ZPR-9 ASSEMBLIES 5 AND 6: HEU (93% ^{235}U) CYLINDRICAL CORES WITH TUNGSTEN, GRAPHITE, AND ALUMINUM DILUENTS WITH A DENSE ALUMINUM REFLECTOR

Evaluators

Karl N. Grimm, Richard M. Lell,
Micheal A. Smith, and Richard D. McKnight
Argonne National Laboratory

Internal Reviewers
Richard M. Lell, Robert W. Schaefer,
Richard D. McKnight, and Micheal A. Smith

Independent Reviewers

Anatoli Tsiboulia and Yevgeniy Rozhikhin
Institute of Physics and Power Engineering

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1.0 DETAILED DESCRIPTION

1.1 Overview of Experiments

Assemblies 5 and 6 were two members of a series of cores built at the Argonne National Laboratory (ANL) ZPR-9 critical facility[a] to study the neutronics of high temperature fast reactors proposed in the Argonne nuclear rocket program of the 1960s. That program recommended a refractory-metal-based fast reactor that would have the potential for operation at very high temperatures. Tungsten (W) was selected for study as the refractory metal, perhaps alloyed with rhenium where added strength or temperature performance was required. A series of tungsten bearing assemblies utilizing differing light weight reflector materials (Al, Al_2O_3, and BeO-Al) were built for development of a fast reactor with tungsten for nuclear propulsion.

The entire series of nine assemblies will be evaluated for potential use as criticality safety benchmarks. Assembly 1 (ZPR-9/1) was selected as a well characterized reference assembly. It contained no tungsten and had an enrichment (^{235}U/U) of ~11%. It differed from ZPR-3 Assemblies 11 and 22 and Assembly 1 of ZPR-6 only in that in ZPR-9/1 the matrix and drawers were aluminum instead of stainless steel, and the reflector plate material was aluminum instead of depleted uranium. This reference assembly is identified in this Handbook as benchmark IEU-MET-FAST-013. In Assemblies 2, 3 and 4 (ZPR-9/2, 3, and 4), one-fourth, one-half, and finally all of the depleted uranium diluent in the core unit cell of Assembly 1 were replaced by tungsten. Assemblies 2 and 3 had ^{235}U/U enrichments of ~16% and ~21%, respectively. Assembly 4, identified in this handbook as benchmark HEU-MET-FAST-060, had a core consisting essentially of just tungsten and 93% enriched uranium. These first four assemblies in this series test the exchange of ^{238}U and tungsten. Some carbon was added to the core cell in Assembly 5 to produce a somewhat softer spectrum. In Assembly 6 some of the tungsten was replaced with perforated aluminum plates. These two assemblies (ZPR-9/5 and 6) are identified in this Handbook as benchmark HEU-MET-FAST-067. In the final three assemblies of this series, the dense aluminum reflector was replaced with Al_2O_3 and BeO-Al, which were more effective reflectors due

[a] ZPR is an acronym for Zero Power Reactor, referring to the four very similar fast-reactor critical experiment facilities at Argonne, two of which were the ZPR-6 and ZPR-9 facilities. A brief and simple description of these facilities is included in the American Nuclear Society monograph by W. G. Davey and W. C. Redman, *Techniques in Fast Reactor Critical Experiments*, Gordon and Breach, Science Publishers, Inc., New York (1970).

to the presence of the oxygen. ZPR-9/7, 8, and 9 are identified in this Handbook as benchmark HEU-MET-FAST-070.

Each of the assemblies in this series was constructed as a clean, cylindrical core with full radial and axial reflectors. Assemblies 5 and 6 had cylindrical cores constructed of highly-enriched-uranium metal and tungsten. In addition, Assembly 5 had graphite plates in the core region and Assembly 6 had perforated aluminum plates in the core region. They had radial and axial reflectors constructed of standard aluminum plates.

Experiments were performed on ZPR-9/5 in October of 1964 and on ZPR-9/6 in January of 1965. The particular configurations selected as being most suitable to form criticality-safety benchmarks are Loading 8 of ZPR-9/5 and Loading 13 of ZPR-9/6. Their loaded fissile masses were 361 and 460 kg ^{235}U, respectively.

The term "benchmark" in a ZPR program connotes a particularly simple loading aimed at gaining basic reactor physics insight, as opposed to studying a reactor design. In fact, ZPR-9 Assemblies 5 and 6 each had a very uniform core assembled entirely from a single core unit cell loaded into aluminum drawers that were then loaded into the aluminum matrix of ZPR-9.[a] Each assembly's core unit cell had a simple loading whose neutronic characteristics were dominated by ^{235}U, tungsten and either graphite (Assembly 5) or aluminum (Assembly 6).

These assemblies provide useful benchmarks for testing criticality calculations. As just noted, ^{235}U dominates the neutronics behavior in the core region. Approximately 75% of all absorptions were in ^{235}U, with nearly all the remainder occurring in W (25% for Assembly 5 and 22% for Assembly 6) and Al (1% for Assembly 5 and 2% for Assembly 6). For each assembly, the bulk of the core neutron spectrum was in the 50-keV to 2-MeV energy range. In Assembly 5, 39% of the fissions occurred at energies between 0.625 eV and 100 keV and 61% above 100 keV. In Assembly 6, 25% of the fissions occurred at energies between 0.625 eV and 100 keV and 75% above 100 keV. Thus, the spectra were in the fast range. The neutron balances for these assemblies are included in Appendix C.

A very accurate transformation to a simplified model is needed to make any of the ZPR assemblies a practical criticality-safety benchmark. There is simply too much geometric detail in an exact model of a ZPR assembly – even a clean benchmark such as these assemblies. The transformation must reduce the detail to a practical level without masking any of the important features of the critical experiment. And it must do this without increasing the total uncertainty far beyond that of the original experiment. Such a transformation is described in Section 3. It was made using a pair of continuous-energy Monte Carlo calculations. First, the loading was modeled in full detail – every plate, drawer, matrix tube, and air gap was modeled explicitly. Then the regionwise compositions and volumes from this model were used to construct a homogeneous, two-dimensional (RZ) model. This simple model is the criticality-safety benchmark model. The difference in k_{eff} values from the two models was used to adjust the measured excess reactivity, yielding a result for the benchmark model. The net difference in k_{eff} and each of the effects that contribute to it are small (<1%). Uncertainties associated with this simplification, which go beyond Monte Carlo statistical uncertainties, have been estimated and determined to be acceptably small (~0.2%).

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[a] The ZPR-9 matrix was changed from aluminum tubes to stainless steel tubes in 1966 prior to construction of Assembly 11.

1.2 Description of Experimental Configuration

The result for the excess reactivity measurement for ZPR-9/5 Loading 8, which was recorded in the experiment logbook on 14 October 1964,[a] was 80 inhours (Ih), which is quite small[b] (see Section 2.1). It was measured at a temperature of 21°C. The result for the excess reactivity measurement for ZPR-9/6 Loading 13, which was recorded in the experiment logbook on 4 January 1965,[c] was 108 Ih at a temperature of 14°C. No measurement of an isothermal temperature coefficient was reported for either assembly.

A lot of details must be presented to describe precisely the as-built assembly. Also, it is useful to define some jargon (to be shown in italics) to facilitate the presentation. For those unfamiliar with ZPR assemblies, the task of absorbing this may be tedious if not a bit overwhelming. In fact, the task of modeling the exact plate-by-plate loading would be unreasonable to do by hand. In practice, the information contained in this section was accumulated in an electronic database and processed into models using computer programs. Readers interested only in using the benchmark model need not be concerned with any of these details, since Section 3 contains a complete specification of the criticality-safety benchmark model.

1.2.1 The ZPR-9 Facility - The ZPR-9 fast critical facility was a horizontal split-table type machine consisting of a large, cast-iron bed supporting two cast-iron tables, one stationary and the other movable.[d] A pictorial view of the ZPR-9 facility is shown in Figure 1. Each table was 12 feet (3.7 m)[e] wide and 8 feet (2.4 m) long. During loading operations, the tables were separated by 5 feet (1.5 m). In operation, the movable table was driven against the stationary table with a nut and lead screw mechanism. Aluminum square tubes, 0.040 inches (1 mm) thick, 2.175 inches (55 mm) on a side (outside dimension) and 4 feet (1.2 m) long, were welded in 5-tube by 5-tube bundles and stacked horizontally on both tables to form a 45-row and 45-column square "honeycomb" matrix.[f] A *matrix position* is specified by three parameters: matrix half (S or M), row number (starting from the top) and column number (starting from the left looking from the movable half towards the stationary half). For example, the central position in the movable half is M-23/23. The matrix tubes were supported on the sides by massive cast-iron structures known as the knees. One of the knees can be seen in Figure 1 behind the ladder. A mild-steel back plate, about 28.7 inches (72.8 cm) behind the matrix tubes on each table, supported the control rod drives. The drives were mounted on the outboard side of the plate and were connected to control rods by steel shafts. Between the matrix tubes and back plate on each table was a plenum region, which provided a flow path for cooling air into and out of the matrix. The matrix machine was near the center of a large cell (room), approximately 40 feet by 30 feet and 30 feet tall (12x9x9 m).

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[a] Applied Physics Division Experiment Logbook 1620F, Argonne National Laboratory, 1964.

[b] J. R. Lamarsh, *Introduction to Nuclear Reactor Theory*, p. 439, Addison-Wesley, Reading, MA (1966).

[c] Applied Physics Division Experiment Logbook 1621F, Argonne National Laboratory, 1964.

[d] W. Y. Kato et al., "Final Safety Analysis Report on the Use of Plutonium in ZPR-6 and -9," Argonne National Laboratory Report, ANL-7442 (February 1970).

[e] Almost all of the references give dimensions in English units and some also give metric equivalents. We display the metric equivalent in parentheses when practical, as a courtesy to international readers.

[f] Misalignment of the matrix bundles produces a gap at the interface when the tables are driven to the "closed" position.

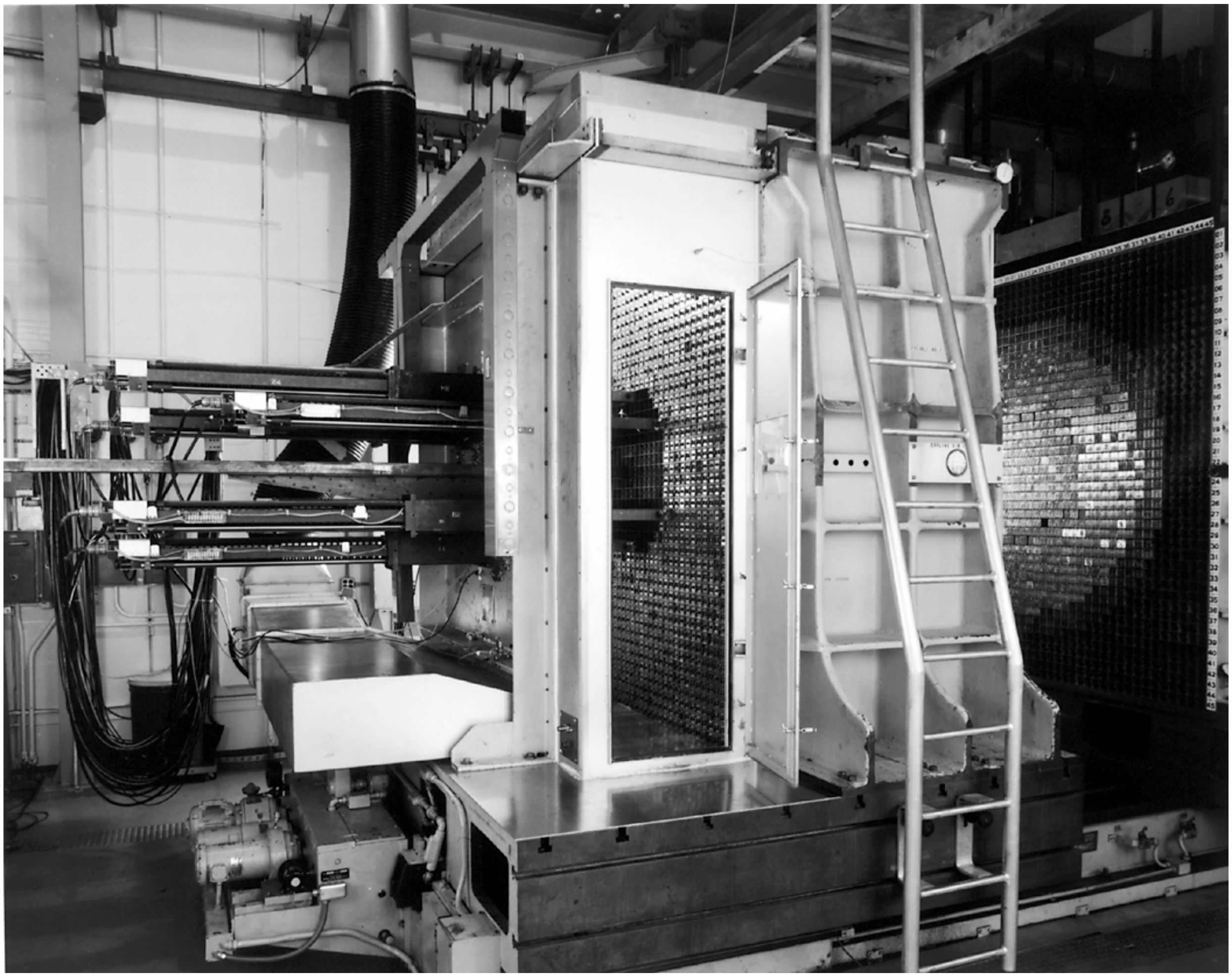

Figure 1. View of the ZPR-9 Facility.

The table, bed, knees, and back plate have a small but non-negligible impact on the k_{eff} of these assemblies, due to poor reflection by aluminum. The evaluations for this nine-assembly, uranium/tungsten series constitute the first time where ex-matrix structures are of significance. The tables and bed reflected neutrons below the matrix. A table was a box-type construction, 18 inches tall (45.72 cm), with a 3.5 inch-thick (8.89 cm) top plate supported by a massive, complicated, internal rib structure. Even accounting for the voids between ribs, the combined table and bed thickness was more than the 30 cm required for infinite reflection. The knees reflected neutrons from the sides. A knee was comprised of a 46.5x99 inch (118x251 cm), 1.5 inch-thick (3.81 cm) plate reinforced by 1.25 inches-wide ribs (3.175 cm) in a 19-inch by 18-inch (48x45 cm) rectangular pattern. Although the knees were not effectively infinite, the next structures, the cell walls, were too far away to contribute significant neutron reflection. There was nothing to cause significant reflection above the matrix tubes; the tie rods and detectors were too small, and the room ceiling was meters away. The back plate and control drive shafts reflected neutrons behind the matrix. The drive shafts were 0.75-inches in diameter (1.905 cm). The back plate was 1.125 inch-thick (2.858 cm). Including an approximation of its supporting beams, it was a 50x50 inch (127 cm) square centered about the central matrix position. Again, the cell walls were too far away to contribute significant neutron reflection.

The desired average composition was achieved by loading the matrix with drawers containing rectangular plates (or, in some assemblies, with cylindrical rods) of different materials such as depleted, enriched, or natural uranium; stainless steel; sodium, etc. A specific plate-loading pattern in a drawer is called a *drawer master*. The plates were bare material or had a cladding or, in the case of uranium, had a protective coating. Figure 2 is an illustration of the plates inside the drawers and matrix forming a unit cell for a particular region in a particular loading (not ZPR-9 Assemblies 5 or 6). The specification of which drawer master was in each matrix position is known as a *matrix loading map*.

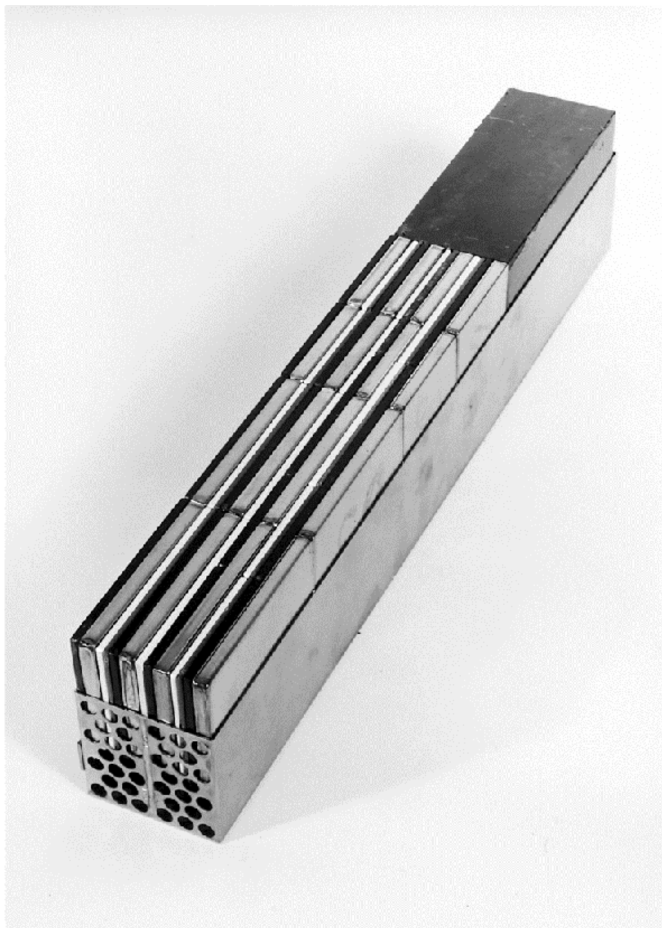

Figure 2. Typical ZPR Drawer.

It was usually the case that a given matrix position had two drawers, a *front drawer* and a *back drawer*. Correspondingly, there would be two matrix loading maps for each half, a front map and a back map. Back drawers were used in ZPR-9 Assemblies 5 and 6 in the entire core region to load the axial reflector. The entire core was loaded into 15.251-inch-long (387.3-mm) aluminum drawers. The core loading was in the first portion of these drawers - first 11 inches (279 mm) for Assembly 5 and first 12 inches (305 mm) for Assembly 6. The axial reflector region, which was comprised of a 12-inch-long (305 mm) loading of aluminum plates, filled the remaining portion of these front drawers and the front portion of 23.314-inch-long (592.2-mm) aluminum back drawers.

The radial reflector regions were built with 24.376-inch-long (619.2-mm) aluminum drawers without a need for back drawers. There are a number of similar drawer masters because drawers for the stationary and movable halves had different (opposite, mirror image) drawer masters.

The ZPR drawers themselves typically were made of 0.03-inch-thick (0.8-mm) aluminum or stainless steel, and their front, back, and side walls were 2 inches (51 mm) tall. Control drawers were generally made of stainless steel; however, they could be of a slightly different construction (e.g., thicker walls, reduced width, etc.).

Typically, two types of control rods were used in a ZPR assembly. One type was the *dual-purpose* (DP) control rod, so-called because it was a drawer that contained a core unit cell but could be driven in and out along a matrix tube to adjust reactivity. There were ten control rods of this type in each of these two assemblies. The other type of control rod was the *poison safety rod* (PSR), which contained a blade of boron powder or B_4C clad with stainless steel, 3/8 inch (9.5 mm) wide by 1.94 inches (49 mm) tall, which traveled in a thin-walled stainless steel guide tube. The rest of the matrix tube containing a PSR was filled by a stationary, narrow drawer with a plate loading as similar as possible to the unit cell of the region. The blade could be attached either to a scram-type drive or to a drive used for fine reactivity control. No PSR control rods were used in either ZPR-9/5 or ZPR-9/6.

