 like 5113 but u=54  $ S Hole
c 5345 like 5114 but u=54  $ S Rod
c 5346 like 5115 but u=54  $ SW Cu Wire
c 5347 like 5116 but u=54  $ SW Hole
c 5348 like 5117 but u=54  $ SW Rod
c 5349 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7141:-7142:7143:7127)
c            (7144:7145:-7146:7127) (7221:7227) (7225:7227)
c            (7226:7227) imp:n=1 u=54 fill=32
c c
c c ------------ Stack 0 - NW, SW (Core 6) ------------
c 5350 like 5100 but u=55  $ NW Cu Wire
c 5351 like 5101 but u=55  $ NW Hole
c 5352 like 5102 but u=55  $ NW Rod
c 5356 like 5115 but u=55  $ SW Cu Wire
c 5357 like 5116 but u=55  $ SW Hole
c 5358 like 5117 but u=55  $ SW Rod
c 5359 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7144:7145:-7146:7127)
c            (7221:7227) (7226:7227) imp:n=1 u=55 fill=27
c c
c c ------------ Stack 1* - NW, N, S, SW (Core 6) ------------
c 5360 like 5100 but u=56  $ NW Cu Wire
c 5361 like 5101 but u=56  $ NW Hole
c 5362 like 5102 but u=56  $ NW Rod
c 5363 like 5103 but u=56  $ N Cu Wire
c 5364 like 5104 but u=56  $ N Hole
c 5365 like 5105 but u=56  $ N Rod
c 5366 like 5112 but u=56  $ S Cu Wire
c 5367 like 5113 but u=56  $ S Hole
c 5368 like 5114 but u=56  $ S Rod
c 5369 like 5115 but u=56  $ SW Cu Wire
c 5370 like 5116 but u=56  $ SW Hole
c 5371 like 5117 but u=56  $ SW Rod
c 5372 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7141:-7142:7143:7127) (7144:7145:-7146:7127) (7221:7227)
c            (7222:7227) (7225:7227) (7226:7227) imp:n=1 u=56 fill=31
c c
c c ------------ Stack 1* - NW, N, SW (Core 6) ------------
c 5373 like 5100 but u=57  $ NW Cu Wire
c 5374 like 5101 but u=57  $ NW Hole
c 5375 like 5102 but u=57  $ NW Rod
c 5376 like 5103 but u=57  $ N Cu Wire
c 5377 like 5104 but u=57  $ N Hole
c 5378 like 5105 but u=57  $ N Rod
c 5379 like 5115 but u=57  $ SW Cu Wire
c 5380 like 5116 but u=57  $ SW Hole
c 5381 like 5117 but u=57  $ SW Rod
c 5382 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7144:7145:-7146:7127) (7221:7227) (7222:7227)
c            (7226:7227) imp:n=1 u=57 fill=31
c c
c c ------------ Stack 2* - NW, N, SW (Core 6) ------------
c 5383 like 5100 but u=58  $ NW Cu Wire
c 5384 like 5101 but u=58  $ NW Hole
c 5385 like 5102 but u=58  $ NW Rod
c 5386 like 5103 but u=58  $ N Cu Wire
c 5387 like 5104 but u=58  $ N Hole
c 5388 like 5105 but u=58  $ N Rod
c 5389 like 5115 but u=58  $ SW Cu Wire
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c 5390 like 5116 but u=58  $ SW Hole
c 5391 like 5117 but u=58  $ SW Rod
c 5392 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7144:7145:-7146:7127) (7221:7227) (7222:7227)
c            (7226:7227) imp:n=1 u=58 fill=32
c c
c c ------------ Stack 0 - NW, N, SW (Core 6) ------------
c 5393 like 5100 but u=59  $ NW Cu Wire
c 5394 like 5101 but u=59  $ NW Hole
c 5395 like 5102 but u=59  $ NW Rod
c 5396 like 5103 but u=59  $ N Cu Wire
c 5397 like 5104 but u=59  $ N Hole
c 5398 like 5105 but u=59  $ N Rod
c 5399 like 5115 but u=59  $ SW Cu Wire
c 5400 like 5116 but u=59  $ SW Hole
c 5401 like 5117 but u=59  $ SW Rod
c 5402 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7144:7145:-7146:7127) (7221:7227) (7222:7227)
c            (7226:7227) imp:n=1 u=59 fill=27
c c
c c ------------ Stack 2* - NW, N (Core 6) ------------
c 5403 like 5100 but u=60  $ NW Cu Wire
c 5404 like 5101 but u=60  $ NW Hole
c 5405 like 5102 but u=60  $ NW Rod
c 5406 like 5103 but u=60  $ N Cu Wire
c 5407 like 5104 but u=60  $ N Hole
c 5408 like 5105 but u=60  $ N Rod
c 5409 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7221:7227) (7222:7227) imp:n=1 u=60 fill=32
c c
c c ------------ Stack 1* - NW, N, NE, SW (Core 6) ------------
c 5410 like 5100 but u=61  $ NW Cu Wire
c 5411 like 5101 but u=61  $ NW Hole
c 5412 like 5102 but u=61  $ NW Rod
c 5413 like 5103 but u=61  $ N Cu Wire
c 5414 like 5104 but u=61  $ N Hole
c 5415 like 5105 but u=61  $ N Rod
c 5416 like 5106 but u=61  $ NE Cu Wire
c 5417 like 5107 but u=61  $ NE Hole
c 5418 like 5108 but u=61  $ NE Rod
c 5419 like 5115 but u=61  $ SW Cu Wire
c 5420 like 5116 but u=61  $ SW Hole
c 5421 like 5117 but u=61  $ SW Rod
c 5422 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7135:7136:-7137:7127) (7144:7145:-7146:7127) (7221:7227)
c            (7222:7227) (7223:7227) (7226:7227) imp:n=1 u=61 fill=31
c c
c c ------------ Stack 1* - NW, N, NE (Core 6) ------------
c 5423 like 5100 but u=62  $ NW Cu Wire
c 5424 like 5101 but u=62  $ NW Hole
c 5425 like 5102 but u=62  $ NW Rod
c 5426 like 5103 but u=62  $ N Cu Wire
c 5427 like 5104 but u=62  $ N Hole
c 5428 like 5105 but u=62  $ N Rod
c 5429 like 5106 but u=62  $ NE Cu Wire
c 5430 like 5107 but u=62  $ NE Hole
c 5431 like 5108 but u=62  $ NE Rod
c 5432 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7135:7136:-7137:7127) (7221:7227) (7222:7227)
c            (7223:7227) imp:n=1 u=62 fill=31
c c
c c ------------ Stack 0 - NW, N, NE (Core 6) ------------
c 5433 like 5100 but u=63  $ NW Cu Wire
c 5434 like 5101 but u=63  $ NW Hole
c 5435 like 5102 but u=63  $ NW Rod
c 5436 like 5103 but u=63  $ N Cu Wire
c 5437 like 5104 but u=63  $ N Hole
c 5438 like 5105 but u=63  $ N Rod
c 5439 like 5106 but u=63  $ NE Cu Wire
c 5440 like 5107 but u=63  $ NE Hole
c 5441 like 5108 but u=63  $ NE Rod
c 5442 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7135:7136:-7137:7127) (7221:7227) (7222:7227)
c            (7223:7227) imp:n=1 u=63 fill=27
c c
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c c ------------ Stack 2* - NW, N, NE (Core 6) ------------
c 5443 like 5100 but u=64  $ NW Cu Wire
c 5444 like 5101 but u=64  $ NW Hole
c 5445 like 5102 but u=64  $ NW Rod
c 5446 like 5103 but u=64  $ N Cu Wire
c 5447 like 5104 but u=64  $ N Hole
c 5448 like 5105 but u=64  $ N Rod
c 5449 like 5106 but u=64  $ NE Cu Wire
c 5450 like 5107 but u=64  $ NE Hole
c 5451 like 5108 but u=64  $ NE Rod
c 5452 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7135:7136:-7137:7127) (7221:7227) (7222:7227)
c            (7223:7227) imp:n=1 u=64 fill=32
c c
c c ------------ Stack 0 - N, NE (Core 6) ------------
c 5453 like 5103 but u=65  $ N Cu Wire
c 5454 like 5104 but u=65  $ N Hole
c 5455 like 5105 but u=65  $ N Rod
c 5456 like 5106 but u=65  $ NE Cu Wire
c 5457 like 5107 but u=65  $ NE Hole
c 5458 like 5108 but u=65  $ NE Rod
c 5459 10 4.8648E-05  -6003 (7132:-7133:7134:7127) (7135:7136:-7137:7127)
c            (7222:7227) (7223:7227) imp:n=1 u=65 fill=27
c c
c c ------------ Stack 1* - NW, N, NE, SE (Core 6) ------------
c 5460 like 5100 but u=66  $ NW Cu Wire
c 5461 like 5101 but u=66  $ NW Hole
c 5462 like 5102 but u=66  $ NW Rod
c 5463 like 5103 but u=66  $ N Cu Wire
c 5464 like 5104 but u=66  $ N Hole
c 5465 like 5105 but u=66  $ N Rod
c 5466 like 5106 but u=66  $ NE Cu Wire
c 5467 like 5107 but u=66  $ NE Hole
c 5468 like 5108 but u=66  $ NE Rod
c 5469 like 5109 but u=66  $ SE Cu Wire
c 5470 like 5110 but u=66  $ SE Hole
c 5471 like 5111 but u=66  $ SE Rod
c 5472 10 4.8648E-05  -6003 (7129:7130:-7131:7127) (7132:-7133:7134:7127)
c            (7135:7136:-7137:7127) (7138:7139:-7140:7127) (7221:7227)
c            (7222:7227) (7223:7227) (7224:7227) imp:n=1 u=66 fill=31
c c
c c ------------ Stack 1* - N, NE, SE (Core 6) ------------
c 5473 like 5103 but u=67  $ N Cu Wire
c 5474 like 5104 but u=67  $ N Hole
c 5475 like 5105 but u=67  $ N Rod
c 5476 like 5106 but u=67  $ NE Cu Wire
c 5477 like 5107 but u=67  $ NE Hole
c 5478 like 5108 but u=67  $ NE Rod
c 5479 like 5109 but u=67  $ SE Cu Wire
c 5480 like 5110 but u=67  $ SE Hole
c 5481 like 5111 but u=67  $ SE Rod
c 5482 10 4.8648E-05  -6003 (7132:-7133:7134:7127) (7135:7136:-7137:7127)
c            (7138:7139:-7140:7127) (7222:7227) (7223:7227)
c            (7224:7227) imp:n=1 u=67 fill=31
c c
c c ------------ Stack 2* - N, NE, SE (Core 6) ------------
c 5483 like 5103 but u=68  $ N Cu Wire
c 5484 like 5104 but u=68  $ N Hole
c 5485 like 5105 but u=68  $ N Rod
c 5486 like 5106 but u=68  $ NE Cu Wire
c 5487 like 5107 but u=68  $ NE Hole
c 5488 like 5108 but u=68  $ NE Rod
c 5489 like 5109 but u=68  $ SE Cu Wire
c 5490 like 5110 but u=68  $ SE Hole
c 5491 like 5111 but u=68  $ SE Rod
c 5492 10 4.8648E-05  -6003 (7132:-7133:7134:7127) (7135:7136:-7137:7127)
c            (7138:7139:-7140:7127) (7222:7227) (7223:7227)
c            (7224:7227) imp:n=1 u=68 fill=32
c c
c c ------------ Stack 0 - N, NE, SE (Core 6) ------------
c 5493 like 5103 but u=69  $ N Cu Wire
c 5494 like 5104 but u=69  $ N Hole
c 5495 like 5105 but u=69  $ N Rod
c 5496 like 5106 but u=69  $ NE Cu Wire
c 5497 like 5107 but u=69  $ NE Hole
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c 5498 like 5108 but u=69  $ NE Rod
c 5499 like 5109 but u=69  $ SE Cu Wire
c 5500 like 5110 but u=69  $ SE Hole
c 5501 like 5111 but u=69  $ SE Rod
c 5502 10 4.8648E-05  -6003 (7132:-7133:7134:7127) (7135:7136:-7137:7127)
c            (7138:7139:-7140:7127) (7222:7227) (7223:7227)
c            (7224:7227) imp:n=1 u=69 fill=27
c
c
c c ------------ Stack 2 - NE, SE (Core 7) ------------
c 5201 like 5103 but u=40  $ NE Rod
c 5202 like 5104 but u=40  $ SE Rod
c 5203 10 4.8648E-05  -6003 (7023:7027) (7024:7027) imp:n=1 u=40 fill=29
c c
c c ------------ Stack 1* - N, NE, SE, S (Core 7) ------------
c 5204 like 5102 but u=41  $ N Rod
c 5205 like 5103 but u=41  $ NE Rod
c 5206 like 5104 but u=41  $ SE Rod
c 5207 like 5105 but u=41  $ S Rod
c 5208 10 4.8648E-05  -6003 (7022:7027) (7023:7027) (7024:7027)
c           (7025:7027) imp:n=1 u=41 fill=31
c c
c c ------------ Stack 1* - NE, SE, S (Core 7) ------------
c 5209 like 5103 but u=42  $ NE Rod
c 5210 like 5104 but u=42  $ SE Rod
c 5211 like 5105 but u=42  $ S Rod
c 5212 10 4.8648E-05  -6003  (7023:7027) (7024:7027)
c           (7025:7027) imp:n=1 u=42 fill=31
c c
c c ------------ Stack 0* - NE, SE, S (Core 7) ------------
c 5213 like 5103 but u=43  $ NE Rod
c 5214 like 5104 but u=43  $ SE Rod
c 5215 like 5105 but u=43  $ S Rod
c 5216 10 4.8648E-05  -6003 (7023:7027) (7024:7027)
c           (7025:7027) imp:n=1 u=43 fill=30
c c
c c ------------ Stack 2 - NE, SE, S (Core 7) ------------
c 5217 like 5103 but u=44  $ NE Rod
c 5218 like 5104 but u=44  $ SE Rod
c 5219 like 5105 but u=44  $ S Rod
c 5220 10 4.8648E-05  -6003 (7023:7027) (7024:7027)
c           (7025:7027) imp:n=1 u=44 fill=29
c c
c c ------------ Stack 0* - SE, S (Core 7) ------------
c 5221 like 5104 but u=45  $ SE Rod
c 5222 like 5105 but u=45  $ S Rod
c 5223 10 4.8648E-05  -6003 (7024:7027) (7025:7027) imp:n=1 u=45 fill=30
c c
c c ------------ Stack 1* - NE, SE, S, SW (Core 7) ------------
c 5224 like 5103 but u=46  $ NE Rod
c 5225 like 5104 but u=46  $ SE Rod
c 5226 like 5105 but u=46  $ S Rod
c 5227 like 5106 but u=46  $ SW Rod
c 5228 10 4.8648E-05  -6003 (7023:7027) (7024:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=46 fill=31
c c
c c ------------ Stack 1* - SE, S, SW (Core 7) ------------
c 5229 like 5104 but u=47  $ SE Rod
c 5230 like 5105 but u=47  $ S Rod
c 5231 like 5106 but u=47  $ SW Rod
c 5232 10 4.8648E-05  -6003 (7024:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=47 fill=31
c c
c c ------------ Stack 2 - SE, S, SW (Core 7) ------------
c 5233 like 5104 but u=48  $ SE Rod
c 5234 like 5105 but u=48  $ S Rod
c 5235 like 5106 but u=48  $ SW Rod
c 5236 10 4.8648E-05  -6003 (7024:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=48 fill=29
c c
c c ------------ Stack 0* - SE, S, SW (Core 7) ------------
c 5237 like 5104 but u=49  $ SE Rod
c 5238 like 5105 but u=49  $ S Rod
c 5239 like 5106 but u=49  $ SW Rod
c 5240 10 4.8648E-05  -6003 (7024:7027)
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c           (7025:7027) (7026:7027) imp:n=1 u=49 fill=30
c c
c c ------------ Stack 2 - S, SW (Core 7) ------------
c 5241 like 5105 but u=50  $ S Rod
c 5242 like 5106 but u=50  $ SW Rod
c 5243 10 4.8648E-05  -6003 (7025:7027) (7026:7027) imp:n=1 u=50 fill=29
c c
c c ------------ Stack 1* - NW, SE, S, SW (Core 7) ------------
c 5244 like 5101 but u=51  $ NW Rod
c 5245 like 5104 but u=51  $ SE Rod
c 5246 like 5105 but u=51  $ S Rod
c 5247 like 5106 but u=51  $ SW Rod
c 5248 10 4.8648E-05  -6003 (7021:7027) (7024:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=51 fill=31
c c
c c ------------ Stack 1* - NW, S, SW (Core 7) ------------
c 5249 like 5101 but u=52  $ NW Rod
c 5250 like 5105 but u=52  $ S Rod
c 5251 like 5106 but u=52  $ SW Rod
c 5252 10 4.8648E-05  -6003 (7021:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=52 fill=31
c c
c c ------------ Stack 0* - NW, S, SW (Core 7) ------------
c 5253 like 5101 but u=53  $ NW Rod
c 5254 like 5105 but u=53  $ S Rod
c 5255 like 5106 but u=53  $ SW Rod
c 5256 10 4.8648E-05  -6003 (7021:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=53 fill=30
c c
c c ------------ Stack 2 - NW, S, SW (Core 7) ------------
c 5257 like 5101 but u=54  $ NW Rod
c 5258 like 5105 but u=54  $ S Rod
c 5259 like 5106 but u=54  $ SW Rod
c 5260 10 4.8648E-05  -6003 (7021:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=54 fill=29
c c
c c ------------ Stack 0* - NW, SW (Core 7) ------------
c 5261 like 5101 but u=55  $ NW Rod
c 5262 like 5106 but u=55  $ SW Rod
c 5263 10 4.8648E-05  -6003 (7021:7027) (7026:7027) imp:n=1 u=55 fill=30
c c
c c ------------ Stack 1* - NW, N, S, SW (Core 7) ------------
c 5264 like 5101 but u=56  $ NW Rod
c 5265 like 5102 but u=56  $ N Rod
c 5266 like 5105 but u=56  $ S Rod
c 5267 like 5106 but u=56  $ SW Rod
c 5268 10 4.8648E-05  -6003 (7021:7027) (7022:7027)
c           (7025:7027) (7026:7027) imp:n=1 u=56 fill=31
c c
c c ------------ Stack 1* - NW, N, SW (Core 7) ------------
c 5269 like 5101 but u=57  $ NW Rod
c 5270 like 5102 but u=57  $ N Rod
c 5271 like 5106 but u=57  $ SW Rod
c 5272 10 4.8648E-05  -6003 (7021:7027) (7022:7027)
c           (7026:7027) imp:n=1 u=57 fill=31
c c
c c ------------ Stack 2 - NW, N, SW (Core 7) ------------
c 5273 like 5101 but u=58  $ NW Rod
c 5274 like 5102 but u=58  $ N Rod
c 5275 like 5106 but u=58  $ SW Rod
c 5276 10 4.8648E-05  -6003 (7021:7027) (7022:7027)
c           (7026:7027) imp:n=1 u=58 fill=29
c c
c c ------------ Stack 0* - NW, N, SW (Core 7) ------------
c 5277 like 5101 but u=59  $ NW Rod
c 5278 like 5102 but u=59  $ N Rod
c 5279 like 5106 but u=59  $ SW Rod
c 5280 10 4.8648E-05  -6003 (7021:7027) (7022:7027)
c           (7026:7027) imp:n=1 u=59 fill=30
c c
c c ------------ Stack 2 - NW, N (Core 7) ------------
c 5281 like 5101 but u=60  $ NW Rod
c 5282 like 5102 but u=60  $ N Rod
c 5283 10 4.8648E-05  -6003 (7021:7027) (7022:7027)  imp:n=1 u=60 fill=29
c c
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c c ------------ Stack 1* - NW, N, NE, SW (Core 7) ------------
c 5284 like 5101 but u=61  $ NW Rod
c 5285 like 5102 but u=61  $ N Rod
c 5286 like 5103 but u=61  $ NE Rod
c 5287 like 5106 but u=61  $ SW Rod
c 5288 10 4.8648E-05  -6003 (7021:7027) (7022:7027) (7023:7027)
c           (7026:7027) imp:n=1 u=61 fill=31
c c
c c ------------ Stack 1* - NW, N, NE (Core 7) ------------
c 5289 like 5101 but u=62  $ NW Rod
c 5290 like 5102 but u=62  $ N Rod
c 5291 like 5103 but u=62  $ NE Rod
c 5292 10 4.8648E-05  -6003 (7021:7027) (7022:7027) (7023:7027)
c           imp:n=1 u=62 fill=31
c c
c c ------------ Stack 0* - NW, N, NE (Core 7) ------------
c 5293 like 5101 but u=63  $ NW Rod
c 5294 like 5102 but u=63  $ N Rod
c 5295 like 5103 but u=63  $ NE Rod
c 5296 10 4.8648E-05  -6003 (7021:7027) (7022:7027) (7023:7027)
c           imp:n=1 u=63 fill=30
c c
c c ------------ Stack 2 - NW, N, NE (Core 7) ------------
c 5297 like 5101 but u=64  $ NW Rod
c 5298 like 5102 but u=64  $ N Rod
c 5299 like 5103 but u=64  $ NE Rod
c 5300 10 4.8648E-05  -6003 (7021:7027) (7022:7027) (7023:7027)
c           imp:n=1 u=64 fill=29
c c
c c ------------ Stack 0* - N, NE (Core 7) ------------
c 5301 like 5102 but u=65  $ N Rod
c 5302 like 5103 but u=65  $ NE Rod
c 5303 10 4.8648E-05  -6003 (7022:7027) (7023:7027) imp:n=1 u=65 fill=30
c c
c c ------------ Stack 1* - NW, N, NE, SE (Core 7) ------------
c 5304 like 5101 but u=66  $ NW Rod
c 5305 like 5102 but u=66  $ N Rod
c 5306 like 5103 but u=66  $ NE Rod
c 5307 like 5104 but u=66  $ SE Rod
c 5308 10 4.8648E-05  -6003 (7021:7027) (7022:7027) (7023:7027) (7024:7027)
c           imp:n=1 u=66 fill=31
c c
c c ------------ Stack 1* - N, NE, SE (Core 7) ------------
c 5309 like 5102 but u=67  $ N Rod
c 5310 like 5103 but u=67  $ NE Rod
c 5311 like 5104 but u=67  $ SE Rod
c 5312 10 4.8648E-05  -6003 (7022:7027) (7023:7027) (7024:7027)
c           imp:n=1 u=67 fill=31
c c
c c ------------ Stack 2 - N, NE, SE (Core 7) ------------
c 5313 like 5102 but u=68  $ N Rod
c 5314 like 5103 but u=68  $ NE Rod
c 5315 like 5104 but u=68  $ SE Rod
c 5316 10 4.8648E-05  -6003 (7022:7027) (7023:7027) (7024:7027)
c           imp:n=1 u=68 fill=29
c c
c c ------------ Stack 0* - N, NE, SE (Core 7) ------------
c 5317 like 5102 but u=69  $ N Rod
c 5318 like 5103 but u=69  $ NE Rod
c 5319 like 5104 but u=69  $ SE Rod
c 5320 10 4.8648E-05  -6003 (7022:7027) (7023:7027) (7024:7027)
c           imp:n=1 u=69 fill=30
c
c
c ------------ Stack 2* - NE, SE (Core 8) ------------
c 5201 like 5107 but u=40  $ NE Hole
c 5202 like 5108 but u=40  $ NE Rod
c 5204 like 5110 but u=40  $ SE Hole
c 5205 like 5111 but u=40  $ SE Rod
c 5206 10 4.8648E-05  -6003 (7135:7136:-7137:7128) (7138:7139:-7140:7128)
c           imp:n=1 u=40 fill=32
c c
c c ------------ Stack 1 - N, NE, SE, S (Core 8) ------------
c 5208 like 5104 but u=41  $ N Hole
c 5209 like 5105 but u=41  $ N Rod
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c 5211 like 5107 but u=41  $ NE Hole
c 5212 like 5108 but u=41  $ NE Rod
c 5214 like 5110 but u=41  $ SE Hole
c 5215 like 5111 but u=41  $ SE Rod
c 5217 like 5113 but u=41  $ S Hole
c 5218 like 5114 but u=41  $ S Rod
c 5219 10 4.8648E-05  -6003 (7132:-7133:7134:7128) (7135:7136:-7137:7128)
c           (7138:7139:-7140:7128) (7141:-7142:7143:7128) imp:n=1 u=41 fill=28
c c
c c ------------ Stack 1 - NE, SE, S (Core 8) ------------
c 5221 like 5107 but u=42  $ NE Hole
c 5222 like 5108 but u=42  $ NE Rod
c 5224 like 5110 but u=42  $ SE Hole
c 5225 like 5111 but u=42  $ SE Rod
c 5227 like 5113 but u=42  $ S Hole
c 5228 like 5114 but u=42  $ S Rod
c 5229 10 4.8648E-05  -6003 (7135:7136:-7137:7128) (7138:7139:-7140:7128)
c           (7141:-7142:7143:7128) imp:n=1 u=42 fill=28
c c
c c ------------ Stack 0* - NE, SE, S (Core 8) ------------
c 5231 like 5107 but u=43  $ NE Hole
c 5232 like 5108 but u=43  $ NE Rod
c 5234 like 5110 but u=43  $ SE Hole
c 5235 like 5111 but u=43  $ SE Rod
c 5237 like 5113 but u=43  $ S Hole
c 5238 like 5114 but u=43  $ S Rod
c 5239 10 4.8648E-05  -6003 (7135:7136:-7137:7128) (7138:7139:-7140:7128)
c           (7141:-7142:7143:7128) imp:n=1 u=43 fill=30
c c
c c ------------ Stack 2* - NE, SE, S (Core 8) ------------
c 5241 like 5107 but u=44  $ NE Hole
c 5242 like 5108 but u=44  $ NE Rod
c 5244 like 5110 but u=44  $ SE Hole
c 5245 like 5111 but u=44  $ SE Rod
c 5247 like 5113 but u=44  $ S Hole
c 5248 like 5114 but u=44  $ S Rod
c 5249 10 4.8648E-05  -6003 (7135:7136:-7137:7128) (7138:7139:-7140:7128)
c           (7141:-7142:7143:7128) imp:n=1 u=44 fill=32
c c
c c ------------ Stack 0* - SE, S (Core 8) ------------
c 5251 like 5110 but u=45  $ SE Hole
c 5252 like 5111 but u=45  $ SE Rod
c 5254 like 5113 but u=45  $ S Hole
c 5255 like 5114 but u=45  $ S Rod
c 5256 10 4.8648E-05  -6003 (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c           imp:n=1 u=45 fill=30