Temperature monitoring of the core was done using *thermocouple drawers*. In this type of drawer master, small thermocouples were attached to fuel plates in several places along a fuel column. The adjacent plate column had to be less than full height to allow room for the thermocouples and wires. No information is available regarding the construction, number, or locations of the thermocouple drawers used in ZPR-9/5 or ZPR-9/6.

A neutron source had to be present in each matrix half during the startup of any ZPR assembly not containing an inherent source in the core (e.g., ^{240}Pu). ZPR-9 Assemblies 5 and 6 had source tubes that ran horizontally within a row of reflector drawers (one tube in each half). Sources were driven close to the core through these two tubes at startup and withdrawn once criticality was achieved.

The full details of a ZPR loading are not usually contained in published reports because of their complexity. Instead, it was usual to give details of a representative drawer master for each region, the matrix loading map in terms of the representative drawer masters, and the average composition for each material region. However, the detailed description was archived in loading records, both electronic and paper.

1.2.2 The Matrix and Drawer Loading Data – A general matrix loading diagram for ZPR-9/5 Loading 8 is shown in Figure 3. The corresponding diagram for ZPR-9/6 Loading 13 is shown in Figure 4. These figures provide the general region boundaries, as well as the locations of the dual-purpose rods.

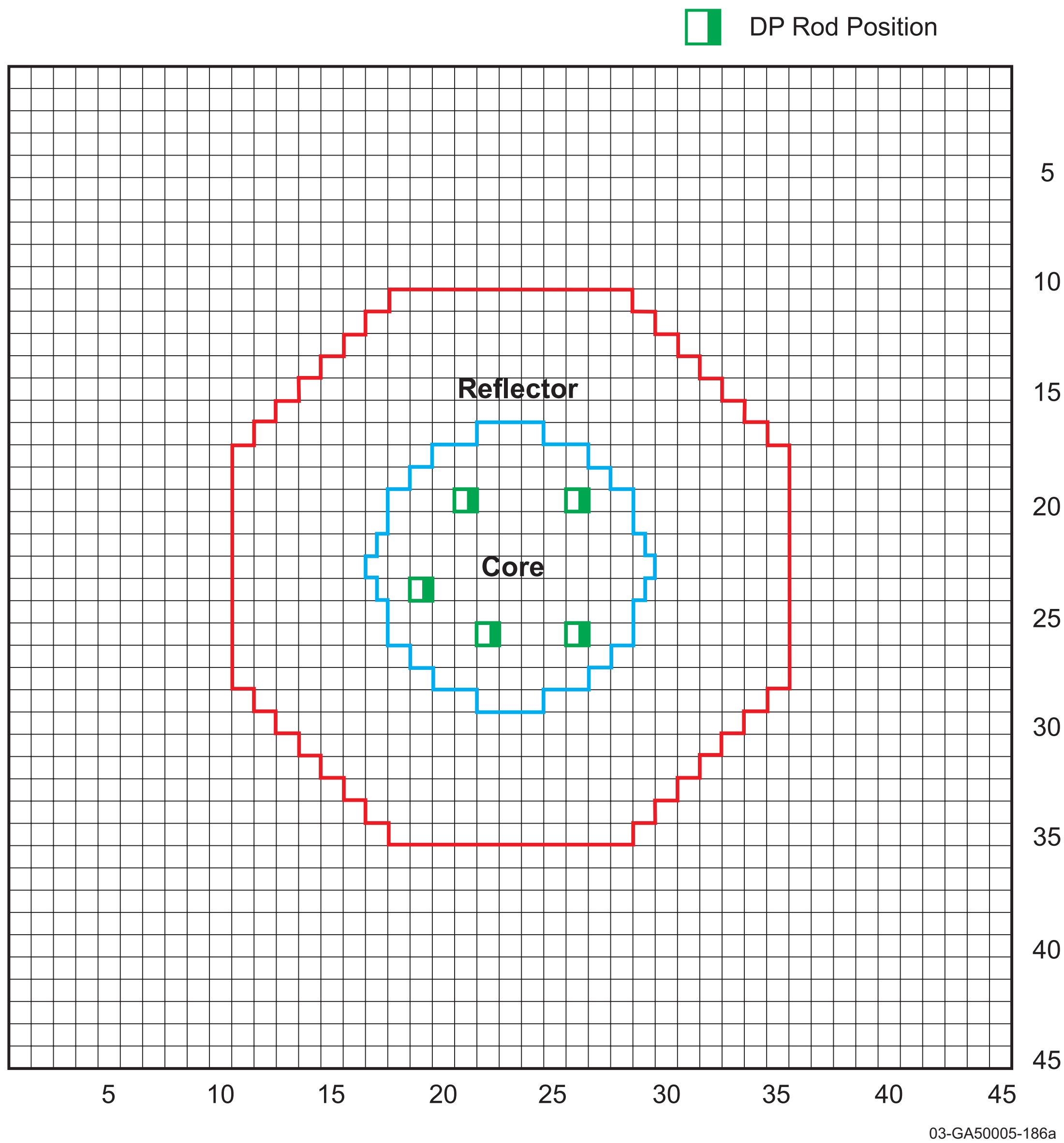

Figure 3. ZPR-9 Assembly 5 (Loading No. 8) Reference Configuration Matrix Loading.

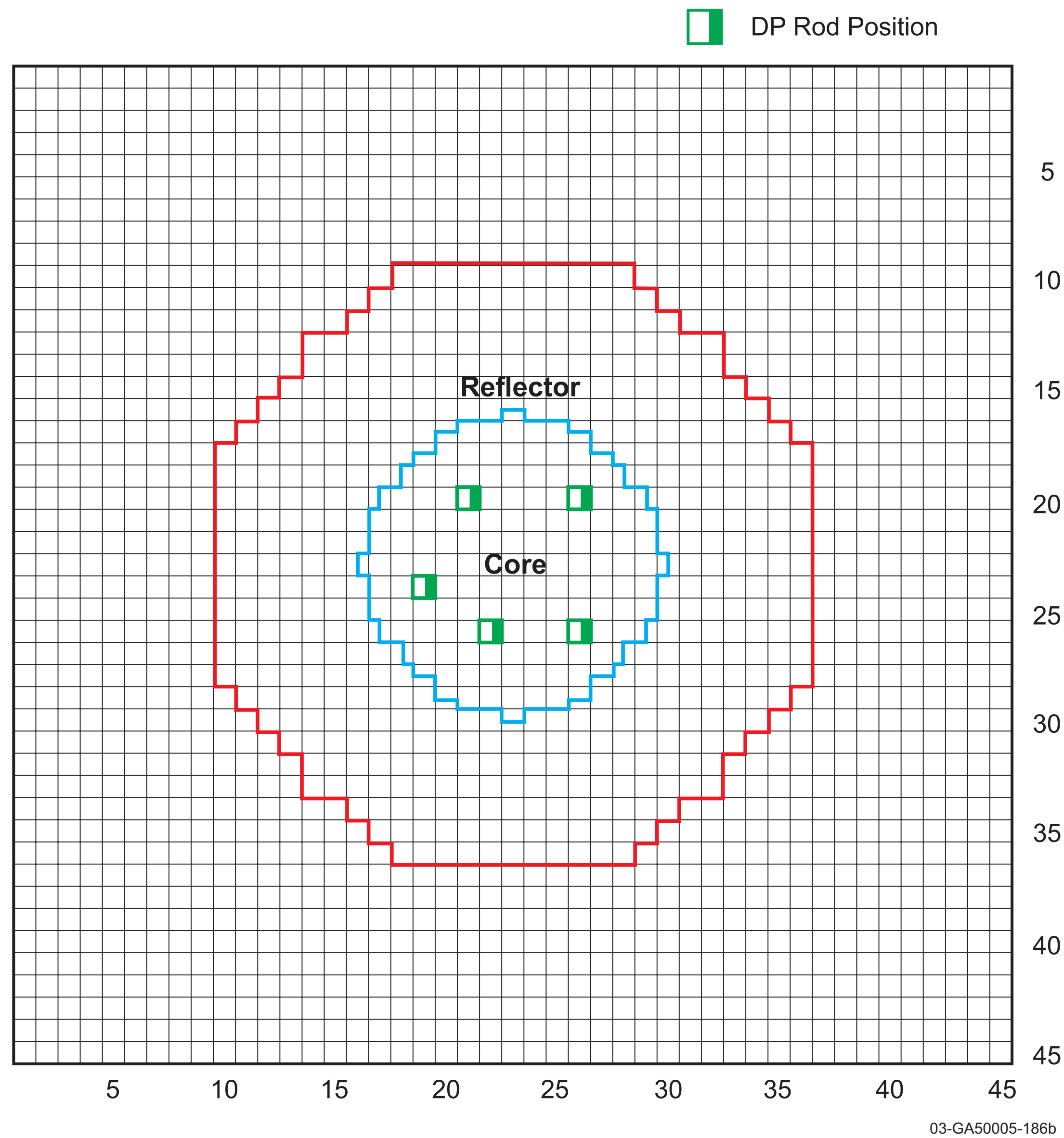

Figure 4. ZPR-9 Assembly 6 (Loading No. 13) Reference Configuration Matrix Loading.

An idea of what the loadings were like at the plate level is given in Figures 5 and 6. Each of these figures is a slice through a matrix position in the core region, showing the matrix tube, drawer and plates, forming a unit cell. The small gap between the top of the plates and the bottom of the upper wall of the matrix tube served as a flow path for cooling air. The standard plate loading in the core region consisted of 4 columns (1/16-inch-thick plates) of highly-enriched uranium metal (F) distributed almost uniformly in the drawer between columns (1/8-inch-thick plates) of tungsten (W) and either graphite (G) or perforated aluminum (A). The column sequence was WGFWGWGFWGWFGWGWFG for Assembly 5 and WAFWAWAFWAWFAWAWFA for Assembly 6. The replacement of graphite with perforated aluminum in going from Assembly 5 to Assembly 6 is apparent here.

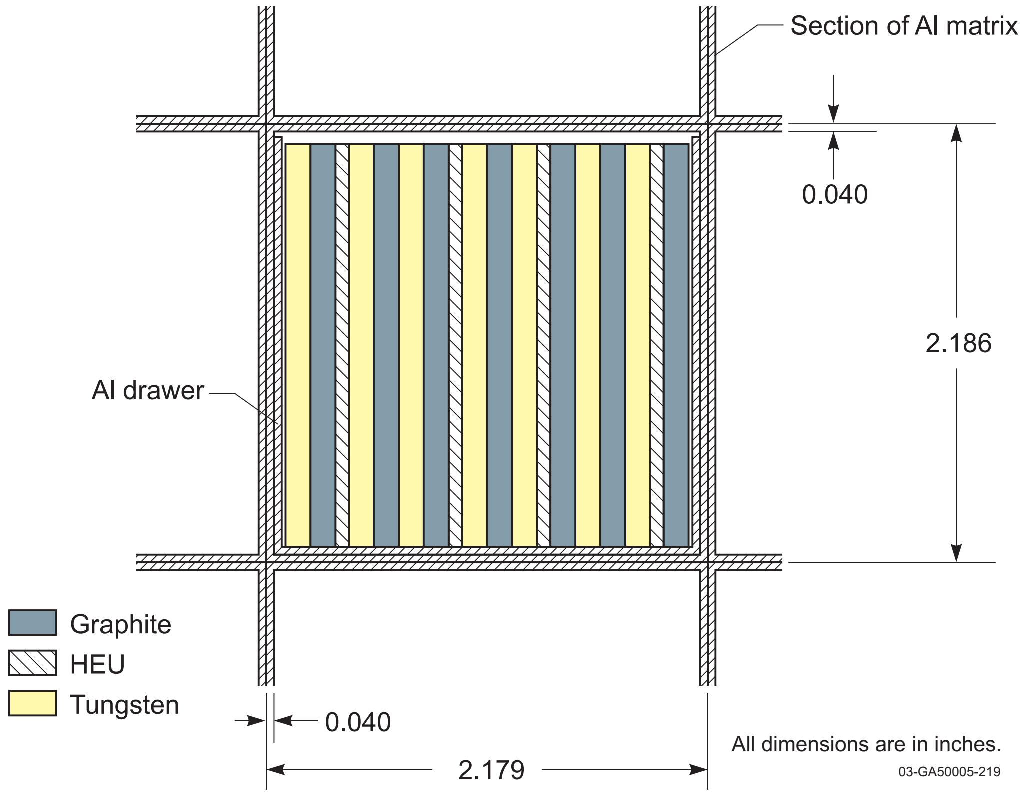

Figure 5. Cross Section of Core Unit-Cell Showing Matrix and Plate-loaded Drawer of ZPR-9 Assembly 5.

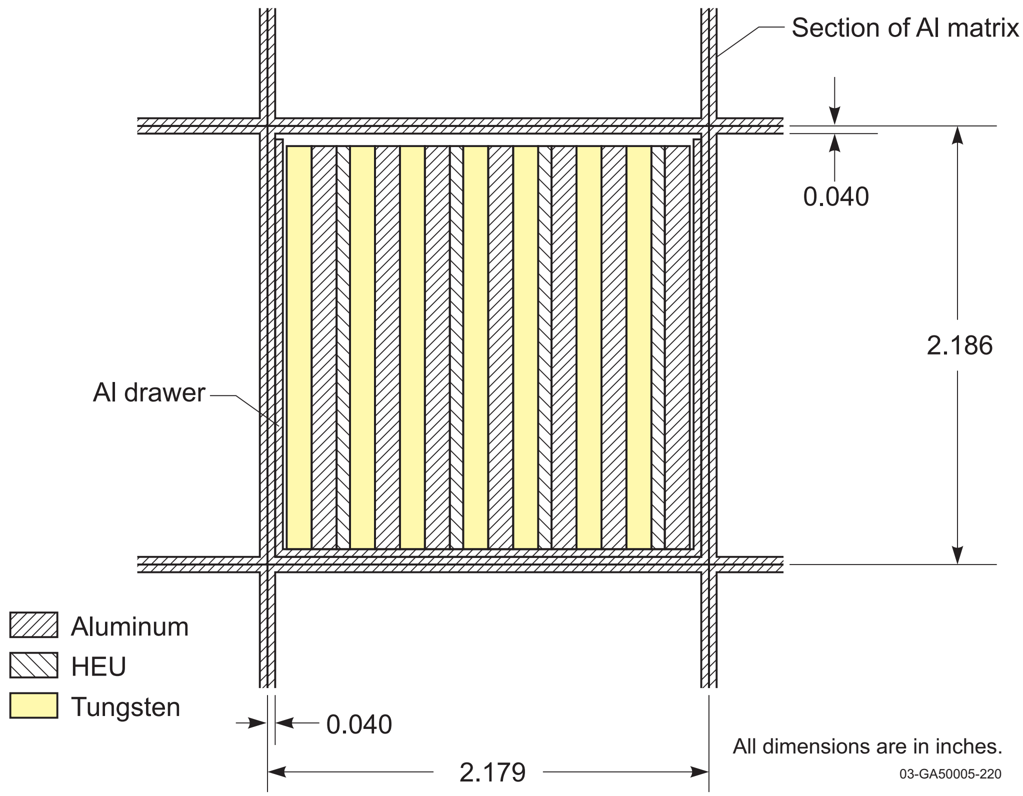

Figure 6. Cross Section of Core Unit-Cell Showing Matrix and Plate-loaded Drawer of ZPR-9 Assembly 6.

Details of the specific drawer loaded into each matrix location of both the movable and stationary halves of the assembly are given in Tables 1 through 4 for ZPR-9/5 and in Tables 5 through 8 for ZPR-9/6. For a given assembly, a unique one-character symbol is used there to represent each drawer master. A broad look at these tables reveals large portions dominated by a single symbol, i.e., by one drawer master. An empty matrix position is identified by the symbol “z”. Several tables are used to define completely the drawer masters represented by each of the other symbols in Tables 1 through 8. Table 9 gives the identification symbol (used in Tables 1 through 4), the ZPR drawer-master number, the length and type of drawer, and the number of occurrences of this drawer master in ZPR-9/5 Loading 8. Table 10 is the corresponding table for ZPR-9/6 Loading 13. Tables 11 and 12 provide the remainder of the geometric detail about each drawer master. Table 11 covers the entire group of drawer masters loaded in the core region of Assembly 5; Table 12 is the corresponding table for the core region of Assembly 6. In each table the drawer masters are identified both in terms of the one-character symbol and by the drawer master number. The interpretation of the information will be illustrated by explaining the first drawer master in Table 11 with the aid of the corresponding drawer master diagram.

Table 1. Moveable-Half Front-Drawer Matrix Map for ZPR-9 Assembly 5.

→ X
↓
Y

COLUMN

	ROW	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	10	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z
	11	z	z	z	z	z	z	z	z	q	q	q	q	q	q	q	q	q	q	q	z	z	z	z	z	z	z	z
	12	z	z	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z	z
	13	z	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z
	14	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z
	15	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z
	16	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z
	17	z	z	r	r	r	r	r	r	r	r	r	r	B	B	B	r	r	r	r	r	r	r	r	r	r	z	z
	18	z	q	r	r	r	r	r	r	r	r	B	B	B	B	B	B	B	r	r	r	r	r	r	r	r	q	z
	19	z	q	r	r	r	r	r	r	r	B	B	B	B	B	B	B	B	B	r	r	r	r	r	r	r	q	z
	20	z	q	r	r	r	r	r	r	B	B	B	D	B	B	B	B	B	B	B	r	r	r	r	r	r	q	z
R	21	z	q	r	r	r	r	r	r	B	B	B	B	B	B	B	B	B	B	B	r	r	r	r	r	r	q	z
	22	z	q	r	r	r	r	r	G	B	B	B	B	B	B	B	B	B	B	B	H	r	r	r	r	r	q	z
O	23	z	t	s	s	s	s	s	B	B	B	B	B	B	D	B	B	B	B	D	B	r	r	r	r	r	q	z
	24	z	q	r	r	r	r	r	G	B	B	B	B	B	B	B	B	B	B	B	H	r	r	r	r	r	q	z
W	25	z	q	r	r	r	r	r	r	B	B	B	D	B	B	B	D	B	B	B	r	r	r	r	r	r	q	z
	26	z	q	r	r	r	r	r	r	B	B	B	B	B	B	B	B	B	B	B	r	r	r	r	r	r	q	z
	27	z	q	r	r	r	r	r	r	r	B	B	B	B	B	B	B	B	B	r	r	r	r	r	r	r	q	z
	28	z	q	r	r	r	r	r	r	r	r	B	B	B	B	B	B	B	r	r	r	r	r	r	r	r	q	z
	29	z	z	r	r	r	r	r	r	r	r	r	r	B	B	B	r	r	r	r	r	r	r	r	r	r	z	z
	30	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z
	31	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z
	32	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z
	33	z	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z
	34	z	z	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z	z
	35	z	z	z	z	z	z	z	z	q	q	q	q	q	q	q	q	q	q	q	z	z	z	z	z	z	z	z
	36	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z

Table 2. Moveable-Half Back-Drawer Matrix Map for ZPR-9 Assembly 5.

→ X
↓
Y

COLUMN

ROW	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
10	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z
11	z	z	z	z	z	z	z	z	q	q	q	q	q	q	q	q	q	q	q	z	z	z	z	z	z	z	z
12	z	z	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z	z	z
13	z	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z	z
14	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z
15	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z
16	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z
17	z	z	r	r	r	r	r	r	r	r	r	r	R	R	R	r	r	r	r	r	r	r	r	r	r	z	z
18	z	q	r	r	r	r	r	r	r	r	R	R	R	R	R	R	R	r	r	r	r	r	r	r	r	q	z
19	z	q	r	r	r	r	r	r	r	R	R	R	R	R	R	R	R	R	r	r	r	r	r	r	r	q	z
20	z	q	r	r	r	r	r	r	R	R	R	n	R	R	R	R	R	R	R	r	r	r	r	r	r	q	z
R 21	z	q	r	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	r	q	z
22	z	q	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	q	z
O 23	z	t	s	s	s	s	s	R	R	R	R	R	R	n	R	R	R	R	n	R	r	r	r	r	r	q	z
24	z	q	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	q	z
W 25	z	q	r	r	r	r	r	r	R	R	R	n	R	R	R	n	R	R	R	r	r	r	r	r	r	q	z
26	z	q	r	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	r	q	z
27	z	q	r	r	r	r	r	r	r	R	R	R	R	R	R	R	R	R	r	r	r	r	r	r	r	q	z
28	z	q	r	r	r	r	r	r	r	r	R	R	R	R	R	R	R	r	r	r	r	r	r	r	r	q	z
29	z	z	r	r	r	r	r	r	r	r	r	r	R	R	R	r	r	r	r	r	r	r	r	r	r	z	z
30	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z
31	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z
32	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z
33	z	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z	z
34	z	z	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z	z	z
35	z	z	z	z	z	z	z	z	q	q	q	q	q	q	q	q	q	q	q	z	z	z	z	z	z	z	z
36	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z

Table 3. Stationary-Half Front-Drawer Matrix Map for ZPR-9 Assembly 5.

→ X
↓
Y

COLUMN

ROW	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
10	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
11	Z	Z	Z	Z	Z	Z	Z	Z	q	q	q	q	q	q	q	q	q	q	q	Z	Z	Z	Z	Z	Z	Z	Z
12	Z	Z	Z	Z	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z	Z	Z	Z	Z
13	Z	Z	Z	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z	Z	Z	Z
14	Z	Z	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z	Z	Z
15	Z	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z	Z
16	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z
17	Z	Z	r	r	r	r	r	r	r	r	r	r	A	A	A	r	r	r	r	r	r	r	r	r	r	Z	Z
18	Z	q	r	r	r	r	r	r	r	r	A	A	A	A	A	A	A	r	r	r	r	r	r	r	r	q	Z
19	Z	q	r	r	r	r	r	r	r	A	A	A	A	A	A	A	A	A	r	r	r	r	r	r	r	q	Z
20	Z	q	r	r	r	r	r	r	A	A	A	C	A	A	A	A	C	A	A	r	r	r	r	r	r	q	Z
R 21	Z	q	r	r	r	r	r	r	A	A	A	A	A	A	A	A	A	A	A	r	r	r	r	r	r	q	Z
22	Z	q	r	r	r	r	r	F	A	A	A	A	A	A	A	A	A	A	A	E	r	r	r	r	r	q	Z
O 23	Z	t	s	s	s	s	s	A	A	A	A	A	A	A	A	A	A	A	A	A	r	r	r	r	r	q	Z
24	Z	q	r	r	r	r	r	F	A	C	A	A	A	A	A	A	A	A	A	E	r	r	r	r	r	q	Z
W 25	Z	q	r	r	r	r	r	r	A	A	A	A	A	A	A	A	A	A	A	r	r	r	r	r	r	q	Z
26	Z	q	r	r	r	r	r	r	A	A	A	A	C	A	A	A	C	A	A	r	r	r	r	r	r	q	Z
27	Z	q	r	r	r	r	r	r	r	A	A	A	A	A	A	A	A	A	r	r	r	r	r	r	r	q	Z
28	Z	q	r	r	r	r	r	r	r	r	A	A	A	A	A	A	A	r	r	r	r	r	r	r	r	q	Z
29	Z	Z	r	r	r	r	r	r	r	r	r	r	A	A	A	r	r	r	r	r	r	r	r	r	r	Z	Z
30	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z
31	Z	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z	Z
32	Z	Z	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z	Z	Z
33	Z	Z	Z	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z	Z	Z	Z
34	Z	Z	Z	Z	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z	Z	Z	Z	Z
35	Z	Z	Z	Z	Z	Z	Z	Z	q	q	q	q	q	q	q	q	q	q	q	Z	Z	Z	Z	Z	Z	Z	Z
36	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z

Table 4. Stationary-Half Back-Drawer Matrix Map for ZPR-9 Assembly 5.

→ X
↓
Y

COLUMN

		10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	10	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z
	11	z	z	z	z	z	z	z	z	q	q	q	q	q	q	q	q	q	q	q	z	z	z	z	z	z	z	z
	12	z	z	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z	z
	13	z	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z
	14	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z
	15	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z
	16	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z
	17	z	z	r	r	r	r	r	r	r	r	r	r	R	R	R	r	r	r	r	r	r	r	r	r	r	z	z
	18	z	q	r	r	r	r	r	r	r	r	R	R	R	R	R	R	R	r	r	r	r	r	r	r	r	q	z
	19	z	q	r	r	r	r	r	r	r	R	R	R	R	R	R	R	R	R	r	r	r	r	r	r	r	q	z
	20	z	q	r	r	r	r	r	r	R	R	R	n	R	R	R	R	n	R	R	r	r	r	r	r	r	q	z
R	21	z	q	r	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	r	q	z
	22	z	q	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	q	z
O	23	z	t	s	s	s	s	s	R	R	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	q	z
	24	z	q	r	r	r	r	r	R	R	n	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	q	z
W	25	z	q	r	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	r	q	z
	26	z	q	r	r	r	r	r	r	R	R	R	R	n	R	R	R	n	R	R	r	r	r	r	r	r	q	z
	27	z	q	r	r	r	r	r	r	r	R	R	R	R	R	R	R	R	R	r	r	r	r	r	r	r	q	z
	28	z	q	r	r	r	r	r	r	r	r	R	R	R	R	R	R	R	r	r	r	r	r	r	r	r	q	z
	29	z	z	r	r	r	r	r	r	r	r	r	r	R	R	R	r	r	r	r	r	r	r	r	r	r	z	z
	30	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z
	31	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z
	32	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z
	33	z	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z
	34	z	z	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z	z
	35	z	z	z	z	z	z	z	z	q	q	q	q	q	q	q	q	q	q	q	z	z	z	z	z	z	z	z
	36	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z

Table 5. Moveable-Half Front-Drawer Matrix Map for ZPR-9 Assembly 6.

→ X
↓
Y

COLUMN

		09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
	09	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z
	10	z	z	z	z	z	z	z	z	z	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	z	z	z	z	z	z	z	z	z
	11	z	z	z	z	z	z	z	z	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	z	z	z	z	z	z	z	z
	12	z	z	z	z	z	z	z	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	z	z	z	z	z	z	z
	13	z	z	z	z	z	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	z	z	z	z	z
	14	z	z	z	z	z	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	z	z	z	z	z
	15	z	z	z	z	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	z	z	z	z
	16	z	z	z	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	L	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	z	z	z
	17	z	z	**q**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	L	B	B	B	B	B	L	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**q**	z	z
	18	z	**q**	**q**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	L	B	B	B	B	B	B	B	L	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**q**	**q**	z
	19	z	**q**	**q**	**r**	**r**	**r**	**r**	**r**	**r**	G	B	B	B	B	B	B	B	B	B	H	**r**	**r**	**r**	**r**	**r**	**r**	**q**	**q**	z
	20	z	**q**	**q**	**r**	**r**	**r**	**r**	**r**	G	B	B	B	**D**	B	B	B	B	B	B	B	H	**r**	**r**	**r**	**r**	**r**	**q**	**q**	z
R	**21**	z	**q**	**q**	**r**	**r**	**r**	**r**	**r**	B	B	B	B	B	B	B	B	B	B	B	B	B	**r**	**r**	**r**	**r**	**r**	**q**	**q**	z
	22	z	**q**	**q**	**r**	**r**	**r**	**r**	**r**	B	B	B	B	B	B	B	B	B	B	B	B	B	**r**	**r**	**r**	**r**	**r**	**q**	**q**	z
O	**23**	z	**t**	**t**	**s**	**s**	**s**	**s**	G	B	B	B	B	B	B	**D**	B	B	B	B	**D**	B	H	**r**	**r**	**r**	**r**	**q**	**q**	z
	24	z	**q**	**q**	**r**	**r**	**r**	**r**	**r**	B	B	B	B	B	B	B	B	B	B	B	B	B	**r**	**r**	**r**	**r**	**r**	**q**	**q**	z
W	**25**	z	**q**	**q**	**r**	**r**	**r**	**r**	**r**	B	B	B	B	**D**	B	B	B	**D**	B	B	B	B	**r**	**r**	**r**	**r**	**r**	**q**	**q**	z
	26	z	**q**	**q**	**r**	**r**	**r**	**r**	**r**	G	B	B	B	B	B	B	B	B	B	B	B	H	**r**	**r**	**r**	**r**	**r**	**q**	**q**	z
	27	z	**q**	**q**	**r**	**r**	**r**	**r**	**r**	**r**	G	B	B	B	B	B	B	B	B	B	H	**r**	**r**	**r**	**r**	**r**	**r**	**q**	**q**	z
	28	z	**q**	**q**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	K	B	B	B	B	B	B	B	K	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**q**	**q**	z
	29	z	z	**q**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	K	B	B	B	B	B	K	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**q**	z	z
	30	z	z	z	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	K	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	z	z	z
	31	z	z	z	z	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	z	z	z	z
	32	z	z	z	z	z	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	z	z	z	z	z
	33	z	z	z	z	z	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	z	z	z	z	z
	34	z	z	z	z	z	z	z	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	**r**	z	z	z	z	z	z	z
	35	z	z	z	z	z	z	z	z	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	z	z	z	z	z	z	z	z
	36	z	z	z	z	z	z	z	z	z	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	**q**	z	z	z	z	z	z	z	z	z
	37	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z

Table 6. Moveable-Half Back-Drawer Matrix Map for ZPR-9 Assembly 6.

→ X
↓
Y

COLUMN

ROW	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
09	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z
10	z	z	z	z	z	z	z	z	z	q	q	q	q	q	q	q	q	q	q	q	q	z	z	z	z	z	z	z	z
11	z	z	z	z	z	z	z	z	q	q	q	q	q	q	q	q	q	q	q	q	q	q	z	z	z	z	z	z	z
12	z	z	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z	z
13	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z
14	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z
15	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z
16	z	z	z	r	r	r	r	r	r	r	r	r	r	r	R	r	r	r	r	r	r	r	r	r	r	r	z	z	z
17	z	z	q	r	r	r	r	r	r	r	r	R	R	R	R	R	R	R	r	r	r	r	r	r	r	r	q	z	z
18	z	q	q	r	r	r	r	r	r	r	R	R	R	R	R	R	R	R	R	r	r	r	r	r	r	r	q	q	z
19	z	q	q	r	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	r	q	q	z
20	z	q	q	r	r	r	r	r	R	R	R	R	n	R	R	R	R	R	R	R	R	r	r	r	r	r	q	q	z
R 21	z	q	q	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	q	q	z
22	z	q	q	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	q	q	z
O 23	z	t	t	s	s	s	s	R	R	R	R	R	R	R	n	R	R	R	R	n	R	R	r	r	r	r	q	q	z
24	z	q	q	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	q	q	z
W 25	z	q	q	r	r	r	r	r	R	R	R	R	n	R	R	R	n	R	R	R	R	r	r	r	r	r	q	q	z
26	z	q	q	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	q	q	z
27	z	q	q	r	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	r	q	q	z
28	z	q	q	r	r	r	r	r	r	r	R	R	R	R	R	R	R	R	R	r	r	r	r	r	r	r	q	q	z
29	z	z	q	r	r	r	r	r	r	r	r	R	R	R	R	R	R	R	r	r	r	r	r	r	r	r	q	z	z
30	z	z	z	r	r	r	r	r	r	r	r	r	r	r	R	r	r	r	r	r	r	r	r	r	r	r	z	z	z
31	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z
32	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z
33	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z
34	z	z	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z	z
35	z	z	z	z	z	z	z	z	q	q	q	q	q	q	q	q	q	q	q	q	q	q	z	z	z	z	z	z	z
36	z	z	z	z	z	z	z	z	z	q	q	q	q	q	q	q	q	q	q	q	q	z	z	z	z	z	z	z	z
37	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z

Table 7. Stationary-Half Front-Drawer Matrix Map for ZPR-9 Assembly 6.

→ X
↓
Y

COLUMN

ROW	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
09	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
10	Z	Z	Z	Z	Z	Z	Z	Z	Z	q	q	q	q	q	q	q	q	q	q	q	Z	Z	Z	Z	Z	Z	Z	Z	Z
11	Z	Z	Z	Z	Z	Z	Z	Z	q	q	q	q	q	q	q	q	q	q	q	q	q	Z	Z	Z	Z	Z	Z	Z	Z
12	Z	Z	Z	Z	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z	Z	Z	Z	Z
13	Z	Z	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z	Z	Z
14	Z	Z	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z	Z	Z
15	Z	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z	Z
16	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	J	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z
17	Z	Z	q	r	r	r	r	r	r	r	r	J	A	A	A	A	A	J	r	r	r	r	r	r	r	r	q	Z	Z
18	Z	q	q	r	r	r	r	r	r	r	J	A	A	A	A	A	A	A	J	r	r	r	r	r	r	r	q	q	Z
19	Z	q	q	r	r	r	r	r	r	F	A	A	A	A	A	A	A	A	A	E	r	r	r	r	r	r	q	q	Z
20	Z	q	q	r	r	r	r	r	F	A	A	A	C	A	A	A	A	C	A	A	E	r	r	r	r	r	q	q	Z
R 21	Z	q	q	r	r	r	r	r	A	A	A	A	A	A	A	A	A	A	A	A	A	r	r	r	r	r	q	q	Z
22	Z	q	q	r	r	r	r	r	A	A	A	A	A	A	A	A	A	A	A	A	A	r	r	r	r	r	q	q	Z
O 23	Z	t	t	s	s	s	s	F	A	A	A	A	A	A	A	A	A	A	A	A	A	E	r	r	r	r	q	q	Z
24	Z	q	q	r	r	r	r	r	A	A	C	A	A	A	A	A	A	A	A	A	A	r	r	r	r	r	q	q	Z
W 25	Z	q	q	r	r	r	r	r	A	A	A	A	A	A	A	A	A	A	A	A	A	r	r	r	r	r	q	q	Z
26	Z	q	q	r	r	r	r	r	F	A	A	A	A	C	A	A	A	C	A	A	E	r	r	r	r	r	q	q	Z
27	Z	q	q	r	r	r	r	r	r	F	A	A	A	A	A	A	A	A	A	E	r	r	r	r	r	r	q	q	Z
28	Z	q	q	r	r	r	r	r	r	r	I	A	A	A	A	A	A	A	I	r	r	r	r	r	r	r	q	q	Z
29	Z	Z	q	r	r	r	r	r	r	r	r	I	A	A	A	A	A	I	r	r	r	r	r	r	r	r	q	Z	Z
30	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	I	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z
31	Z	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z	Z
32	Z	Z	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z	Z	Z
33	Z	Z	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z	Z	Z
34	Z	Z	Z	Z	Z	Z	Z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	Z	Z	Z	Z	Z	Z	Z
35	Z	Z	Z	Z	Z	Z	Z	Z	q	q	q	q	q	q	q	q	q	q	q	q	q	Z	Z	Z	Z	Z	Z	Z	Z
36	Z	Z	Z	Z	Z	Z	Z	Z	Z	q	q	q	q	q	q	q	q	q	q	q	Z	Z	Z	Z	Z	Z	Z	Z	Z
37	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z

Table 8. Stationary-Half Back-Drawer Matrix Map for ZPR-9 Assembly 6.

→ X
↓
Y

COLUMN

		09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
	09	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z
	10	z	z	z	z	z	z	z	z	z	q	q	q	q	q	q	q	q	q	q	q	z	z	z	z	z	z	z	z	z
	11	z	z	z	z	z	z	z	z	q	q	q	q	q	q	q	q	q	q	q	q	q	z	z	z	z	z	z	z	z
	12	z	z	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z	z
	13	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z
	14	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z
	15	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z
	16	z	z	z	r	r	r	r	r	r	r	r	r	r	r	R	r	r	r	r	r	r	r	r	r	r	r	z	z	z
	17	z	z	q	r	r	r	r	r	r	r	r	R	R	R	R	R	R	R	r	r	r	r	r	r	r	r	q	z	z
	18	z	q	q	r	r	r	r	r	r	r	R	R	R	R	R	R	R	R	R	r	r	r	r	r	r	r	q	q	z
	19	z	q	q	r	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	r	q	q	z
	20	z	q	q	r	r	r	r	r	R	R	R	R	n	R	R	R	R	n	R	R	R	r	r	r	r	r	q	q	z
R	21	z	q	q	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	q	q	z
	22	z	q	q	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	q	q	z
O	23	z	t	t	s	s	s	s	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	q	q	z
	24	z	q	q	r	r	r	r	r	R	R	n	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	q	q	z
W	25	z	q	q	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	q	q	z
	26	z	q	q	r	r	r	r	r	R	R	R	R	R	n	R	R	R	n	R	R	R	r	r	r	r	r	q	q	z
	27	z	q	q	r	r	r	r	r	r	R	R	R	R	R	R	R	R	R	R	R	r	r	r	r	r	r	q	q	z
	28	z	q	q	r	r	r	r	r	r	r	R	R	R	R	R	R	R	R	R	r	r	r	r	r	r	r	q	q	z
	29	z	z	q	r	r	r	r	r	r	r	r	R	R	R	R	R	R	R	r	r	r	r	r	r	r	r	q	z	z
	30	z	z	z	r	r	r	r	r	r	r	r	r	r	r	R	r	r	r	r	r	r	r	r	r	r	r	z	z	z
	31	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z
	32	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z
	33	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z
	34	z	z	z	z	z	z	z	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	z	z	z	z	z	z	z
	35	z	z	z	z	z	z	z	z	q	q	q	q	q	q	q	q	q	q	q	q	q	z	z	z	z	z	z	z	z
	36	z	z	z	z	z	z	z	z	z	q	q	q	q	q	q	q	q	q	q	q	z	z	z	z	z	z	z	z	z
	37	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z	z

Table 9. Drawer Identification and Type Data for ZPR-9 Assembly 5.

Identification Symbol	Drawer Master Number	Role of Drawer	Length (inches)	Type of Drawer	Number in Loading No. 8
Core Drawer Masters					
A	500-Core-FS	Normal Core	15.251	Al	112
B	501-Core-FM	Normal Core	15.251	Al	112
C	502-CR-FS	Control Rod Core	40.750	SST	5
D	503-CR-FM	Control Rod Core	40.750	SST	5
E	504-Core-FS	Partial Core Drawer	15.251	Al	2
F	505-Core-FS	Partial Core Drawer	15.251	Al	2
G	506-Core-FM	Partial Core Drawer	15.251	Al	2
H	507-Core-FM	Partial Core Drawer	15.251	Al	2
Source and Fission Counter Drawer Masters					
n	190-CR-BS/M	DP Drive Shaft	24.376	Al	10
Reflector Drawer Masters					
q	105-Refl-FS/M	Radial Reflector	24.376	Al	86
r	106-Refl-FS/M	Radial Reflector	24.376	Al	686
R	107-Refl-FS/M	Axial Reflector	23.314	Al	224
s	190-SRC-FS/M	Reflector with Src Hole	24.376	Al	10
t	192-SRC-FS/M	Reflector with Src Hole	24.376	Al	2

Table 10. Drawer Identification and Type Data for ZPR-9 Assembly 6.