c c
c c ------------ Stack 1 - NE, SE, S, SW (Core 8) ------------
c 5258 like 5107 but u=46  $ NE Hole
c 5259 like 5108 but u=46  $ NE Rod
c 5261 like 5110 but u=46  $ SE Hole
c 5262 like 5111 but u=46  $ SE Rod
c 5264 like 5113 but u=46  $ S Hole
c 5265 like 5114 but u=46  $ S Rod
c 5267 like 5116 but u=46  $ SW Hole
c 5268 like 5117 but u=46  $ SW Rod
c 5269 10 4.8648E-05  -6003 (7135:7136:-7137:7128) (7138:7139:-7140:7128)
c           (7141:-7142:7143:7128) (7144:7145:-7146:7128) imp:n=1 u=46 fill=28
c c
c c ------------ Stack 1 - SE, S, SW (Core 8) ------------
c 5271 like 5110 but u=47  $ SE Hole
c 5272 like 5111 but u=47  $ SE Rod
c 5274 like 5113 but u=47  $ S Hole
c 5275 like 5114 but u=47  $ S Rod
c 5277 like 5116 but u=47  $ SW Hole
c 5278 like 5117 but u=47  $ SW Rod
c 5279 10 4.8648E-05  -6003 (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=47 fill=28
c c
c c ------------ Stack 2* - SE, S, SW (Core 8) ------------
c 5281 like 5110 but u=48  $ SE Hole
c 5282 like 5111 but u=48  $ SE Rod
c 5284 like 5113 but u=48  $ S Hole
c 5285 like 5114 but u=48  $ S Rod
c 5287 like 5116 but u=48  $ SW Hole
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c 5288 like 5117 but u=48  $ SW Rod
c 5289 10 4.8648E-05  -6003 (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=48 fill=32
c c
c c ------------ Stack 0* - SE, S, SW (Core 8) ------------
c 5291 like 5110 but u=49  $ SE Hole
c 5292 like 5111 but u=49  $ SE Rod
c 5294 like 5113 but u=49  $ S Hole
c 5295 like 5114 but u=49  $ S Rod
c 5297 like 5116 but u=49  $ SW Hole
c 5298 like 5117 but u=49  $ SW Rod
c 5299 10 4.8648E-05  -6003 (7138:7139:-7140:7128) (7141:-7142:7143:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=49 fill=30
c c
c c ------------ Stack 2* - S, SW (Core 8) ------------
c 5301 like 5113 but u=50  $ S Hole
c 5302 like 5114 but u=50  $ S Rod
c 5304 like 5116 but u=50  $ SW Hole
c 5305 like 5117 but u=50  $ SW Rod
c 5306 10 4.8648E-05  -6003 (7141:-7142:7143:7128) (7144:7145:-7146:7128)
c            imp:n=1 u=50 fill=32
c c
c c ------------ Stack 1 - NW, SE, S, SW (Core 8) ------------
c 5308 like 5101 but u=51  $ NW Hole
c 5309 like 5102 but u=51  $ NW Rod
c 5311 like 5110 but u=51  $ SE Hole
c 5312 like 5111 but u=51  $ SE Rod
c 5314 like 5113 but u=51  $ S Hole
c 5315 like 5114 but u=51  $ S Rod
c 5317 like 5116 but u=51  $ SW Hole
c 5318 like 5117 but u=51  $ SW Rod
c 5319 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7138:7139:-7140:7128)
c            (7141:-7142:7143:7128) (7144:7145:-7146:7128) imp:n=1 u=51 fill=28
c c
c c ------------ Stack 1 - NW, S, SW (Core 8) ------------
c 5321 like 5101 but u=52  $ NW Hole
c 5322 like 5102 but u=52  $ NW Rod
c 5324 like 5113 but u=52  $ S Hole
c 5325 like 5114 but u=52  $ S Rod
c 5327 like 5116 but u=52  $ SW Hole
c 5328 like 5117 but u=52  $ SW Rod
c 5329 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7141:-7142:7143:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=52 fill=28
c c
c c ------------ Stack 0* - NW, S, SW (Core 8) ------------
c 5331 like 5101 but u=53  $ NW Hole
c 5332 like 5102 but u=53  $ NW Rod
c 5334 like 5113 but u=53  $ S Hole
c 5335 like 5114 but u=53  $ S Rod
c 5337 like 5116 but u=53  $ SW Hole
c 5338 like 5117 but u=53  $ SW Rod
c 5339 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7141:-7142:7143:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=53 fill=30
c c
c c ------------ Stack 2* - NW, S, SW (Core 8) ------------
c 5341 like 5101 but u=54  $ NW Hole
c 5342 like 5102 but u=54  $ NW Rod
c 5344 like 5113 but u=54  $ S Hole
c 5345 like 5114 but u=54  $ S Rod
c 5347 like 5116 but u=54  $ SW Hole
c 5348 like 5117 but u=54  $ SW Rod
c 5349 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7141:-7142:7143:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=54 fill=32
c c
c c ------------ Stack 0* - NW, SW (Core 8) ------------
c 5351 like 5101 but u=55  $ NW Hole
c 5352 like 5102 but u=55  $ NW Rod
c 5357 like 5116 but u=55  $ SW Hole
c 5358 like 5117 but u=55  $ SW Rod
c 5359 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7144:7145:-7146:7128)
c            imp:n=1 u=55 fill=30
c c
c c ------------ Stack 1 - NW, N, S, SW (Core 8) ------------
c 5361 like 5101 but u=56  $ NW Hole
c 5362 like 5102 but u=56  $ NW Rod
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c 5364 like 5104 but u=56  $ N Hole
c 5365 like 5105 but u=56  $ N Rod
c 5367 like 5113 but u=56  $ S Hole
c 5368 like 5114 but u=56  $ S Rod
c 5370 like 5116 but u=56  $ SW Hole
c 5371 like 5117 but u=56  $ SW Rod
c 5372 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7141:-7142:7143:7128) (7144:7145:-7146:7128) imp:n=1 u=56 fill=28
c c
c c ------------ Stack 1 - NW, N, SW (Core 8) ------------
c 5374 like 5101 but u=57  $ NW Hole
c 5375 like 5102 but u=57  $ NW Rod
c 5377 like 5104 but u=57  $ N Hole
c 5378 like 5105 but u=57  $ N Rod
c 5380 like 5116 but u=57  $ SW Hole
c 5381 like 5117 but u=57  $ SW Rod
c 5382 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=57 fill=28
c c
c c ------------ Stack 2* - NW, N, SW (Core 8) ------------
c 5384 like 5101 but u=58  $ NW Hole
c 5385 like 5102 but u=58  $ NW Rod
c 5387 like 5104 but u=58  $ N Hole
c 5388 like 5105 but u=58  $ N Rod
c 5390 like 5116 but u=58  $ SW Hole
c 5391 like 5117 but u=58  $ SW Rod
c 5392 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=58 fill=32
c c
c c ------------ Stack 0* - NW, N, SW (Core 8) ------------
c 5394 like 5101 but u=59  $ NW Hole
c 5395 like 5102 but u=59  $ NW Rod
c 5397 like 5104 but u=59  $ N Hole
c 5398 like 5105 but u=59  $ N Rod
c 5400 like 5116 but u=59  $ SW Hole
c 5401 like 5117 but u=59  $ SW Rod
c 5402 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7144:7145:-7146:7128) imp:n=1 u=59 fill=30
c c
c c ------------ Stack 2* - NW, N (Core 8) ------------
c 5404 like 5101 but u=60  $ NW Hole
c 5405 like 5102 but u=60  $ NW Rod
c 5407 like 5104 but u=60  $ N Hole
c 5408 like 5105 but u=60  $ N Rod
c 5409 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            imp:n=1 u=60 fill=32
c c
c c ------------ Stack 1 - NW, N, NE, SW (Core 8) ------------
c 5411 like 5101 but u=61  $ NW Hole
c 5412 like 5102 but u=61  $ NW Rod
c 5414 like 5104 but u=61  $ N Hole
c 5415 like 5105 but u=61  $ N Rod
c 5417 like 5107 but u=61  $ NE Hole
c 5418 like 5108 but u=61  $ NE Rod
c 5420 like 5116 but u=61  $ SW Hole
c 5421 like 5117 but u=61  $ SW Rod
c 5422 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7135:7136:-7137:7128) (7144:7145:-7146:7128) imp:n=1 u=61 fill=28
c c
c c ------------ Stack 1 - NW, N, NE (Core 8) ------------
c 5424 like 5101 but u=62  $ NW Hole
c 5425 like 5102 but u=62  $ NW Rod
c 5427 like 5104 but u=62  $ N Hole
c 5428 like 5105 but u=62  $ N Rod
c 5430 like 5107 but u=62  $ NE Hole
c 5431 like 5108 but u=62  $ NE Rod
c 5432 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7135:7136:-7137:7128) imp:n=1 u=62 fill=28
c c
c c ------------ Stack 0* - NW, N, NE (Core 8) ------------
c 5434 like 5101 but u=63  $ NW Hole
c 5435 like 5102 but u=63  $ NW Rod
c 5437 like 5104 but u=63  $ N Hole
c 5438 like 5105 but u=63  $ N Rod
c 5440 like 5107 but u=63  $ NE Hole
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c 5441 like 5108 but u=63  $ NE Rod
c 5442 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7135:7136:-7137:7128) imp:n=1 u=63 fill=30
c c
c c ------------ Stack 2* - NW, N, NE (Core 8) ------------
c 5444 like 5101 but u=64  $ NW Hole
c 5445 like 5102 but u=64  $ NW Rod
c 5447 like 5104 but u=64  $ N Hole
c 5448 like 5105 but u=64  $ N Rod
c 5450 like 5107 but u=64  $ NE Hole
c 5451 like 5108 but u=64  $ NE Rod
c 5452 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7135:7136:-7137:7128) imp:n=1 u=64 fill=32
c c
c c ------------ Stack 0* - N, NE (Core 8) ------------
c 5454 like 5104 but u=65  $ N Hole
c 5455 like 5105 but u=65  $ N Rod
c 5457 like 5107 but u=65  $ NE Hole
c 5458 like 5108 but u=65  $ NE Rod
c 5459 10 4.8648E-05  -6003 (7132:-7133:7134:7128) (7135:7136:-7137:7128)
c            imp:n=1 u=65 fill=30
c c
c c ------------ Stack 1 - NW, N, NE, SE (Core 8) ------------
c 5461 like 5101 but u=66  $ NW Hole
c 5462 like 5102 but u=66  $ NW Rod
c 5464 like 5104 but u=66  $ N Hole
c 5465 like 5105 but u=66  $ N Rod
c 5467 like 5107 but u=66  $ NE Hole
c 5468 like 5108 but u=66  $ NE Rod
c 5470 like 5110 but u=66  $ SE Hole
c 5471 like 5111 but u=66  $ SE Rod
c 5472 10 4.8648E-05  -6003 (7129:7130:-7131:7128) (7132:-7133:7134:7128)
c            (7135:7136:-7137:7128) (7138:7139:-7140:7128) imp:n=1 u=66 fill=28
c c
c c ------------ Stack 1 - N, NE, SE (Core 8) ------------
c 5474 like 5104 but u=67  $ N Hole
c 5475 like 5105 but u=67  $ N Rod
c 5477 like 5107 but u=67  $ NE Hole
c 5478 like 5108 but u=67  $ NE Rod
c 5480 like 5110 but u=67  $ SE Hole
c 5481 like 5111 but u=67  $ SE Rod
c 5482 10 4.8648E-05  -6003 (7132:-7133:7134:7128) (7135:7136:-7137:7128)
c            (7138:7139:-7140:7128) imp:n=1 u=67 fill=28
c c
c c ------------ Stack 2* - N, NE, SE (Core 8) ------------
c 5484 like 5104 but u=68  $ N Hole
c 5485 like 5105 but u=68  $ N Rod
c 5487 like 5107 but u=68  $ NE Hole
c 5488 like 5108 but u=68  $ NE Rod
c 5490 like 5110 but u=68  $ SE Hole
c 5491 like 5111 but u=68  $ SE Rod
c 5492 10 4.8648E-05  -6003 (7132:-7133:7134:7128) (7135:7136:-7137:7128)
c            (7138:7139:-7140:7128)  imp:n=1 u=68 fill=32
c c
c c ------------ Stack 0* - N, NE, SE (Core 8) ------------
c 5494 like 5104 but u=69  $ N Hole
c 5495 like 5105 but u=69  $ N Rod
c 5497 like 5107 but u=69  $ NE Hole
c 5498 like 5108 but u=69  $ NE Rod
c 5500 like 5110 but u=69  $ SE Hole
c 5501 like 5111 but u=69  $ SE Rod
c 5502 10 4.8648E-05  -6003 (7132:-7133:7134:7128) (7135:7136:-7137:7128)
c            (7138:7139:-7140:7128) imp:n=1 u=69 fill=30
c
c
c ------ Core Arrangement ------------------------------------------------------
c --------- Core 5 Lattice Description ---------
7001 10 4.8648E-05  -6002 imp:n=1 u=100 lat=2 fill=-12:12 -12:12 0:0
      26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
      26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 30 28 32 30 28 32 26 26 26 26
      26 26 26 26 26 26 26 26 26 26 26 26 26 30 28 32 30 28 32 30 28 32 26 26 26
      26 26 26 26 26 26 26 26 26 26 26 30 28 32 30 28 32 30 28 32 30 28 32 26 26
      26 26 26 26 26 26 26 26 26 30 28 32 30 28 29 27 28 29 27 28 32 30 28 32 26
      26 26 26 26 26 26 26 26 28 32 30 28 29 27 28 29 27 28 29 27 28 32 30 28 26
      26 26 26 26 26 26 26 32 30 28 29 27 28 29 27 28 29 27 28 29 27 28 32 30 26
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      26 26 26 26 26 26 30 28 32 27 28 29 27 28 29 27 28 29 27 28 29 30 28 32 26
      26 26 26 26 26 28 32 30 28 29 27 28 29 27 28 29 27 28 29 27 28 32 30 28 26
      26 26 26 26 32 30 28 29 27 28 29 27 28 29 27 28 29 27 28 29 27 28 32 30 26
      26 26 26 26 28 32 27 28 29 27 28 29 27 28 29 27 28 29 27 28 29 30 28 26 26
      26 26 26 32 30 28 29 27 28 29 27 28 29 27 28 29 27 28 29 27 28 32 30 26 26
c
      26 26 26 28 32 27 28 29 27 28 29 27 28 29 27 28 29 27 28 29 30 28 26 26 26
c
      26 26 32 30 28 29 27 28 29 27 28 29 27 28 29 27 28 29 27 28 32 30 26 26 26
      26 26 28 32 27 28 29 27 28 29 27 28 29 27 28 29 27 28 29 30 28 26 26 26 26
      26 32 30 28 29 27 28 29 27 28 29 27 28 29 27 28 29 27 28 32 30 26 26 26 26
      26 28 32 30 28 29 27 28 29 27 28 29 27 28 29 27 28 32 30 28 26 26 26 26 26
      26 30 28 32 27 28 29 27 28 29 27 28 29 27 28 29 30 28 32 26 26 26 26 26 26
      26 32 30 28 29 27 28 29 27 28 29 27 28 29 27 28 32 30 26 26 26 26 26 26 26
      26 28 32 30 28 29 27 28 29 27 28 29 27 28 32 30 28 26 26 26 26 26 26 26 26
      26 30 28 32 30 28 29 27 28 29 27 28 32 30 28 32 26 26 26 26 26 26 26 26 26
      26 26 30 28 32 30 28 32 30 28 32 30 28 32 26 26 26 26 26 26 26 26 26 26 26
      26 26 26 30 28 32 30 28 32 30 28 32 26 26 26 26 26 26 26 26 26 26 26 26 26
      26 26 26 26 30 28 32 30 28 32 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
      26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c
c --------- Core 6 Lattice Description ---------
c 7001 10 4.8648E-05  -6002 imp:n=1 u=100 lat=2 fill=-12:12 -12:12 0:0
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 65 62 64 63 62 60 26 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 65 66 39 34 38 39 34 61 60 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 65 66 39 34 38 39 34 38 39 34 61 60 26 26 26
c       26 26 26 26 26 26 26 26 65 66 39 34 38 36 34 35 36 34 38 39 34 61 60 26 26
c       26 26 26 26 26 26 26 67 39 34 38 36 34 35 36 34 35 36 34 38 39 34 57 26 26
c       26 26 26 26 26 26 68 34 38 36 34 35 36 34 35 36 34 35 36 34 38 39 59 26 26
c       26 26 26 26 26 69 38 39 34 35 36 34 35 36 34 35 36 34 35 36 34 38 58 26 26
c       26 26 26 26 67 39 34 35 36 34 35 36 34 35 36 34 35 36 34 35 39 34 57 26 26
c       26 26 26 40 34 38 36 34 35 36 34 35 36 34 35 36 34 35 36 34 38 39 55 26 26
c       26 26 26 41 39 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 34 56 26 26 26
c       26 26 26 40 34 38 36 34 35 36 34 35 36 34 35 36 34 35 36 34 38 39 55 26 26
c c
c       26 26 26 41 39 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 34 56 26 26 26
c c
c       26 26 40 34 38 36 34 35 36 34 35 36 34 35 36 34 35 36 34 38 39 55 26 26 26
c       26 26 41 39 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 34 56 26 26 26 26
c       26 40 34 38 36 34 35 36 34 35 36 34 35 36 34 35 36 34 38 39 55 26 26 26 26
c       26 42 39 34 35 36 34 35 36 34 35 36 34 35 36 34 35 39 34 52 26 26 26 26 26
c       26 43 38 39 34 35 36 34 35 36 34 35 36 34 35 36 34 38 54 26 26 26 26 26 26
c       26 44 34 38 36 34 35 36 34 35 36 34 35 36 34 38 39 53 26 26 26 26 26 26 26
c       26 42 39 34 38 36 34 35 36 34 35 36 34 38 39 34 52 26 26 26 26 26 26 26 26
c       26 45 46 39 34 38 36 34 35 36 34 38 39 34 51 50 26 26 26 26 26 26 26 26 26
c       26 26 45 46 39 34 38 39 34 38 39 34 51 50 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 45 46 39 34 38 39 34 51 50 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 45 47 48 49 47 50 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c
c --------- Core 7 Lattice Description ---------
c 7001 10 4.8648E-05  -6002 imp:n=1 u=100 lat=2 fill=-12:12 -12:12 0:0
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 65 62 64 63 62 60 26 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 65 66 36 37 38 36 37 61 60 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 65 66 36 37 38 36 37 38 36 37 61 60 26 26 26
c       26 26 26 26 26 26 26 26 65 66 36 37 38 36 34 35 36 34 38 36 37 61 60 26 26
c       26 26 26 26 26 26 26 67 36 37 38 36 34 35 36 34 35 36 34 38 36 37 57 26 26
c       26 26 26 26 26 26 68 37 38 36 34 35 36 34 35 36 34 35 36 34 38 36 59 26 26
c       26 26 26 26 26 69 38 36 34 35 36 34 35 36 34 35 36 34 35 36 37 38 58 26 26
c       26 26 26 26 67 36 37 35 36 34 35 36 34 35 36 34 35 36 34 35 36 37 57 26 26
c       26 26 26 40 37 38 36 34 35 36 34 35 36 34 35 36 34 35 36 34 38 36 55 26 26
c       26 26 26 41 36 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 37 56 26 26 26
c       26 26 26 40 37 38 36 34 35 36 34 35 36 34 35 36 34 35 36 34 38 36 55 26 26
c c
c       26 26 26 41 36 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 37 56 26 26 26
c c
c       26 26 40 37 38 36 34 35 36 34 35 36 34 35 36 34 35 36 34 38 36 55 26 26 26
c       26 26 41 36 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 37 56 26 26 26 26
c       26 40 37 38 36 34 35 36 34 35 36 34 35 36 34 35 36 34 38 36 55 26 26 26 26
c       26 42 36 37 35 36 34 35 36 34 35 36 34 35 36 34 35 36 37 52 26 26 26 26 26
c       26 43 38 36 34 35 36 34 35 36 34 35 36 34 35 36 37 38 54 26 26 26 26 26 26
c       26 44 37 38 36 34 35 36 34 35 36 34 35 36 34 38 36 53 26 26 26 26 26 26 26
c       26 42 36 37 38 36 34 35 36 34 35 36 34 38 36 37 52 26 26 26 26 26 26 26 26
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c       26 45 46 36 37 38 36 34 35 36 34 38 36 37 51 50 26 26 26 26 26 26 26 26 26
c       26 26 45 46 36 37 38 36 37 38 36 37 51 50 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 45 46 36 37 38 36 37 51 50 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 45 47 48 49 47 50 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c
c --------- Core 8 Lattice Description ---------
c 7001 10 4.8648E-05  -6002 imp:n=1 u=100 lat=2 fill=-12:12 -12:12 0:0
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 65 62 64 63 62 60 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 26 65 66 39 37 35 39 37 61 60 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 65 66 39 37 35 39 37 35 39 37 61 60 26 26
c       26 26 26 26 26 26 26 26 26 65 66 39 37 35 36 34 35 36 34 35 39 37 61 60 26
c       26 26 26 26 26 26 26 26 67 39 37 35 36 34 35 36 34 35 36 34 35 39 37 57 26
c       26 26 26 26 26 26 26 68 37 35 36 34 35 36 34 35 36 34 35 36 34 35 39 59 26
c       26 26 26 26 26 26 69 35 39 34 35 36 34 35 36 34 35 36 34 35 36 37 35 58 26
c       26 26 26 26 26 67 39 37 35 36 34 35 36 34 35 36 34 35 36 34 35 39 37 57 26
c       26 26 26 26 40 37 35 36 34 35 36 34 35 36 34 35 36 34 35 36 34 35 39 55 26
c       26 26 26 26 41 39 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 37 56 26 26
c       26 26 26 40 37 35 36 34 35 36 34 35 36 34 35 36 34 35 36 34 35 39 55 26 26
c c
c       26 26 26 41 39 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 37 56 26 26 26
c c
c       26 26 40 37 35 36 34 35 36 34 35 36 34 35 36 34 35 36 34 35 39 55 26 26 26
c       26 26 41 39 34 35 36 34 35 36 34 35 36 34 35 36 34 35 36 37 56 26 26 26 26
c       26 40 37 35 36 34 35 36 34 35 36 34 35 36 34 35 36 34 35 39 55 26 26 26 26
c       26 42 39 37 35 36 34 35 36 34 35 36 34 35 36 34 35 39 37 52 26 26 26 26 26
c       26 43 35 39 34 35 36 34 35 36 34 35 36 34 35 36 37 35 54 26 26 26 26 26 26
c       26 44 37 35 36 34 35 36 34 35 36 34 35 36 34 35 39 53 26 26 26 26 26 26 26
c       26 42 39 37 35 36 34 35 36 34 35 36 34 35 39 37 52 26 26 26 26 26 26 26 26
c       26 45 46 39 37 35 36 34 35 36 34 35 39 37 51 50 26 26 26 26 26 26 26 26 26
c       26 26 45 46 39 37 35 39 37 35 39 37 51 50 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 45 46 39 37 35 39 37 51 50 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 45 47 48 49 47 50 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c       26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26
c
c --------- Pebble-Filled Core Cavity ---------
7101 10 4.8648E-05  -7001 -7002 -7003 imp:n=1 fill=100 (0 0 75)
c
c --- Graphite Fillers ---------------------------------------------------------
c ------ Axial Modifiers ------
9001 31 8.2629E-02  (7001:7002) 1811 -7003
          -7501 -7502 -7503 -7504 -7505 -7506 -7507 -7508 -7509 -7510 -7511
          -7512 -7513 -7514 -7515 -7516 -7517 -7518 -7519 -7520 -7521 -7522
          imp:n=1
c
c ------ Lattice Spacers ------
c    *Lattice Spacers Not Used
c
c ------ Cavity Floor ------
c    *Cavity Floor Fillers Not Used
c
c --- Auxiliary Components -----------------------------------------------------
c ------ Start-Up Source ------
c    *Start-Up Source Information Unknown
c
c ------ Detectors ------
c    *Detector Information Unknown
c
c ------ Temperature Sensors ------
c    *Temperature Sensor Information Unknown
c
c --- Model Boundary -----------------------------------------------------------
9999  0  -2:4:-6:8:-15:9 imp:n=0  $ The Great Void
c

c Surface Cards ****************************************************************
c --- Structural Surroundings --------------------------------------------------
c ------ Concrete ------
1      py  -205.0  $ Inside South Face
2      py  -285.0  $ Outside South Face
3      py   205.0  $ Inside North Face
4      py   285.0  $ Outside North Face
5      px  -205.0  $ Inside West Face
6      px  -285.0  $ Outside West Face
```

```
7     px   205.0  $ Inside East Face
8     px   285.0  $ Outside East Face
9     pz   620.4   $ Top of Concrete Shielding
c
c ------ Steel Plate Pedestal ------
15    pz    -7.5
c
c ------ Thermal Column ------
21    pz    98.4 $ Bottom of Column
22    pz   218.4 $ Top of Column
c    *Same as Inside South Face of Concrete $ South Face of Concrete
23    px   -60   $ West Face of Column
24    px    60   $ East Face of Column
c
c --- Radial Reflector ---------------------------------------------------------
c ------ Graphite Annulus ------
31    pz     0.0   $ Bottom of Reflector
32    pz   330.4   $ Top of Reflector
33    cz    62.79726  $ Inside Radial Equivalent-Area Cavity Surface
34    cz   163.76986  $ Outside Radial Equivalent-Area Surface
c
c --------- Inside Surfaces of 22-Sided Polygon ---------
7501  p  -63.28338   0.00000 0  -60.56463  18.34968 0  -60.56463  18.34968 1
7502  p  -60.56463  18.34968 0  -52.64200  35.12271 0  -52.64200  35.12271 1
7503  p  -52.64200  35.12271 0  -40.19623  48.87790 0  -40.19623  48.87790 1
7504  p  -40.19623  48.87790 0  -24.29668  58.43336 0  -24.29668  58.43336 1
7505  p  -24.29668  58.43336 0   -6.30949  62.96806 0   -6.30949  62.96806 1
7506  p   -6.30949  62.96806 0   12.21983  62.09236 0   12.21983  62.09236 1
7507  p   12.21983  62.09236 0   29.69919  55.88152 0   29.69919  55.88152 1
7508  p   29.69919  55.88152 0   44.62671  44.86917 0   44.62671  44.86917 1
7509  p   44.62671  44.86917 0   55.71977  30.00154 0   55.71977  30.00154 1
7510  p   55.71977  30.00154 0   62.02524  12.55610 0   62.02524  12.55610 1
7511  p   62.02524  12.55610 0   63.00132  -5.96821 0   63.00132  -5.96821 1
7512  p   63.00132  -5.96821 0   58.56415 -23.97970 0   58.56415 -23.97970 1
7513  p   58.56415 -23.97970 0   49.09498 -39.93080 0   49.09498 -39.93080 1
7514  p   49.09498 -39.93080 0   35.40743 -52.45092 0   35.40743 -52.45092 1
7515  p   35.40743 -52.45092 0   18.67758 -60.46432 0   18.67758 -60.46432 1
7516  p   18.67758 -60.46432 0    0.34290 -63.28245 0    0.34290 -63.28245 1
7517  p    0.34290 -63.28245 0  -18.02125 -60.66320 0  -18.02125 -60.66320 1
7518  p  -18.02125 -60.66320 0  -34.83696 -52.83154 0  -34.83696 -52.83154 1
7519  p  -34.83696 -52.83154 0  -40.19623 -48.87790 0  -40.19623 -48.87790 1
7520  p  -40.19623 -48.87790 0  -52.64200 -35.12271 0  -52.64200 -35.12271 1
7521  p  -52.64200 -35.12271 0  -60.56463 -18.34968 0  -60.56463 -18.34968 1
7522  p  -60.56463 -18.34968 0  -63.28338   0.00000 0  -63.28338   0.00000 1
c
c --------- Outside Surfaces of 22-Sided Polygon ---------
7531  p -164.94114    0.00000 0 -157.85504   47.82643 0 -157.85504   47.82643 1
7532  p -157.85504   47.82643 0 -137.20558   91.54348 0 -137.20558   91.54348 1
7533  p -137.20558   91.54348 0 -104.76704  127.39485 0 -104.76704  127.39485 1
7534  p -104.76704  127.39485 0  -63.32661  152.30010 0  -63.32661  152.30010 1
7535  p  -63.32661  152.30010 0  -16.44498  164.11930 0  -16.44498  164.11930 1
7536  p  -16.44498  164.11930 0   31.84963  161.83690 0   31.84963  161.83690 1
7537  p   31.84963  161.83690 0   77.40766  145.64901 0   77.40766  145.64901 1
7538  p   77.40766  145.64901 0  116.31459  116.94655 0  116.31459  116.94655 1
7539  p  116.31459  116.94655 0  145.22745   78.19572 0  145.22745   78.19572 1
7540  p  145.22745   78.19572 0  161.66194   32.72608 0  161.66194   32.72608 1
7541  p  161.66194   32.72608 0  164.20599  -15.55547 0  164.20599  -15.55547 1
7542  p  164.20599  -15.55547 0  152.64100  -62.50045 0  152.64100  -62.50045 1
7543  p  152.64100  -62.50045 0  127.96066 -104.07522 0  127.96066 -104.07522 1
7544  p  127.96066 -104.07522 0   92.28558 -136.70755 0   92.28558 -136.70755 1
7545  p   92.28558 -136.70755 0   48.68106 -157.59358 0   48.68106 -157.59358 1
7546  p   48.68106 -157.59358 0    0.89372 -164.93872 0    0.89372 -164.93872 1
7547  p    0.89372 -164.93872 0  -46.97040 -158.11187 0  -46.97040 -158.11187 1
7548  p  -46.97040 -158.11187 0  -90.79870 -137.69959 0  -90.79870 -137.69959 1
7549  p  -90.79870 -137.69959 0 -104.76704 -127.39485 0 -104.76704 -127.39485 1
7550  p -104.76704 -127.39485 0 -137.20558  -91.54348 0 -137.20558  -91.54348 1
7551  p -137.20558  -91.54348 0 -157.85504  -47.82643 0 -157.85504  -47.82643 1
7552  p -157.85504  -47.82643 0 -164.94114    0.00000 0 -164.94114    0.00000 1
c
c ------ Safety Ring ------
41    pz   254.4  $ Bottom Surface
42    pz   255.4  $ Top Surface
43    cz    60.4  $ Inner Radius
44    cz    70.0  $ Outer Radius
c
```

```
c ------ C-Driver Channels ------
c --------- Ring 1 ---------
101   c/z  -67.20   0.00  1.3715  $ Position 1
102   c/z  -66.88   6.59  1.3715  $ Position 2
103   c/z  -65.91  13.11  1.3715  $ Position 3
104   c/z  -64.31  19.51  1.3715  $ Position 4
105   c/z  -62.08  25.72  1.3715  $ Position 5
106   c/z  -59.27  31.68  1.3715  $ Position 6
107   c/z  -55.87  37.33  1.3715  $ Position 7
108   c/z  -51.95  42.63  1.3715  $ Position 8
109   c/z  -47.52  47.52  1.3715  $ Position 9
110   c/z  -42.63  51.95  1.3715  $ Position 10
111   c/z  -37.33  55.87  1.3715  $ Position 11
112   c/z  -31.68  59.27  1.3715  $ Position 12
113   c/z  -25.72  62.08  1.3715  $ Position 13
114   c/z  -19.51  64.31  1.3715  $ Position 14
115   c/z  -13.11  65.91  1.3715  $ Position 15
116   c/z   -6.59  66.88  1.3715  $ Position 16
117   c/z    0.00  67.20  1.3715  $ Position 17
118   c/z    6.59  66.88  1.3715  $ Position 18
119   c/z   13.11  65.91  1.3715  $ Position 19
120   c/z   19.51  64.31  1.3715  $ Position 20
121   c/z   25.72  62.08  1.3715  $ Position 21
122   c/z   31.68  59.27  1.3715  $ Position 22
123   c/z   37.33  55.87  1.3715  $ Position 23
124   c/z   42.63  51.95  1.3715  $ Position 24
125   c/z   47.52  47.52  1.3715  $ Position 25
126   c/z   51.95  42.63  1.3715  $ Position 26
127   c/z   55.87  37.33  1.3715  $ Position 27
128   c/z   59.27  31.68  1.3715  $ Position 28
129   c/z   62.08  25.72  1.3715  $ Position 29
130   c/z   64.31  19.51  1.3715  $ Position 30
131   c/z   65.91  13.11  1.3715  $ Position 31
132   c/z   66.88   6.59  1.3715  $ Position 32
133   c/z   67.20   0.00  1.3715  $ Position 33
134   c/z   66.88  -6.59  1.3715  $ Position 34
135   c/z   65.91 -13.11  1.3715  $ Position 35
136   c/z   64.31 -19.51  1.3715  $ Position 36
137   c/z   62.08 -25.72  1.3715  $ Position 37
138   c/z   59.27 -31.68  1.3715  $ Position 38
139   c/z   55.87 -37.33  1.3715  $ Position 39
140   c/z   51.95 -42.63  1.3715  $ Position 40
141   c/z   47.52 -47.52  1.3715  $ Position 41
142   c/z   42.63 -51.95  1.3715  $ Position 42
143   c/z   37.33 -55.87  1.3715  $ Position 43
144   c/z   31.68 -59.27  1.3715  $ Position 44
145   c/z   25.72 -62.08  1.3715  $ Position 45
146   c/z   19.51 -64.31  1.3715  $ Position 46
147   c/z   13.11 -65.91  1.3715  $ Position 47
148   c/z    6.59 -66.88  1.3715  $ Position 48
149   c/z    0.00 -67.20  1.3715  $ Position 49
150   c/z   -6.59 -66.88  1.3715  $ Position 50
151   c/z  -13.11 -65.91  1.3715  $ Position 51
152   c/z  -19.51 -64.31  1.3715  $ Position 52
153   c/z  -25.72 -62.08  1.3715  $ Position 53
154   c/z  -31.68 -59.27  1.3715  $ Position 54
155   c/z  -37.33 -55.87  1.3715  $ Position 55
156   c/z  -42.63 -51.95  1.3715  $ Position 56
157   c/z  -47.52 -47.52  1.3715  $ Position 57
158   c/z  -51.95 -42.63  1.3715  $ Position 58
159   c/z  -55.87 -37.33  1.3715  $ Position 59
160   c/z  -59.27 -31.68  1.3715  $ Position 60
161   c/z  -62.08 -25.72  1.3715  $ Position 61
162   c/z  -64.31 -19.51  1.3715  $ Position 62
163   c/z  -65.91 -13.11  1.3715  $ Position 63
164   c/z  -66.88  -6.59  1.3715  $ Position 64
c
165   cz    70.125  $ Ring Divider for Modeling Simplification
c
c --------- Ring 2 ---------
201   c/z  -72.96   3.58  1.3715  $ Position 1
202   c/z  -72.26  10.72  1.3715  $ Position 2
203   c/z  -70.86  17.75  1.3715  $ Position 3
204   c/z  -68.78  24.61  1.3715  $ Position 4
205   c/z  -66.04  31.23  1.3715  $ Position 5
```

```
206   c/z  -62.66  37.56  1.3715  $ Position 6
207   c/z  -58.67  43.52  1.3715  $ Position 7
208   c/z  -54.13  49.06  1.3715  $ Position 8
209   c/z  -49.06  54.13  1.3715  $ Position 9
210   c/z  -43.52  58.67  1.3715  $ Position 10
211   c/z  -37.56  62.66  1.3715  $ Position 11
212   c/z  -31.23  66.04  1.3715  $ Position 12
213   c/z  -24.61  68.78  1.3715  $ Position 13
214   c/z  -17.75  70.86  1.3715  $ Position 14
215   c/z  -10.72  72.26  1.3715  $ Position 15
216   c/z   -3.58  72.96  1.3715  $ Position 16
217   c/z    3.58  72.96  1.3715  $ Position 17
218   c/z   10.72  72.26  1.3715  $ Position 18
219   c/z   17.75  70.86  1.3715  $ Position 19
220   c/z   24.61  68.78  1.3715  $ Position 20
221   c/z   31.23  66.04  1.3715  $ Position 21
222   c/z   37.56  62.66  1.3715  $ Position 22
223   c/z   43.52  58.67  1.3715  $ Position 23
224   c/z   49.06  54.13  1.3715  $ Position 24
225   c/z   54.13  49.06  1.3715  $ Position 25
226   c/z   58.67  43.52  1.3715  $ Position 26
227   c/z   62.66  37.56  1.3715  $ Position 27
228   c/z   66.04  31.23  1.3715  $ Position 28
229   c/z   68.78  24.61  1.3715  $ Position 29
230   c/z   70.86  17.75  1.3715  $ Position 30
231   c/z   72.26  10.72  1.3715  $ Position 31
232   c/z   72.96   3.58  1.3715  $ Position 32
233   c/z   72.96  -3.58  1.3715  $ Position 33
234   c/z   72.26 -10.72  1.3715  $ Position 34
235   c/z   70.86 -17.75  1.3715  $ Position 35
236   c/z   68.78 -24.61  1.3715  $ Position 36
237   c/z   66.04 -31.23  1.3715  $ Position 37
238   c/z   62.66 -37.56  1.3715  $ Position 38
239   c/z   58.67 -43.52  1.3715  $ Position 39
240   c/z   54.13 -49.06  1.3715  $ Position 40
241   c/z   49.06 -54.13  1.3715  $ Position 41
242   c/z   43.52 -58.67  1.3715  $ Position 42
243   c/z   37.56 -62.66  1.3715  $ Position 43
244   c/z   31.23 -66.04  1.3715  $ Position 44
245   c/z   24.61 -68.78  1.3715  $ Position 45
246   c/z   17.75 -70.86  1.3715  $ Position 46
247   c/z   10.72 -72.26  1.3715  $ Position 47
248   c/z    3.58 -72.96  1.3715  $ Position 48
249   c/z   -3.58 -72.96  1.3715  $ Position 49
250   c/z  -10.72 -72.26  1.3715  $ Position 50
251   c/z  -17.75 -70.86  1.3715  $ Position 51
252   c/z  -24.61 -68.78  1.3715  $ Position 52
253   c/z  -31.23 -66.04  1.3715  $ Position 53
254   c/z  -37.56 -62.66  1.3715  $ Position 54
255   c/z  -43.52 -58.67  1.3715  $ Position 55
256   c/z  -49.06 -54.13  1.3715  $ Position 56
257   c/z  -54.13 -49.06  1.3715  $ Position 57
258   c/z  -58.67 -43.52  1.3715  $ Position 58
259   c/z  -62.66 -37.56  1.3715  $ Position 59
260   c/z  -66.04 -31.23  1.3715  $ Position 60
261   c/z  -68.78 -24.61  1.3715  $ Position 61
262   c/z  -70.86 -17.75  1.3715  $ Position 62
263   c/z  -72.26 -10.72  1.3715  $ Position 63
264   c/z  -72.96  -3.58  1.3715  $ Position 64
c
265   cz    75.975  $ Ring Divider for Modeling Simplification
c
c --------- Ring 3 ---------
301   c/z  -78.52   7.73  1.3715  $ Position 1
302   c/z  -77.38  15.39  1.3715  $ Position 2
303   c/z  -75.50  22.90  1.3715  $ Position 3
304   c/z  -72.89  30.19  1.3715  $ Position 4
305   c/z  -69.58  37.19  1.3715  $ Position 5
306   c/z  -65.60  43.83  1.3715  $ Position 6
307   c/z  -60.99  50.05  1.3715  $ Position 7
308   c/z  -55.79  55.79  1.3715  $ Position 8
309   c/z  -50.05  60.99  1.3715  $ Position 9
310   c/z  -43.83  65.60  1.3715  $ Position 10
311   c/z  -37.19  69.58  1.3715  $ Position 11
312   c/z  -30.19  72.89  1.3715  $ Position 12
```

```
313   c/z  -22.90  75.50  1.3715  $ Position 13
314   c/z  -15.39  77.38  1.3715  $ Position 14
315   c/z   -7.73  78.52  1.3715  $ Position 15
316   c/z    0.00  78.90  1.3715  $ Position 16
317   c/z    7.73  78.52  1.3715  $ Position 17
318   c/z   15.39  77.38  1.3715  $ Position 18
319   c/z   22.90  75.50  1.3715  $ Position 19
320   c/z   30.19  72.89  1.3715  $ Position 20
321   c/z   37.19  69.58  1.3715  $ Position 21
322   c/z   43.83  65.60  1.3715  $ Position 22
323   c/z   50.05  60.99  1.3715  $ Position 23
324   c/z   55.79  55.79  1.3715  $ Position 24
325   c/z   60.99  50.05  1.3715  $ Position 25
326   c/z   65.60  43.83  1.3715  $ Position 26
327   c/z   69.58  37.19  1.3715  $ Position 27
328   c/z   72.89  30.19  1.3715  $ Position 28
329   c/z   75.50  22.90  1.3715  $ Position 29
330   c/z   77.38  15.39  1.3715  $ Position 30
331   c/z   78.52   7.73  1.3715  $ Position 31
332   c/z   78.90   0.00  1.3715  $ Position 32
333   c/z   78.52  -7.73  1.3715  $ Position 33
334   c/z   77.38 -15.39  1.3715  $ Position 34
335   c/z   75.50 -22.90  1.3715  $ Position 35
336   c/z   72.89 -30.19  1.3715  $ Position 36
337   c/z   69.58 -37.19  1.3715  $ Position 37
338   c/z   65.60 -43.83  1.3715  $ Position 38
339   c/z   60.99 -50.05  1.3715  $ Position 39
340   c/z   55.79 -55.79  1.3715  $ Position 40
341   c/z   50.05 -60.99  1.3715  $ Position 41
342   c/z   43.83 -65.60  1.3715  $ Position 42
343   c/z   37.19 -69.58  1.3715  $ Position 43
344   c/z   30.19 -72.89  1.3715  $ Position 44
345   c/z   22.90 -75.50  1.3715  $ Position 45
346   c/z   15.39 -77.38  1.3715  $ Position 46
347   c/z    7.73 -78.52  1.3715  $ Position 47
348   c/z    0.00 -78.90  1.3715  $ Position 48
349   c/z   -7.73 -78.52  1.3715  $ Position 49
350   c/z  -15.39 -77.38  1.3715  $ Position 50
351   c/z  -22.90 -75.50  1.3715  $ Position 51
352   c/z  -30.19 -72.89  1.3715  $ Position 52
353   c/z  -37.19 -69.58  1.3715  $ Position 53
354   c/z  -43.83 -65.60  1.3715  $ Position 54
355   c/z  -50.05 -60.99  1.3715  $ Position 55
356   c/z  -55.79 -55.79  1.3715  $ Position 56
357   c/z  -60.99 -50.05  1.3715  $ Position 57
358   c/z  -65.60 -43.83  1.3715  $ Position 58
359   c/z  -69.58 -37.19  1.3715  $ Position 59
360   c/z  -72.89 -30.19  1.3715  $ Position 60
361   c/z  -75.50 -22.90  1.3715  $ Position 61
362   c/z  -77.38 -15.39  1.3715  $ Position 62
363   c/z  -78.52  -7.73  1.3715  $ Position 63
364   c/z  -78.90   0.00  1.3715  $ Position 64
c
365   cz    81.825  $ Ring Divider for Modeling Simplification
c
c --------- Ring 4 ---------
401   c/z  -83.83  12.44  1.3715  $ Position 1
402   c/z  -82.21  20.59  1.3715  $ Position 2
403   c/z  -79.80  28.55  1.3715  $ Position 3
404   c/z  -76.61  36.24  1.3715  $ Position 4
405   c/z  -72.69  43.57  1.3715  $ Position 5
406   c/z  -68.07  50.49  1.3715  $ Position 6
407   c/z  -62.80  56.91  1.3715  $ Position 7
408   c/z  -56.91  62.80  1.3715  $ Position 8
409   c/z  -50.49  68.07  1.3715  $ Position 9
410   c/z  -43.57  72.69  1.3715  $ Position 10
411   c/z  -36.24  76.61  1.3715  $ Position 11
412   c/z  -28.55  79.80  1.3715  $ Position 12
413   c/z  -20.59  82.21  1.3715  $ Position 13
414   c/z  -12.44  83.83  1.3715  $ Position 14
415   c/z   -4.16  84.65  1.3715  $ Position 15
416   c/z    4.16  84.65  1.3715  $ Position 16
417   c/z   12.44  83.83  1.3715  $ Position 17
418   c/z   20.59  82.21  1.3715  $ Position 18
419   c/z   28.55  79.80  1.3715  $ Position 19
```

```
420   c/z   36.24  76.61  1.3715  $ Position 20
421   c/z   43.57  72.69  1.3715  $ Position 21
422   c/z   50.49  68.07  1.3715  $ Position 22
423   c/z   56.91  62.80  1.3715  $ Position 23
424   c/z   62.80  56.91  1.3715  $ Position 24
425   c/z   68.07  50.49  1.3715  $ Position 25
426   c/z   72.69  43.57  1.3715  $ Position 26
427   c/z   76.61  36.24  1.3715  $ Position 27
428   c/z   79.80  28.55  1.3715  $ Position 28
429   c/z   82.21  20.59  1.3715  $ Position 29
430   c/z   83.83  12.44  1.3715  $ Position 30
431   c/z   84.65   4.16  1.3715  $ Position 31
432   c/z   84.65  -4.16  1.3715  $ Position 32
433   c/z   83.83 -12.44  1.3715  $ Position 33
434   c/z   82.21 -20.59  1.3715  $ Position 34
435   c/z   79.80 -28.55  1.3715  $ Position 35
436   c/z   76.61 -36.24  1.3715  $ Position 36
437   c/z   72.69 -43.57  1.3715  $ Position 37
438   c/z   68.07 -50.49  1.3715  $ Position 38
439   c/z   62.80 -56.91  1.3715  $ Position 39
440   c/z   56.91 -62.80  1.3715  $ Position 40
441   c/z   50.49 -68.07  1.3715  $ Position 41
442   c/z   43.57 -72.69  1.3715  $ Position 42
443   c/z   36.24 -76.61  1.3715  $ Position 43
444   c/z   28.55 -79.80  1.3715  $ Position 44
445   c/z   20.59 -82.21  1.3715  $ Position 45
446   c/z   12.44 -83.83  1.3715  $ Position 46
447   c/z    4.16 -84.65  1.3715  $ Position 47
448   c/z   -4.16 -84.65  1.3715  $ Position 48
449   c/z  -12.44 -83.83  1.3715  $ Position 49
450   c/z  -20.59 -82.21  1.3715  $ Position 50
451   c/z  -28.55 -79.80  1.3715  $ Position 51
452   c/z  -36.24 -76.61  1.3715  $ Position 52
453   c/z  -43.57 -72.69  1.3715  $ Position 53
454   c/z  -50.49 -68.07  1.3715  $ Position 54
455   c/z  -56.91 -62.80  1.3715  $ Position 55
456   c/z  -62.80 -56.91  1.3715  $ Position 56
457   c/z  -68.07 -50.49  1.3715  $ Position 57
458   c/z  -72.69 -43.57  1.3715  $ Position 58
459   c/z  -76.61 -36.24  1.3715  $ Position 59
460   c/z  -79.80 -28.55  1.3715  $ Position 60
461   c/z  -82.21 -20.59  1.3715  $ Position 61
462   c/z  -83.83 -12.44  1.3715  $ Position 62
463   c/z  -84.65  -4.16  1.3715  $ Position 63
464   c/z  -84.65   4.16  1.3715  $ Position 64
c
465   cz    87.675  $ Ring Divider for Modeling Simplification
c
c --------- Ring 5 ---------
501   c/z  -88.86  17.68  1.3715  $ Position 1
502   c/z  -86.70  26.30  1.3715  $ Position 2
503   c/z  -83.70  34.67  1.3715  $ Position 3
504   c/z  -79.90  42.71  1.3715  $ Position 4
505   c/z  -75.33  50.33  1.3715  $ Position 5
506   c/z  -70.03  57.48  1.3715  $ Position 6
507   c/z  -64.06  64.06  1.3715  $ Position 7
508   c/z  -57.48  70.03  1.3715  $ Position 8
509   c/z  -50.33  75.33  1.3715  $ Position 9
510   c/z  -42.71  79.90  1.3715  $ Position 10
511   c/z  -34.67  83.70  1.3715  $ Position 11
512   c/z  -26.30  86.70  1.3715  $ Position 12
513   c/z  -17.68  88.86  1.3715  $ Position 13
514   c/z   -8.88  90.16  1.3715  $ Position 14
515   c/z    0.00  90.60  1.3715  $ Position 15
516   c/z    8.88  90.16  1.3715  $ Position 16
517   c/z   17.68  88.86  1.3715  $ Position 17
518   c/z   26.30  86.70  1.3715  $ Position 18
519   c/z   34.67  83.70  1.3715  $ Position 19
520   c/z   42.71  79.90  1.3715  $ Position 20
521   c/z   50.33  75.33  1.3715  $ Position 21
522   c/z   57.48  70.03  1.3715  $ Position 22
523   c/z   64.06  64.06  1.3715  $ Position 23
524   c/z   70.03  57.48  1.3715  $ Position 24
525   c/z   75.33  50.33  1.3715  $ Position 25
526   c/z   79.90  42.71  1.3715  $ Position 26
```