Identification Symbol	Drawer Master Number	Role of Drawer	Length (inches)	Type of Drawer	Number in Loading No. 13
Core Drawer Masters					
A	600-Core-FS	Normal Core	15.251	Al	124
B	601-Core-FM	Normal Core	15.251	Al	124
C	602-CR-FS	Control Rod Core	40.750	SST	5
D	603-CR-FM	Control Rod Core	40.750	SST	5
E	604-Core-FS	Partial Core Drawer	15.251	Al	5
F	605-Core-FS	Partial Core Drawer	15.251	Al	5
G	606-Core-FM	Partial Core Drawer	15.251	Al	5
H	607-Core-FM	Partial Core Drawer	15.251	Al	5
I	608-Core-FS	Partial Core Drawer	15.251	Al	5
J	609-Core-FS	Partial Core Drawer	15.251	Al	5
K	610-Core-FM	Partial Core Drawer	15.251	Al	5
L	611-Core-FM	Partial Core Drawer	15.251	Al	5
Source and Fission Counter Drawer Masters					
n	191-CR-BS/M	DP Drive Shaft	19.000	Al	10
Reflector Drawer Masters					
q	105-Refl-FS/M	Radial Reflector	24.376	Al	188
r	106-Refl-FS/M	Radial Reflector	24.376	Al	680
R	107-Refl-BS/M	Axial Reflector	23.314	Al	288
s	190-SRC-BS/M	Reflector with Src Hole	24.376	Al	8
t	192-SRC-BS/M	Reflector with Src Hole	24.376	Al	4

Table 11. Core Drawer Plate Loading Descriptions for ZPR-9 Assembly 5.

Plate ID (size in inches)	Starting X Location	Starting Y Location	Starting Z Location	X#	Y#	Z#
Identification Symbol A, Drawer Master 500-Core-FS						
Tungsten (1/8x2x3)	0	0	0	1	1	3
Tungsten (1/8x2x2)	0	0	9	1	1	1
Aluminum (2x2x4)	0	0	11	1	1	1
Graphite NC (1/8x2x3)	0.125	0	0	1	1	3
Graphite NC (1/8x2x2)	0.125	0	9	1	1	1
93% Enriched U (1/16x2x3)	0.25	0	0	1	1	3
93% Enriched U (1/16x2x2)	0.25	0	9	1	1	1
Tungsten (1/8x2x3)	0.3125	0	0	1	1	3
Tungsten (1/8x2x2)	0.3125	0	9	1	1	1
Graphite NC (1/8x2x3)	0.4375	0	0	1	1	3
Graphite NC (1/8x2x2)	0.4375	0	9	1	1	1
Tungsten (1/8x2x3)	0.5625	0	0	1	1	3
Tungsten (1/8x2x2)	0.5625	0	9	1	1	1
Graphite NC (1/8x2x3)	0.6875	0	0	1	1	3
Graphite NC (1/8x2x2)	0.6875	0	9	1	1	1
93% Enriched U (1/16x2x3)	0.8125	0	0	1	1	3
93% Enriched U (1/16x2x2)	0.8125	0	9	1	1	1
Tungsten (1/8x2x3)	0.875	0	0	1	1	3
Tungsten (1/8x2x2)	0.875	0	9	1	1	1
Graphite NC (1/8x2x3)	1	0	0	1	1	3
Graphite NC (1/8x2x2)	1	0	9	1	1	1
Tungsten (1/8x2x3)	1.125	0	0	1	1	3
Tungsten (1/8x2x2)	1.125	0	9	1	1	1
93% Enriched U (1/16x2x3)	1.25	0	0	1	1	3
93% Enriched U (1/16x2x2)	1.25	0	9	1	1	1
Graphite NC (1/8x2x3)	1.3125	0	0	1	1	3
Graphite NC (1/8x2x2)	1.3125	0	9	1	1	1
Tungsten (1/8x2x3)	1.4375	0	0	1	1	3
Tungsten (1/8x2x2)	1.4375	0	9	1	1	1
Graphite NC (1/8x2x3)	1.5625	0	0	1	1	3
Graphite NC (1/8x2x2)	1.5625	0	9	1	1	1
Tungsten (1/8x2x3)	1.6875	0	0	1	1	3
Tungsten (1/8x2x2)	1.6875	0	9	1	1	1
93% Enriched U (1/16x2x3)	1.8125	0	0	1	1	3
93% Enriched U (1/16x2x2)	1.8125	0	9	1	1	1
Graphite NC (1/8x2x3)	1.875	0	0	1	1	3
Graphite NC (1/8x2x2)	1.875	0	9	1	1	1
Retainer Spring (2x2x1/16)	0	0	15.251	1	1	1

Table 11 (cont'd). Core Drawer Plate Loading Descriptions for ZPR-9 Assembly 5.

Plate ID (size in inches)	Starting X Location	Starting Y Location	Starting Z Location	X#	Y#	Z#
Identification Symbol B, Drawer Master 501-Core-FM						
Graphite NC (1/8x2x3)	0	0	0	1	1	3
Graphite NC (1/8x2x2)	0	0	9	1	1	1
Aluminum (2x2x4)	0	0	11	1	1	1
93% Enriched U (1/16x2x3)	0.125	0	0	1	1	3
93% Enriched U (1/16x2x2)	0.125	0	9	1	1	1
Tungsten (1/8x2x3)	0.1875	0	0	1	1	3
Tungsten (1/8x2x2)	0.1875	0	9	1	1	1
Graphite NC (1/8x2x3)	0.3125	0	0	1	1	3
Graphite NC (1/8x2x2)	0.3125	0	9	1	1	1
Tungsten (1/8x2x3)	0.4375	0	0	1	1	3
Tungsten (1/8x2x2)	0.4375	0	9	1	1	1
Graphite NC (1/8x2x3)	0.5625	0	0	1	1	3
Graphite NC (1/8x2x2)	0.5625	0	9	1	1	1
93% Enriched U (1/16x2x3)	0.6875	0	0	1	1	3
93% Enriched U (1/16x2x2)	0.6875	0	9	1	1	1
Tungsten (1/8x2x3)	0.75	0	0	1	1	3
Tungsten (1/8x2x2)	0.75	0	9	1	1	1
Graphite NC (1/8x2x3)	0.875	0	0	1	1	3
Graphite NC (1/8x2x2)	0.875	0	9	1	1	1
Tungsten (1/8x2x3)	1	0	0	1	1	3
Tungsten (1/8x2x2)	1	0	9	1	1	1
93% Enriched U (1/16x2x3)	1.125	0	0	1	1	3
93% Enriched U (1/16x2x2)	1.125	0	9	1	1	1
Graphite NC (1/8x2x3)	1.1875	0	0	1	1	3
Graphite NC (1/8x2x2)	1.1875	0	9	1	1	1
Tungsten (1/8x2x3)	1.3125	0	0	1	1	3
Tungsten (1/8x2x2)	1.3125	0	9	1	1	1
Graphite NC (1/8x2x3)	1.4375	0	0	1	1	3
Graphite NC (1/8x2x2)	1.4375	0	9	1	1	1
Tungsten (1/8x2x3)	1.5625	0	0	1	1	3
Tungsten (1/8x2x2)	1.5625	0	9	1	1	1
93% Enriched U (1/16x2x3)	1.6875	0	0	1	1	3
93% Enriched U (1/16x2x2)	1.6875	0	9	1	1	1
Graphite NC (1/8x2x3)	1.75	0	0	1	1	3
Graphite NC (1/8x2x2)	1.75	0	9	1	1	1
Tungsten (1/8x2x3)	1.875	0	0	1	1	3
Tungsten (1/8x2x2)	1.875	0	9	1	1	1
Retainer Spring (2x2x1/16)	0	0	15.251	1	1	1

Table 11 (cont'd). Core Drawer Plate Loading Descriptions for ZPR-9 Assembly 5.

Plate ID (size in inches)	Starting X Location	Starting Y Location	Starting Z Location	X#	Y#	Z#
Identification Symbol C, Drawer Master 502-CR-FS						
Tungsten (1/16x2x3)	0	0	0	1	1	3
Tungsten (1/16x2x2)	0	0	9	1	1	1
Aluminum DP cut (1.9375x2x1)	0	0	11	1	1	9
Fe DP T-bar (1.9375x2x1/4)	0	0	20	1	1	1
Fe DP T-bar (1.9375x2x1/4)	0	0	40.25	1	1	1
Graphite NC (1/8x2x3)	0.0625	0	0	1	1	3
Graphite NC (1/8x2x2)	0.0625	0	9	1	1	1
93% Enriched U (1/16x2x3)	0.1875	0	0	1	1	3
93% Enriched U (1/16x2x2)	0.1875	0	9	1	1	1
Tungsten (1/8x2x3)	0.25	0	0	1	1	3
Tungsten (1/8x2x2)	0.25	0	9	1	1	1
Graphite NC (1/8x2x3)	0.375	0	0	1	1	3
Graphite NC (1/8x2x2)	0.375	0	9	1	1	1
Tungsten (1/8x2x3)	0.5	0	0	1	1	3
Tungsten (1/8x2x2)	0.5	0	9	1	1	1
Graphite NC (1/8x2x3)	0.625	0	0	1	1	3
Graphite NC (1/8x2x2)	0.625	0	9	1	1	1
93% Enriched U (1/16x2x3)	0.75	0	0	1	1	3
93% Enriched U (1/16x2x2)	0.75	0	9	1	1	1
Tungsten (1/8x2x3)	0.8125	0	0	1	1	3
Tungsten (1/8x2x2)	0.8125	0	9	1	1	1
Fe DP T-bar (1/8x2x2)	0.875	0	20.25	2	1	10
Graphite NC (1/8x2x3)	0.9375	0	0	1	1	3
Graphite NC (1/8x2x2)	0.9375	0	9	1	1	1
Tungsten (1/8x2x3)	1.0625	0	0	1	1	3
Tungsten (1/8x2x2)	1.0625	0	9	1	1	1
93% Enriched U (1/16x2x3)	1.1875	0	0	1	1	3
93% Enriched U (1/16x2x2)	1.1875	0	9	1	1	1
Graphite NC (1/8x2x3)	1.25	0	0	1	1	3
Graphite NC (1/8x2x2)	1.25	0	9	1	1	1
Tungsten (1/8x2x3)	1.375	0	0	1	1	3
Tungsten (1/8x2x2)	1.375	0	9	1	1	1
Graphite NC (1/8x2x3)	1.5	0	0	1	1	3
Graphite NC (1/8x2x2)	1.5	0	9	1	1	1
Tungsten (1/8x2x3)	1.625	0	0	1	1	3
Tungsten (1/8x2x2)	1.625	0	9	1	1	1
93% Enriched U (1/16x2x3)	1.75	0	0	1	1	3
93% Enriched U (1/16x2x2)	1.75	0	9	1	1	1
Graphite NC (1/8x2x3)	1.8125	0	0	1	1	3
Graphite NC (1/8x2x2)	1.8125	0	9	1	1	1

Table 11 (cont'd). Core Drawer Plate Loading Descriptions for ZPR-9 Assembly 5.

Plate ID (size in inches)	Starting X Location	Starting Y Location	Starting Z Location	X#	Y#	Z#
Identification Symbol D, Drawer Master 503-CR-FM						
Graphite NC (1/8x2x3)	0	0	0	1	1	3
Graphite NC (1/8x2x2)	0	0	9	1	1	1
Aluminum DP cut (1.9375x2x1)	0	0	11	1	1	9
Fe DP T-bar (1.9375x2x1/4)	0	0	20	1	1	1
Fe DP T-bar (1.9375x2x1/4)	0	0	40.25	1	1	1
93% Enriched U (1/16x2x3)	0.125	0	0	1	1	3
93% Enriched U (1/16x2x2)	0.125	0	9	1	1	1
Tungsten (1/8x2x3)	0.1875	0	0	1	1	3
Tungsten (1/8x2x2)	0.1875	0	9	1	1	1
Graphite NC (1/8x2x3)	0.3125	0	0	1	1	3
Graphite NC (1/8x2x2)	0.3125	0	9	1	1	1
Tungsten (1/8x2x3)	0.4375	0	0	1	1	3
Tungsten (1/8x2x2)	0.4375	0	9	1	1	1
Graphite NC (1/8x2x3)	0.5625	0	0	1	1	3
Graphite NC (1/8x2x2)	0.5625	0	9	1	1	1
93% Enriched U (1/16x2x3)	0.6875	0	0	1	1	3
93% Enriched U (1/16x2x2)	0.6875	0	9	1	1	1
Tungsten (1/8x2x3)	0.75	0	0	1	1	3
Tungsten (1/8x2x2)	0.75	0	9	1	1	1
Graphite NC (1/8x2x3)	0.875	0	0	1	1	3
Graphite NC (1/8x2x2)	0.875	0	9	1	1	1
Fe DP T-bar (1/8x2x2)	0.875	0	20.25	2	1	10
Tungsten (1/8x2x3)	1	0	0	1	1	3
Tungsten (1/8x2x2)	1	0	9	1	1	1
93% Enriched U (1/16x2x3)	1.125	0	0	1	1	3
93% Enriched U (1/16x2x2)	1.125	0	9	1	1	1
Graphite NC (1/8x2x3)	1.1875	0	0	1	1	3
Graphite NC (1/8x2x2)	1.1875	0	9	1	1	1
Tungsten (1/8x2x3)	1.3125	0	0	1	1	3
Tungsten (1/8x2x2)	1.3125	0	9	1	1	1
Graphite NC (1/8x2x3)	1.4375	0	0	1	1	3
Graphite NC (1/8x2x2)	1.4375	0	9	1	1	1
Tungsten (1/8x2x3)	1.5625	0	0	1	1	3
Tungsten (1/8x2x2)	1.5625	0	9	1	1	1
93% Enriched U (1/16x2x3)	1.6875	0	0	1	1	3
93% Enriched U (1/16x2x2)	1.6875	0	9	1	1	1
Graphite NC (1/8x2x3)	1.75	0	0	1	1	3
Graphite NC (1/8x2x2)	1.75	0	9	1	1	1
Tungsten (1/16x2x3)	1.875	0	0	1	1	3
Tungsten (1/16x2x2)	1.875	0	9	1	1	1

Table 11 (cont'd). Core Drawer Plate Loading Descriptions for ZPR-9 Assembly 5.

Plate ID (size in inches)	Starting X Location	Starting Y Location	Starting Z Location	X#	Y#	Z#
Identification Symbol E, Drawer Master 504-Core-FS						
Tungsten (1/8x2x3)	0	0	0	1	1	3
Tungsten (1/8x2x2)	0	0	9	1	1	1
Aluminum (2x2x4)	0	0	11	1	1	1
Graphite NC (1/8x2x3)	0.125	0	0	1	1	3
Graphite NC (1/8x2x2)	0.125	0	9	1	1	1
93% Enriched U (1/16x2x3)	0.25	0	0	1	1	3
93% Enriched U (1/16x2x2)	0.25	0	9	1	1	1
Tungsten (1/8x2x3)	0.3125	0	0	1	1	3
Tungsten (1/8x2x2)	0.3125	0	9	1	1	1
Graphite NC (1/8x2x3)	0.4375	0	0	1	1	3
Graphite NC (1/8x2x2)	0.4375	0	9	1	1	1
Tungsten (1/8x2x3)	0.5625	0	0	1	1	3
Tungsten (1/8x2x2)	0.5625	0	9	1	1	1
Graphite NC (1/8x2x3)	0.6875	0	0	1	1	3
Graphite NC (1/8x2x2)	0.6875	0	9	1	1	1
93% Enriched U (1/16x2x3)	0.8125	0	0	1	1	3
93% Enriched U (1/16x2x2)	0.8125	0	9	1	1	1
Tungsten (1/8x2x3)	0.875	0	0	1	1	3
Tungsten (1/8x2x2)	0.875	0	9	1	1	1
Aluminum (1x1x3)	1	0	0	1	1	3
Aluminum (1x1x3)	1	1	0	1	1	3
Aluminum (1x1x2)	1	0	9	1	2	1
Retainer Spring (2x2x1/16)	0	0	15.251	1	1	1
Identification Symbol F, Drawer Master 505-Core-FS						
Aluminum (1x1x3)	0	0	0	1	1	3
Aluminum (1x1x3)	0	1	0	1	1	3
Aluminum (1x1x2)	0	0	9	1	2	1
Aluminum (2x2x4)	0	0	11	1	1	1
Graphite NC (1/8x2x3)	1	0	0	1	1	3
Graphite NC (1/8x2x2)	1	0	9	1	1	1
Tungsten (1/8x2x3)	1.125	0	0	1	1	3
Tungsten (1/8x2x2)	1.125	0	9	1	1	1
93% Enriched U (1/16x2x3)	1.25	0	0	1	1	3
93% Enriched U (1/16x2x2)	1.25	0	9	1	1	1
Graphite NC (1/8x2x3)	1.3125	0	0	1	1	3
Graphite NC (1/8x2x2)	1.3125	0	9	1	1	1
Tungsten (1/8x2x3)	1.4375	0	0	1	1	3
Tungsten (1/8x2x2)	1.4375	0	9	1	1	1
Graphite NC (1/8x2x3)	1.5625	0	0	1	1	3

Table 11 (cont'd). Core Drawer Plate Loading Descriptions for ZPR-9 Assembly 5.