```
527   c/z   83.70  34.67  1.3715  $ Position 27
528   c/z   86.70  26.30  1.3715  $ Position 28
529   c/z   88.86  17.68  1.3715  $ Position 29
530   c/z   90.16   8.88  1.3715  $ Position 30
531   c/z   90.60   0.00  1.3715  $ Position 31
532   c/z   90.16  -8.88  1.3715  $ Position 32
533   c/z   88.86 -17.68  1.3715  $ Position 33
534   c/z   86.70 -26.30  1.3715  $ Position 34
535   c/z   83.70 -34.67  1.3715  $ Position 35
536   c/z   79.90 -42.71  1.3715  $ Position 36
537   c/z   75.33 -50.33  1.3715  $ Position 37
538   c/z   70.03 -57.48  1.3715  $ Position 38
539   c/z   64.06 -64.06  1.3715  $ Position 39
540   c/z   57.48 -70.03  1.3715  $ Position 40
541   c/z   50.33 -75.33  1.3715  $ Position 41
542   c/z   42.71 -79.90  1.3715  $ Position 42
543   c/z   34.67 -83.70  1.3715  $ Position 43
544   c/z   26.30 -86.70  1.3715  $ Position 44
545   c/z   17.68 -88.86  1.3715  $ Position 45
546   c/z    8.88 -90.16  1.3715  $ Position 46
547   c/z    0.00 -90.60  1.3715  $ Position 47
548   c/z   -8.88 -90.16  1.3715  $ Position 48
549   c/z  -17.68 -88.86  1.3715  $ Position 49
550   c/z  -26.30 -86.70  1.3715  $ Position 50
551   c/z  -34.67 -83.70  1.3715  $ Position 51
552   c/z  -42.71 -79.90  1.3715  $ Position 52
553   c/z  -50.33 -75.33  1.3715  $ Position 53
554   c/z  -57.48 -70.03  1.3715  $ Position 54
555   c/z  -64.06 -64.06  1.3715  $ Position 55
556   c/z  -70.03 -57.48  1.3715  $ Position 56
557   c/z  -75.33 -50.33  1.3715  $ Position 57
558   c/z  -79.90 -42.71  1.3715  $ Position 58
559   c/z  -83.70 -34.67  1.3715  $ Position 59
560   c/z  -86.70 -26.30  1.3715  $ Position 60
561   c/z  -88.86 -17.68  1.3715  $ Position 61
562   c/z  -90.16  -8.88  1.3715  $ Position 62
563   c/z  -90.60   0.00  1.3715  $ Position 63
564   c/z  -90.16   8.88  1.3715  $ Position 64
c
c ------ Graphite Plugs ------
c --------- Ring 1 ---------
601   c/z  -67.20   0.00  1.325  $ Position 1
602   c/z  -66.88   6.59  1.325  $ Position 2
603   c/z  -65.91  13.11  1.325  $ Position 3
604   c/z  -64.31  19.51  1.325  $ Position 4
605   c/z  -62.08  25.72  1.325  $ Position 5
606   c/z  -59.27  31.68  1.325  $ Position 6
607   c/z  -55.87  37.33  1.325  $ Position 7
608   c/z  -51.95  42.63  1.325  $ Position 8
609   c/z  -47.52  47.52  1.325  $ Position 9
610   c/z  -42.63  51.95  1.325  $ Position 10
611   c/z  -37.33  55.87  1.325  $ Position 11
612   c/z  -31.68  59.27  1.325  $ Position 12
613   c/z  -25.72  62.08  1.325  $ Position 13
614   c/z  -19.51  64.31  1.325  $ Position 14
615   c/z  -13.11  65.91  1.325  $ Position 15
616   c/z   -6.59  66.88  1.325  $ Position 16
617   c/z    0.00  67.20  1.325  $ Position 17
618   c/z    6.59  66.88  1.325  $ Position 18
619   c/z   13.11  65.91  1.325  $ Position 19
620   c/z   19.51  64.31  1.325  $ Position 20
621   c/z   25.72  62.08  1.325  $ Position 21
622   c/z   31.68  59.27  1.325  $ Position 22
623   c/z   37.33  55.87  1.325  $ Position 23
624   c/z   42.63  51.95  1.325  $ Position 24
625   c/z   47.52  47.52  1.325  $ Position 25
626   c/z   51.95  42.63  1.325  $ Position 26
627   c/z   55.87  37.33  1.325  $ Position 27
628   c/z   59.27  31.68  1.325  $ Position 28
629   c/z   62.08  25.72  1.325  $ Position 29
630   c/z   64.31  19.51  1.325  $ Position 30
631   c/z   65.91  13.11  1.325  $ Position 31
632   c/z   66.88   6.59  1.325  $ Position 32
633   c/z   67.20   0.00  1.325  $ Position 33
634   c/z   66.88  -6.59  1.325  $ Position 34
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635   c/z   65.91 -13.11  1.325  $ Position 35
636   c/z   64.31 -19.51  1.325  $ Position 36
637   c/z   62.08 -25.72  1.325  $ Position 37
638   c/z   59.27 -31.68  1.325  $ Position 38
639   c/z   55.87 -37.33  1.325  $ Position 39
640   c/z   51.95 -42.63  1.325  $ Position 40
641   c/z   47.52 -47.52  1.325  $ Position 41
642   c/z   42.63 -51.95  1.325  $ Position 42
643   c/z   37.33 -55.87  1.325  $ Position 43
644   c/z   31.68 -59.27  1.325  $ Position 44
645   c/z   25.72 -62.08  1.325  $ Position 45
646   c/z   19.51 -64.31  1.325  $ Position 46
647   c/z   13.11 -65.91  1.325  $ Position 47
648   c/z    6.59 -66.88  1.325  $ Position 48
649   c/z    0.00 -67.20  1.325  $ Position 49
650   c/z   -6.59 -66.88  1.325  $ Position 50
651   c/z  -13.11 -65.91  1.325  $ Position 51
652   c/z  -19.51 -64.31  1.325  $ Position 52
653   c/z  -25.72 -62.08  1.325  $ Position 53
654   c/z  -31.68 -59.27  1.325  $ Position 54
655   c/z  -37.33 -55.87  1.325  $ Position 55
656   c/z  -42.63 -51.95  1.325  $ Position 56
657   c/z  -47.52 -47.52  1.325  $ Position 57
658   c/z  -51.95 -42.63  1.325  $ Position 58
659   c/z  -55.87 -37.33  1.325  $ Position 59
660   c/z  -59.27 -31.68  1.325  $ Position 60
661   c/z  -62.08 -25.72  1.325  $ Position 61
662   c/z  -64.31 -19.51  1.325  $ Position 62
663   c/z  -65.91 -13.11  1.325  $ Position 63
664   c/z  -66.88  -6.59  1.325  $ Position 64
c
c --------- Ring 2 ---------
701   c/z  -72.96   3.58  1.325  $ Position 1
702   c/z  -72.26  10.72  1.325  $ Position 2
703   c/z  -70.86  17.75  1.325  $ Position 3
704   c/z  -68.78  24.61  1.325  $ Position 4
705   c/z  -66.04  31.23  1.325  $ Position 5
706   c/z  -62.66  37.56  1.325  $ Position 6
707   c/z  -58.67  43.52  1.325  $ Position 7
708   c/z  -54.13  49.06  1.325  $ Position 8
709   c/z  -49.06  54.13  1.325  $ Position 9
710   c/z  -43.52  58.67  1.325  $ Position 10
711   c/z  -37.56  62.66  1.325  $ Position 11
712   c/z  -31.23  66.04  1.325  $ Position 12
713   c/z  -24.61  68.78  1.325  $ Position 13
714   c/z  -17.75  70.86  1.325  $ Position 14
715   c/z  -10.72  72.26  1.325  $ Position 15
716   c/z   -3.58  72.96  1.325  $ Position 16
717   c/z    3.58  72.96  1.325  $ Position 17
718   c/z   10.72  72.26  1.325  $ Position 18
719   c/z   17.75  70.86  1.325  $ Position 19
720   c/z   24.61  68.78  1.325  $ Position 20
721   c/z   31.23  66.04  1.325  $ Position 21
722   c/z   37.56  62.66  1.325  $ Position 22
723   c/z   43.52  58.67  1.325  $ Position 23
724   c/z   49.06  54.13  1.325  $ Position 24
725   c/z   54.13  49.06  1.325  $ Position 25
726   c/z   58.67  43.52  1.325  $ Position 26
727   c/z   62.66  37.56  1.325  $ Position 27
728   c/z   66.04  31.23  1.325  $ Position 28
729   c/z   68.78  24.61  1.325  $ Position 29
730   c/z   70.86  17.75  1.325  $ Position 30
731   c/z   72.26  10.72  1.325  $ Position 31
732   c/z   72.96   3.58  1.325  $ Position 32
733   c/z   72.96  -3.58  1.325  $ Position 33
734   c/z   72.26 -10.72  1.325  $ Position 34
735   c/z   70.86 -17.75  1.325  $ Position 35
736   c/z   68.78 -24.61  1.325  $ Position 36
737   c/z   66.04 -31.23  1.325  $ Position 37
738   c/z   62.66 -37.56  1.325  $ Position 38
739   c/z   58.67 -43.52  1.325  $ Position 39
740   c/z   54.13 -49.06  1.325  $ Position 40
741   c/z   49.06 -54.13  1.325  $ Position 41
742   c/z   43.52 -58.67  1.325  $ Position 42
743   c/z   37.56 -62.66  1.325  $ Position 43
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744   c/z   31.23 -66.04  1.325  $ Position 44
745   c/z   24.61 -68.78  1.325  $ Position 45
746   c/z   17.75 -70.86  1.325  $ Position 46
747   c/z   10.72 -72.26  1.325  $ Position 47
748   c/z    3.58 -72.96  1.325  $ Position 48
749   c/z   -3.58 -72.96  1.325  $ Position 49
750   c/z  -10.72 -72.26  1.325  $ Position 50
751   c/z  -17.75 -70.86  1.325  $ Position 51
752   c/z  -24.61 -68.78  1.325  $ Position 52
753   c/z  -31.23 -66.04  1.325  $ Position 53
754   c/z  -37.56 -62.66  1.325  $ Position 54
755   c/z  -43.52 -58.67  1.325  $ Position 55
756   c/z  -49.06 -54.13  1.325  $ Position 56
757   c/z  -54.13 -49.06  1.325  $ Position 57
758   c/z  -58.67 -43.52  1.325  $ Position 58
759   c/z  -62.66 -37.56  1.325  $ Position 59
760   c/z  -66.04 -31.23  1.325  $ Position 60
761   c/z  -68.78 -24.61  1.325  $ Position 61
762   c/z  -70.86 -17.75  1.325  $ Position 62
763   c/z  -72.26 -10.72  1.325  $ Position 63
764   c/z  -72.96  -3.58  1.325  $ Position 64
c
c --------- Ring 3 ---------
801   c/z  -78.52   7.73  1.325  $ Position 1
802   c/z  -77.38  15.39  1.325  $ Position 2
803   c/z  -75.50  22.90  1.325  $ Position 3
804   c/z  -72.89  30.19  1.325  $ Position 4
805   c/z  -69.58  37.19  1.325  $ Position 5
806   c/z  -65.60  43.83  1.325  $ Position 6
807   c/z  -60.99  50.05  1.325  $ Position 7
808   c/z  -55.79  55.79  1.325  $ Position 8
809   c/z  -50.05  60.99  1.325  $ Position 9
810   c/z  -43.83  65.60  1.325  $ Position 10
811   c/z  -37.19  69.58  1.325  $ Position 11
812   c/z  -30.19  72.89  1.325  $ Position 12
813   c/z  -22.90  75.50  1.325  $ Position 13
814   c/z  -15.39  77.38  1.325  $ Position 14
815   c/z   -7.73  78.52  1.325  $ Position 15
816   c/z    0.00  78.90  1.325  $ Position 16
817   c/z    7.73  78.52  1.325  $ Position 17
818   c/z   15.39  77.38  1.325  $ Position 18
819   c/z   22.90  75.50  1.325  $ Position 19
820   c/z   30.19  72.89  1.325  $ Position 20
821   c/z   37.19  69.58  1.325  $ Position 21
822   c/z   43.83  65.60  1.325  $ Position 22
823   c/z   50.05  60.99  1.325  $ Position 23
824   c/z   55.79  55.79  1.325  $ Position 24
825   c/z   60.99  50.05  1.325  $ Position 25
826   c/z   65.60  43.83  1.325  $ Position 26
827   c/z   69.58  37.19  1.325  $ Position 27
828   c/z   72.89  30.19  1.325  $ Position 28
829   c/z   75.50  22.90  1.325  $ Position 29
830   c/z   77.38  15.39  1.325  $ Position 30
831   c/z   78.52   7.73  1.325  $ Position 31
832   c/z   78.90   0.00  1.325  $ Position 32
833   c/z   78.52  -7.73  1.325  $ Position 33
834   c/z   77.38 -15.39  1.325  $ Position 34
835   c/z   75.50 -22.90  1.325  $ Position 35
836   c/z   72.89 -30.19  1.325  $ Position 36
837   c/z   69.58 -37.19  1.325  $ Position 37
838   c/z   65.60 -43.83  1.325  $ Position 38
839   c/z   60.99 -50.05  1.325  $ Position 39
840   c/z   55.79 -55.79  1.325  $ Position 40
841   c/z   50.05 -60.99  1.325  $ Position 41
842   c/z   43.83 -65.60  1.325  $ Position 42
843   c/z   37.19 -69.58  1.325  $ Position 43
844   c/z   30.19 -72.89  1.325  $ Position 44
845   c/z   22.90 -75.50  1.325  $ Position 45
846   c/z   15.39 -77.38  1.325  $ Position 46
847   c/z    7.73 -78.52  1.325  $ Position 47
848   c/z    0.00 -78.90  1.325  $ Position 48
849   c/z   -7.73 -78.52  1.325  $ Position 49
850   c/z  -15.39 -77.38  1.325  $ Position 50
851   c/z  -22.90 -75.50  1.325  $ Position 51
852   c/z  -30.19 -72.89  1.325  $ Position 52
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853   c/z  -37.19 -69.58  1.325  $ Position 53
854   c/z  -43.83 -65.60  1.325  $ Position 54
855   c/z  -50.05 -60.99  1.325  $ Position 55
856   c/z  -55.79 -55.79  1.325  $ Position 56
857   c/z  -60.99 -50.05  1.325  $ Position 57
858   c/z  -65.60 -43.83  1.325  $ Position 58
859   c/z  -69.58 -37.19  1.325  $ Position 59
860   c/z  -72.89 -30.19  1.325  $ Position 60
861   c/z  -75.50 -22.90  1.325  $ Position 61
862   c/z  -77.38 -15.39  1.325  $ Position 62
863   c/z  -78.52  -7.73  1.325  $ Position 63
864   c/z  -78.90   0.00  1.325  $ Position 64
c
c --------- Ring 4 ---------
901   c/z  -83.83  12.44  1.325  $ Position 1
902   c/z  -82.21  20.59  1.325  $ Position 2
903   c/z  -79.80  28.55  1.325  $ Position 3
904   c/z  -76.61  36.24  1.325  $ Position 4
905   c/z  -72.69  43.57  1.325  $ Position 5
906   c/z  -68.07  50.49  1.325  $ Position 6
907   c/z  -62.80  56.91  1.325  $ Position 7
908   c/z  -56.91  62.80  1.325  $ Position 8
909   c/z  -50.49  68.07  1.325  $ Position 9
910   c/z  -43.57  72.69  1.325  $ Position 10
911   c/z  -36.24  76.61  1.325  $ Position 11
912   c/z  -28.55  79.80  1.325  $ Position 12
913   c/z  -20.59  82.21  1.325  $ Position 13
914   c/z  -12.44  83.83  1.325  $ Position 14
915   c/z   -4.16  84.65  1.325  $ Position 15
916   c/z    4.16  84.65  1.325  $ Position 16
917   c/z   12.44  83.83  1.325  $ Position 17
918   c/z   20.59  82.21  1.325  $ Position 18
919   c/z   28.55  79.80  1.325  $ Position 19
920   c/z   36.24  76.61  1.325  $ Position 20
921   c/z   43.57  72.69  1.325  $ Position 21
922   c/z   50.49  68.07  1.325  $ Position 22
923   c/z   56.91  62.80  1.325  $ Position 23
924   c/z   62.80  56.91  1.325  $ Position 24
925   c/z   68.07  50.49  1.325  $ Position 25
926   c/z   72.69  43.57  1.325  $ Position 26
927   c/z   76.61  36.24  1.325  $ Position 27
928   c/z   79.80  28.55  1.325  $ Position 28
929   c/z   82.21  20.59  1.325  $ Position 29
930   c/z   83.83  12.44  1.325  $ Position 30
931   c/z   84.65   4.16  1.325  $ Position 31
932   c/z   84.65  -4.16  1.325  $ Position 32
933   c/z   83.83 -12.44  1.325  $ Position 33
934   c/z   82.21 -20.59  1.325  $ Position 34
935   c/z   79.80 -28.55  1.325  $ Position 35
936   c/z   76.61 -36.24  1.325  $ Position 36
937   c/z   72.69 -43.57  1.325  $ Position 37
938   c/z   68.07 -50.49  1.325  $ Position 38
939   c/z   62.80 -56.91  1.325  $ Position 39
940   c/z   56.91 -62.80  1.325  $ Position 40
941   c/z   50.49 -68.07  1.325  $ Position 41
942   c/z   43.57 -72.69  1.325  $ Position 42
943   c/z   36.24 -76.61  1.325  $ Position 43
944   c/z   28.55 -79.80  1.325  $ Position 44
945   c/z   20.59 -82.21  1.325  $ Position 45
946   c/z   12.44 -83.83  1.325  $ Position 46
947   c/z    4.16 -84.65  1.325  $ Position 47
948   c/z   -4.16 -84.65  1.325  $ Position 48
949   c/z  -12.44 -83.83  1.325  $ Position 49
950   c/z  -20.59 -82.21  1.325  $ Position 50
951   c/z  -28.55 -79.80  1.325  $ Position 51
952   c/z  -36.24 -76.61  1.325  $ Position 52
953   c/z  -43.57 -72.69  1.325  $ Position 53
954   c/z  -50.49 -68.07  1.325  $ Position 54
955   c/z  -56.91 -62.80  1.325  $ Position 55
956   c/z  -62.80 -56.91  1.325  $ Position 56
957   c/z  -68.07 -50.49  1.325  $ Position 57
958   c/z  -72.69 -43.57  1.325  $ Position 58
959   c/z  -76.61 -36.24  1.325  $ Position 59
960   c/z  -79.80 -28.55  1.325  $ Position 60
961   c/z  -82.21 -20.59  1.325  $ Position 61
```

```
962   c/z  -83.83 -12.44  1.325  $ Position 62
963   c/z  -84.65  -4.16  1.325  $ Position 63
964   c/z  -84.65   4.16  1.325  $ Position 64
c
c --------- Ring 5 ---------
1001  c/z  -88.86  17.68  1.325  $ Position 1
1002  c/z  -86.70  26.30  1.325  $ Position 2
1003  c/z  -83.70  34.67  1.325  $ Position 3
1004  c/z  -79.90  42.71  1.325  $ Position 4
1005  c/z  -75.33  50.33  1.325  $ Position 5
1006  c/z  -70.03  57.48  1.325  $ Position 6
1007  c/z  -64.06  64.06  1.325  $ Position 7
1008  c/z  -57.48  70.03  1.325  $ Position 8
1009  c/z  -50.33  75.33  1.325  $ Position 9
1010  c/z  -42.71  79.90  1.325  $ Position 10
1011  c/z  -34.67  83.70  1.325  $ Position 11
1012  c/z  -26.30  86.70  1.325  $ Position 12
1013  c/z  -17.68  88.86  1.325  $ Position 13
1014  c/z   -8.88  90.16  1.325  $ Position 14
1015  c/z    0.00  90.60  1.325  $ Position 15
1016  c/z    8.88  90.16  1.325  $ Position 16
1017  c/z   17.68  88.86  1.325  $ Position 17
1018  c/z   26.30  86.70  1.325  $ Position 18
1019  c/z   34.67  83.70  1.325  $ Position 19
1020  c/z   42.71  79.90  1.325  $ Position 20
1021  c/z   50.33  75.33  1.325  $ Position 21
1022  c/z   57.48  70.03  1.325  $ Position 22
1023  c/z   64.06  64.06  1.325  $ Position 23
1024  c/z   70.03  57.48  1.325  $ Position 24
1025  c/z   75.33  50.33  1.325  $ Position 25
1026  c/z   79.90  42.71  1.325  $ Position 26
1027  c/z   83.70  34.67  1.325  $ Position 27
1028  c/z   86.70  26.30  1.325  $ Position 28
1029  c/z   88.86  17.68  1.325  $ Position 29
1030  c/z   90.16   8.88  1.325  $ Position 30
1031  c/z   90.60   0.00  1.325  $ Position 31
1032  c/z   90.16  -8.88  1.325  $ Position 32
1033  c/z   88.86 -17.68  1.325  $ Position 33
1034  c/z   86.70 -26.30  1.325  $ Position 34
1035  c/z   83.70 -34.67  1.325  $ Position 35
1036  c/z   79.90 -42.71  1.325  $ Position 36
1037  c/z   75.33 -50.33  1.325  $ Position 37
1038  c/z   70.03 -57.48  1.325  $ Position 38
1039  c/z   64.06 -64.06  1.325  $ Position 39
1040  c/z   57.48 -70.03  1.325  $ Position 40
1041  c/z   50.33 -75.33  1.325  $ Position 41
1042  c/z   42.71 -79.90  1.325  $ Position 42
1043  c/z   34.67 -83.70  1.325  $ Position 43
1044  c/z   26.30 -86.70  1.325  $ Position 44
1045  c/z   17.68 -88.86  1.325  $ Position 45
1046  c/z    8.88 -90.16  1.325  $ Position 46
1047  c/z    0.00 -90.60  1.325  $ Position 47
1048  c/z   -8.88 -90.16  1.325  $ Position 48
1049  c/z  -17.68 -88.86  1.325  $ Position 49
1050  c/z  -26.30 -86.70  1.325  $ Position 50
1051  c/z  -34.67 -83.70  1.325  $ Position 51
1052  c/z  -42.71 -79.90  1.325  $ Position 52
1053  c/z  -50.33 -75.33  1.325  $ Position 53
1054  c/z  -57.48 -70.03  1.325  $ Position 54
1055  c/z  -64.06 -64.06  1.325  $ Position 55
1056  c/z  -70.03 -57.48  1.325  $ Position 56
1057  c/z  -75.33 -50.33  1.325  $ Position 57
1058  c/z  -79.90 -42.71  1.325  $ Position 58
1059  c/z  -83.70 -34.67  1.325  $ Position 59
1060  c/z  -86.70 -26.30  1.325  $ Position 60
1061  c/z  -88.86 -17.68  1.325  $ Position 61
1062  c/z  -90.16  -8.88  1.325  $ Position 62
1063  c/z  -90.60   0.00  1.325  $ Position 63
1064  c/z  -90.16   8.88  1.325  $ Position 64
c
c ------ Safety/Shutdown Rod Holes ------
1101  c/z  -38.45  56.57  2.25  $ Rod 1
1102  c/z   32.74 -60.05  2.25  $ Rod 2
1103  c/z   57.17  37.55  2.25  $ Rod 3
1104  c/z  -53.23 -42.95  2.25  $ Rod 4
```

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1105  c/z   67.19 -12.82  2.25  $ Rod 5
1106  c/z  -66.98  13.87  2.25  $ Rod 6
1107  c/z   19.31  65.62  2.25  $ Rod 7
1108  c/z  -13.87 -66.98  2.25  $ Rod 8
c
c ------ ZEBRA Control Rod Holes ------
1109  c/z   21.84  86.93  2.25  $ Rod 1
1110  c/z   86.93 -21.84  2.25  $ Rod 2
1111  c/z  -21.84 -86.93  2.25  $ Rod 3
1112  c/z  -86.93  21.84  2.25  $ Rod 4
c
c ------ ZEBRA Control Rod Hole Fillers ------
11109  c/z   21.84  86.93  2.2  $ Rod Position 1
11110  c/z   86.93 -21.84  2.2  $ Rod Position 2
11111  c/z  -21.84 -86.93  2.2  $ Rod Position 3
11112  c/z  -86.93  21.84  2.2  $ Rod Position 4
c
c ------ Withdrawable Control Rod Holes ------
c    *Same as Ring 5 Position 19 $ Rod 1
c    *Same as Ring 5 Position 35 $ Rod 2
c    *Same as Ring 5 Position 51 $ Rod 3
c    *Same as Ring 5 Position 3  $ Rod 4
c
c ------ Autorod Hole ------
1113  c/z   17.36 -87.29  2.75
c
c --- Upper Axial Reflector ----------------------------------------------------
c ------ Central Cylinder ------
1201  pz   267.3     $ Bottom of Graphite
1202  pz   345.3     $ Top of Graphite
1203  cz     1.3715  $ Central Coolant Channel
1204  cz    19.7     $ Outer Radius
c
c ------ Graphite Annulus ------
1211  cz    20.93    $ Inner Radius
1212  cz    61.7     $ Outer Radius
c
c ------ Air Gaps ------
1221  cz    19.8     $ Outside of Central Cylinder
1222  cz    20.5     $ Inside of Annulus
1223  cz    61.8     $ Outside of Annulus
c
c ------ Coolant Channels ------
c --------- Ring 1 ---------
1301  c/z  -29.86   2.94  1.3715  $ Position 1
1302  c/z  -28.71   8.71  1.3715  $ Position 2
1303  c/z  -26.46  14.14  1.3715  $ Position 3
1304  c/z  -23.19  19.03  1.3715  $ Position 4
1305  c/z  -19.03  23.19  1.3715  $ Position 5
1306  c/z  -14.14  26.46  1.3715  $ Position 6
1307  c/z   -8.71  28.71  1.3715  $ Position 7
1308  c/z   -2.94  29.86  1.3715  $ Position 8
1309  c/z    2.94  29.86  1.3715  $ Position 9
1310  c/z    8.71  28.71  1.3715  $ Position 10
1311  c/z   14.14  26.46  1.3715  $ Position 11
1312  c/z   19.03  23.19  1.3715  $ Position 12
1313  c/z   23.19  19.03  1.3715  $ Position 13
1314  c/z   26.46  14.14  1.3715  $ Position 14
1315  c/z   28.71   8.71  1.3715  $ Position 15
1316  c/z   29.86   2.94  1.3715  $ Position 16
1317  c/z   29.86  -2.94  1.3715  $ Position 17
1318  c/z   28.71  -8.71  1.3715  $ Position 18
1319  c/z   26.46 -14.14  1.3715  $ Position 19
1320  c/z   23.19 -19.03  1.3715  $ Position 20
1321  c/z   19.03 -23.19  1.3715  $ Position 21
1322  c/z   14.14 -26.46  1.3715  $ Position 22
1323  c/z    8.71 -28.71  1.3715  $ Position 23
1324  c/z    2.94 -29.86  1.3715  $ Position 24
1325  c/z   -2.94 -29.86  1.3715  $ Position 25
1326  c/z   -8.71 -28.71  1.3715  $ Position 26
1327  c/z  -14.14 -26.46  1.3715  $ Position 27
1328  c/z  -19.03 -23.19  1.3715  $ Position 28
1329  c/z  -23.19 -19.03  1.3715  $ Position 29
1330  c/z  -26.46 -14.14  1.3715  $ Position 30
1331  c/z  -28.71  -8.71  1.3715  $ Position 31
```

```
1332  c/z  -29.86  -2.94  1.3715  $ Position 32
c
1333  cz    32.75  $ Ring Divider for Modeling Simplification
c
c --------- Ring 2 ---------
1401  c/z  -34.82   6.93  1.3715  $ Position 1
1402  c/z  -32.80  13.59  1.3715  $ Position 2
1403  c/z  -29.52  19.72  1.3715  $ Position 3
1404  c/z  -25.10  25.10  1.3715  $ Position 4
1405  c/z  -19.72  29.52  1.3715  $ Position 5
1406  c/z  -13.59  32.80  1.3715  $ Position 6
1407  c/z   -6.93  34.82  1.3715  $ Position 7
1408  c/z    0.00  35.50  1.3715  $ Position 8
1409  c/z    6.93  34.82  1.3715  $ Position 9
1410  c/z   13.59  32.80  1.3715  $ Position 10
1411  c/z   19.72  29.52  1.3715  $ Position 11
1412  c/z   25.10  25.10  1.3715  $ Position 12
1413  c/z   29.52  19.72  1.3715  $ Position 13
1414  c/z   32.80  13.59  1.3715  $ Position 14
1415  c/z   34.82   6.93  1.3715  $ Position 15
1416  c/z   35.50   0.00  1.3715  $ Position 16
1417  c/z   34.82  -6.93  1.3715  $ Position 17
1418  c/z   32.80 -13.59  1.3715  $ Position 18
1419  c/z   29.52 -19.72  1.3715  $ Position 19
1420  c/z   25.10 -25.10  1.3715  $ Position 20
1421  c/z   19.72 -29.52  1.3715  $ Position 21
1422  c/z   13.59 -32.80  1.3715  $ Position 22
1423  c/z    6.93 -34.82  1.3715  $ Position 23
1424  c/z    0.00 -35.50  1.3715  $ Position 24
1425  c/z   -6.93 -34.82  1.3715  $ Position 25
1426  c/z  -13.59 -32.80  1.3715  $ Position 26
1427  c/z  -19.72 -29.52  1.3715  $ Position 27
1428  c/z  -25.10 -25.10  1.3715  $ Position 28
1429  c/z  -29.52 -19.72  1.3715  $ Position 29
1430  c/z  -32.80 -13.59  1.3715  $ Position 30
1431  c/z  -34.82  -6.93  1.3715  $ Position 31
1432  c/z  -35.50   0.00  1.3715  $ Position 32
c
1433  cz    38.25  $ Ring Divider for Modeling Simplification
c
c --------- Ring 3 ---------
1501  c/z  -39.23  11.90  1.3715  $ Position 1
1502  c/z  -36.16  19.33  1.3715  $ Position 2
1503  c/z  -31.69  26.01  1.3715  $ Position 3
1504  c/z  -26.01  31.69  1.3715  $ Position 4
1505  c/z  -19.33  36.16  1.3715  $ Position 5
1506  c/z  -11.90  39.23  1.3715  $ Position 6
1507  c/z   -4.02  40.80  1.3715  $ Position 7
1508  c/z    4.02  40.80  1.3715  $ Position 8
1509  c/z   11.90  39.23  1.3715  $ Position 9
1510  c/z   19.33  36.16  1.3715  $ Position 10
1511  c/z   26.01  31.69  1.3715  $ Position 11
1512  c/z   31.69  26.01  1.3715  $ Position 12
1513  c/z   36.16  19.33  1.3715  $ Position 13
1514  c/z   39.23  11.90  1.3715  $ Position 14
1515  c/z   40.80   4.02  1.3715  $ Position 15
1516  c/z   40.80  -4.02  1.3715  $ Position 16
1517  c/z   39.23 -11.90  1.3715  $ Position 17
1518  c/z   36.16 -19.33  1.3715  $ Position 18
1519  c/z   31.69 -26.01  1.3715  $ Position 19
1520  c/z   26.01 -31.69  1.3715  $ Position 20
1521  c/z   19.33 -36.16  1.3715  $ Position 21
1522  c/z   11.90 -39.23  1.3715  $ Position 22
1523  c/z    4.02 -40.80  1.3715  $ Position 23
1524  c/z   -4.02 -40.80  1.3715  $ Position 24
1525  c/z  -11.90 -39.23  1.3715  $ Position 25
1526  c/z  -19.33 -36.16  1.3715  $ Position 26
1527  c/z  -26.01 -31.69  1.3715  $ Position 27
1528  c/z  -31.69 -26.01  1.3715  $ Position 28
1529  c/z  -36.16 -19.33  1.3715  $ Position 29
1530  c/z  -39.23 -11.90  1.3715  $ Position 30
1531  c/z  -40.80  -4.02  1.3715  $ Position 31
1532  c/z  -40.80   4.02  1.3715  $ Position 32
c
1533  cz    43.625  $ Ring Divider for Modeling Simplification
```

```
c
c --------- Ring 4 ---------
1601  c/z  -42.73  17.70  1.3715  $ Position 1
1602  c/z  -38.46  25.70  1.3715  $ Position 2
1603  c/z  -32.70  32.70  1.3715  $ Position 3
1604  c/z  -25.70  38.46  1.3715  $ Position 4
1605  c/z  -17.70  42.73  1.3715  $ Position 5
1606  c/z   -9.02  45.36  1.3715  $ Position 6
1607  c/z    0.00  46.25  1.3715  $ Position 7
1608  c/z    9.02  45.36  1.3715  $ Position 8
1609  c/z   17.70  42.73  1.3715  $ Position 9
1610  c/z   25.70  38.46  1.3715  $ Position 10
1611  c/z   32.70  32.70  1.3715  $ Position 11
1612  c/z   38.46  25.70  1.3715  $ Position 12
1613  c/z   42.73  17.70  1.3715  $ Position 13
1614  c/z   45.36   9.02  1.3715  $ Position 14
1615  c/z   46.25   0.00  1.3715  $ Position 15
1616  c/z   45.36  -9.02  1.3715  $ Position 16
1617  c/z   42.73 -17.70  1.3715  $ Position 17
1618  c/z   38.46 -25.70  1.3715  $ Position 18
1619  c/z   32.70 -32.70  1.3715  $ Position 19
1620  c/z   25.70 -38.46  1.3715  $ Position 20
1621  c/z   17.70 -42.73  1.3715  $ Position 21
1622  c/z    9.02 -45.36  1.3715  $ Position 22
1623  c/z    0.00 -46.25  1.3715  $ Position 23
1624  c/z   -9.02 -45.36  1.3715  $ Position 24
1625  c/z  -17.70 -42.73  1.3715  $ Position 25
1626  c/z  -25.70 -38.46  1.3715  $ Position 26
1627  c/z  -32.70 -32.70  1.3715  $ Position 27
1628  c/z  -38.46 -25.70  1.3715  $ Position 28
1629  c/z  -42.73 -17.70  1.3715  $ Position 29
1630  c/z  -45.36  -9.02  1.3715  $ Position 30
1631  c/z  -46.25   0.00  1.3715  $ Position 31
1632  c/z  -45.36   9.02  1.3715  $ Position 32
c
1633  cz    48.875  $ Ring Divider for Modeling Simplification
c
c --------- Ring 5 ---------
1701  c/z  -45.42  24.28  1.3715  $ Position 1
1702  c/z  -39.81  32.67  1.3715  $ Position 2
1703  c/z  -32.67  39.81  1.3715  $ Position 3
1704  c/z  -24.28  45.42  1.3715  $ Position 4
1705  c/z  -14.95  49.28  1.3715  $ Position 5
1706  c/z   -5.05  51.25  1.3715  $ Position 6
1707  c/z    5.05  51.25  1.3715  $ Position 7
1708  c/z   14.95  49.28  1.3715  $ Position 8
1709  c/z   24.28  45.42  1.3715  $ Position 9
1710  c/z   32.67  39.81  1.3715  $ Position 10
1711  c/z   39.81  32.67  1.3715  $ Position 11
1712  c/z   45.42  24.28  1.3715  $ Position 12
1713  c/z   49.28  14.95  1.3715  $ Position 13
1714  c/z   51.25   5.05  1.3715  $ Position 14
1715  c/z   51.25  -5.05  1.3715  $ Position 15
1716  c/z   49.28 -14.95  1.3715  $ Position 16
1717  c/z   45.42 -24.28  1.3715  $ Position 17
1718  c/z   39.81 -32.67  1.3715  $ Position 18
1719  c/z   32.67 -39.81  1.3715  $ Position 19
1720  c/z   24.28 -45.42  1.3715  $ Position 20
1721  c/z   14.95 -49.28  1.3715  $ Position 21
1722  c/z    5.05 -51.25  1.3715  $ Position 22
1723  c/z   -5.05 -51.25  1.3715  $ Position 23
1724  c/z  -14.95 -49.28  1.3715  $ Position 24
1725  c/z  -24.28 -45.42  1.3715  $ Position 25
1726  c/z  -32.67 -39.81  1.3715  $ Position 26
1727  c/z  -39.81 -32.67  1.3715  $ Position 27
1728  c/z  -45.42 -24.28  1.3715  $ Position 28
1729  c/z  -49.28 -14.95  1.3715  $ Position 29
1730  c/z  -51.25  -5.05  1.3715  $ Position 30
1731  c/z  -51.25   5.05  1.3715  $ Position 31
1732  c/z  -49.28  14.95  1.3715  $ Position 32
c
c ------ Aluminum Tank ------
1801  pz   266.9             $ Bottom of Aluminum
1802  cz    62.1             $ Outer Radius
1803  pz   251.7             $ Top of Bottom Center
```

```
1804  pz   251.3             $ Bottom of Bottom Center
1805  sz   376.7612 127.125  $ Outer Curved Liner
1806  sz   377.1612 127.125  $ Inner Curved Liner
1807  cz    43.4             $ Inner Support Radius
1808  cz    43.8             $ Outer Support Radius
c
c --- Lower Axial Reflector --------------------------------------------------
c ------ Inner Cylinder ------
1811  pz    78.0   $ Inside Bottom of Cavity
1812  cz    24.75  $ Outer Radius
c
c ------ Neutron Source Position ------
1821  pz    25.0   $ Neutron Source Channel
1822  cz     6.05  $ Neutron Source Channel
1823  cz     6.0   $ Graphite Plug
c
c ------ Graphite Annulus ------
1831  cz    25.04581  $ Inner Radial Equivalent-Area Surface
1832  cz    62.49876  $ Outer Radial Equivalent-Area Surface
c
c --------- Inside Surfaces of 21-Sided Polygon ---------
7561  p -25.24309   0.00000 0  -24.15733   7.32375 0  -24.15733   7.32375 1
7562  p -24.15733   7.32375 0  -20.99343  14.01747 0  -20.99343  14.01747 1
7563  p -20.99343  14.01747 0  -16.02358  19.50535 0  -16.02358  19.50535 1
7564  p -16.02358  19.50535 0   -9.67530  23.31528 0   -9.67530  23.31528 1
7565  p  -9.67530  23.31528 0   -2.49471  25.11952 0   -2.49471  25.11952 1
7566  p  -2.49471  25.11952 0    4.90049  24.76285 0    4.90049  24.76285 1
7567  p   4.90049  24.76285 0   11.87412  22.27597 0   11.87412  22.27597 1
7568  p  11.87412  22.27597 0   17.82629  17.87280 0   17.82629  17.87280 1
7569  p  17.82629  17.87280 0   22.24495  11.93213 0   22.24495  11.93213 1
7570  p  22.24495  11.93213 0   24.75000   4.96500 0   24.75000   4.96500 1
7571  p  24.75000   4.96500 0   25.12593  -2.42924 0   25.12593  -2.42924 1
7572  p  25.12593  -2.42924 0   23.34041  -9.61451 0   23.34041  -9.61451 1
7573  p  23.34041  -9.61451 0   19.54704 -15.97270 0   19.54704 -15.97270 1
7574  p  19.54704 -15.97270 0   14.07213 -20.95683 0   14.07213 -20.95683 1
7575  p  14.07213 -20.95683 0    7.38668 -24.13816 0    7.38668 -24.13816 1
7576  p   7.38668 -24.13816 0    0.06578 -25.24301 0    0.06578 -25.24301 1
7577  p   0.06578 -25.24301 0   -7.26077 -24.17633 0   -7.26077 -24.17633 1
7578  p  -7.26077 -24.17633 0  -16.02358 -19.50535 0  -16.02358 -19.50535 1
7579  p -16.02358 -19.50535 0  -20.99343 -14.01747 0  -20.99343 -14.01747 1
7580  p -20.99343 -14.01747 0  -24.15733  -7.32375 0  -24.15733  -7.32375 1
7581  p -24.15733  -7.32375 0  -25.24309   0.00000 0  -25.24309   0.00000 1
c
c --------- Outside Surfaces of 21-Sided Polygon ---------
7601  p -63.19671   0.00000 0  -60.47846  18.33519 0  -60.47846  18.33519 1
7602  p -60.47846  18.33519 0  -52.55757  35.09309 0  -52.55757  35.09309 1
7603  p -52.55757  35.09309 0  -40.11543  48.83212 0  -40.11543  48.83212 1
7604  p -40.11543  48.83212 0  -24.22236  58.37037 0  -24.22236  58.37037 1
7605  p -24.22236  58.37037 0   -6.24557  62.88733 0   -6.24557  62.88733 1
7606  p  -6.24557  62.88733 0   12.26849  61.99442 0   12.26849  61.99442 1
7607  p  12.26849  61.99442 0   29.72716  55.76845 0   29.72716  55.76845 1
7608  p  29.72716  55.76845 0   44.62856  44.74501 0   44.62856  44.74501 1
7609  p  44.62856  44.74501 0   55.69079  29.87239 0   55.69079  29.87239 1
7610  p  55.69079  29.87239 0   61.96224  12.43000 0   61.96224  12.43000 1
7611  p  61.96224  12.43000 0   62.90339  -6.08167 0   62.90339  -6.08167 1
7612  p  62.90339  -6.08167 0   58.43330 -24.07017 0   58.43330 -24.07017 1
7613  p  58.43330 -24.07017 0   48.93649 -39.98804 0   48.93649 -39.98804 1
7614  p  48.93649 -39.98804 0   35.22993 -52.46595 0   35.22993 -52.46595 1
7615  p  35.22993 -52.46595 0   18.49273 -60.43048 0   18.49273 -60.43048 1
7616  p  18.49273 -60.43048 0    0.16469 -63.19649 0    0.16469 -63.19649 1
7617  p   0.16469 -63.19649 0  -18.17752 -60.52604 0  -18.17752 -60.52604 1
7618  p -18.17752 -60.52604 0  -40.11543 -48.83212 0  -40.11543 -48.83212 1
7619  p -40.11543 -48.83212 0  -52.55757 -35.09309 0  -52.55757 -35.09309 1
7620  p -52.55757 -35.09309 0  -60.47846 -18.33519 0  -60.47846 -18.33519 1
7621  p -60.47846 -18.33519 0  -63.19671   0.00000 0  -63.19671   0.00000 1
c
c ------ Coolant Channels ------
c --------- Ring 1 ---------
1901  c/z  -29.86   2.94  1.371  $ Position 1
1902  c/z  -28.71   8.71  1.371  $ Position 2
1903  c/z  -26.46  14.14  1.371  $ Position 3
1904  c/z  -23.19  19.03  1.371  $ Position 4
1905  c/z  -19.03  23.19  1.371  $ Position 5
1906  c/z  -14.14  26.46  1.371  $ Position 6
1907  c/z   -8.71  28.71  1.371  $ Position 7
```