Plate ID (size in inches)	**Starting X Location**	**Starting Y Location**	**Starting Z Location**	**X#**	**Y#**	**Z#**
Identification Symbol F, Drawer Master 505-Core-FS (cont'd)						
Graphite NC (1/8x2x2)	1.5625	0	9	1	1	1
Tungsten (1/8x2x3)	1.6875	0	0	1	1	3
Tungsten (1/8x2x2)	1.6875	0	9	1	1	1
93% Enriched U (1/16x2x3)	1.8125	0	0	1	1	3
93% Enriched U (1/16x2x2)	1.8125	0	9	1	1	1
Graphite NC (1/8x2x3)	1.875	0	0	1	1	3
Graphite NC (1/8x2x2)	1.875	0	9	1	1	1
Retainer Spring (2x2x1/16)	0	0	15.251	1	1	1
Identification Symbol G, Drawer Master 506-Core-FM						
Graphite NC (1/8x2x3)	0	0	0	1	1	3
Graphite NC (1/8x2x2)	0	0	9	1	1	1
Aluminum (2x2x4)	0	0	11	1	1	1
93% Enriched U (1/16x2x3)	0.125	0	0	1	1	3
93% Enriched U (1/16x2x2)	0.125	0	9	1	1	1
Tungsten (1/8x2x3)	0.1875	0	0	1	1	3
Tungsten (1/8x2x2)	0.1875	0	9	1	1	1
Graphite NC (1/8x2x3)	0.3125	0	0	1	1	3
Graphite NC (1/8x2x2)	0.3125	0	9	1	1	1
Tungsten (1/8x2x3)	0.4375	0	0	1	1	3
Tungsten (1/8x2x2)	0.4375	0	9	1	1	1
Graphite NC (1/8x2x3)	0.5625	0	0	1	1	3
Graphite NC (1/8x2x2)	0.5625	0	9	1	1	1
93% Enriched U (1/16x2x3)	0.6875	0	0	1	1	3
93% Enriched U (1/16x2x2)	0.6875	0	9	1	1	1
Tungsten (1/8x2x3)	0.75	0	0	1	1	3
Tungsten (1/8x2x2)	0.75	0	9	1	1	1
Graphite NC (1/8x2x3)	0.875	0	0	1	1	3
Graphite NC (1/8x2x2)	0.875	0	9	1	1	1
Aluminum (1x1x3)	1	0	0	1	1	3
Aluminum (1x1x3)	1	1	0	1	1	3
Aluminum (1x1x2)	1	0	9	1	2	1
Retainer Spring (2x2x1/16)	0	0	15.251	1	1	1
Identification Symbol H, Drawer Master 507-Core-FM						
Aluminum (1x1x3)	0	0	0	1	1	3
Aluminum (1x1x3)	0	1	0	1	1	3
Aluminum (1x1x2)	0	0	9	1	2	1
Aluminum (2x2x4)	0	0	11	1	1	1
Tungsten (1/8x2x3)	1	0	0	1	1	3
Tungsten (1/8x2x2)	1	0	9	1	1	1
93% Enriched U (1/16x2x3)	1.125	0	0	1	1	3
93% Enriched U (1/16x2x2)	1.125	0	9	1	1	1

Table 11 (cont'd). Core Drawer Plate Loading Descriptions for ZPR-9 Assembly 5.

Plate ID (size in inches)	Starting X Location	Starting Y Location	Starting Z Location	X#	Y#	Z#
Identification Symbol H, Drawer Master 507-Core-FM (cont'd)						
Graphite NC (1/8x2x3)	1.1875	0	0	1	1	3
Graphite NC (1/8x2x2)	1.1875	0	9	1	1	1
Tungsten (1/8x2x3)	1.3125	0	0	1	1	3
Tungsten (1/8x2x2)	1.3125	0	9	1	1	1
Graphite NC (1/8x2x3)	1.4375	0	0	1	1	3
Graphite NC (1/8x2x2)	1.4375	0	9	1	1	1
Tungsten (1/8x2x3)	1.5625	0	0	1	1	3
Tungsten (1/8x2x2)	1.5625	0	9	1	1	1
93% Enriched U (1/16x2x3)	1.6875	0	0	1	1	3
93% Enriched U (1/16x2x2)	1.6875	0	9	1	1	1
Graphite NC (1/8x2x3)	1.75	0	0	1	1	3
Graphite NC (1/8x2x2)	1.75	0	9	1	1	1
Tungsten (1/8x2x3)	1.875	0	0	1	1	3
Tungsten (1/8x2x2)	1.875	0	9	1	1	1
Retainer Spring (2x2x1/16)	0	0	15.251	1	1	1
Identification Symbol f, Drawer Master 108-FC-FS/M						
Aluminum (2x2x5)	0	0	10	1	1	2
Aluminum (2x2x4)	0	0	20	1	1	1
Retainer Spring (2x2x1/16)	0	0	24.376	1	1	1
Identification Symbol n, Drawer Master Drive Shaft						
Stainless Steel (1/4x2x1)	0.9225	0	0	1	1	19
Identification Symbol q, Drawer Master 106-Refl-FS/M						
Aluminum (2x2x4)	0	0	0	1	1	6
Retainer Spring (2x2x1/16)	0	0	24.376	1	1	1
Identification Symbol r, Drawer Master 106-Refl-FS/M						
Aluminum (2x2x4)	0	0	0	1	1	6
Retainer Spring (2x2x1/16)	0	0	24.376	1	1	1
Identification Symbol R, Drawer Master 107-Refl-FS/M						
Aluminum (1/4x2x2)	0	0	0	8	1	2
Aluminum (2x2x4)	0	0	4	1	1	1

Table 11 (cont'd). Core Drawer Plate Loading Descriptions for ZPR-9 Assembly 5.

Plate ID (size in inches)	Starting X Location	Starting Y Location	Starting Z Location	X#	Y#	Z#
Identification Symbol s, Drawer Master 190-SRC-FS/M						
Aluminum (2x2x4)	0	0	0	1	1	1
Al with Src Tube Hole (2x0.773x1)	0	0	4	1	1	1
Aluminum (2x2x3)	0	0	5	1	1	1
Aluminum (2x2x4)	0	0	8	1	1	4
Retainer Spring (2x2x1/16)	0	0	24.376	1	1	1
Identification Symbol t, Drawer Master 192-SRC-FS/M						
Aluminum (2x2x4)	0	0	0	1	1	1
Al with Src Tube Hole (2x0.773x1)	0	0	4	1	1	1
Aluminum (2x2x3)	0	0	5	1	1	1
Aluminum (2x2x4)	0	0	8	1	1	4
Retainer Spring (2x2x1/16)	0	0	24.376	1	1	1

Table 12. Core Drawer Plate Loading Descriptions for ZPR-9 Assembly 6.

Plate ID (size in inches)	Starting X Location	Starting Y Location	Starting Z Location	X#	Y#	Z#
Identification Symbol A, Drawer Master 600-Core-FS						
Tungsten (1/8x2x3)	0	0	0	1	1	2
Tungsten (1/8x2x2)	0	0	6	1	1	3
Aluminum (2x2x3)	0	0	12	1	1	1
Aluminum-45 Void-55 (1/8x2x3)	0.125	0	0	1	1	2
Aluminum-45 Void-55 (1/8x2x2)	0.125	0	6	1	1	3
93% Enriched U (1/16x2x3)	0.25	0	0	1	1	3
93% Enriched U (1/16x2x2)	0.25	0	9	1	1	1
93% Enriched U (1/16x2x1)	0.25	0	11	1	1	1
Tungsten (1/8x2x3)	0.3125	0	0	1	1	2
Tungsten (1/8x2x2)	0.3125	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	0.4375	0	0	1	1	2
Aluminum-45 Void-55 (1/8x2x2)	0.4375	0	6	1	1	3
Tungsten (1/8x2x3)	0.5625	0	0	1	1	2
Tungsten (1/8x2x2)	0.5625	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	0.6875	0	0	1	1	2
Aluminum-45 Void-55 (1/8x2x2)	0.6875	0	6	1	1	3
93% Enriched U (1/16x2x3)	0.8125	0	0	1	1	3
93% Enriched U (1/16x2x2)	0.8125	0	9	1	1	1
93% Enriched U (1/16x2x1)	0.8125	0	11	1	1	1
Tungsten (1/8x2x3)	0.875	0	0	1	1	2
Tungsten (1/8x2x2)	0.875	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	1	0	0	1	1	2
Aluminum-45 Void-55 (1/8x2x2)	1	0	6	1	1	3
Tungsten (1/8x2x3)	1.125	0	0	1	1	2
Tungsten (1/8x2x2)	1.125	0	6	1	1	3
93% Enriched U (1/16x2x3)	1.25	0	0	1	1	2
93% Enriched U (1/16x2x2)	1.25	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	1.3125	0	0	1	1	2
Aluminum-45 Void-55 (1/8x2x2)	1.3125	0	6	1	1	3
Tungsten (1/8x2x3)	1.4375	0	0	1	1	2
Tungsten (1/8x2x2)	1.4375	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	1.5625	0	0	1	1	2
Aluminum-45 Void-55 (1/8x2x2)	1.5625	0	6	1	1	3
Tungsten (1/8x2x3)	1.6875	0	0	1	1	2
Tungsten (1/8x2x2)	1.6875	0	6	1	1	3
93% Enriched U (1/16x2x3)	1.8125	0	0	1	1	2
93% Enriched U (1/16x2x2)	1.8125	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	1.875	0	0	1	1	2
Aluminum-45 Void-55 (1/8x2x2)	1.875	0	6	1	1	3
Retainer Spring (2x2x1/16)	0	0	15.251	1	1	1

Table 12 (cont'd). Core Drawer Plate Loading Descriptions for ZPR-9 Assembly 6.

Plate ID (size in inches)	Starting X Location	Starting Y Location	Starting Z Location	X#	Y#	Z#
Identification Symbol B, Drawer Master 601-Core-FM						
Aluminum-45 Void-55 (1/8x2x3)	0	0	0	1	1	2
Aluminum-45 Void-55 (1/8x2x2)	0	0	6	1	1	3
Aluminum (2x2x3)	0	0	12	1	1	1
93% Enriched U (1/16x2x3)	0.125	0	0	1	1	3
93% Enriched U (1/16x2x2)	0.125	0	9	1	1	1
93% Enriched U (1/16x2x1)	0.125	0	11	1	1	1
Tungsten (1/8x2x3)	0.1875	0	0	1	1	2
Tungsten (1/8x2x2)	0.1875	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	0.3125	0	0	1	1	2
Aluminum-45 Void-55 (1/8x2x2)	0.3125	0	6	1	1	3
Tungsten (1/8x2x3)	0.4375	0	0	1	1	2
Tungsten (1/8x2x2)	0.4375	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	0.5625	0	0	1	1	2
Aluminum-45 Void-55 (1/8x2x2)	0.5625	0	6	1	1	3
93% Enriched U (1/16x2x3)	0.6875	0	0	1	1	3
93% Enriched U (1/16x2x2)	0.6875	0	9	1	1	1
93% Enriched U (1/16x2x1)	0.6875	0	11	1	1	1
Tungsten (1/8x2x3)	0.75	0	0	1	1	2
Tungsten (1/8x2x2)	0.75	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	0.875	0	0	1	1	2
Aluminum-45 Void-55 (1/8x2x2)	0.875	0	6	1	1	3
Tungsten (1/8x2x3)	1	0	0	1	1	2
Tungsten (1/8x2x2)	1	0	6	1	1	3
93% Enriched U (1/16x2x3)	1.125	0	0	1	1	2
93% Enriched U (1/16x2x2)	1.125	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	1.1875	0	0	1	1	2
Aluminum-45 Void-55 (1/8x2x2)	1.1875	0	6	1	1	3
Tungsten (1/8x2x3)	1.3125	0	0	1	1	2
Tungsten (1/8x2x2)	1.3125	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	1.4375	0	0	1	1	2
Aluminum-45 Void-55 (1/8x2x2)	1.4375	0	6	1	1	3
Tungsten (1/8x2x3)	1.5625	0	0	1	1	2
Tungsten (1/8x2x2)	1.5625	0	6	1	1	3
93% Enriched U (1/16x2x3)	1.6875	0	0	1	1	2
93% Enriched U (1/16x2x2)	1.6875	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	1.75	0	0	1	1	2
Aluminum-45 Void-55 (1/8x2x2)	1.75	0	6	1	1	3
Tungsten (1/8x2x3)	1.875	0	0	1	1	2
Tungsten (1/8x2x2)	1.875	0	6	1	1	3
Retainer Spring (2x2x1/16)	0	0	15.251	1	1	1

Table 12 (cont'd). Core Drawer Plate Loading Descriptions for ZPR-9 Assembly 6.

Plate ID (size in inches)	Starting X Location	Starting Y Location	Starting Z Location	X#	Y#	Z#
Identification Symbol C, Drawer Master 602-CR-FS						
Tungsten (1/16x2x3)	0	0	0	1	1	2
Tungsten (1/16x2x2)	0	0	6	1	1	3
Aluminum DP cut (1.9375x2x1)	0	0	12	1	1	8
Fe DP T-bar (1.9375x2x1/4)	0	0	20	1	1	1
Fe DP T-bar (1.9375x2x1/4)	0	0	40.25	1	1	1
Aluminum-45 Void-55 (1/8x2x3)	0.0625	0	0	1	1	4
93% Enriched U (1/16x2x3)	0.1875	0	0	1	1	4
Tungsten (1/8x2x3)	0.25	0	0	1	1	2
Tungsten (1/8x2x2)	0.25	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	0.375	0	0	1	1	4
Tungsten (1/8x2x3)	0.5	0	0	1	1	2
Tungsten (1/8x2x2)	0.5	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	0.625	0	0	1	1	4
93% Enriched U (1/16x2x3)	0.75	0	0	1	1	4
Tungsten (1/8x2x3)	0.8125	0	0	1	1	2
Tungsten (1/8x2x2)	0.8125	0	6	1	1	3
Fe DP T-bar (1/8x2x2)	0.875	0	20.25	2	1	10
Aluminum-45 Void-55 (1/8x2x3)	0.9375	0	0	1	1	4
Tungsten (1/8x2x3)	1.0625	0	0	1	1	2
Tungsten (1/8x2x2)	1.0625	0	6	1	1	3
93% Enriched U (1/16x2x3)	1.1875	0	0	1	1	4
Aluminum-45 Void-55 (1/8x2x3)	1.25	0	0	1	1	4
Tungsten (1/8x2x3)	1.375	0	0	1	1	2
Tungsten (1/8x2x2)	1.375	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	1.5	0	0	1	1	4
Tungsten (1/8x2x3)	1.625	0	0	1	1	2
Tungsten (1/8x2x2)	1.625	0	6	1	1	3
93% Enriched U (1/16x2x3)	1.75	0	0	1	1	4
Aluminum-45 Void-55 (1/8x2x3)	1.8125	0	0	1	1	4
Identification Symbol D, Drawer Master 603-CR-FM						
Aluminum-45 Void-55 (1/8x2x3)	0	0	0	1	1	4
Aluminum DP cut (1.9375x2x1)	0	0	12	1	1	8
Fe DP T-bar (1.9375x2x1/4)	0	0	20	1	1	1
Fe DP T-bar (1.9375x2x1/4)	0	0	40.25	1	1	1
93% Enriched U (1/16x2x3)	0.125	0	0	1	1	4
Tungsten (1/8x2x3)	0.1875	0	0	1	1	2
Tungsten (1/8x2x2)	0.1875	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	0.3125	0	0	1	1	4
Tungsten (1/8x2x3)	0.4375	0	0	1	1	2

Table 12 (cont'd). Core Drawer Plate Loading Descriptions for ZPR-9 Assembly 6.

Plate ID (size in inches)	Starting X Location	Starting Y Location	Starting Z Location	X#	Y#	Z#
Identification Symbol D, Drawer Master 603-CR-FM (cont'd)						
Tungsten (1/8x2x2)	0.4375	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	0.5625	0	0	1	1	4
93% Enriched U (1/16x2x3)	0.6875	0	0	1	1	4
Tungsten (1/8x2x3)	0.75	0	0	1	1	2
Tungsten (1/8x2x2)	0.75	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	0.875	0	0	1	1	4
Fe DP T-bar (1/8x2x2)	0.875	0	20.25	2	1	10
Tungsten (1/8x2x3)	1	0	0	1	1	2
Tungsten (1/8x2x2)	1	0	6	1	1	3
93% Enriched U (1/16x2x3)	1.125	0	0	1	1	4
Aluminum-45 Void-55 (1/8x2x3)	1.1875	0	0	1	1	4
Tungsten (1/8x2x3)	1.3125	0	0	1	1	2
Tungsten (1/8x2x2)	1.3125	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	1.4375	0	0	1	1	4
Tungsten (1/8x2x3)	1.5625	0	0	1	1	2
Tungsten (1/8x2x2)	1.5625	0	6	1	1	3
93% Enriched U (1/16x2x3)	1.6875	0	0	1	1	4
Aluminum-45 Void-55 (1/8x2x3)	1.75	0	0	1	1	4
Tungsten (1/16x2x3)	1.875	0	0	1	1	2
Tungsten (1/16x2x2)	1.875	0	6	1	1	3
Identification Symbol E, Drawer Master 604-Core-FS						
Tungsten (1/8x2x3)	0	0	0	1	1	2
Tungsten (1/8x2x2)	0	0	6	1	1	3
Aluminum (2x2x3)	0	0	12	1	1	1
Aluminum-45 Void-55 (1/8x2x3)	0.125	0	0	1	1	4
93% Enriched U (1/16x2x3)	0.25	0	0	1	1	4
Tungsten (1/8x2x3)	0.3125	0	0	1	1	2
Tungsten (1/8x2x2)	0.3125	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	0.4375	0	0	1	1	4
Tungsten (1/8x2x3)	0.5625	0	0	1	1	2
Tungsten (1/8x2x2)	0.5625	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	0.6875	0	0	1	1	4
93% Enriched U (1/16x2x3)	0.8125	0	0	1	1	4
Tungsten (1/8x2x3)	0.875	0	0	1	1	2
Tungsten (1/8x2x2)	0.875	0	6	1	1	3
Aluminum (1x1x3)	1	0	0	1	1	4
Aluminum (1x1x3)	1	1	0	1	1	4
Retainer Spring (2x2x1/16)	0	0	15.251	1	1	1

Table 12 (cont'd). Core Drawer Plate Loading Descriptions for ZPR-9 Assembly 6.

Plate ID (size in inches)	Starting X Location	Starting Y Location	Starting Z Location	X#	Y#	Z#
Identification Symbol F, Drawer Master 605-Core-FS						
Aluminum (1x1x3)	0	0	0	1	1	4
Aluminum (1x1x3)	0	1	0	1	1	4
Aluminum (2x2x3)	0	0	12	1	1	1
Aluminum-45 Void-55 (1/8x2x3)	1	0	0	1	1	4
Tungsten (1/8x2x3)	1.125	0	0	1	1	2
Tungsten (1/8x2x2)	1.125	0	6	1	1	3
93% Enriched U (1/16x2x3)	1.25	0	0	1	1	4
Aluminum-45 Void-55 (1/8x2x3)	1.3125	0	0	1	1	4
Tungsten (1/8x2x3)	1.4375	0	0	1	1	2
Tungsten (1/8x2x2)	1.4375	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	1.5625	0	0	1	1	4
Tungsten (1/8x2x3)	1.6875	0	0	1	1	2
Tungsten (1/8x2x2)	1.6875	0	6	1	1	3
93% Enriched U (1/16x2x3)	1.8125	0	0	1	1	4
Aluminum-45 Void-55 (1/8x2x3)	1.875	0	0	1	1	4
Retainer Spring (2x2x1/16)	0	0	15.251	1	1	1
Identification Symbol G, Drawer Master 606-Core-FM						
Aluminum-45 Void-55 (1/8x2x3)	0	0	0	1	1	4
Aluminum (2x2x3)	0	0	12	1	1	1
93% Enriched U (1/16x2x3)	0.125	0	0	1	1	4
Tungsten (1/8x2x3)	0.1875	0	0	1	1	2
Tungsten (1/8x2x2)	0.1875	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	0.3125	0	0	1	1	4
Tungsten (1/8x2x3)	0.4375	0	0	1	1	2
Tungsten (1/8x2x2)	0.4375	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	0.5625	0	0	1	1	4
93% Enriched U (1/16x2x3)	0.6875	0	0	1	1	4
Tungsten (1/8x2x3)	0.75	0	0	1	1	2
Tungsten (1/8x2x2)	0.75	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	0.875	0	0	1	1	4
Aluminum (1x1x3)	1	0	0	1	1	4
Aluminum (1x1x3)	1	1	0	1	1	4
Retainer Spring (2x2x1/16)	0	0	15.251	1	1	1
Identification Symbol H, Drawer Master 607-Core-FM						
Aluminum (1x1x3)	0	0	0	1	1	4
Aluminum (1x1x3)	0	1	0	1	1	4
Aluminum (2x2x3)	0	0	12	1	1	1
Tungsten (1/8x2x3)	1	0	0	1	1	2
Tungsten (1/8x2x2)	1	0	6	1	1	3

Table 12 (cont'd). Core Drawer Plate Loading Descriptions for ZPR-9 Assembly 6.

Plate ID (size in inches)	Starting X Location	Starting Y Location	Starting Z Location	X#	Y#	Z#
Identification Symbol H, Drawer Master 607-Core-FM (cont'd)						
93% Enriched U (1/16x2x3)	1.125	0	0	1	1	4
Aluminum-45 Void-55 (1/8x2x3)	1.1875	0	0	1	1	4
Tungsten (1/8x2x3)	1.3125	0	0	1	1	2
Tungsten (1/8x2x2)	1.3125	0	6	1	1	3
Aluminum-45 Void-55 (1/8x2x3)	1.4375	0	0	1	1	4
Tungsten (1/8x2x3)	1.5625	0	0	1	1	2
Tungsten (1/8x2x2)	1.5625	0	6	1	1	3
93% Enriched U (1/16x2x3)	1.6875	0	0	1	1	4
Aluminum-45 Void-55 (1/8x2x3)	1.75	0	0	1	1	4
Tungsten (1/8x2x3)	1.875	0	0	1	1	2
Tungsten (1/8x2x2)	1.875	0	6	1	1	3
Retainer Spring (2x2x1/16)	0	0	15.251	1	1	1
Identification Symbol I, Drawer Master 608-Core-FS						
Aluminum (1x1x3)	0	0	0	1	1	4
Tungsten (2x1/8x3)	0	1	0	1	1	2
Tungsten (2x1/8x2)	0	1	6	1	1	3
93% Enriched U (2x1/16x3)	0	1.125	0	1	1	4
Aluminum-45 Void-55 (2x1/8x3)	0	1.1875	0	1	1	4
Tungsten (2x1/8x3)	0	1.3125	0	1	1	2
Tungsten (2x1/8x2)	0	1.3125	6	1	1	3
Aluminum-45 Void-55 (2x1/8x3)	0	1.4375	0	1	1	4
Tungsten (2x1/8x3)	0	1.5625	0	1	1	2
Tungsten (2x1/8x2)	0	1.5625	6	1	1	3
93% Enriched U (2x1/16x3)	0	1.6875	0	1	1	4
Aluminum-45 Void-55 (2x1/8x3)	0	1.75	0	1	1	4
Tungsten (2x1/8x3)	0	1.875	0	1	1	2
Tungsten (2x1/8x2)	0	1.875	6	1	1	3
Aluminum (2x2x3)	0	0	12	1	1	1
Aluminum (1x1x3)	1	0	0	1	1	4
Retainer Spring (2x2x1/16)	0	0	15.251	1	1	1
Identification Symbol J, Drawer Master 609-Core-FS						
Aluminum-45 Void-55 (2x1/8x3)	0	0	0	1	1	4
93% Enriched U (2x1/16x3)	0	0.125	0	1	1	4
Tungsten (2x1/8x3)	0	0.1875	0	1	1	2
Tungsten (2x1/8x2)	0	0.1875	6	1	1	3
Aluminum-45 Void-55 (2x1/8x3)	0	0.3125	0	1	1	4
Tungsten (2x1/8x3)	0	0.4375	0	1	1	2
Tungsten (2x1/8x2)	0	0.4375	6	1	1	3
Aluminum-45 Void-55 (2x1/8x3)	0	0.5625	0	1	1	4
93% Enriched U (2x1/16x3)	0	0.6875	0	1	1	4

Table 12 (cont'd). Core Drawer Plate Loading Descriptions for ZPR-9 Assembly 6.

Plate ID (size in inches)	Starting X Location	Starting Y Location	Starting Z Location	X#	Y#	Z#
Identification Symbol J, Drawer Master 609-Core-FS (cont'd)						
Tungsten (2x1/8x3)	0	0.75	0	1	1	2
Tungsten (2x1/8x2)	0	0.75	6	1	1	3
Aluminum-45 Void-55 (2x1/8x3)	0	0.875	0	1	1	4
Aluminum (1x1x3)	0	1	0	1	1	4
Aluminum (2x2x3)	0	0	12	1	1	1
Aluminum (1x1x3)	1	1	0	1	1	4
Retainer Spring (2x2x1/16)	0	0	15.251	1	1	1
Identification Symbol K, Drawer Master 610-Core-FM						
Aluminum (1x1x3)	0	0	0	1	1	4
Aluminum-45 Void-55 (2x1/8x3)	0	1	0	1	1	4
Tungsten (2x1/8x3)	0	1.125	0	1	1	2
Tungsten (2x1/8x2)	0	1.125	6	1	1	3
93% Enriched U (2x1/16x3)	0	1.25	0	1	1	4
Aluminum-45 Void-55 (2x1/8x3)	0	1.3125	0	1	1	4
Tungsten (2x1/8x3)	0	1.4375	0	1	1	2
Tungsten (2x1/8x2)	0	1.4375	6	1	1	3
Aluminum-45 Void-55 (2x1/8x3)	0	1.5625	0	1	1	4
Tungsten (2x1/8x3)	0	1.6875	0	1	1	2
Tungsten (2x1/8x2)	0	1.6875	6	1	1	3
93% Enriched U (2x1/16x3)	0	1.8125	0	1	1	4
Aluminum-45 Void-55 (2x1/8x3)	0	1.875	0	1	1	4
Aluminum (2x2x3)	0	0	12	1	1	1
Aluminum (1x1x3)	1	0	0	1	1	4
Retainer Spring (2x2x1/16)	0	0	15.251	1	1	1
Identification Symbol L, Drawer Master 611-Core-FM						
Tungsten (2x1/8x3)	0	0	0	1	1	2
Tungsten (2x1/8x2)	0	0	6	1	1	3
93% Enriched U (2x1/16x3)	0	0.125	0	1	1	4
Aluminum-45 Void-55 (2x1/8x3)	0	0.1875	0	1	1	4
Tungsten (2x1/8x3)	0	0.3125	0	1	1	2
Tungsten (2x1/8x2)	0	0.3125	6	1	1	3
Aluminum-45 Void-55 (2x1/8x3)	0	0.4375	0	1	1	4
Tungsten (2x1/8x3)	0	0.5625	0	1	1	2
Tungsten (2x1/8x2)	0	0.5625	6	1	1	3
93% Enriched U (2x1/16x3)	0	0.6875	0	1	1	4
Aluminum-45 Void-55 (2x1/8x3)	0	0.75	0	1	1	4
Tungsten (2x1/8x3)	0	0.875	0	1	1	2
Tungsten (2x1/8x2)	0	0.875	6	1	1	3
Aluminum (1x1x3)	0	1	0	1	1	4
Aluminum (2x2x3)	0	0	12	1	1	1
Aluminum (1x1x3)	1	1	0	1	1	4
Retainer Spring (2x2x1/16)	0	0	15.251	1	1	1

Table 12 (cont'd). Core Drawer Plate Loading Descriptions for ZPR-9 Assembly 6.

Plate ID (size in inches)	Starting X Location	Starting Y Location	Starting Z Location	X#	Y#	Z#
Identification Symbol n, Drawer Master 191-CR-BS/M						
Stainless Steel (1/4x2x1)	0.9225	0	0	1	1	19
Identification Symbol q, Drawer Master 106-Refl-FS/M						
Aluminum (2x2x4)	0	0	0	1	1	6
Retainer Spring (2x2x1/16)	0	0	24.376	1	1	1
Identification Symbol r, Drawer Master 106-Refl-FS/M						
Aluminum (2x2x4)	0	0	0	1	1	6
Retainer Spring (2x2x1/16)	0	0	24.376	1	1	1
Identification Symbol R, Drawer Master 107-Refl-BS/M						
Aluminum (1/4x2x2)	0	0	0	8	1	2
Aluminum (2x2x5)	0	0	4	1	1	1
Identification Symbol s, Drawer Master 190-SRC-BS/M						
Aluminum (2x2x4)	0	0	0	1	1	1
Al with Src Tube Hole (2x0.773x1)	0	0	4	1	1	1
Aluminum (2x2x3)	0	0	5	1	1	1
Aluminum (2x2x4)	0	0	8	1	1	4
Retainer Spring (2x2x1/16)	0	0	24.376	1	1	1
Identification Symbol t, Drawer Master 192-SRC-BS/M						
Aluminum (2x2x4)	0	0	0	1	1	1
Al with Src Tube Hole (2x0.773x1)	0	0	4	1	1	1
Aluminum (2x2x3)	0	0	5	1	1	1
Aluminum (2x2x4)	0	0	8	1	1	4
Retainer Spring (2x2x1/16)	0	0	24.376	1	1	1

A two-dimensional diagram of Assembly 5 drawer master 500-Core-FS (identified in the matrix loading maps by the symbol "A") is shown in Figure 7. Figure 8 is the corresponding diagram for Assembly 6, showing drawer master 600-Core-FS. These are XZ views, i.e., looking down at the top of the drawer, and show the columns of plates. (The drawer itself is not shown.) The origin of the drawer master coordinate system is at the front lower left corner of the space inside the drawer, which is near the upper left corner of the figure. The X axis is along the drawer width and is divided in eighth-inch units from zero to two inches (16 eighths). The Z axis is along the drawer length and goes from zero to 15 inches in inch units.[a] The Y axis is transverse to the page, pointing towards the viewer, and the range encompassing the plate loading is from zero to two inches. The plates being viewed are 2 inches tall, unless there is a note indicating otherwise.

[a] Note that the coordinate convention for ZPR assemblies is unusual in that the Z direction is horizontal, not vertical.

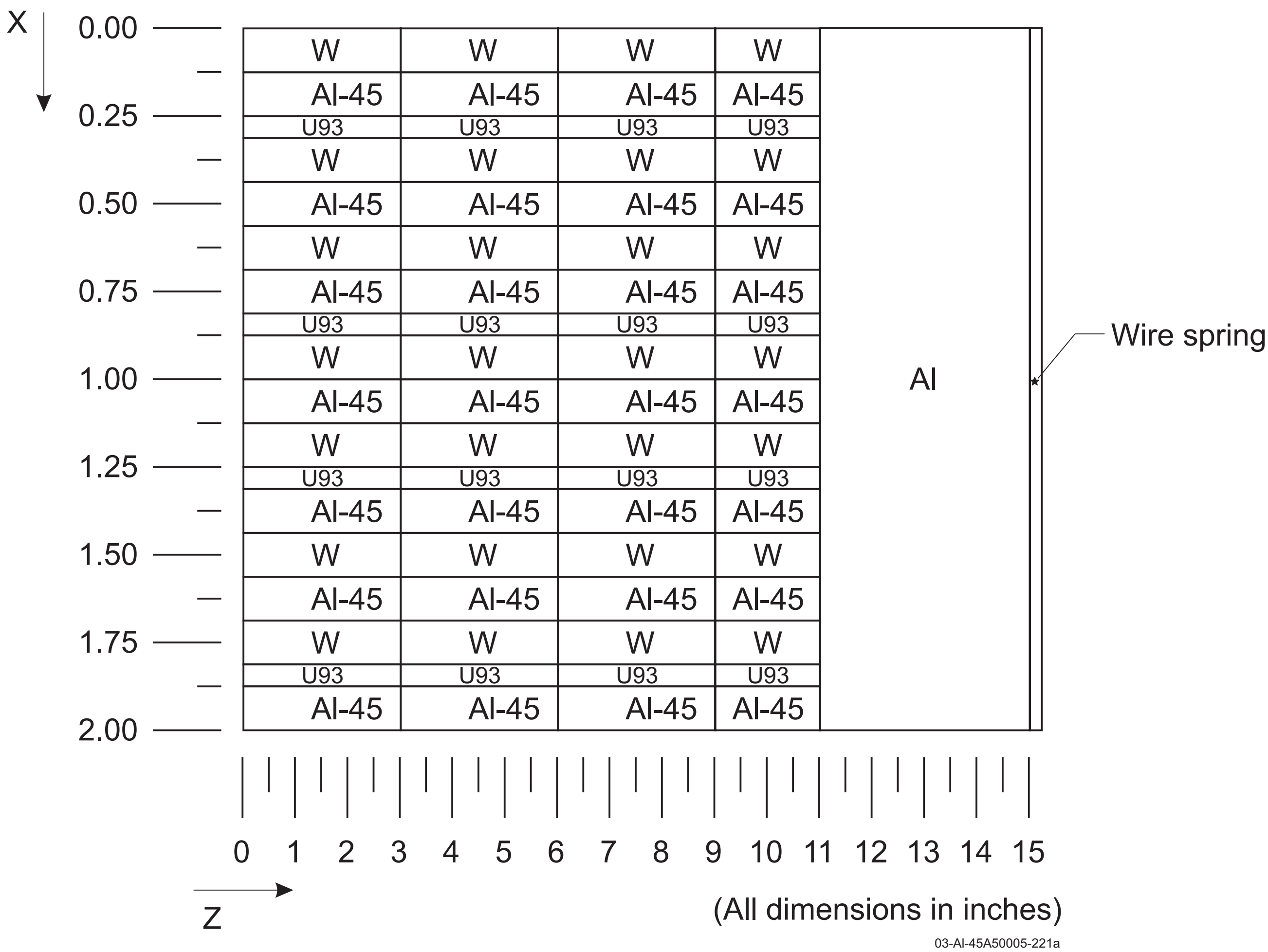

Figure 7. Diagram for Normal Core Drawer Master 500-Core-FS of ZPR-9/5.

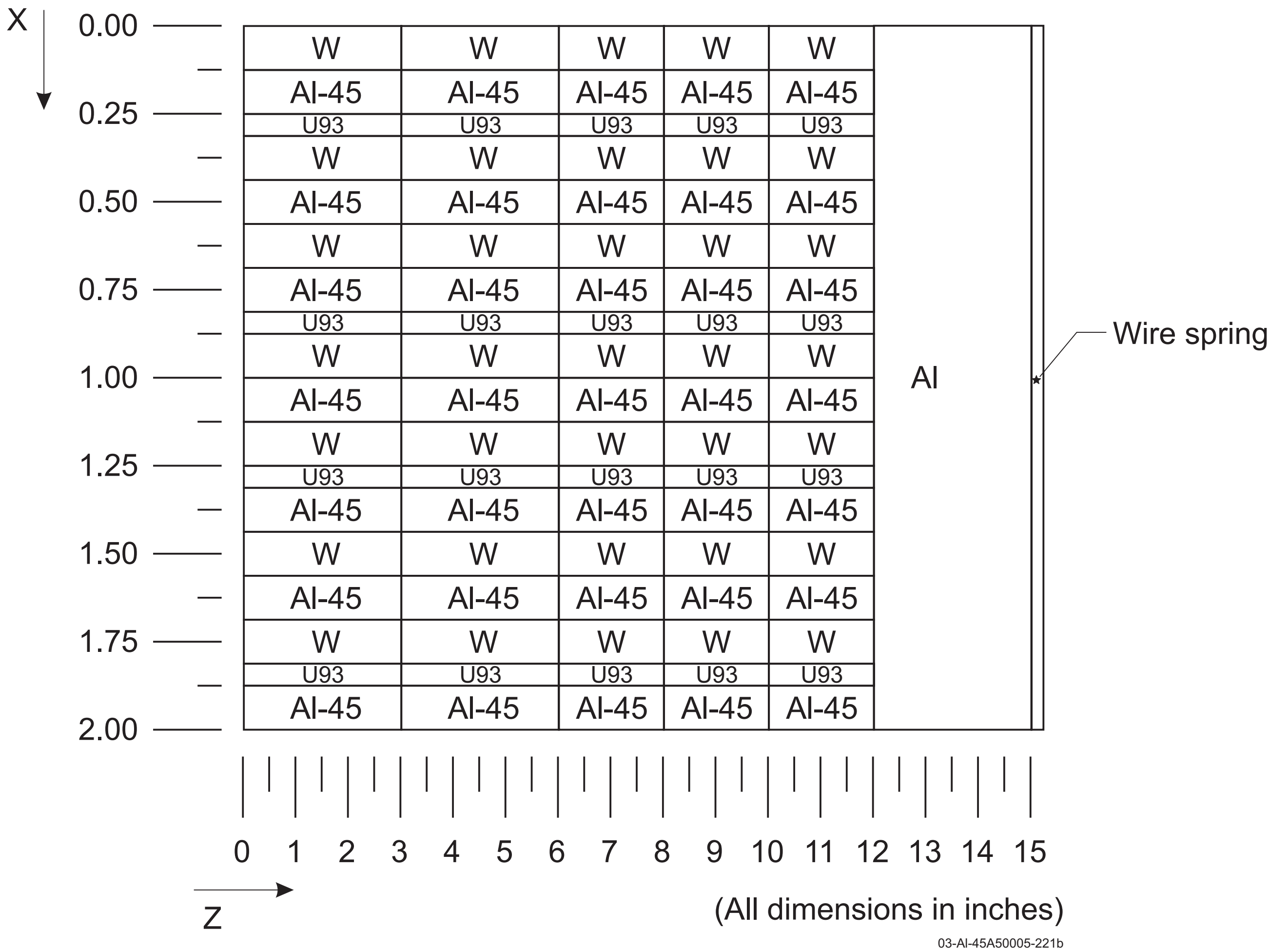

Figure 8. Diagram for Normal Core Drawer Master 600-Core-FS of ZPR-9/6.

We begin the illustration by observing from Figure 7 that the first axial section (Z direction) of the plate loading consists of 18 plate columns which are each 11 inches long. The first column in this section is comprised of 4 tungsten (W) plates, three 3 inches and one 2 inches in length. Turning to Table 11, the first plate in master 500-Core-FS indeed is shown to be 1/8 x 2 x 3-inch tungsten; the first column of the table gives two pieces of information, a plate ID, which corresponds to the material description given in Section 1.3, and the X, Y, and Z dimensions of the plate. The beginning of the plate ID should give an approximate indication of the plate material (e.g., W is tungsten, G is graphite, U93 is high-enriched [93% ^{235}U/U] metal fuel, Al-45 is perforated aluminum [45% aluminum, 55%void], and Al is aluminum). The remaining columns of each table give the positions of the plates within the drawer. The second through fourth columns give the X, Y, and Z coordinates of the front lower left corner of a block of contiguous plates of this type. In this case, that position is seen to be the origin of the drawer coordinates, again consistent with Figure 7. The last three columns describe whether there is a single plate or a contiguous block of plates of this type. In this case, the block is 1 wide in X, 1 tall in Y, and 3 long in Z, i.e., there are three plates. The next row in Table 11 describes the 1/8 x 2 x 2-inch tungsten plate, which continues this first column of tungsten, i.e., it begins axially at 9 inches. In this manner, the first two rows describe the four plates that comprise the first W plate column.

The axial reflector begins at 11 inches. The drawer was long enough to hold only the first 4 inches of this reflector. (The remainder is described in the back-drawer master 107-Refl-BS/M.) The next line in Table 11 for master 500-Core-FS describes a single 2x2x4 aluminum plate that spans the drawer width and spans the space from 11 inches to 15 inches axially.