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1908  c/z   -2.94  29.86  1.371  $ Position 8
1909  c/z    2.94  29.86  1.371  $ Position 9
1910  c/z    8.71  28.71  1.371  $ Position 10
1911  c/z   14.14  26.46  1.371  $ Position 11
1912  c/z   19.03  23.19  1.371  $ Position 12
1913  c/z   23.19  19.03  1.371  $ Position 13
1914  c/z   26.46  14.14  1.371  $ Position 14
1915  c/z   28.71   8.71  1.371  $ Position 15
1916  c/z   29.86   2.94  1.371  $ Position 16
1917  c/z   29.86  -2.94  1.371  $ Position 17
1918  c/z   28.71  -8.71  1.371  $ Position 18
1919  c/z   26.46 -14.14  1.371  $ Position 19
1920  c/z   23.19 -19.03  1.371  $ Position 20
1921  c/z   19.03 -23.19  1.371  $ Position 21
1922  c/z   14.14 -26.46  1.371  $ Position 22
1923  c/z    8.71 -28.71  1.371  $ Position 23
1924  c/z    2.94 -29.86  1.371  $ Position 24
1925  c/z   -2.94 -29.86  1.371  $ Position 25
1926  c/z   -8.71 -28.71  1.371  $ Position 26
1927  c/z  -14.14 -26.46  1.371  $ Position 27
1928  c/z  -19.03 -23.19  1.371  $ Position 28
1929  c/z  -23.19 -19.03  1.371  $ Position 29
1930  c/z  -26.46 -14.14  1.371  $ Position 30
1931  c/z  -28.71 -8.71   1.371  $ Position 31
1932  c/z  -29.86 -2.94   1.371  $ Position 32
c
c --------- Ring 2 ---------
2001  c/z  -34.82   6.93  1.371  $ Position 1
2002  c/z  -32.80  13.59  1.371  $ Position 2
2003  c/z  -29.52  19.72  1.371  $ Position 3
2004  c/z  -25.10  25.10  1.371  $ Position 4
2005  c/z  -19.72  29.52  1.371  $ Position 5
2006  c/z  -13.59  32.80  1.371  $ Position 6
2007  c/z   -6.93  34.82  1.371  $ Position 7
2008  c/z    0.00  35.50  1.371  $ Position 8
2009  c/z    6.93  34.82  1.371  $ Position 9
2010  c/z   13.59  32.80  1.371  $ Position 10
2011  c/z   19.72  29.52  1.371  $ Position 11
2012  c/z   25.10  25.10  1.371  $ Position 12
2013  c/z   29.52  19.72  1.371  $ Position 13
2014  c/z   32.80  13.59  1.371  $ Position 14
2015  c/z   34.82   6.93  1.371  $ Position 15
2016  c/z   35.50   0.00  1.371  $ Position 16
2017  c/z   34.82  -6.93  1.371  $ Position 17
2018  c/z   32.80 -13.59  1.371  $ Position 18
2019  c/z   29.52 -19.72  1.371  $ Position 19
2020  c/z   25.10 -25.10  1.371  $ Position 20
2021  c/z   19.72 -29.52  1.371  $ Position 21
2022  c/z   13.59 -32.80  1.371  $ Position 22
2023  c/z    6.93 -34.82  1.371  $ Position 23
2024  c/z    0.00 -35.50  1.371  $ Position 24
2025  c/z   -6.93 -34.82  1.371  $ Position 25
2026  c/z  -13.59 -32.80  1.371  $ Position 26
2027  c/z  -19.72 -29.52  1.371  $ Position 27
2028  c/z  -25.10 -25.10  1.371  $ Position 28
2029  c/z  -29.52 -19.72  1.371  $ Position 29
2030  c/z  -32.80 -13.59  1.371  $ Position 30
2031  c/z  -34.82  -6.93  1.371  $ Position 31
2032  c/z  -35.50   0.00  1.371  $ Position 32
c
c --------- Ring 3 ---------
2101  c/z  -39.23  11.90  1.371  $ Position 1
2102  c/z  -36.16  19.33  1.371  $ Position 2
2103  c/z  -31.69  26.01  1.371  $ Position 3
2104  c/z  -26.01  31.69  1.371  $ Position 4
2105  c/z  -19.33  36.16  1.371  $ Position 5
2106  c/z  -11.90  39.23  1.371  $ Position 6
2107  c/z   -4.02  40.80  1.371  $ Position 7
2108  c/z    4.02  40.80  1.371  $ Position 8
2109  c/z   11.90  39.23  1.371  $ Position 9
2110  c/z   19.33  36.16  1.371  $ Position 10
2111  c/z   26.01  31.69  1.371  $ Position 11
2112  c/z   31.69  26.01  1.371  $ Position 12
2113  c/z   36.16  19.33  1.371  $ Position 13
2114  c/z   39.23  11.90  1.371  $ Position 14
```

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2115  c/z   40.80   4.02  1.371  $ Position 15
2116  c/z   40.80  -4.02  1.371  $ Position 16
2117  c/z   39.23 -11.90  1.371  $ Position 17
2118  c/z   36.16 -19.33  1.371  $ Position 18
2119  c/z   31.69 -26.01  1.371  $ Position 19
2120  c/z   26.01 -31.69  1.371  $ Position 20
2121  c/z   19.33 -36.16  1.371  $ Position 21
2122  c/z   11.90 -39.23  1.371  $ Position 22
2123  c/z    4.02 -40.80  1.371  $ Position 23
2124  c/z   -4.02 -40.80  1.371  $ Position 24
2125  c/z  -11.90 -39.23  1.371  $ Position 25
2126  c/z  -19.33 -36.16  1.371  $ Position 26
2127  c/z  -26.01 -31.69  1.371  $ Position 27
2128  c/z  -31.69 -26.01  1.371  $ Position 28
2129  c/z  -36.16 -19.33  1.371  $ Position 29
2130  c/z  -39.23 -11.90  1.371  $ Position 30
2131  c/z  -40.80  -4.02  1.371  $ Position 31
2132  c/z  -40.80   4.02  1.371  $ Position 32
c
c --------- Ring 4 ---------
2201  c/z  -42.73  17.70  1.371  $ Position 1
2202  c/z  -38.46  25.70  1.371  $ Position 2
2203  c/z  -32.70  32.70  1.371  $ Position 3
2204  c/z  -25.70  38.46  1.371  $ Position 4
2205  c/z  -17.70  42.73  1.371  $ Position 5
2206  c/z   -9.02  45.36  1.371  $ Position 6
2207  c/z    0.00  46.25  1.371  $ Position 7
2208  c/z    9.02  45.36  1.371  $ Position 8
2209  c/z   17.70  42.73  1.371  $ Position 9
2210  c/z   25.70  38.46  1.371  $ Position 10
2211  c/z   32.70  32.70  1.371  $ Position 11
2212  c/z   38.46  25.70  1.371  $ Position 12
2213  c/z   42.73  17.70  1.371  $ Position 13
2214  c/z   45.36   9.02  1.371  $ Position 14
2215  c/z   46.25   0.00  1.371  $ Position 15
2216  c/z   45.36  -9.02  1.371  $ Position 16
2217  c/z   42.73 -17.70  1.371  $ Position 17
2218  c/z   38.46 -25.70  1.371  $ Position 18
2219  c/z   32.70 -32.70  1.371  $ Position 19
2220  c/z   25.70 -38.46  1.371  $ Position 20
2221  c/z   17.70 -42.73  1.371  $ Position 21
2222  c/z    9.02 -45.36  1.371  $ Position 22
2223  c/z    0.00 -46.25  1.371  $ Position 23
2224  c/z   -9.02 -45.36  1.371  $ Position 24
2225  c/z  -17.70 -42.73  1.371  $ Position 25
2226  c/z  -25.70 -38.46  1.371  $ Position 26
2227  c/z  -32.70 -32.70  1.371  $ Position 27
2228  c/z  -38.46 -25.70  1.371  $ Position 28
2229  c/z  -42.73 -17.70  1.371  $ Position 29
2230  c/z  -45.36  -9.02  1.371  $ Position 30
2231  c/z  -46.25   0.00  1.371  $ Position 31
2232  c/z  -45.36   9.02  1.371  $ Position 32
c
c --------- Ring 5 ---------
2301  c/z  -45.42  24.28  1.371  $ Position 1
2302  c/z  -39.81  32.67  1.371  $ Position 2
2303  c/z  -32.67  39.81  1.371  $ Position 3
2304  c/z  -24.28  45.42  1.371  $ Position 4
2305  c/z  -14.95  49.28  1.371  $ Position 5
2306  c/z   -5.05  51.25  1.371  $ Position 6
2307  c/z    5.05  51.25  1.371  $ Position 7
2308  c/z   14.95  49.28  1.371  $ Position 8
2309  c/z   24.28  45.42  1.371  $ Position 9
2310  c/z   32.67  39.81  1.371  $ Position 10
2311  c/z   39.81  32.67  1.371  $ Position 11
2312  c/z   45.42  24.28  1.371  $ Position 12
2313  c/z   49.28  14.95  1.371  $ Position 13
2314  c/z   51.25   5.05  1.371  $ Position 14
2315  c/z   51.25  -5.05  1.371  $ Position 15
2316  c/z   49.28 -14.95  1.371  $ Position 16
2317  c/z   45.42 -24.28  1.371  $ Position 17
2318  c/z   39.81 -32.67  1.371  $ Position 18
2319  c/z   32.67 -39.81  1.371  $ Position 19
2320  c/z   24.28 -45.42  1.371  $ Position 20
2321  c/z   14.95 -49.28  1.371  $ Position 21
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2322  c/z    5.05 -51.25  1.371  $ Position 22
2323  c/z   -5.05 -51.25  1.371  $ Position 23
2324  c/z  -14.95 -49.28  1.371  $ Position 24
2325  c/z  -24.28 -45.42  1.371  $ Position 25
2326  c/z  -32.67 -39.81  1.371  $ Position 26
2327  c/z  -39.81 -32.67  1.371  $ Position 27
2328  c/z  -45.42 -24.28  1.371  $ Position 28
2329  c/z  -49.28 -14.95  1.371  $ Position 29
2330  c/z  -51.25  -5.05  1.371  $ Position 30
2331  c/z  -51.25   5.05  1.371  $ Position 31
2332  c/z  -49.28  14.95  1.371  $ Position 32
c
c ------ Graphite Plugs ------
c --------- Ring 1 ---------
2401  c/z  -29.86   2.94  1.325  $ Position 1
2402  c/z  -28.71   8.71  1.325  $ Position 2
2403  c/z  -26.46  14.14  1.325  $ Position 3
2404  c/z  -23.19  19.03  1.325  $ Position 4
2405  c/z  -19.03  23.19  1.325  $ Position 5
2406  c/z  -14.14  26.46  1.325  $ Position 6
2407  c/z   -8.71  28.71  1.325  $ Position 7
2408  c/z   -2.94  29.86  1.325  $ Position 8
2409  c/z    2.94  29.86  1.325  $ Position 9
2410  c/z    8.71  28.71  1.325  $ Position 10
2411  c/z   14.14  26.46  1.325  $ Position 11
2412  c/z   19.03  23.19  1.325  $ Position 12
2413  c/z   23.19  19.03  1.325  $ Position 13
2414  c/z   26.46  14.14  1.325  $ Position 14
2415  c/z   28.71   8.71  1.325  $ Position 15
2416  c/z   29.86   2.94  1.325  $ Position 16
2417  c/z   29.86  -2.94  1.325  $ Position 17
2418  c/z   28.71  -8.71  1.325  $ Position 18
2419  c/z   26.46 -14.14  1.325  $ Position 19
2420  c/z   23.19 -19.03  1.325  $ Position 20
2421  c/z   19.03 -23.19  1.325  $ Position 21
2422  c/z   14.14 -26.46  1.325  $ Position 22
2423  c/z    8.71 -28.71  1.325  $ Position 23
2424  c/z    2.94 -29.86  1.325  $ Position 24
2425  c/z   -2.94 -29.86  1.325  $ Position 25
2426  c/z   -8.71 -28.71  1.325  $ Position 26
2427  c/z  -14.14 -26.46  1.325  $ Position 27
2428  c/z  -19.03 -23.19  1.325  $ Position 28
2429  c/z  -23.19 -19.03  1.325  $ Position 29
2430  c/z  -26.46 -14.14  1.325  $ Position 30
2431  c/z  -28.71  -8.71  1.325  $ Position 31
2432  c/z  -29.86  -2.94  1.325  $ Position 32
c
c --------- Ring 2 ---------
2501  c/z  -34.82   6.93  1.325  $ Position 1
2502  c/z  -32.80  13.59  1.325  $ Position 2
2503  c/z  -29.52  19.72  1.325  $ Position 3
2504  c/z  -25.10  25.10  1.325  $ Position 4
2505  c/z  -19.72  29.52  1.325  $ Position 5
2506  c/z  -13.59  32.80  1.325  $ Position 6
2507  c/z   -6.93  34.82  1.325  $ Position 7
2508  c/z    0.00  35.50  1.325  $ Position 8
2509  c/z    6.93  34.82  1.325  $ Position 9
2510  c/z   13.59  32.80  1.325  $ Position 10
2511  c/z   19.72  29.52  1.325  $ Position 11
2512  c/z   25.10  25.10  1.325  $ Position 12
2513  c/z   29.52  19.72  1.325  $ Position 13
2514  c/z   32.80  13.59  1.325  $ Position 14
2515  c/z   34.82   6.93  1.325  $ Position 15
2516  c/z   35.50   0.00  1.325  $ Position 16
2517  c/z   34.82  -6.93  1.325  $ Position 17
2518  c/z   32.80 -13.59  1.325  $ Position 18
2519  c/z   29.52 -19.72  1.325  $ Position 19
2520  c/z   25.10 -25.10  1.325  $ Position 20
2521  c/z   19.72 -29.52  1.325  $ Position 21
2522  c/z   13.59 -32.80  1.325  $ Position 22
2523  c/z    6.93 -34.82  1.325  $ Position 23
2524  c/z    0.00 -35.50  1.325  $ Position 24
2525  c/z   -6.93 -34.82  1.325  $ Position 25
2526  c/z  -13.59 -32.80  1.325  $ Position 26
2527  c/z  -19.72 -29.52  1.325  $ Position 27
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2528  c/z  -25.10 -25.10  1.325  $ Position 28
2529  c/z  -29.52 -19.72  1.325  $ Position 29
2530  c/z  -32.80 -13.59  1.325  $ Position 30
2531  c/z  -34.82  -6.93  1.325  $ Position 31
2532  c/z  -35.50   0.00  1.325  $ Position 32
c
c --------- Ring 3 ---------
2601  c/z  -39.23  11.90  1.325  $ Position 1
2602  c/z  -36.16  19.33  1.325  $ Position 2
2603  c/z  -31.69  26.01  1.325  $ Position 3
2604  c/z  -26.01  31.69  1.325  $ Position 4
2605  c/z  -19.33  36.16  1.325  $ Position 5
2606  c/z  -11.90  39.23  1.325  $ Position 6
2607  c/z   -4.02  40.80  1.325  $ Position 7
2608  c/z    4.02  40.80  1.325  $ Position 8
2609  c/z   11.90  39.23  1.325  $ Position 9
2610  c/z   19.33  36.16  1.325  $ Position 10
2611  c/z   26.01  31.69  1.325  $ Position 11
2612  c/z   31.69  26.01  1.325  $ Position 12
2613  c/z   36.16  19.33  1.325  $ Position 13
2614  c/z   39.23  11.90  1.325  $ Position 14
2615  c/z   40.80   4.02  1.325  $ Position 15
2616  c/z   40.80  -4.02  1.325  $ Position 16
2617  c/z   39.23 -11.90  1.325  $ Position 17
2618  c/z   36.16 -19.33  1.325  $ Position 18
2619  c/z   31.69 -26.01  1.325  $ Position 19
2620  c/z   26.01 -31.69  1.325  $ Position 20
2621  c/z   19.33 -36.16  1.325  $ Position 21
2622  c/z   11.90 -39.23  1.325  $ Position 22
2623  c/z    4.02 -40.80  1.325  $ Position 23
2624  c/z   -4.02 -40.80  1.325  $ Position 24
2625  c/z  -11.90 -39.23  1.325  $ Position 25
2626  c/z  -19.33 -36.16  1.325  $ Position 26
2627  c/z  -26.01 -31.69  1.325  $ Position 27
2628  c/z  -31.69 -26.01  1.325  $ Position 28
2629  c/z  -36.16 -19.33  1.325  $ Position 29
2630  c/z  -39.23 -11.90  1.325  $ Position 30
2631  c/z  -40.80  -4.02  1.325  $ Position 31
2632  c/z  -40.80   4.02  1.325  $ Position 32
c
c --------- Ring 4 ---------
2701  c/z  -42.73  17.70  1.325  $ Position 1
2702  c/z  -38.46  25.70  1.325  $ Position 2
2703  c/z  -32.70  32.70  1.325  $ Position 3
2704  c/z  -25.70  38.46  1.325  $ Position 4
2705  c/z  -17.70  42.73  1.325  $ Position 5
2706  c/z   -9.02  45.36  1.325  $ Position 6
2707  c/z    0.00  46.25  1.325  $ Position 7
2708  c/z    9.02  45.36  1.325  $ Position 8
2709  c/z   17.70  42.73  1.325  $ Position 9
2710  c/z   25.70  38.46  1.325  $ Position 10
2711  c/z   32.70  32.70  1.325  $ Position 11
2712  c/z   38.46  25.70  1.325  $ Position 12
2713  c/z   42.73  17.70  1.325  $ Position 13
2714  c/z   45.36   9.02  1.325  $ Position 14
2715  c/z   46.25   0.00  1.325  $ Position 15
2716  c/z   45.36  -9.02  1.325  $ Position 16
2717  c/z   42.73 -17.70  1.325  $ Position 17
2718  c/z   38.46 -25.70  1.325  $ Position 18
2719  c/z   32.70 -32.70  1.325  $ Position 19
2720  c/z   25.70 -38.46  1.325  $ Position 20
2721  c/z   17.70 -42.73  1.325  $ Position 21
2722  c/z    9.02 -45.36  1.325  $ Position 22
2723  c/z    0.00 -46.25  1.325  $ Position 23
2724  c/z   -9.02 -45.36  1.325  $ Position 24
2725  c/z  -17.70 -42.73  1.325  $ Position 25
2726  c/z  -25.70 -38.46  1.325  $ Position 26
2727  c/z  -32.70 -32.70  1.325  $ Position 27
2728  c/z  -38.46 -25.70  1.325  $ Position 28
2729  c/z  -42.73 -17.70  1.325  $ Position 29
2730  c/z  -45.36  -9.02  1.325  $ Position 30
2731  c/z  -46.25   0.00  1.325  $ Position 31
2732  c/z  -45.36   9.02  1.325  $ Position 32
c
c --------- Ring 5 ---------
```

```
2801  c/z  -45.42  24.28  1.325  $ Position 1
2802  c/z  -39.81  32.67  1.325  $ Position 2
2803  c/z  -32.67  39.81  1.325  $ Position 3
2804  c/z  -24.28  45.42  1.325  $ Position 4
2805  c/z  -14.95  49.28  1.325  $ Position 5
2806  c/z   -5.05  51.25  1.325  $ Position 6
2807  c/z    5.05  51.25  1.325  $ Position 7
2808  c/z   14.95  49.28  1.325  $ Position 8
2809  c/z   24.28  45.42  1.325  $ Position 9
2810  c/z   32.67  39.81  1.325  $ Position 10
2811  c/z   39.81  32.67  1.325  $ Position 11
2812  c/z   45.42  24.28  1.325  $ Position 12
2813  c/z   49.28  14.95  1.325  $ Position 13
2814  c/z   51.25   5.05  1.325  $ Position 14
2815  c/z   51.25  -5.05  1.325  $ Position 15
2816  c/z   49.28 -14.95  1.325  $ Position 16
2817  c/z   45.42 -24.28  1.325  $ Position 17
2818  c/z   39.81 -32.67  1.325  $ Position 18
2819  c/z   32.67 -39.81  1.325  $ Position 19
2820  c/z   24.28 -45.42  1.325  $ Position 20
2821  c/z   14.95 -49.28  1.325  $ Position 21
2822  c/z    5.05 -51.25  1.325  $ Position 22
2823  c/z   -5.05 -51.25  1.325  $ Position 23
2824  c/z  -14.95 -49.28  1.325  $ Position 24
2825  c/z  -24.28 -45.42  1.325  $ Position 25
2826  c/z  -32.67 -39.81  1.325  $ Position 26
2827  c/z  -39.81 -32.67  1.325  $ Position 27
2828  c/z  -45.42 -24.28  1.325  $ Position 28
2829  c/z  -49.28 -14.95  1.325  $ Position 29
2830  c/z  -51.25  -5.05  1.325  $ Position 30
2831  c/z  -51.25   5.05  1.325  $ Position 31
2832  c/z  -49.28  14.95  1.325  $ Position 32
c
c ------ Aluminum Plugs ------
c    *There were no aluminum plugs in the Core
c
c --- Control Rods -------------------------------------------------------------
c ------ Safety/Shutdown Rods ------
3001  pz   32.2   $ Bottom of Steel Tube
3002  pz   41.0   $ Bottom of Borated Steel Rods
3003  pz  253.0   $ Top of Borated Steel Rods
3004  pz  254.2   $ Top of Steel Tube
3005  cz    1.75  $ Borated Steel Rod Radius
3006  cz    1.8   $ Steel Tube Inner Radius
3007  cz    2.0   $ Steel Tube Outer Radius
c
3011  pz    0.2   $ Bottom Aluminum End Plug
3012  pz   28.25  $ Bottom of Aluminum Shock Damper
3013  pz   28.45  $ Top Aluminum End Plug
3014  cz    1.45  $ Aluminum Tube Inner Radius
3015  cz    2.001 $ Aluminum Tube Outer Radius
c    *Steel Shock Damper Below Reflector Not Modeled
c
c ------ Autorod ------
3031  px   -0.15  $ Coreside Copper Plate Face
3032  px    0.15  $ Farside Copper Plate Face
3033  pz  222.5   $ Top Surface of Plate
3034  p    -0.15 0 -7.5  0.15 0 -7.5  -0.15 -1.95 222.5 $ Angled Plate Surface
3035  p    -0.15 0 -7.5  0.15 0 -7.5  -0.15 1.95 222.5  $ Angled Plate Surface
3036  cz    2     $ Aluminum Tube Inner Radius
3037  cz    2.2   $ Aluminum Tube Outer Radius
c
c ------ Static Measurement Rods ------
c    *There were no Static Measurement Rods in the Core
c
c ------ ZEBRA Rods ------
c    *There were no ZEBRA Control Rods in the Core
c
c ------ Withdrawable Control Rods ------
3081  pz   75.5    $ Bottom of Bottom End Plug
3082  pz   77.0    $ Bottom of Tubes
3083  pz   78.0    $ Top of Bottom End Plug
3084  pz  287.0    $ Bottom of Top End Plug
3085  pz  292.0    $ Top of Tubes
3086  pz  294.5    $ Top of Top End Plug
```

```
3087  cz    0.475  $ Inner Tube Inner Radius
3088  cz    0.675  $ Inner Tube Outer Radius
3089  cz    0.7    $ Outer Tube Inner Radius
3090  cz    1.1    $ Outer Tube Outer Radius
c
3091  pz   73.0    $ Top of Graphite Plug
3092  cz    1.325  $ Radius of Graphite Plug
c
3095  so 1000      $ A Very Large Sphere
c
c --- Pebbles -----------------------------------------------------------------
c ------ TRISO ------
3111  so  0.0251   $ UO2 Kernel
3112  so  0.03425  $ Buffer Coating
3113  so  0.03824  $ IPyC Coating
3114  so  0.04177  $ SiC Coating
3115  so  0.04577  $ OPyC Coating
c
c ------ TRISO Lattice ------
3121  rpp -0.0879 0.0879 -0.0879 0.0879 -0.0879 0.0879
c
c ------ Fuel Pebble ------
3131  s   0 0 0  2.35  $ Fuel Zone
3132  s   0 0 0  3.00  $ Pebble Shell (Unfueled Zone)
c
c ------ Moderator Pebble ------
c    *Same dimension as Fuel Pebble Shell
c
c ------ CHPOP Pebble Lattice ------
6001  hex  0 0 -3.00  0 0 6.00  3.00 0 0
c
c ------ CHPOP Pebble Stack Lattice ------
6002  hex  0 0 -9.00  0 0 264.  3.00 0 0  $ Core Lattice
6003  hex  0 0 -9.00  0 0 264.  3.4  0 0  $ Adding Poly Rods
c
c --- Graphite Fillers --------------------------------------------------------
c ------ Axial Modifiers ------
7000  cz   60.92759  $ Radial Equivalent-Area Surface
7001  hex  0 0 78  0 0 172.9  60.15 0 0
7002  hex  0 0 78  0 0 172.9  0 60.3 0
7003  pz  250.9  $ Top Surface
c
c ------ Lattice Spacers ------
c    *Lattice Spacers Not Used
c
c ------ Cavity Floor ------
c    *Cavity Floor Fillers Not Used
c
c --- Water Ingress Simulation ------------------------------------------------
c    *Polyethylene Rods Not Used in Configuration 5
c
c ------ Polyethylene Rods (Cores 6 & 8) ------
7121  c/z  -3.0  1.732050808 0.300  $ NW Hole
7122  c/z   0.0  3.464101615 0.300  $ N Hole
7123  c/z   3.0  1.732050808 0.300  $ NE Hole
7124  c/z   3.0 -1.732050808 0.300  $ SE Hole
7125  c/z   0.0 -3.464101615 0.300  $ S Hole
7126  c/z  -3.0 -1.732050808 0.300  $ SW Hole
c
7127  pz    142                     $ Top of Rods (Core 6)
7128  pz     18                     $ Top of Rods (Core 8)
c
7129  p -3.0 0.866025404 1  -3.75 2.16506351 1  -3.75 2.16506351 -1  $ NW Rod Side 1
7130  p -3.75 2.16506351 1  -2.25 2.16506351 1  -2.25 2.16506351 -1  $ NW Rod Side 2
7131  p -2.25 2.16506351 1  -3.0 0.866025404 1  -3.0 0.866025404 -1  $ NW Rod Side 3
c
7132  p  0.0 4.330127019 1  -0.75 3.031088913 1  -0.75 3.031088913 -1  $ N Rod Side 1
7133  p -0.75 3.031088913 1  0.75 3.031088913 1  0.75 3.031088913 -1   $ N Rod Side 2
7134  p  0.75 3.031088913 1  0.0 4.330127019 1  0.0 4.330127019 -1     $ N Rod Side 3
c
7135  p  3.0 0.866025404 1  3.75 2.16506351 1  3.75 2.16506351 -1  $ NE Rod Side 1
7136  p  3.75 2.16506351 1  2.25 2.16506351 1  2.25 2.16506351 -1  $ NE Rod Side 2
7137  p  2.25 2.16506351 1  3.0 0.866025404 1  3.0 0.866025404 -1  $ NE Rod Side 3
c
7138  p  3.0 -0.866025404 1  3.75 -2.16506351 1  3.75 -2.16506351 -1  $ SE Rod Side 1
```

```
7139  p  3.75 -2.16506351 1  2.25 -2.16506351 1  2.25 -2.16506351 -1  $ SE Rod Side 2
7140  p  2.25 -2.16506351 1  3.0 -0.866025404 1  3.0 -0.866025404 -1  $ SE Rod Side 3
c
7141  p  0.0 -4.330127019 1  -0.75 -3.031088913 1  -0.75 -3.031088913 -1  $ S Rod Side 1
7142  p -0.75 -3.031088913 1  0.75 -3.031088913 1  0.75 -3.031088913 -1   $ S Rod Side 2
7143  p  0.75 -3.031088913 1  0.0 -4.330127019 1  0.0 -4.330127019 -1     $ S Rod Side 3
c
7144  p -3.0 -0.866025404 1  -3.75 -2.16506351 1  -3.75 -2.16506351 -1  $ SW Rod Side 1
7145  p -3.75 -2.16506351 1  -2.25 -2.16506351 1  -2.25 -2.16506351 -1  $ SW Rod Side 2
7146  p -2.25 -2.16506351 1  -3.0 -0.866025404 1  -3.0 -0.866025404 -1  $ SW Rod Side 3
c
c ------ Polyethylene Rods (Core 7) ------
7021  c/z  -3.0  1.732050808 0.415  $ NW Rod
7022  c/z   0.0  3.464101615 0.415  $ N Rod
7023  c/z   3.0  1.732050808 0.415  $ NE Rod
7024  c/z   3.0 -1.732050808 0.415  $ SE Rod
7025  c/z   0.0 -3.464101615 0.415  $ S Rod
7026  c/z  -3.0 -1.732050808 0.415  $ SW Rod
7027  pz    112                     $ Top of Rods
c
c ------ Copper Wire ------
c    Copper Wire Only Used in Configuration 6
c
7221  c/z  -3.0  1.732050808 0.0892  $ NW Hole
7222  c/z   0.0  3.464101615 0.0892  $ N Hole
7223  c/z   3.0  1.732050808 0.0892  $ NE Hole
7224  c/z   3.0 -1.732050808 0.0892  $ SE Hole
7225  c/z   0.0 -3.464101615 0.0892  $ S Hole
7226  c/z  -3.0 -1.732050808 0.0892  $ SW Hole
c
7227  pz    143                     $ Top of Wire
c
c --- Auxiliary Components ----------------------------------------------------
c ------ Start-Up Source ------
c    *Start-Up Source Information Unknown
c
c ------ Detectors ------
c    *Detector Information Unknown
c
c ------ Temperature Sensors ------
c    *Temperature Sensor Information Unknown
c
c ------ Very Large Sphere ------
9999  so  1000  $ For Modeling Purposes Only
c

c Data Cards ******************************************************************
c
c *** Material Cards **********************************************************
c --- Structural Surroundings -------------------------------------------------
c ------ Concrete ------
m1    56130.70c 7.2096E-06  56132.70c 6.8695E-06  56134.70c 1.6439E-04
      56135.70c 4.4836E-04  56136.70c 5.3419E-04  56137.70c 7.6395E-04
      56138.70c 4.8766E-03   8016.70c 1.3583E-02   8017.70c 5.1633E-06
      16032.70c 2.0325E-02  16033.70c 1.6272E-04  16034.70c 9.1849E-04
      16036.70c 4.2820E-06  20040.70c 2.4517E-03  20042.70c 1.6363E-05
      20043.70c 3.4142E-06  20044.70c 5.2756E-05  20046.70c 1.0116E-07
      20048.70c 4.7293E-06  26054.70c 1.0031E-04  26056.70c 1.5747E-03
      26057.70c 3.6367E-05  26058.70c 4.8398E-06  14028.70c 6.9592E-04
      14029.70c 3.5337E-05  14030.70c 2.3295E-05   1001.70c 1.4518E-02
       1002.70c 1.6697E-06  13027.70c 3.1016E-04  12024.70c 7.7127E-05
      12025.70c 9.7642E-06  12026.70c 1.0750E-05
c         Total 6.1726E-02
mt1   lwtr.10t hwtr.10t
c
c ------ Steel Plate (i.e. SS 301/302/304) ------
m2    24050.70c 7.1741E-04  24052.70c 1.3834E-02  24053.70c 1.5687E-03
      24054.70c 3.9049E-04  26054.70c 3.6154E-03  26056.70c 5.6755E-02
      26057.70c 1.3107E-03  26058.70c 1.7443E-04  28058.70c 4.4256E-03
      28060.70c 1.7047E-03  28061.70c 7.4104E-05  28062.70c 2.3628E-04
      28064.70c 6.0172E-05   6000.70c 2.9783E-04  14028.70c 7.8313E-04
      14029.70c 3.9765E-05  14030.70c 2.6214E-05  25055.70c 8.6816E-04
c         Total 8.6882E-02
mt2   fe56.12t
c
```

```
c ------ Graphite (Radial Reflector Annulus & Thermal Column) ------
m3     5010.70c 2.3356E-08   5011.70c 9.4011E-08   6000.70c 8.8245E-02
c         Total 8.8245E-02
mt3   grph.10t
c
c ------ Graphite (Lower Axial Reflector Cylinder) ------
m4     5010.70c 2.3223E-08   5011.70c 9.3476E-08   6000.70c 8.7744E-02
c         Total 8.7744E-02
mt4   grph.10t
c
c ------ Graphite (Lower Axial Reflector Annulus) ------
m5     5010.70c 2.3356E-08   5011.70c 9.4011E-08   6000.70c 8.8245E-02
c         Total 8.8245E-02
mt5   grph.10t
c
c ------ Graphite (Upper Axial Reflector Cylinder) ------
m6     5010.70c 2.3235E-08   5011.70c 9.3524E-08   6000.70c 8.7789E-02
c         Total 8.7789E-02
mt6   grph.10t
c
c ------ Graphite (Upper Axial Reflector Annulus) ------
m7     5010.70c 2.3368E-08   5011.70c 9.4059E-08   6000.70c 8.8291E-02
c         Total 8.8291E-02
mt7   grph.10t
c
c ------ Peraluman-300 (Safety Ring) ------
m8     5010.70c 1.4688E-07   5011.70c 5.9119E-07  12024.70c 8.0390E-04
      12025.70c 1.0177E-04  12026.70c 1.1205E-04  13027.70c 5.7575E-02
      14028.70c 2.0962E-04  14029.70c 1.0644E-05  14030.70c 7.0168E-06
      25055.70c 7.2621E-05  26054.70c 5.0109E-06  26056.70c 7.8660E-05
      26057.70c 1.8166E-06  26058.70c 2.4176E-07  29063.70c 8.6855E-06
      29065.70c 3.8712E-06  30000.70c 2.4398E-05  31069.70c 6.8789E-07
      31071.70c 4.5653E-07  48106.70c 8.8729E-10  48108.70c 6.3175E-10
      48110.70c 8.8658E-09  48111.70c 9.0858E-09  48112.70c 1.7128E-08
      48113.70c 8.6741E-09  48114.70c 2.0393E-08  48116.70c 5.3166E-09
c         Total 5.9018E-02
mt8   al27.12t fe56.12t
c
c ------ Peraluman-300 (Upper Axial Reflector) ------
m9     5010.70c 1.4688E-07   5011.70c 5.9119E-07  12024.70c 8.0390E-04
      12025.70c 1.0177E-04  12026.70c 1.1205E-04  13027.70c 5.7575E-02
      14028.70c 2.0962E-04  14029.70c 1.0644E-05  14030.70c 7.0168E-06
      25055.70c 7.2621E-05  26054.70c 5.0109E-06  26056.70c 7.8660E-05
      26057.70c 1.8166E-06  26058.70c 2.4176E-07  29063.70c 8.6855E-06
      29065.70c 3.8712E-06  30000.70c 2.4398E-05  31069.70c 6.8789E-07
      31071.70c 4.5653E-07  48106.70c 8.8729E-10  48108.70c 6.3175E-10
      48110.70c 8.8658E-09  48111.70c 9.0858E-09  48112.70c 1.7128E-08
      48113.70c 8.6741E-09  48114.70c 2.0393E-08  48116.70c 5.3166E-09
c         Total 5.9018E-02
mt9   al27.12t fe56.12t
c
c ------ Air (Core 5) ------
m10    1001.70c 5.0236E-07   1002.70c 5.7778E-11   7014.70c 3.7427E-05
       7015.70c 1.3824E-07   8016.70c 1.0342E-05   8017.70c 3.9316E-09
      18036.70c 7.5601E-10  18038.70c 1.4199E-10  18040.70c 2.2377E-07
       6000.70c 9.1815E-09   2003.70c 1.7268E-16   2004.70c 1.2604E-10
      36078.70c 9.5977E-14  36080.70c 6.2522E-13  36082.70c 3.1755E-12
      36083.70c 3.1508E-12  36084.70c 1.5631E-11  36086.70c 4.7440E-12
c         Total 4.8648E-05
c
c ------ Air (Core 6) ------
c m10    1001.70c 4.1770E-07   1002.70c 4.8041E-11   7014.70c 3.7485E-05
c        7015.70c 1.3846E-07   8016.70c 1.0316E-05   8017.70c 3.9215E-09
c       18036.70c 7.5718E-10  18038.70c 1.4221E-10  18040.70c 2.2412E-07
c        6000.70c 9.1959E-09   2003.70c 1.7295E-16   2004.70c 1.2624E-10
c       36078.70c 9.6126E-14  36080.70c 6.2619E-13  36082.70c 3.1804E-12
c       36083.70c 3.1557E-12  36084.70c 1.5655E-11  36086.70c 4.7514E-12
c         Total 4.8595E-05
c
c ------ Air (Core 7) ------
c m10    1001.70c 8.3057E-07   1002.70c 9.5527E-11   7014.70c 3.7339E-05
c        7015.70c 1.3791E-07   8016.70c 1.0483E-05   8017.70c 3.9849E-09
c       18036.70c 7.5422E-10  18038.70c 1.4165E-10  18040.70c 2.2324E-07
c        6000.70c 9.1599E-09   2003.70c 1.7227E-16   2004.70c 1.2575E-10
c       36078.70c 9.5750E-14  36080.70c 6.2374E-13  36082.70c 3.1680E-12
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c       36083.70c 3.1433E-12  36084.70c 1.5594E-11  36086.70c 4.7328E-12
c         Total 4.9027E-05
c
c ------ Air (Core 8) ------
c m10    1001.70c 2.6327E-07   1002.70c 3.0279E-11   7014.70c 3.7415E-05
c        7015.70c 1.3819E-07   8016.70c 1.0219E-05   8017.70c 3.8849E-09
c       18036.70c 7.5576E-10  18038.70c 1.4194E-10  18040.70c 2.2370E-07
c        6000.70c 9.1785E-09   2003.70c 1.7262E-16   2004.70c 1.2600E-10
c       36078.70c 9.5945E-14  36080.70c 6.2501E-13  36082.70c 3.1744E-12
c       36083.70c 3.1497E-12  36084.70c 1.5625E-11  36086.70c 4.7424E-12
c         Total 4.8273E-05
c
mt10  lwtr.10t hwtr.10t
c
c ------ Aluminum Plugs ------
c    *There were no aluminum plugs in the Core
c
c --- Control Rods -------------------------------------------------------------
c ------ 5 wt.% Borated Steel ------
m11    5010.70c 3.9257E-03   5011.70c 1.4282E-02  14028.70c 1.4007E-03
      14029.70c 7.1124E-05  14030.70c 4.6885E-05  24050.70c 1.4117E-03
      24052.70c 2.7224E-02  24053.70c 3.0870E-03  24054.70c 7.6842E-04
      25055.70c 9.8952E-04  26054.70c 1.8295E-03  26056.70c 2.8719E-02
      26057.70c 6.6325E-04  26058.70c 8.8267E-05  28058.70c 4.7678E-03
      28060.70c 1.8366E-03  28061.70c 7.9834E-05  28062.70c 2.5455E-04
      28064.70c 6.4825E-05
c         Total 9.1511E-02
mt11  fe56.12t
c
c ------ 18/8 Stainless Steel (i.e. SS 301/302/304) ------
m12   24050.70c 7.1741E-04  24052.70c 1.3834E-02  24053.70c 1.5687E-03
      24054.70c 3.9049E-04  26054.70c 3.6154E-03  26056.70c 5.6755E-02
      26057.70c 1.3107E-03  26058.70c 1.7443E-04  28058.70c 4.4256E-03
      28060.70c 1.7047E-03  28061.70c 7.4104E-05  28062.70c 2.3628E-04
      28064.70c 6.0172E-05   6000.70c 2.9783E-04  14028.70c 7.8313E-04
      14029.70c 3.9765E-05  14030.70c 2.6214E-05  25055.70c 8.6816E-04
c         Total 8.6882E-02
mt12  fe56.12t
c
c ------ Copper Autorod (i.e. C110) ------
m13   29063.70c 5.8245E-02  29065.70c 2.5961E-02   8016.70c 6.6898E-05
       8017.70c 2.5431E-08  47107.70c 1.9296E-06  47109.70c 1.7927E-06
      16032.70c 1.1887E-05  16033.70c 9.5169E-08  16034.70c 5.3720E-07
      16036.70c 2.5044E-09  28058.70c 4.6572E-06  28060.70c 1.7939E-06
      28061.70c 7.7981E-08  28062.70c 2.4864E-07  28064.70c 6.3321E-08
      26054.70c 4.2025E-07  26056.70c 6.5971E-06  26057.70c 1.5236E-07
      26058.70c 2.0276E-08
c         Total 8.4303E-02
mt13  fe56.12t
c
c ------ Pure Aluminum Autorod Guide Tube (i.e. AL 1100) ------
m113  14028.70c 2.6697E-04  14029.70c 1.3556E-05  14030.70c 8.9364E-06
      26054.70c 8.5091E-06  26056.70c 1.3357E-04  26057.70c 3.0848E-06
      26058.70c 4.1053E-07  29063.70c 2.2123E-05  29065.70c 9.8607E-06
      25055.70c 7.3991E-06  30000.70c 1.2429E-05  27059.70c 6.8975E-05
      28058.70c 4.7148E-05  28060.70c 1.8161E-05  28061.70c 7.8946E-07
      28062.70c 2.5171E-06  28064.70c 6.4104E-07  50112.70c 3.3215E-07
      50114.70c 2.2600E-07  50115.70c 1.1642E-07  50116.70c 4.9788E-06
      50117.70c 2.6298E-06  50118.70c 8.2935E-06  50119.70c 2.9414E-06
      50120.70c 1.1156E-05  50122.70c 1.5854E-06  50124.70c 1.9826E-06
      13027.70c 5.9087E-02
c         Total 5.9746E-02
mt113  al27.12t fe56.12t
c
c ------ Pure Aluminum Shock Dampers (i.e. AL 1100) ------
m14   14028.70c 3.6377E-04  14029.70c 1.8471E-05  14030.70c 1.2177E-05
      26054.70c 1.1594E-05  26056.70c 1.8200E-04  26057.70c 4.2033E-06
      26058.70c 5.5938E-07  29063.70c 3.0145E-05  29065.70c 1.3436E-05
      25055.70c 1.0082E-05  30000.70c 1.6936E-05  27059.70c 9.3983E-05
      28058.70c 6.4242E-05  28060.70c 2.4746E-05  28061.70c 1.0757E-06
      28062.70c 3.4298E-06  28064.70c 8.7346E-07  50112.70c 4.5258E-07
      50114.70c 3.0794E-07  50115.70c 1.5864E-07  50116.70c 6.7840E-06
      50117.70c 3.5833E-06  50118.70c 1.1300E-05  50119.70c 4.0079E-06
      50120.70c 1.5201E-05  50122.70c 2.1602E-06  50124.70c 2.7015E-06
      13027.70c 8.0510E-02
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c         Total 8.1409E-02
mt14  al27.12t fe56.12t
c
c ------ St1.4301 Stainless Steel (Inner Tube) ------
m17    6000.70c 1.3864E-04  14028.70c 7.8115E-04  14029.70c 3.9665E-05
      14030.70c 2.6147E-05  25055.70c 8.6597E-04  24050.70c 7.3547E-04
      24052.70c 1.4183E-02  24053.70c 1.6082E-03  24054.70c 4.0032E-04
      28058.70c 5.6560E-03  28060.70c 2.1787E-03  28061.70c 9.4706E-05
      28062.70c 3.0196E-04  28064.70c 7.6901E-05  26054.70c 3.4714E-03
      26056.70c 5.4493E-02  26057.70c 1.2585E-03  26058.70c 1.6748E-04
c         Total 8.6477E-02
mt17  fe56.12t
c
c ------ St1.4541 Stainless Steel (Outer Tube) ------
m18     6000.70c 1.9805E-04  14028.70c 7.8115E-04  14029.70c 3.9665E-05
       14030.70c 2.6147E-05  25055.70c 8.6597E-04  24050.70c 7.1559E-04
       24052.70c 1.3800E-02  24053.70c 1.5648E-03  24054.70c 3.8950E-04
       28058.70c 5.6560E-03  28060.70c 2.1787E-03  28061.70c 9.4706E-05
       28062.70c 3.0196E-04  28064.70c 7.6901E-05  22046.70c 4.0998E-06
       22047.70c 3.6973E-06  22048.70c 3.6635E-05  22049.70c 2.6885E-06
       22050.70c 2.5742E-06  26054.70c 3.4930E-03  26056.70c 5.4833E-02
       26057.70c 1.2663E-03  26058.70c 1.6853E-04
c         Total 8.6499E-02
mt18  fe56.12t
c
c --- Pebbles ------------------------------------------------------------------
c ------ UO2 ------
m19    8016.70c 4.8593E-02   8017.70c 1.8472E-05  92234.70c 3.3079E-05
      92235.70c 4.1172E-03  92236.70c 2.0499E-05  92238.70c 2.0135E-02
      47107.70c 3.1488E-09  47109.70c 2.9254E-09   5010.70c 1.0251E-08
       5011.70c 4.1263E-08  20040.70c 8.0826E-06  20042.70c 5.3944E-08
      20043.70c 1.1256E-08  20044.70c 1.7392E-07  20046.70c 3.3350E-10
      20048.70c 1.5591E-08  48106.70c 7.2858E-11  48108.70c 5.1875E-11
      48110.70c 7.2800E-10  48111.70c 7.4607E-10  48112.70c 1.4065E-09
      48113.70c 7.1226E-10  48114.70c 1.6746E-09  48116.70c 4.3657E-10
      17035.70c 2.1007E-07  17037.70c 6.7141E-08  27059.70c 5.5589E-08
      24050.70c 1.2593E-07  24052.70c 2.4284E-06  24053.70c 2.7536E-07
      24054.70c 6.8543E-08  66156.70c 2.4192E-13  66158.70c 4.0320E-13
      66160.70c 9.4349E-12  66161.70c 7.6246E-11  66162.70c 1.0286E-10
      66163.70c 1.0040E-10  66164.70c 1.1362E-10  63151.70c 2.0614E-10
      63153.70c 2.2502E-10  26054.70c 1.9201E-07  26056.70c 3.0142E-06
      26057.70c 6.9612E-08  26058.70c 9.2640E-09  64152.70c 8.3333E-13
      64154.70c 9.0833E-12  64155.70c 6.1666E-11  64156.70c 8.5291E-11
      64157.70c 6.5208E-11  64158.70c 1.0350E-10  64160.70c 9.1083E-11
       3006.70c 3.5823E-08   3007.70c 4.3616E-07  25055.70c 8.9447E-07
      42092.70c 1.5202E-08  42094.70c 9.4757E-09  42095.70c 1.6308E-08
      42096.70c 1.7087E-08  42097.70c 9.7830E-09  42098.70c 2.4719E-08
      42100.70c 9.8649E-09  28058.70c 1.8999E-07  28060.70c 7.3183E-08
      28061.70c 3.1812E-09  28062.70c 1.0143E-08  28064.70c 2.5832E-09
      16032.70c 3.8795E-09  16033.70c 3.1059E-11  16034.70c 1.7532E-10
      16036.70c 8.1735E-13  22046.70c 5.6463E-08  22047.70c 5.0919E-08
      22048.70c 5.0454E-07  22049.70c 3.7026E-08  22050.70c 3.5452E-08
      23000.70c 6.4310E-07
c         Total 7.2935E-02
mt19  o2/u.10t u/o2.10t
c
c ------ Buffer ------
m20    6000.70c 5.2640E-02  47107.70c 3.0388E-10  47109.70c 2.8232E-10
       5010.70c 1.1756E-09   5011.70c 4.7318E-09  20040.70c 1.4193E-07
      20042.70c 9.4729E-10  20043.70c 1.9766E-10  20044.70c 3.0542E-09
      20046.70c 5.8565E-12  20048.70c 2.7379E-10  48106.70c 3.6211E-12
      48108.70c 2.5783E-12  48110.70c 3.6182E-11  48111.70c 3.7081E-11
      48112.70c 6.9903E-11  48113.70c 3.5400E-11  48114.70c 8.3228E-11
      48116.70c 2.1698E-11  17035.70c 2.0274E-08  17037.70c 6.4796E-09
      27059.70c 6.9741E-10  24050.70c 9.5639E-10  24052.70c 1.8443E-08
      24053.70c 2.0913E-09  24054.70c 5.2057E-10  66156.70c 1.1674E-14
      66158.70c 1.9456E-14  66160.70c 4.5527E-13  66161.70c 3.6791E-12
      66162.70c 4.9632E-12  66163.70c 4.8445E-12  66164.70c 5.4827E-12
      63151.70c 9.9468E-12  63153.70c 1.0858E-11  26054.70c 1.9524E-09
      26056.70c 3.0648E-08  26057.70c 7.0779E-10  26058.70c 9.4194E-11
      64152.70c 4.0211E-14  64154.70c 4.3830E-13  64155.70c 2.9756E-12
      64156.70c 4.1156E-12  64157.70c 3.1465E-12  64158.70c 4.9942E-12
      64160.70c 4.3951E-12   3006.70c 3.4572E-09   3007.70c 4.2092E-08
      25055.70c 4.9492E-09  28058.70c 3.6671E-09  28060.70c 1.4125E-09
      28061.70c 6.1402E-11  28062.70c 1.9578E-10  28064.70c 4.9859E-11
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      16032.70c 1.0296E-10  16033.70c 8.2429E-13  16034.70c 4.6529E-12
      16036.70c 2.1692E-14  22046.70c 5.4164E-10  22047.70c 4.8846E-10
      22048.70c 4.8400E-09  22049.70c 3.5519E-10  22050.70c 3.4008E-10
      23000.70c 2.6873E-09   1001.70c 7.0190E-06   1002.70c 8.0728E-10
       8016.70c 3.5086E-06   8017.70c 1.3338E-09
c         Total 5.2651E-02
mt20  grph.10t lwtr.10t hwtr.10t
c
c ------ IPyC ------
m21    6000.70c 9.5254E-02  47107.70c 5.4988E-10  47109.70c 5.1086E-10
       5010.70c 2.1272E-09   5011.70c 8.5623E-09  20040.70c 2.5683E-07
      20042.70c 1.7141E-09  20043.70c 3.5767E-10  20044.70c 5.5266E-09
      20046.70c 1.0598E-11  20048.70c 4.9543E-10  48106.70c 6.5525E-12
      48108.70c 4.6654E-12  48110.70c 6.5473E-11  48111.70c 6.7098E-11
      48112.70c 1.2649E-10  48113.70c 6.4058E-11  48114.70c 1.5060E-10
      48116.70c 3.9263E-11  17035.70c 3.6685E-08  17037.70c 1.1725E-08
      27059.70c 1.2620E-09  24050.70c 1.7306E-09  24052.70c 3.3373E-08
      24053.70c 3.7842E-09  24054.70c 9.4198E-10  66156.70c 2.1124E-14
      66158.70c 3.5206E-14  66160.70c 8.2382E-13  66161.70c 6.6575E-12
      66162.70c 8.9811E-12  66163.70c 8.7663E-12  66164.70c 9.9211E-12
      63151.70c 1.7999E-11  63153.70c 1.9648E-11  26054.70c 3.5328E-09
      26056.70c 5.5458E-08  26057.70c 1.2808E-09  26058.70c 1.7045E-10
      64152.70c 7.2763E-14  64154.70c 7.9312E-13  64155.70c 5.3845E-12
      64156.70c 7.4473E-12  64157.70c 5.6937E-12  64158.70c 9.0372E-12
      64160.70c 7.9530E-12   3006.70c 6.2559E-09   3007.70c 7.6167E-08
      25055.70c 8.9556E-09  28058.70c 6.6356E-09  28060.70c 2.5560E-09
      28061.70c 1.1111E-10  28062.70c 3.5426E-10  28064.70c 9.0221E-11
      16032.70c 1.8631E-10  16033.70c 1.4916E-12  16034.70c 8.4196E-12
      16036.70c 3.9252E-14  22046.70c 9.8011E-10  22047.70c 8.8388E-10
      22048.70c 8.7580E-09  22049.70c 6.4272E-10  22050.70c 6.1539E-10
      23000.70c 4.8628E-09   1001.70c 1.2701E-05   1002.70c 1.4608E-09
       8016.70c 6.3489E-06   8017.70c 2.4135E-09
c         Total 9.5273E-02
mt21  grph.10t lwtr.10t hwtr.10t
c
c ------ SiC ------
m22   14028.70c 4.4323E-02  14029.70c 2.2506E-03  14030.70c 1.4836E-03
       6000.70c 4.8052E-02  47107.70c 9.2611E-10  47109.70c 8.6040E-10
       5010.70c 3.5827E-09   5011.70c 1.4421E-08  20040.70c 4.3256E-07
      20042.70c 2.8870E-09  20043.70c 6.0238E-10  20044.70c 9.3080E-09
      20046.70c 1.7848E-11  20048.70c 8.3441E-10  48106.70c 1.1036E-11
      48108.70c 7.8575E-12  48110.70c 1.1027E-10  48111.70c 1.1301E-10
      48112.70c 2.1304E-10  48113.70c 1.0789E-10  48114.70c 2.5365E-10
      48116.70c 6.6127E-11  17035.70c 6.1786E-08  17037.70c 1.9747E-08
      27059.70c 2.1255E-09  24050.70c 2.9147E-09  24052.70c 5.6207E-08
      24053.70c 6.3735E-09  24054.70c 1.5865E-09  66156.70c 3.5577E-14
      66158.70c 5.9295E-14  66160.70c 1.3875E-12  66161.70c 1.1213E-11
      66162.70c 1.5126E-11  66163.70c 1.4764E-11  66164.70c 1.6709E-11
      63151.70c 3.0314E-11  63153.70c 3.3091E-11  26054.70c 5.9500E-09
      26056.70c 9.3403E-08  26057.70c 2.1571E-09  26058.70c 2.8707E-10
      64152.70c 1.2255E-13  64154.70c 1.3358E-12  64155.70c 9.0686E-12
      64156.70c 1.2543E-11  64157.70c 9.5894E-12  64158.70c 1.5220E-11
      64160.70c 1.3395E-11   3006.70c 1.0536E-08   3007.70c 1.2828E-07
      25055.70c 1.5083E-08  28058.70c 1.1176E-08  28060.70c 4.3049E-09
      28061.70c 1.8713E-10  28062.70c 5.9666E-10  28064.70c 1.5195E-10
      16032.70c 3.1379E-10  16033.70c 2.5121E-12  16034.70c 1.4180E-11
      16036.70c 6.6109E-14  22046.70c 1.6507E-09  22047.70c 1.4886E-09
      22048.70c 1.4750E-08  22049.70c 1.0825E-09  22050.70c 1.0364E-09
      23000.70c 8.1900E-09   1001.70c 2.1391E-05   1002.70c 2.4603E-09
       8016.70c 1.0693E-05   8017.70c 4.0648E-09
c         Total 9.6142E-02
mt22  grph.10t lwtr.10t hwtr.10t
c
c ------ OPyC ------
m23    6000.70c 9.4752E-02  47107.70c 5.4698E-10  47109.70c 5.0817E-10
       5010.70c 2.1160E-09   5011.70c 8.5172E-09  20040.70c 2.5548E-07
      20042.70c 1.7051E-09  20043.70c 3.5578E-10  20044.70c 5.4975E-09
      20046.70c 1.0542E-11  20048.70c 4.9283E-10  48106.70c 6.5181E-12
      48108.70c 4.6409E-12  48110.70c 6.5128E-11  48111.70c 6.6745E-11
      48112.70c 1.2582E-10  48113.70c 6.3721E-11  48114.70c 1.4981E-10
      48116.70c 3.9056E-11  17035.70c 3.6492E-08  17037.70c 1.1663E-08
      27059.70c 1.2553E-09  24050.70c 1.7215E-09  24052.70c 3.3197E-08
      24053.70c 3.7643E-09  24054.70c 9.3702E-10  66156.70c 2.1012E-14
      66158.70c 3.5021E-14  66160.70c 8.1949E-13  66161.70c 6.6224E-12
      66162.70c 8.9338E-12  66163.70c 8.7202E-12  66164.70c 9.8689E-12
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      63151.70c 1.7904E-11  63153.70c 1.9545E-11  26054.70c 3.5142E-09
      26056.70c 5.5166E-08  26057.70c 1.2740E-09  26058.70c 1.6955E-10
      64152.70c 7.2380E-14  64154.70c 7.8894E-13  64155.70c 5.3561E-12
      64156.70c 7.4081E-12  64157.70c 5.6637E-12  64158.70c 8.9896E-12
      64160.70c 7.9111E-12   3006.70c 6.2230E-09   3007.70c 7.5766E-08
      25055.70c 8.9085E-09  28058.70c 6.6007E-09  28060.70c 2.5426E-09
      28061.70c 1.1052E-10  28062.70c 3.5240E-10  28064.70c 8.9746E-11
      16032.70c 1.8533E-10  16033.70c 1.4837E-12  16034.70c 8.3753E-12
      16036.70c 3.9046E-14  22046.70c 9.7495E-10  22047.70c 8.7923E-10
      22048.70c 8.7119E-09  22049.70c 6.3933E-10  22050.70c 6.1215E-10
      23000.70c 4.8372E-09   1001.70c 1.2634E-05   1002.70c 1.4531E-09
       8016.70c 6.3154E-06   8017.70c 2.4008E-09
c         Total 9.4772E-02
mt23  grph.10t lwtr.10t hwtr.10t
c
c ------ Fueled Zone ------
m24    6000.70c 8.6842E-02  47107.70c 5.0131E-10  47109.70c 4.6575E-10
       5010.70c 1.9393E-09   5011.70c 7.8061E-09  20040.70c 2.3415E-07
      20042.70c 1.5628E-09  20043.70c 3.2608E-10  20044.70c 5.0385E-09
      20046.70c 9.6616E-12  20048.70c 4.5168E-10  48106.70c 5.9739E-12
      48108.70c 4.2534E-12  48110.70c 5.9691E-11  48111.70c 6.1172E-11
      48112.70c 1.1532E-10  48113.70c 5.8401E-11  48114.70c 1.3730E-10
      48116.70c 3.5795E-11  17035.70c 3.3446E-08  17037.70c 1.0690E-08
      27059.70c 1.1505E-09  24050.70c 1.5778E-09  24052.70c 3.0426E-08
      24053.70c 3.4500E-09  24054.70c 8.5879E-10  66156.70c 1.9258E-14
      66158.70c 3.2097E-14  66160.70c 7.5107E-13  66161.70c 6.0695E-12
      66162.70c 8.1879E-12  66163.70c 7.9921E-12  66164.70c 9.0449E-12
      63151.70c 1.6409E-11  63153.70c 1.7913E-11  26054.70c 3.2208E-09
      26056.70c 5.0560E-08  26057.70c 1.1677E-09  26058.70c 1.5539E-10
      64152.70c 6.6337E-14  64154.70c 7.2307E-13  64155.70c 4.9089E-12
      64156.70c 6.7896E-12  64157.70c 5.1909E-12  64158.70c 8.2391E-12
      64160.70c 7.2506E-12   3006.70c 5.7034E-09   3007.70c 6.9441E-08
      25055.70c 8.1647E-09  28058.70c 6.0496E-09  28060.70c 2.3303E-09
      28061.70c 1.0130E-10  28062.70c 3.2298E-10  28064.70c 8.2253E-11
      16032.70c 1.6986E-10  16033.70c 1.3599E-12  16034.70c 7.6760E-12
      16036.70c 3.5786E-14  22046.70c 8.9355E-10  22047.70c 8.0582E-10
      22048.70c 7.9846E-09  22049.70c 5.8596E-10  22050.70c 5.6104E-10
      23000.70c 4.4334E-09   1001.70c 1.1579E-05   1002.70c 1.3318E-09
       8016.70c 5.7882E-06   8017.70c 2.2003E-09
c         Total 8.6859E-02
mt24  grph.10t lwtr.10t hwtr.10t
c
c ------ Unfueled Zone ------
m25    6000.70c 8.6842E-02  47107.70c 5.0131E-10  47109.70c 4.6575E-10
       5010.70c 1.9393E-09   5011.70c 7.8061E-09  20040.70c 2.3415E-07
      20042.70c 1.5628E-09  20043.70c 3.2608E-10  20044.70c 5.0385E-09
      20046.70c 9.6616E-12  20048.70c 4.5168E-10  48106.70c 5.9739E-12
      48108.70c 4.2534E-12  48110.70c 5.9691E-11  48111.70c 6.1172E-11
      48112.70c 1.1532E-10  48113.70c 5.8401E-11  48114.70c 1.3730E-10
      48116.70c 3.5795E-11  17035.70c 3.3446E-08  17037.70c 1.0690E-08
      27059.70c 1.1505E-09  24050.70c 1.5778E-09  24052.70c 3.0426E-08
      24053.70c 3.4500E-09  24054.70c 8.5879E-10  66156.70c 1.9258E-14
      66158.70c 3.2097E-14  66160.70c 7.5107E-13  66161.70c 6.0695E-12
      66162.70c 8.1879E-12  66163.70c 7.9921E-12  66164.70c 9.0449E-12
      63151.70c 1.6409E-11  63153.70c 1.7913E-11  26054.70c 3.2208E-09
      26056.70c 5.0560E-08  26057.70c 1.1677E-09  26058.70c 1.5539E-10
      64152.70c 6.6337E-14  64154.70c 7.2307E-13  64155.70c 4.9089E-12
      64156.70c 6.7896E-12  64157.70c 5.1909E-12  64158.70c 8.2391E-12
      64160.70c 7.2506E-12   3006.70c 5.7034E-09   3007.70c 6.9441E-08
      25055.70c 8.1647E-09  28058.70c 6.0496E-09  28060.70c 2.3303E-09
      28061.70c 1.0130E-10  28062.70c 3.2298E-10  28064.70c 8.2253E-11
      16032.70c 1.6986E-10  16033.70c 1.3599E-12  16034.70c 7.6760E-12
      16036.70c 3.5786E-14  22046.70c 8.9355E-10  22047.70c 8.0582E-10
      22048.70c 7.9846E-09  22049.70c 5.8596E-10  22050.70c 5.6104E-10
      23000.70c 4.4334E-09   1001.70c 1.1579E-05   1002.70c 1.3318E-09
       8016.70c 5.7882E-06   8017.70c 2.2003E-09
c         Total 8.6859E-02
mt25  grph.10t lwtr.10t hwtr.10t
c
c ------ Moderator Pebbles ------
m26    6000.70c 8.4434E-02   5010.70c 1.4193E-08   5011.70c 5.7130E-08
      20040.70c 3.1657E-06  20042.70c 2.1129E-08  20043.70c 4.4086E-09
      20044.70c 6.8121E-08  20046.70c 1.3062E-10  20048.70c 6.1067E-09
      48106.70c 3.3846E-11  48108.70c 2.4098E-11  48110.70c 3.3819E-10
      48111.70c 3.4658E-10  48112.70c 6.5336E-10  48113.70c 3.3088E-10
```

```
      48114.70c 7.7791E-10  48116.70c 2.0280E-10  17035.70c 4.0423E-07
      17037.70c 1.2920E-07  66156.70c 2.4350E-13  66158.70c 4.0583E-13
      66160.70c 9.4964E-12  66161.70c 7.6742E-11  66162.70c 1.0353E-10
      66163.70c 1.0105E-10  66164.70c 1.1436E-10  63151.70c 4.1496E-10
      63153.70c 4.5297E-10  26054.70c 6.2652E-09  26056.70c 9.8350E-08
      26057.70c 2.2713E-09  26058.70c 3.0227E-10  64152.70c 5.1616E-13
      64154.70c 5.6261E-12  64155.70c 3.8196E-11  64156.70c 5.2829E-11
      64157.70c 4.0389E-11  64158.70c 6.4107E-11  64160.70c 5.6416E-11
       3006.70c 9.7630E-09   3007.70c 1.1887E-07  28058.70c 9.1788E-09
      28060.70c 3.5357E-09  28061.70c 1.5369E-10  28062.70c 4.9004E-10
      28064.70c 1.2480E-10  16032.70c 4.2052E-06  16033.70c 3.3666E-08
      16034.70c 1.9004E-07  16036.70c 8.8595E-10  14028.70c 1.1661E-06
      14029.70c 5.9212E-08  14030.70c 3.9033E-08  62144.70c 1.7815E-11
      62147.70c 8.6986E-11  62148.70c 6.5225E-11  62149.70c 8.0197E-11
      62150.70c 4.2826E-11  62152.70c 1.5523E-10  62154.70c 1.3202E-10
      22046.70c 1.7486E-08  22047.70c 1.5770E-08  22048.70c 1.5625E-07
      22049.70c 1.1467E-08  22050.70c 1.0979E-08  23000.70c 2.5891E-07
       1001.70c 1.1262E-05   1002.70c 1.2953E-09   8016.70c 5.6296E-06
       8017.70c 2.1401E-09
c         Total 8.4461E-02
mt26  grph.10t lwtr.10t hwtr.10t
c
c --- Graphite Fillers --------------------------------------------------------
c ------ Long Plugs/Rods (Radial Reflector C-Driver Positions) ------
m27    5010.70c 2.3422E-08   5011.70c 9.4278E-08   6000.70c 8.8496E-02
c         Total 8.8496E-02
mt27  grph.10t
c
c ------ Long Plugs/Rods (Radial Reflector ZEBRA Positions) ------
m28    5010.70c 2.3621E-08   5011.70c 9.5079E-08   6000.70c 8.9248E-02
c         Total 8.9248E-02
mt28  grph.10t
c
c ------ Short Plugs/Rods (Axial Reflectors) ------
m29    5010.70c 2.3356E-08   5011.70c 9.4011E-08   6000.70c 8.8245E-02
c         Total 8.8245E-02
mt29  grph.10t
c
c ------ Source Plug (Lower Axial Reflector) ------
m30    5010.70c 2.3356E-08   5011.70c 9.4011E-08   6000.70c 8.8245E-02
c         Total 8.8245E-02
mt30  grph.10t
c
c ------ Axial Modifiers ------
m31    5010.70c 2.1869E-08   5011.70c 8.8027E-08   6000.70c 8.2629E-02
c         Total 8.2629E-02
mt31  grph.10t
c
c ------ Lattice Spacers ------
c    *Lattice Spacers Not Used
c
c ------ Cavity Floor ------
c    *Cavity Floor Fillers Not Used
c
c --- Water Ingress Simulation ------------------------------------------------
c ------ Polyethylene Rods (Cores 6 & 8) ------
m34    5010.70c 5.1775E-09   5011.70c 2.0840E-08   1001.70c 8.1231E-02
       1002.70c 9.3427E-06   6000.70c 4.0020E-02
c         Total 1.2126E-01
c
c ------ Polyethylene Rods (Core 7) ------
c m34    5010.70c 5.2110E-09   5011.70c 2.0975E-08   1001.70c 8.1756E-02
c        1002.70c 9.4031E-06   6000.70c 4.0279E-02
c         Total 1.2204E-01
c
mt34  poly.10t
c
c ------ Copper Wire (Core 6) ------
m35   29063.70c 5.8504E-02  29065.70c 2.6076E-02   8016.70c 6.7195E-05
       8017.70c 2.5544E-08  47107.70c 1.9382E-06  47109.70c 1.8007E-06
      16032.70c 1.1940E-05  16033.70c 9.5591E-08  16034.70c 5.3959E-07
      16036.70c 2.5156E-09  28058.70c 4.6778E-06  28060.70c 1.8019E-06
      28061.70c 7.8327E-08  28062.70c 2.4974E-07  28064.70c 6.3602E-08
      26054.70c 4.2212E-07  26056.70c 6.6264E-06  26057.70c 1.5303E-07
      26058.70c 2.0366E-08
```

```
c         Total 8.4678E-02
mt35  fe56.12t
c
c --- Auxiliary Components ---------------------------------------------------
c ------ Start-Up Source ------
c    *Start-Up Source Information Unknown
c
c ------ Detectors ------
c    *Detector Information Unknown
c
c ------ Temperature Sensors ------
c    *Temperature Sensor Information Unknown
c
c *** Control Cards **********************************************************
mode  n
kcode 100000 1 150 1650
ksrc  0 0  80  40 40  80  40 -40  80  -40 -40  80  -40 40  80
      0 0  90  40 40  90  40 -40  90  -40 -40  90  -40 40  90
      0 0 100  40 40 100  40 -40 100  -40 -40 100  -40 40 100
      0 0 110  40 40 110  40 -40 110  -40 -40 110  -40 40 110
      0 0 120  40 40 120  40 -40 120  -40 -40 120  -40 40 120
      0 0 130  40 40 130  40 -40 130  -40 -40 130  -40 40 130
      0 0 140  40 40 140  40 -40 140  -40 -40 140  -40 40 140
      0 0 150  40 40 150  40 -40 150  -40 -40 150  -40 40 150
      0 20  80  20 0  80  -20 0  80  0 -20  80
      0 20  90  20 0  90  -20 0  90  0 -20  90
      0 20 100  20 0 100  -20 0 100  0 -20 100
      0 20 110  20 0 110  -20 0 110  0 -20 110
      0 20 120  20 0 120  -20 0 120  0 -20 120
      0 20 130  20 0 130  -20 0 130  0 -20 130
      0 20 140  20 0 140  -20 0 140  0 -20 140
      0 20 150  20 0 150  -20 0 150  0 -20 150
      0 50  80  50 0  80  -50 0  80  0 -50  80
      0 50  90  50 0  90  -50 0  90  0 -50  90
      0 50 100  50 0 100  -50 0 100  0 -50 100
      0 50 110  50 0 110  -50 0 110  0 -50 110
      0 50 120  50 0 120  -50 0 120  0 -50 120
      0 50 130  50 0 130  -50 0 130  0 -50 130
      0 50 140  50 0 140  -50 0 140  0 -50 140
      0 50 150  50 0 150  -50 0 150  0 -50 150
c
kopts  blocksize=10 kinetics=yes precursor=yes
c print
c
```