This procedure is repeated in Table 11 for master 500-Core-FS for all the tungsten (W), graphite (G), and enriched uranium (U 93) columns shown in Figure 7. The only geometrical difference between the columns in Figure 7 is that the tungsten (W), and graphite (G) columns are 1/8-inch thick, whereas the enriched uranium (U 93) columns are 1/16-inch thick.

Finally, there is a spring at the back of the drawer that keeps all the plates in the drawer from moving axially. The spring is the last entry in Table 11 for master 500-Core-FS. Hopefully, the line-by-line interpretation of Tables 11 and 12 is reasonably clear now.

Another potential point of confusion should be addressed, namely a difference between the convention for identifying matrix positions in the two halves and the convention for viewing drawer masters in the two halves. It was noted in Section 1.2.1 that, for both halves, the matrix column number (essentially the X coordinate) is counted from the left when looking from the movable half towards the stationary half. In contrast, the origin of the drawer master coordinates is at the left edge of the plates when looking from the matrix interface towards the matrix half that contains the drawer. To see how this works, compare the description of stationary-half drawer master 500-Core-FS in Table 11 with the description of movable-half drawer master 501-Core-FM in Table 11. The initial single tungsten column is at the left edge in the stationary-half master and at the right edge in the movable-half master, yet these two (and the remaining) columns aligned when the halves were brought together and these masters were in corresponding matrix positions, say S-26/24 and M-26/24.

The section that follows offers a broader interpretation of the loading data. It is an attempt to describe the characteristics of each region of the assembly.

1.2.3 Characteristics of the Assembly Regions - We begin by observing some more characteristics of the drawer masters described in Tables 9-12. The half-height of the core is (nominally) 11 inches in Assembly 5 and 12 inches in Assembly 6. Note that the discussion given in this section of the axial regions of the assembly refers to the nominal dimensions of the plates. The physical location of these plates in the assembly is also determined by the drawer front and/or back thicknesses. For example, fuel plates loaded in the core are displaced from the axial midplane by the thickness of the drawer front (0.032 inches).

The core matrix locations with non-standard drawer masters were the ten DP rods (5 per half near the core periphery) in each assembly and the partial-core drawers in Assemblies 5 and 6. The loadings of these drawer types differed only slightly from the standard core drawers. In the case of the DP rods, the drawers themselves were different. The DP drawers were made of stainless steel and were slightly narrower (nominally 1-15/16 inches wide), with thicker walls. The drawer loading of each control drawer was identical to that of the normal core drawer loading except that one of the tungsten columns was 1/16 inch wide, rather than 1/8 inch wide. In the partial-core drawers, the plate loadings represent a simple fraction of the complete core unit cell; the remaining fraction is loaded with aluminum plates, consistent with the adjacent radial reflector region. Thus, overall, the core loading was quite uniform. In summary, there were only minor perturbations in the core loading; these small loading variations are known and they were modeled.

The 12-inch-long axial reflector region was built by filling the remainder of the 15-inch-long front drawers with aluminum blocks (see Figures 7 and 8), followed by the balance of the aluminum plates (8 inches in Assembly 5 and 9 inches in Assembly 6) in the front portion of 23.314-inch-long (592.2-mm) aluminum back drawers.

The radial reflector region was built by filling the 24-inch aluminum drawers completely with aluminum blocks. The core was surrounded by these aluminum-filled drawers to form an aluminum reflector region that was about seven drawers thick (or ~14-15 inches). The radial reflector portion of the partial-core drawers in Assemblies 5 and 6 made a small contribution to the radial reflector thickness. There was only one further perturbation in the loading of the radial reflector. In one radial position per half, the aluminum reflector loading included a hole that allowed the insertion of a neutron source. Overall, the aluminum radial reflector was quite uniform.

In summary, ZPR-9 Assemblies 5 and 6 had very clean and uniform cores built with simple HEU/G/W (Assembly 5) or HEU/Al-45/W (Assembly 6) core unit cells. These core regions were reasonably well isolated by solid radial and axial aluminum reflectors. The simplicity and uniformity of these assemblies was intended to make them clean benchmark assemblies.

1.3 Description of Material Data

The composition data here were taken from working documents that are referred to informally as “hot constants memos”. The original documentation on most of the inventory used in these assemblies has been lost, but the hot constants memos are available. These memos give average composition by batch or lot, but not uncertainties. The issue of estimating composition uncertainties is addressed in Section 2. The compositions of the uranium plates were taken from the Illinois hot constants memo,[a] which is the most reliable source of information on these materials. The ZPPR (Zero Power Physics Reactor) hot constants memo[b] was used for all other components that it describes because this memo has the most complete and accurate description of trace elements. The few non-uranium components not described in the ZPPR memo were taken from the Illinois memo.

As noted earlier, the uranium plates had a paint-like protective coating. The weight percents for the coating material, called Kel-F, are given in the Illinois hot constants memo[a] and shown in Table 13. It can be seen there that Kel-F is nearly hydrogen free. Table 13 is needed in conjunction with the tables giving the compositions of the uranium plates.

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[a] W. R. Robinson, Applied Physics Division Reactor Materials Inventory Manual–Chapter 3, A0033-1000-SE-01, July 1978.

[b] T. S. Huntsman, ZPPR Materials Compositions, July 1983.

Table 13. Kel-F Composition.

Element	Weight Percent
Hydrogen	0.5
Carbon	20.6
Chlorine	30.5
Fluorine	48.4

Table 14 gives the data on the enriched-uranium plates. All the sizes except 1/16x2x1 were used in the core region of Assembly 5 and all were used in the core region of Assembly 6. A significant density variation is evident there. The enrichment is quite uniform, however.

Table 14. U93 Plate Compositions.

Nominal Size (inches)	Number used		U Mass (g)	U Density[(a)] (g/cc)	^{234}U (wt.%)	^{235}U (wt.%)	^{236}U (wt.%)	^{238}U (wt.%)	Kel-F (g)
	#5	#6							
1/16 x 2 x 1	0	496	36.83	17.98	0.92	93.16	0.44	5.48	0.028
1/16 x 2 x 2	952	1984	73.57	17.96	0.92	93.18	0.44	5.46	0.054
1/16 x 2 x 3	2856	2960	111.04	18.07	0.92	93.17	0.45	5.46	0.080

(a) Derived from mass and nominal dimensions.

The mass and composition of the tungsten plates, which were used in the core regions of both assemblies, are given in Table 15.

Table 15. Tungsten Plate Compositions.

Plate ID	Nominal Size (inches)	Tungsten Mass (g)	W (wt.%)
Tungsten (1/8x2x3)	0.125x2.00x3.00	219.2	100.0
Tungsten (1/8x2x2)	0.125x2.00x2.00	146.1	100.0

The mass and composition of the graphite plates, which were used in the core regions of Assembly 5, are given in Table 16.

Table 16. Graphite Plate Compositions.

Plate ID	Nominal Size (inches)	Graphite Mass (g)	C (wt.%)
Graphite (1/8x2x2)	0.125x2.00x2.00	12.97	100.0
Graphite (1/8x2x3)	0.125x2.00x3.00	20.04	100.0

The mass and composition of the perforated aluminum plates(45% aluminum, 55% void), which were used in the core regions of Assembly 6, are given in Table 17. The density reduction was achieved by perforating standard aluminum plates.

Table 17. Perforated Aluminum (Al-45) Plate Compositions.

Plate ID	Nominal Size (inches)	Aluminum Mass (g)	Al (wt.%)
Aluminum (1/8x2x2)	0.125x2.00x2.00	9.13	100.0
Aluminum (1/8x2x3)	0.125x2.00x3.00	14.01	100.0

The mass and composition of the aluminum plates used in the reflector for these assemblies are given in Table 18.

Table 18. Aluminum Plate Compositions.

Plate ID	Nominal Size (inches)	Aluminum Mass (g)	Al (wt.%)
Aluminum (1/4x2x2)	0.25x2.00x2.00	43.43	100.0
Aluminum (1x1x2)	1.00x1.00x2.00	87.16	100.0
Aluminum (1x1x3)	1.00x1.00x3.00	130.97	100.0
Aluminum (2x2x3)	2.00x2.00x3.00	528.0	100.0
Aluminum (2x2x4)	2.00x2.00x4.00	705.1	100.0
Aluminum (2x2x5)	2.00x2.00x5.00	882.4	100.0
Aluminum (1-15/16x2x1)	1-15/16x2.00x1.00	170.5	100.0
Aluminum (2x0.773x1)	2.00x0.773x2.00	68.10	100.0

The compositions of the T-bar and the T-bar plates are given in Table 19.

Table 19. T-Bar Materials.

Description	Size	C (g)	Si (g)	Mn (g)	Fe (g)	Ni (g)	Cu (g)
T-Bar Plate	1.935 x 2 x 0.25	0.182	0.023	0.479	118.762	0.012	0.012
T-Bar	0.125 x 2 x 2	0.094	0.012	0.247	61.295	0.006	0.006

The composition of the wire spring is given in Table 20. The wire spring was used to compress the plates toward the front of the drawer.

Table 20. Wire Spring Mass and Composition.

Component	C (g)	Fe (g)
Wire Spring	0.097	9.862

The tables giving the compositions of the remaining components present the information in a different form from that in earlier tables. The mass of each element is shown, rather than the total mass, total density and weight percent by isotope. The drawer is broken down into various walls or wall combinations. The second column gives the nominal dimensions in the order $X \times Y \times Z$ (following the convention described in Section 1.2.2). Note that the masses given for the sides plus bottom are per inch of drawer length, not for the total drawer length.

Table 21 has the stainless steel drawer descriptions in this format. These drawers were made of Type 304 stainless steel. Some components were perforated to varying degrees while others had no holes. An example of perforations in a drawer front is shown in Figure 2. The control drawers not only had thicker walls, but also had a very thin (~ few mils) steel cover. (The mass of this thin cover is included in the side walls and bottom in the modeling of this drawer for the VIM continuous-energy Monte Carlo code.[a])

[a] R. N. Blomquist, R. M. Lell and E. M. Gelbard, "VIM – A Continuous Energy Monte Carlo Code at ANL," A Review of the Theory and Application of Monte Carlo Methods, Proceedings of a Seminar-Workshop, Oak Ridge, TN, April 21-23, 1980, ORNL/RSIC-44, p. 31, August 1980.

Table 21. Stainless Steel Drawer Compositions.

Description	Nominal Size (inches)	C (g)	Si (g)	P (g)	S (g)	Cr (g)	Mn (g)	Fe (g)	Ni (g)	Cu (g)	Mo (g)
40.75-inch Control Drawer /											
Side Walls[(a)] + Cover[(a)] + Bottom[(a)]	2x(.060x2x1) + 2x.060x1	0.023	0.076	0.010	0.006	6.980	0.591	26.864	3.242	0.076	0.095
Front	2 x 2 x 0.060	0.016	0.053	0.007	0.004	4.873	0.412	18.756	2.264	0.053	0.665
Back	2 x 2 x 0.375	0.11	0.78	0.04	0.02	32.80	2.42	123.89	16.50	0.21	0.23

(a) Mass per inch of length.

Table 22 has the aluminum drawer descriptions in this same format.

Table 22. Aluminum Drawer Compositions.

Description	Nominal Size (inches)	Mg (g)	Al (g)	Si (g)	Ti (g)	Cr (g)	Mn (g)	Fe (g)	Cu (g)	Zn (g)
15.251-inch Core Drawer										
Side Walls[(a)] + Bottom[(a)]	2x(.032x2x1) + 2 x.032x1	0.2750	6.5075	0.0138	0.0055	0.0103	0.0309	0.0172	0.0069	0.0089
Front	2 x 2 x .032	0.1914	4.5285	0.0096	0.0038	0.0072	0.0215	0.0120	0.0048	0.0062
Back	2 x 2 x .032	0.1914	4.5285	0.0096	0.0038	0.0072	0.0215	0.0120	0.0048	0.0062
24.376-inch Core Drawer										
Side Walls[(a)] + Bottom[(a)]	2x(.032x2x1) + 2 x.032x1	0.3284	7.7690	0.0164	0.0066	0.0123	0.0369	0.0205	0.0082	0.0107
Front	2 x 2 x .032	0.2285	5.4058	0.0114	0.0046	0.0086	0.0257	0.0143	0.0057	0.0074
Back	2 x 2 x .032	0.2285	5.4058	0.0114	0.0046	0.0086	0.0257	0.0143	0.0057	0.0074
23.314-inch Core Drawer										
Side Walls[(a)] + Bottom[(a)]	2x(.032x2x1) + 2 x.032x1	0.3490	8.2564	0.0175	0.0070	0.0131	0.0393	0.0218	0.0087	0.0113
Front	2 x 2 x .032	0.2428	5.7456	0.0121	0.0049	0.0091	0.0273	0.0152	0.0061	0.0079
Back	2 x 2 x .032	0.2428	5.7456	0.0121	0.0049	0.0091	0.0273	0.0152	0.0061	0.0079

(a) Mass per inch of length.

The compositions of the aluminum matrix tubes are given in Table 23.

Table 23. Aluminum Matrix Tube.

Component	Mg (g)	Al (g)	Si (g)	Cr (g)	Mn (g)	Fe (g)	Cu (g)	Zn (g)
Matrix Tube[(a)]	0.0913	8.8807	0.0548	0.0183	0.0073	0.0320	0.0256	0.0119
Matrix Tube[(b)]	0.1482	14.4159	0.0889	0.0296	0.0119	0.0519	0.0415	0.0193

(a) Mass of first inch.
(b) Mass per inch of length.

The compositions of the structural materials external to the assembly matrix is are given in Table 24.

Table 24. Compositions of Ex-Matrix Structures (wt.%).

Component	C	Si	P	S	Mn	Fe
Table, Bed, Knees	3.15	1.70	0.15	0.105	0.95	93.945
Back Plate	0.20	0.30	-	-	0.55	98.95

1.4 Supplemental Experimental Measurements

A list of experiments performed in ZPR-9 Assemblies 5 and 6 is given below. Although none of the listed measurements, other than criticality, was made in the selected loadings, the loadings were so similar that the results are directly applicable. References 1-6 are open-literature documents that contain information about some of the experiments.

Experiments performed in ZPR-9/5 and ZPR-9/6:

- Criticality.
- Kinetics parameters.
- Control rod calibrations (Comparison of Inverse Kinetics and Positive-Period Methods).
- Central reaction rates.
- Reaction-rate axial and radial distributions.
- Central material reactivity worths.
- Radial material reactivity worths.
- Gap worth (ZPR-9/6 only).

2.0 EVALUATION OF EXPERIMENTAL DATA

As noted in Section 1.1, there were several critical loadings for ZPR-9 Assemblies 5 and 6. Any of them would provide about the same basic criticality-safety benchmark information, so the basis for selecting a particular loading for use here was the precision and accuracy with which the critical assembly could be described. The selected loadings are Assembly 5 Loading 8 and Assembly 6 Loading 13.

Most of the experimental information used here was taken from the logbook and other original, internal documents. Some of these data were cross-checked with the open-literature publications, References 1-6. Reference 5 is expected usually to have the most accurate data on ZPR-9 Assemblies 5 and 6, since it has the latest publication date.

The reactivity effects of many of the uncertainties discussed below were quantified using a TWODANT model of the RZ benchmark (described in Section 3 and in Appendix B). The calculations used cross sections derived from ENDF/B-V data that were processed with Argonne cross section codes (see Appendix B). In some cases the Δk for the exact perturbation of interest was computed explicitly with a pair of TWODANT calculations. In cases where the change in k_{eff} might be too small to obtain accurately with the 10^{-7} k_{eff} convergence criterion, the atom density changes were scaled up to give about a 10^{-4} change in k_{eff} and the resulting Δk was then scaled down to the actual perturbation. A 10^{-4} k_{eff} change is small enough to be a first-order perturbation, which justifies the scaling. The uncertainties are put in units of %Δk (100 times the change in k_{eff}). For consistency in accounting, they are always displayed to four decimal places, even though that level of precision is not always justified on physical grounds.

The uncertainties affecting criticality have been divided into three broad categories. They are the uncertainties associated with 1) measurement technique, 2) geometry, and 3) compositions. Each category is considered in turn and then the combined experimental uncertainty is presented. Each uncertainty estimate is one standard deviation.

2.1 Measurement Technique Uncertainties

The excess reactivity was determined from the worth of a partially withdrawn DP control rod. The rod worth was determined by period measurements and by what was then a new technique, inverse kinetics. The excess reactivities reported by the experimenters in Reference 5 are 79.8 Ih and 108.4 Ih for Assemblies 5 and 6, respectively. The experimenters claimed an 1σ uncertainty in these values of ±0.10 Ih (Reference 5).

To convert from the natural measurement units of Ih to units of k_{eff} requires knowledge of the delayed-neutron kinetics parameters, particularly β_{eff}. The conversions reported in Reference 5 are 425 Ih/%Δk and 431 Ih/%Δk for Assemblies 5 and 6, respectively. These values are assumed to be uncertain by 5%. Using these conversion factors, the measured excess reactivities are 0.1878 and 0.2515 %Δk in Assemblies 5 and 6, respectively, with a measurement uncertainty of ±0.0002 % Δk in each case. The uncertainty in the conversion factor applied to the excess reactivity leads to additional uncertainties of ±0.0094 %Δk and ±0.0126 %Δk for Assemblies 5 and 6, respectively.

The reported temperatures of these assemblies during the criticality measurements, 20.7°C and 14.0°C for Assemblies 5 and 6, respectively, are uncertain. It is estimated that the uncertainty in the thermocouple calibration is 0.5°C and the uncertainty in the core-average temperature obtained from the average of several thermocouples is 1.0°C. No measured temperature coefficient results were found. However, a set of coefficients from three other enriched-uranium-fueled ZPR assemblies has a mean of -1.57 Ih/°C and a range of -1.27 to -1.8 Ih/°C. Using the mean value, the temperature uncertainty translates to a ±0.0037 %Δk and ±0.0036 %Δk contribution for Assemblies 5 and 6, respectively, to the k_{eff} uncertainty.

2.2 Geometry Uncertainties

Because the matrix halves were not perfectly aligned, there was a small gap of variable width between the two halves of the assembly, even when the halves made contact at a point. Gap worth measurements made on two closely related assemblies have been reported: a ZPR-9 Assembly 4 measurement in Reference 6 and a ZPR-9 Assembly 6 measurement in Reference 5. Both measurements indicated that the slope of the reactivity-vs-gap width curve is much less steep near full closure than it is at larger gap widths. This trend has been observed in gap measurements in other assemblies, e.g., ZPR-6/10 (PU-MET-INTER-002). This slope variation is being emphasized because gap corrections reported in Reference 5 for Assemblies 3, 4, 5 and 6 are based erroneously on the large-gap slope. Consequently it is not appropriate simply to scale those reported corrections. The small-gap slope from the Assembly 4 measurement results shown in Figure 7 of Reference 6 was used here because it is more precise than is the small-gap slope from the Assembly 6 measurement. The estimated small-gap slope is 0.145 %Δk/cm, which is assumed to apply to Assemblies 5 and 6. The experimenters estimated the average gap to be 30 mils (0.076 cm), as reported in Reference 5. Based on these values, increasing the experimental k_{eff} by 0.011 %Δk would account for omission of the gap from the models. As in previous evaluations of ZPR assemblies, the ±2σ uncertainty in the gap width is estimated to be 50 mils (0.127 cm). Using the same slope yields a 1σ gap uncertainty effect of ±0.0046 %Δk.