APPENDIX D: HTR-PROTEUS HISTORICAL DATA

D.1 Validation of Safety Related Physics Calculations for Low Enriched HTGRs

The IARA CRP on Validation of Safety Related Physics Calculations for Low Enriched HTGRs (established in 1990) represented a collaboration between China, France, Japan, Switzerland, Germany, the Netherlands, the USA, and the Russian Federation to fill the gaps in validation data for physics methods used in the core design of gas-cooled reactors fueled with low enriched uranium. An international team of researchers assembled at the PROTEUS critical experiment facility of the Paul Scherrer Institute in Villigen, Switzerland to plan, conduct, and analyze a new series of critical experiments focused on the needs of the participating countries.

The following institutes participated in this CRP:

- Paul Scherrer Institute (PSI), Villigen, Switzerland
- Institute for Nuclear Energy Technology (INET), Tsinghua University, Beijing, China
- Forschungzentrum Jülich (FZJ), Jülich, Germany
- Japan Atomic Energy Research Institute (JAERI), Tokai-mura, Japan
- Interfaculty Reactor Institute, Delft University, Delft, the Netherlands
- Centre d'Etudes de Cadarache (CEA), St. Paul les Durance-Cedex, France
- Oak Ridge National Laboratory (ORNL), Oak Ridge, USA
- Russian Research Center Kurchatov Institute (RRC-KI), Moscow, Russia
- Energy Research Center, Petten, the Netherlands
- General Atomics (GA), San Diego, USA
- Experimental Machine Building Design Bureau (OKBM), Nizhny Novgorod, Russia

The PROTEUS graphite moderated LEU critical experiments were planned to fill gaps in the base of validation data. The constraints included room temperature and 5500 LEU fuel pebbles supplied by the KFA Research Center in Jülich, Germany. Specifically, the experiments which could be conducted at the PROTEUS facility with available AVR LEU fuel are summarized in Table D.1-1. The experimental conditions achievable at PROTEUS are summarized in Table D.1-2 (Ref. 3).

Table D.1-1. Summary of PROTEUS Critical Experiments (Ref. 3).

- Clean critical cores.
- LEU pebble-type fuel with 16.76 % ^{235}U enrichment.
- A range of C/U atom ratios from 946 to 1890 (achieved by varying the moderator-to-fuel pebble ratio from 0.5 to 2.0).
- Core (equivalent) diameter = 1.25 m.
- Core height = 0.843 m to 1.73 m (with simulated water ingress smaller core heights possible).
- Core H/D from 0.7 to 1.4.
- Flux distribution measurements and spectral distribution measurements (including measurements in side reflector).
- Kinetic parameter measurements.
- Worth of reflector control rods (partially and fully inserted).
- Worth of in-core control rod (partially and fully inserted).
- Effects of moisture ingress over range of water density up to 0.25 g H_2O/cm^3 void (corresponds to 0.065 g H_2O/cm^3 core for PROTEUS). Water is simulated with polyethylene inserts.
  – Effect on core reactivity.
  – Effect on worth of reflector control rods.
  – Effect on worth of in-core control rod.
  – Effect on burnable poison worth.
  – Effect on prompt neutron lifetime.
  – Effect on flux and power distributions.

Table D.1-2. Experimental Conditions Achievable at PROTEUS (Ref. 3).

- The PROTEUS critical provide validation data for low-enriched uranium fuel with an enrichment near to that planned for advanced GCR designs.
- PROTEUS moisture ingress experiments will investigate the effects which are important for advanced GCR designs (i.e., reactivity worth of moisture, and the effect of moisture on control rod and burnable poison worth and on reaction rate distributions) over the range of moisture densities of interest.
- The achievable range of C/U atom ratios at PROTEUS is near to, but higher than, that of advanced GCR designs (this ratio is an important factor in determining the neutron energy spectrum).
- PROTEUS provides the validation data
  - For the worth of reflector control rods.
  - For the worth of an in-core control rod.
  - For the worth of small samples of burnable poison (B_4C).
  - For fission rate distributions in core and reflector.

D.2 PROTEUS Critical Experiment Facility History and HTR Reconfiguration

The zero-power reactor facility PROTEUS is a part of the Paul Scherrer Institute (formerly EIR) and is situated near Würenlingen in the canton of Aargau in northern Switzerland. In the past it had been configured as a multi-zone (driven) system for reactor physics investigations of gas-cooled fast breeder and high conversion reactors. Various test configurations were built into a central, subcritical test zone which was driven critical by means of annular, thermal driver zones. PROTEUS was configured, for the first time, as a single zone for the HTR experiments with a pebble bed system surrounded radially and axially by a thick graphite reflector (Ref. 3).

A brief history of the facility is as follows (Ref. 3):[a]

- January 1968 – September 1970
  - Operation as a “zero-reactivity experiment” with a thermal, D_2O moderated test-lattice and a graphite driver.
- September 1970 – April 1972
  - Mixed fast-thermal system with a “buffer-zone” and reduced size test-zone.
- April 1972 – April 1979
  - Sixteen different configurations of the gas-cooled fast reactor type.
- January 1980 – August 1980
  - Preliminary HTR experiments.
- August 1980 – May 1981
  - Rebuild of the test-zone to accommodate light-water high conversion reactor experiments.
- May 1981 – October 1982
  - Phase I of the advanced light-water reactor experiments. Six configurations were investigated.
- February 1983 – May 1985
  - Re-configuration of the test-zone for Phase II of the light-water high conversion reactor experiments.

[a] PROTEUS Home Page, http://proteus.web.psi.ch/, Paul Scherrer Institut, Villigen, Switzerland (Accessed January 11, 2011).

- June 1985 – December 1990
  - Phase II of the advanced light-water experiments. Fourteen different test-zones, containing more representative fuel than in Phase I.
- January 1991 – July 1991
  - Rebuild for the LEU-HTR experiments.
- July 1992 – October 1996
  - HTR-PROTEUS critical experiments. Ten core configurations, some with multiple reference states.
- 1996 – 1997
  - Rebuild for LWR-PROTEUS experiments for validation of LWR fuel design and analysis tools.
- 1997 – 2001
  - Phase I – SVEA96+ BWR fuel: fission rates and reactivity worths.
- 2001 – 2003
  - Phase II – PWR fuel: reactivity of burnt fuel segments.
- 2003 – 2005
  - Phase III – SVEA-96 Optima2 BWR fuel: fission rates and moderator density effects.
- 2005 – 2011
  - LIFE@PROTEUS experimental program (Large-scale Irradiated Fuel Experiments): power distributions and mismatch, reaction rates, reactivity effects, and characterization of burnt fuel.

A brief summary of the work performed to rebuild the PROTEUS for the HTR-PROTEUS experiments is as follows (Ref. 3):

- All driver and buffer fuel discharged and stored.
- Fuel in test-zone discharged and stored.
- All installations inside graphite reflector removed.
- Construction of upper reflector assembly for HTR, an aluminum tank containing an annular region of old graphite and a central cylinder of new graphite.
- Filling of ~50 % of the ~300 C-Driver holes with new graphite rods. The other ~50 % were filled with existing graphite rods.
- Renewal of the safety/shutdown rods – increased length to allow for greater core height and better characterization of material properties – for improved benchmark quality of experiments.
- Increased height of radial reflector by 12 cm.
- Reconstruction of lower axial reflector, including central part of new graphite.
- Mounting of graphite panels in core cavity to modify the cavity shape to accommodate deterministic loadings.
- Fuel and moderator pebbles loaded.
- After the rest worths of the original ZEBRA control rods were found to be unacceptably high, these rods were replaced with conventional withdrawable control rods.

D.3 HTR-PROTEUS Timeline and Test Matrix

The time periods spanned by each configuration is provided in Figure D.3-1. A summary of the test matrix parameters investigated as part of each configuration is presented in Table D.3-3.

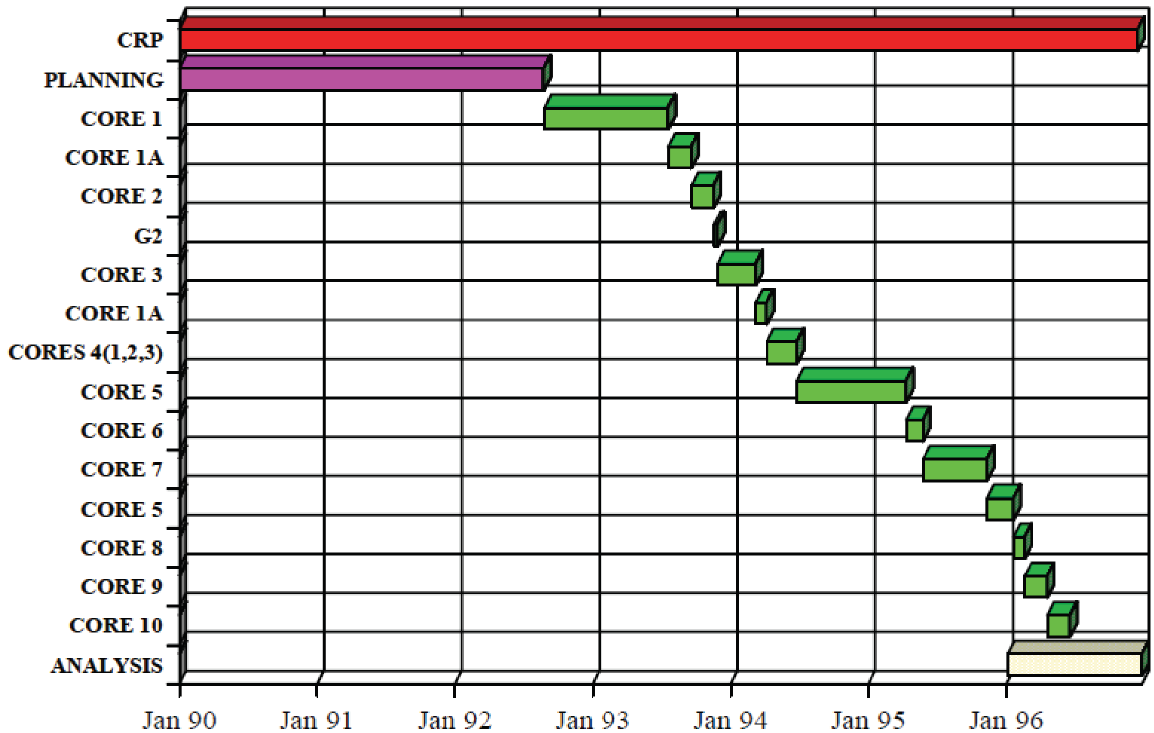

Figure D.3-1. Time Allocation for HTR-PROTEUS Experiments (Ref. 3).

Table D.3-1. Test Matrix for Cores 1 through 10 (Ref. 3).

	CRITICAL LOADING	Σ_a	SUBCRIT CORE	SHUTDOWN RODS		CONTROL RODS		UPPER REFL.	β/Λ	MEAS. RODS	CENT. CONT. ROD	TEMP. COEFF	COM-PONENT WORTHS	MISC	REACTION RATE DISTRIBUTIONS					REACTION RATE RATIOS		
															IN CORE			IN PEBBLE		AT CORE CENTRE		
CORE \ METHOD	PEBBLE COUNT	PNS	PNS	PNS	IK	SP	PNS	PNS (SP)	PNS	PNS	PNS	COMP	COMP	-	FOILS	FISSION CHAMBER.	γ SCAN	FOILS	PARTICLE FOILS	FOILS	PARTICLE FOILS	WHOLE PEBBLE
G1		✓													F: 5 C: 8	F: 5, 8, 7, 9, 2, 1						
1	✓		✓	✓	✓	✓	✓		✓	✓			✓		F: 5,8 C: 8	F: 5, 8, 7						
1A	✓				✓	✓										F: 5, 8, 7						
2	✓			✓	✓	✓	✓	✓	✓						F: 5,8 C: 8	F: 5, 8, 7						
G2		✓														F: 5, 8						
3	✓		✓	✓	✓	✓	✓		✓													
1A	✓			✓		✓																
4(1)	✓					✓																
4(2)	✓			✓	✓	✓																
4(3)	✓			✓		✓																
5	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	water/ CH_2 CH_2 in lower axial reflector	F:5,8 C8	F:5,8,7	C8, Ftot	F:5,8,9 C8	Ftot C8	F:5,8,9 C8	C8/Ftot	C8/Ftot
6	✓					✓																
7	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓		water/ CH_2 CH_2 in lower axial reflector	F:5,8 C8	F:5,8,7	C8, Ftot	F:5,8,9 C8	Ftot C8	F:5,8,9 C8	C8/Ftot	C8/Ftot
8	✓						✓															
9	✓				✓	✓	✓	✓	✓	✓					F:5	F:5,8,7,9	C8, Ftot	F:5,8,9 C:8				
10	✓		✓		✓	✓	✓	✓	✓	✓				subcriticality with CH_2 removed	F:5	F:5,8,7,9	C8, Ftot	F:5,8,9 C:8				

✓ F: 5 = PLANNED AND EXECUTED

F=fission, C=capture, 5=U-235, 8=U-238, 9=Pu-239, 7=Np-237, 2=Pu-242, G1,2=graphite (no fuel in core), COMP. = compensation with calibrated control rods

APPENDIX E: Data from the 16th edition chart of the Nuclides[a]

E.1 Isotopic Abundances and Atomic Weights

This evaluation incorporated atomic weights and isotopic abundances found in the 16th edition of the Chart of the Nuclides. A list of the values used in the benchmark model or in the generation of the MCNP input deck is compiled in Table E.1-1.

[a] E. M. Baum, H. D. Knox, and T. R. Miller, *Nuclides and Isotopes: 16th Edition*, Knolls Atomic Power Laboratory (2002).

Table E.1-1. Summary of Data Employed from the 16th Ed. of the Chart of the Nuclides.

Isotope or Element	Atomic Weight (g/mol)	Isotopic Abundance (at.%)	Isotope or Element	Atomic Weight (g/mol)	Isotopic Abundance (at.%)
H	1.00794	--	S	32.065	--
^{1}H	--	99.9885	^{32}S	--	94.93
^{2}H	--	0.0115	^{33}S	--	0.76
He	4.002602	--	^{34}S	--	4.29
^{3}He	--	0.000137	^{36}S	--	0.02
^{4}He	--	99.999863	Cl	35.453	--
Li	6.941	--	^{35}Cl	--	75.78
^{6}Li	--	7.59	^{37}Cl	--	24.22
^{7}Li	--	92.41	Ar	39.948	--
B	10.811	--	^{36}Ar	--	0.3365
^{10}B	10.012937	19.9	^{38}Ar	--	0.0632
^{11}B	11.0093055	80.1	^{40}Ar	--	99.6003
C[(a)]	12.0107	--	Ca	40.078	--
N	14.0067	--	^{40}Ca	--	96.941
^{14}N	--	99.632	^{42}Ca	--	0.647
^{15}N	--	0.368	^{43}Ca	--	0.135
O	15.9994	--	^{44}Ca	--	2.086
^{16}O	--	99.757	^{46}Ca	--	0.004
^{17}O	--	0.038	^{48}Ca	--	0.187
^{18}O[(a)]	--	0.205	Ti	47.867	--
Ne	20.1797	--	^{46}Ti	--	8.25
Mg	24.3050	--	^{47}Ti	--	7.44
^{24}Mg	--	78.99	^{48}Ti	--	73.72
^{25}Mg	--	10	^{49}Ti	--	5.41
^{26}Mg	--	11.01	^{50}Ti	--	5.18
Al	26.981538	--	V[(a)]	50.9415	--
Si	28.0855	--	Cr	51.9961	--
^{28}Si	--	92.2297	^{50}Cr	--	4.345
^{29}Si	--	4.6832	^{52}Cr	--	83.789
^{30}Si	--	3.0872	^{53}Cr	--	9.501
P	30.973761	--	^{54}Cr	--	2.365

Table E.1-1. (cont.). Summary of Data Employed from the 16th Ed. of the Chart of the Nuclides.

Isotope or Element	Atomic Weight (g/mol)	Isotopic Abundance (at.%)	Isotope or Element	Atomic Weight (g/mol)	Isotopic Abundance (at.%)
Mn	54.938049	--	Mo	95.94	--
Fe	55.845	--	^{92}Mo	--	14.84
^{54}Fe	--	5.845	^{94}Mo	--	9.25
^{56}Fe	--	91.754	^{95}Mo	--	15.92
^{57}Fe	--	2.119	^{96}Mo	--	16.68
^{58}Fe	--	0.282	^{97}Mo	--	9.55
Co	58.933200	--	^{98}Mo	--	24.13
Ni	58.6934	--	^{100}Mo	--	9.63
^{58}Ni	--	68.0769	Ag	107.8682	--
^{60}Ni	--	26.2231	^{107}Ag	--	51.839
^{61}Ni	--	1.1399	^{109}Ag	--	48.161
^{62}Ni	--	3.6345	Cd	112.411	--
^{64}Ni	--	0.9256	^{106}Cd	--	1.25
Cu	63.546	--	^{108}Cd	--	0.89
^{63}Cu	--	69.17	^{110}Cd	--	12.49
^{65}Cu	--	30.83	^{111}Cd	--	12.8
Zn[(a)]	65.409	--	^{112}Cd	--	24.13
Ga	69.723	--	^{113}Cd	--	12.22
^{69}Ga	--	60.108	^{114}Cd	--	28.73
^{71}Ga	--	39.892	^{116}Cd	--	7.49
Kr	83.798	--	Sn	118.710	--
^{78}Kr	--	0.35	^{112}Sn	--	0.97
^{80}Kr	--	2.28	^{114}Sn	--	0.66
^{82}Kr	--	11.58	^{115}Sn	--	0.34
^{83}Kr	--	11.49	^{116}Sn	--	14.54
^{84}Kr	--	57	^{117}Sn	--	7.68
^{86}Kr	--	17.3	^{118}Sn	--	24.22
			^{119}Sn	--	8.59
			^{120}Sn	--	32.58
			^{122}Sn	--	4.63
			^{124}Sn	--	5.79

Table E.1-1. (cont.). Summary of Data Employed from the
16th Ed. of the Chart of the Nuclides.

Isotope or Element	Atomic Weight (g/mol)	Isotopic Abundance (at.%)	Isotope or Element	Atomic Weight (g/mol)	Isotopic Abundance (at.%)
Ba	137.327	--	Gd	157.25	--
^{130}Ba	--	0.106	^{152}Gd	--	0.2
^{132}Ba	--	0.101	^{154}Gd	--	2.18
^{134}Ba	--	2.417	^{155}Gd	--	14.8
^{135}Ba	--	6.592	^{156}Gd	--	20.47
^{136}Ba	--	7.854	^{157}Gd	--	15.65
^{137}Ba	--	11.232	^{158}Gd	--	24.84
^{138}Ba	--	71.698	^{160}Gd	--	21.86
Sm	150.36	--	Dy	162.500	--
^{144}Sm	--	3.07	^{156}Dy	--	0.06
^{147}Sm	--	14.99	^{158}Dy	--	0.1
^{148}Sm	--	11.24	^{160}Dy	--	2.34
^{149}Sm	--	13.82	^{161}Dy	--	18.91
^{150}Sm	--	7.38	^{162}Dy	--	25.51
^{152}Sm	--	26.75	^{163}Dy	--	24.9
^{154}Sm	--	22.75	^{164}Dy	--	28.18
Eu	151.964	--	Pb	207.2	--
^{151}Eu	--	47.81	^{204}Pb	--	1.4
^{153}Eu	--	52.19	^{206}Pb	--	24.1
			^{207}Pb	--	22.1
			^{208}Pb	--	52.4
			Bi	208.98038	--
			^{234}U	234.040946	0.0055(b)
			^{235}U	235.043923	0.7200(b)
			^{238}U	238.050783	99.2745(b)

a. Natural element without isotopic breakdown.
b. Neutronically, ^{18}O is treated as ^{16}O.
c. Natural isotopic abundance of U.