Besides the table gap, there are three issues regarding the exact location of materials. One such possibility is that the drawer fronts might not have been flush with the front edge of the matrix tubes. This component was minimized by ensuring the tabs on the drawer sides mated with notches in the matrix tubes. During drawer loading and unloading, care would have been taken to make the drawers flush with the matrix surface. The second issue is the possibility that the plate columns might not have been all the way forward against the drawer front. This problem was minimized by following the drawer loading procedure and by using springs to hold the plates in a fixed position. Both of these two issues are assumed covered by the table gap uncertainty.

The third issue involves deviations from nominal dimensions for plates, drawers, and matrix tubes. Deviations in the dimensions that affect the precise X and Y positions of materials in the unit cell are too small to impact k_{eff} significantly. The dimensions that determine the volumes over which the material masses are distributed can have an effect. The plate lengths and drawer front thickness affect the axial positions of materials, similar to the interface gap effect. It is estimated that the collective uncertainty in these dimensions is ±10 mils (0.25 mm). Using the gap coefficient as a measure of the reactivity effect yields a k_{eff} uncertainty contribution of ±0.0037 %Δk. A deviation from the nominal average spacing between matrix tubes, discussed next, also would affect region volumes.

Dimensional measurements, including deflection under load, were made on the ZPR-9 aluminum matrix. Under appropriate load conditions, the average pitch was 2.179 inches in the horizontal direction and 2.186 inches in the vertical direction.[a] The measured pitch is assumed to be uncertain by 1 mil. The effect of increasing the pitch by 1 mil in each direction was computed by increasing all radii and reducing atom densities correspondingly to preserve masses. The results were -0.0533 and -0.0584 %Δk per mil (.00254 cm) increase in square pitch for Assemblies 5 and 6, respectively. The magnitudes of these results are taken to be the pitch contribution to the k_{eff} uncertainty.

An evaluation of the room return effect was made for the closely related assembly, ZPR-9 Assembly 4 (HEU-MET-FAST-060). It showed that the aluminum reflectors are so ineffective that it is important to model the complete matrix, the bed and table below, the knees on each side and the back plate behind the matrix. All of these structures are included in the as-built models of Assemblies 5 and 6, as they were in the as-built model of Assembly 4. The total uncertainty in modeling return from the structures beyond the matrix was estimated to be ±0.0427 %Δk for Assembly 4 and this value is assumed to apply to Assemblies 5 and 6.

2.3 Composition Uncertainties

A bit of history about the materials inventory records is needed to appreciate the extent and limitations of the information available on the compositions used in these assemblies. The material inventory for Argonne's ZPR facilities was accumulated over a period of more than three decades, starting in the mid-1950s. The procurement acceptance process required thorough documentation on dimensions, masses, composition, etc. Information needed for day-to-day operations was extracted and compiled in working documents known informally as "hot constants memos." These memos give batch or lot average values of dimensions, masses, and weight percents of constituents but no uncertainties. The original documentation on some of the inventory used in these assemblies is no longer available but the hot constants documents are available. Consequently, indirect evidence and estimates were used to quantify many of the composition uncertainties.

The composition uncertainty for a component is treated in two parts: the uncertainty in total mass and the uncertainty in the weight percents of the constituents. Since these two sources of uncertainty are independent, they are added in quadrature. The reactivity effect of the composition uncertainty was determined by computing the change in the k_{eff} using the TWODANT model of the benchmark.

The details of the mass measurements are unknown for all the materials in these assemblies. For the plates and most of the drawers it is assumed that measurements of masses were within 0.01 g of actual value for plates of up to tens of grams and within 1 g for larger plates weighing kilograms, i.e., the uncertainty in weighing was 0.1%. The working standard used to calibrate the scale is taken to have an uncertainty of 0.05%, which is a systematic uncertainty. The uncertainty in weighing could be statistical, but since no details of the process are available, we take the most pessimistic

[a] R. C. Doerner et al, "ZPR-9 Assemblies No. 6-9 Critical Experiments," ANL-7208, Argonne National Laboratory (March 1967).

assumption and consider this to be a systematic uncertainty, making a total uncertainty in mass of 0.15%. The mass uncertainty assumptions made for other items are specified as needed.

The materials that could contribute in a significant way to the composition uncertainties are: the enriched-uranium fuel plates (which had Kel-F coating), the graphite plates (Assembly 5), the perforated aluminum plates (Assembly 6), and tungsten plates in the core, the aluminum plates in the reflectors, the aluminum drawers, the stainless steel control drawers and the aluminum matrix tubes. Masses and compositions for all of these materials are known reasonably well. The effect of uncertainties in the compositions of the structures beyond the matrix is covered in the room return modeling uncertainty (see Section 2.2).

The evidence currently available regarding the uncertainties in the isotopic weight percents for the enriched uranium is discussed in the ZPR-9/4 benchmark document, HEU-MET-FAST-060. A ±0.05 wt.% uncertainty estimate for the ^{235}U and ^{238}U content was derived from this evidence. The reactivity effect was calculated directly using a TWODANT model of the benchmark. The ^{235}U mass was increased by 0.05 wt.% of the enriched uranium mass and the ^{238}U mass was reduced correspondingly. The component uncertainties for ^{235}U are 0.0265 %Δk and 0.0269 %Δk for Assemblies 5 and 6, respectively. The ^{238}U mass was increased by 0.05 wt.% of the enriched uranium mass and the ^{235}U mass was reduced correspondingly. The component uncertainties for ^{238}U are 0.0013 %Δk and 0.0016 %Δk for Assemblies 5 and 6, respectively. Although these 0.05 wt.% uncertainty estimates are themselves uncertain, their computed reactivity effect was so small that a reasonable revision of the wt.% estimate clearly would also yield an unimportant reactivity effect. The component uncertainties of ^{234}U and ^{236}U were negligible (<0.001%Δk). When added in quadrature, the total enrichment uncertainties are ±0.0266 %Δk and ±0.0269 %Δk for Assemblies 5 and 6, respectively.

The impurities in the enriched uranium are also discussed in HEU-MET-FAST-060. The estimated total impurity level is 885 weight ppm, with the following distribution: C 340, Ni 174, Fe 125, Cu 65, Na 63, Ca 40, Si 35, Al 30, and Mn 13. It is estimated that a one-sigma uncertainty of 50% applies to this impurity model. The effect of the estimated enriched uranium impurities was calculated directly with TWODANT. Since the presence of the impurities was neglected in the reference model, the perturbation consisted of adding the nine impurities and reducing the enriched uranium to preserve mass. The computed effects are -0.0412 %Δk and -0.0439 %Δk for Assemblies 5 and 6, respectively, implying that increasing the experimental k_{eff} values by these amounts would compensate for the omission of the impurities in the models. (It should be noted that, for both assemblies, the computed effect of the initial impurities comes primarily from the reduction in uranium mass. For example, in Assembly 5 the reduction in enriched uranium concentration has a -0.0489 %Δk effect. This is only slightly offset by the increase in moderation from the addition of the nine impurities, a +0.0077 %Δk effect.) The 50% uncertainty in the impurity level corresponds to ±0.0206 %Δk and ±0.0220 %Δk for Assemblies 5 and 6, respectively, which must be added in quadrature with the other k_{eff} uncertainty components.

The effect of increasing the mass of the enriched uranium by the assumed 0.15% uncertainty was calculated directly with TWODANT. The results are ±0.0778 %Δk and ±0.0817 %Δk for Assemblies 5 and 6, respectively.

Adding in quadrature the enrichment, impurity and mass uncertainty effects yields k_{eff} uncertainty contributions associated with the enriched uranium of ±0.0848 %Δk and ±0.0888 %Δk for Assemblies 5 and 6, respectively. The adjustment to the experimental k_{eff} values for impurities are +0.0412 %Δk and +0.0439 %Δk for Assemblies 5 and 6, respectively.

The uncertainty for the Kel-F coating on the uranium plates is dominated by the possibility that some flaked off in handling the plates. It is assumed, pessimistically, that 10% of the coating could have been lost. The effect of removing all the Kel-F from the TWODANT model was computed to be 0.0097 %Δk and 0.0077 %Δk, so the Kel-F uncertainty is ±0.0010 %Δk and ±0.0008 %Δk for Assemblies 5 and 6, respectively. For convenience this is not treated as a one-sided uncertainty.

There are uncertainties in mass and impurities associated with the tungsten plates. The assumed 0.15% uncertainty in the mass of the tungsten plates was calculated to have an effect of ±0.0132 %Δk and ±0.0086 %Δk for Assemblies 5 and 6, respectively. There is a tungsten mass bias because there must have been some special tungsten plates less than 2 inches tall to accommodate thermocouples. Record keeping of the 1960s was not precise enough to include a thermocouple drawer master but there definitely was temperature monitoring. It is estimated that there would have been three thermocouple drawers per half, and one 1/8-inch tungsten plate column in each of these drawers would be 1 ¾ inches tall, rather than 2 inches tall. Assuming these values, the tungsten mass in the as-built model is too large by 0.045% and 0.038% for Assemblies 5 and 6, respectively. Decreasing the experimental k_{eff} by 0.0040 %Δk in Assembly 5 and 0.0022 %Δk in Assembly 6 would account for this discrepancy and, assuming a 50% uncertainty, there is an uncertainty contribution of ±0.0020 %Δk and ±0.0011 %Δk for Assemblies 5 and 6, respectively.

The tungsten plates are listed in the hot constants memos as being 100% W. This value was used in the as-built model but there must be some impurities. Although 99.99 wt.% pure W is commercially available, the high cost makes it likely that the more common purity level of 99.9 wt.% was used to manufacture these plates. Since Fe and Mo appear to be the common impurities, the uncertainty perturbation was assumed to have 0.05 wt.% of each of these and 99.9 wt.% W. The effects of this perturbation are +0.0107 %Δk and +0.0112 %Δk for Assemblies 5 and 6, respectively. Decreasing the experimental k_{eff} by this amount would compensate for the omission of the impurities in the model. This impurity estimate is assumed to be uncertain by 100%, implying uncertainty contributions of ±0.0107 %Δk and ±0.0112 %Δk for Assemblies 5 and 6, respectively.

Combining these tungsten results yields adjustments of -0.0147 %Δk and -0.0134 %Δk to the experimental k_{eff} values and uncertainty contributions of ±0.0171 %Δk and ±0.0142 %Δk for Assemblies 5 and 6, respectively.

The assumed 0.15% uncertainty in the mass of the graphite plates, which are only in the core region of Assembly 5, was calculated to be ±0.0081 %Δk. These plates are listed in the hot constants memo as being 100% graphite. A conservative upper bound on the effect of any impurities that might be present was calculated by adding 5 parts per million ^{10}B, which is approximately the contamination observed in the TREAT reactor graphite.[a] This calculated bound is ±0.0016 %Δk for Assembly 5. The quadrature sum of the mass and impurity uncertainty is ±0.0083 %Δk.

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[a] H. P. Iskenderian, "Post Criticality Studies on the TREAT Reactor," ANL-6115, Argonne National Laboratory, February 1960.

Aluminum plates appear only in the reflector regions in Assembly 5, but in both core and reflector regions in Assembly 6. The plates in the Assembly 6 core region are perforated aluminum to simulate void, whereas, the reflector region aluminum plates in both assemblies are not perforated. These two different aluminum plate types will be discussed separately.

The assumed 0.15% uncertainty in the mass of the Assembly 6 core aluminum plates was calculated to have a ±0.0026 %Δk effect. These plates are listed in the Hot Constants memo as being 100% aluminum but there must be impurities. "Super-purity" aluminum, 99.99% pure, is commercially available but is relatively expensive. As a measure of the composition uncertainty, the 100% pure aluminum plates in the TWODANT model were replaced with 99.8% pure aluminum, which is a reasonably common variety. It was assumed that the two dominant impurities in "primary" aluminum, Fe and Si, each are present at 0.1 wt.%. The calculated effect is ±0.0011 %Δk.

The aluminum plates dominate the compositions of the reflectors. In addition to the assumed 0.15% mass uncertainty in the Hot Constants plate masses, there is a mass uncertainty due to the fact that the plate sizes used to construct the reflectors usually are not specified in the drawer masters. Separate assessments of radial and axial reflectors were made for ZPR-9/4, which had nearly the same reflectors as Assemblies 5 and 6. Because the uncertainty contribution observed there for the axial reflector is relatively small, a simpler approach is used here. The 0.20% total mass uncertainty assigned to the radial reflector is assigned to both the radial and axial reflectors and there treated simultaneously. The calculated effects of this mass uncertainty are ±0.0124 %Δk and ±0.0161 %Δk for Assemblies 5 and 6, respectively.

There is uncertainty in the weight percents for the aluminum plates. The reflector composition uncertainty was treated like the core composition uncertainty discussed above. The calculated effects are ±0.0055 %Δk and ±0.0060 %Δk for Assemblies 5 and 6, respectively.

The aluminum matrix and aluminum drawers are relatively unimportant. They contribute approximately 7% and 4%, respectively, to the total aluminum in the reflectors. They account for all the aluminum in the core in Assembly 5, but aluminum is not an important core constituent. The uncertainty contributions computed for ZPR9/4, which had the same matrix and nearly the same drawers, are adopted here. That contribution is ±0.0023 %Δk for each assembly.

The combined aluminum uncertainty is the quadrature sum of plate, matrix tube and drawer contributions. The combined uncertainty effects are ±0.0138 %Δk and ±0.0176 %Δk for Assemblies 5 and 6, respectively.

The stainless steel DP control drawers make a small contribution to the core and axial reflector compositions. The effect of a 0.15% mass uncertainty was calculated for ZPR-9/4 and was found to be only ±0.0001 %Δk. This result is assumed to apply to Assemblies 5 and 6. With such a small mass result, the stainless steel composition uncertainty must have a totally negligible effect.

A very small bias and uncertainty due to the presence of humidity in the air was derived for an earlier ZPR assembly. This was done by comparing calculations with the assembly gaps filled by dry air and by saturated air. The calculated effect, 0.0001% Δk, is assumed to apply to these assemblies and will be included simply as an uncertainty.

2.4 Combined Uncertainties and Final Excess Reactivity

All of the uncertainties discussed in the previous sections are summarized in Table 25. None of the uncertainties in the measurement technique category are important and their quadrature sums are only 0.0101%Δk and 0.0131%Δk for Assemblies 5 and 6, respectively. Two of the four geometry uncertainties are significant and the quadrature sums of the four are 0.0685 %Δk and 0.0726 %Δk for Assemblies 5 and 6, respectively. The enriched uranium fuel composition uncertainty is by far the most important single contributor. The total uncertainties, 0.1120 %Δk and 0.1176 %Δk for Assemblies 5 and 6, respectively, are believed to be conservative but reasonable. Treating each of these uncertainties as if it were 1σ of normal distributions should be acceptable for the purposes of the benchmark models. As discussed throughout Section 2, this uncertainty covers the effects of simplifying adjustments to the experiment, such as removal of the matrix interface gap and omission of impurities.

Table 25. Summary of the Uncertainties in the Experimental k_{eff} for ZPR-9 Assemblies 5 and 6.

Source of Uncertainty	Uncertainty in Excess Reactivity (% Δk)	
	ZPR-9/5	ZPR-9/6
Measurement Technique		
Data Fitting	0.0002	0.0002
Ih to Δk	0.0094	0.0126
Temperature	0.0037	0.0036
Geometry		
Matrix Interface Gap	0.0046	0.0046
Nominal Plate Dimensions	0.0037	0.0037
Matrix Tube Pitch	0.0533	0.0584
Room Return	0.0427	0.0427
Composition		
Enriched Uranium	0.0848	0.0888
Kel-F	0.0010	0.0008
Tungsten	0.0171	0.0142
Graphite (Carbon)	0.0083	
Aluminum	0.0138	0.0176
DP Rod Steel	0.0001	0.0001
Humidity	0.0001	0.0001
Total	0.1120	0.1176

ZPR-9 Assemblies 5 and 6 have been determined to comprise acceptable criticality-safety benchmark experiments.

3.0 BENCHMARK SPECIFICATIONS

3.1 Description of Model

Even the most casual perusal of Section 1 makes it clear that these assemblies are too complicated to be practical criticality-safety benchmark models without a great deal of simplification. Fortunately, it is possible to eliminate virtually all of the complexity and obtain simple benchmark models without losing any of the essential physics. Furthermore, this can be done without compromising the high accuracy of the experiments.

This was accomplished by computing the transformation from the detailed as-built experiment model to a simple RZ benchmark model using the VIM continuous-energy Monte Carlo code.[a] Note that the term "transformation" will be used repeatedly through Section 3.0 and will, in all cases, refer to both the simplification of the model from the as-built platewise heterogeneous experiment model to the homogeneous cylindrical benchmark model, and the corresponding correction of k_{eff} to account for these simplifications. VIM eigenvalue calculations were made for the as-built model and for the benchmark model. The k_{eff} correction is simply the difference in k_{eff} between the two models.

The modeling of all the experimental detail was made tractable by the development of the BLDVIM computer code[b] which generates the VIM input file for the as-built model. BLDVIM reads an electronic database containing a description of the ZPPR plate and drawer inventory, the assembly drawer masters, and the matrix loading maps. The code and database were recently rewritten for UNIX-based workstations, at which time the values of Avogadro's number and the atomic masses were made to conform to the values recommended by the ICSBEP. The VIM input for the as-built models are provided in Appendix D.

VIM input requires that an edit region number be assigned to each geometric region. Each geometric region associated with the ZPR-9/5 core (each plate, air gap, drawer segment, etc) was assigned edit region number 1. Similarly, each geometric region of the first segment of the axial reflector was assigned edit region number 2, and so on. Of course, the composition (atom densities) associated with each geometric region of the as-built model must also be assigned. These assignments were made with the aid of the BLDVIM code, reducing the actual hand-generated input from thousands of numbers to just a few. When the resulting as-built model was processed by the VIM code, the total volume and the volume-averaged atom densities for each edit region were edited. The same process was followed for ZPR-9/6.

The key features retained in the benchmark model are the region-averaged compositions, region volumes, and global RZ geometry. The Assembly 5 benchmark geometry is depicted in Figure 9. Some drawers at the core-radial reflector interface had core-region plates in part of the drawer and radial reflector-region plates (aluminum) in the remainder of the drawer (partial-core drawers).

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[a] R. N. Blomquist, R. M. Lell and E. M. Gelbard, "VIM – A Continuous Energy Monte Carlo Code at ANL," A Review of the Theory and Application of Monte Carlo Methods, Proceedings of a Seminar-Workshop, Oak Ridge, TN, April 21-23, 1980, ORNL/RSIC-44, p. 31, August 1980.

[b] R. W. Schaefer, R. D. McKnight and P. J. Collins, "Lessons Learned from Applying VIM to Fast Reactor Critical Experiments," *Proceedings of the Nuclear Criticality Technology Safety Workshop*, San Diego, CA, pp. 129-136, LA-13439-C (1995).

These partial-core drawers had the standard axial-reflector loading behind the core/radial-reflector plate loading. This resulted in the radius of the core being smaller than the radius of the axial reflector. The DP control drawers had a thicker drawer wall than the standard core drawers, making the core plate loading extend 0.044 cm further back in the control drawers. The total length of the model was to the end of the radial reflector drawer. The Assembly 6 benchmark geometry is depicted in Figure 10. Again, the radial reflector drawer length was used in the benchmark model. Volumes and masses are preserved exactly for all regions in both models.

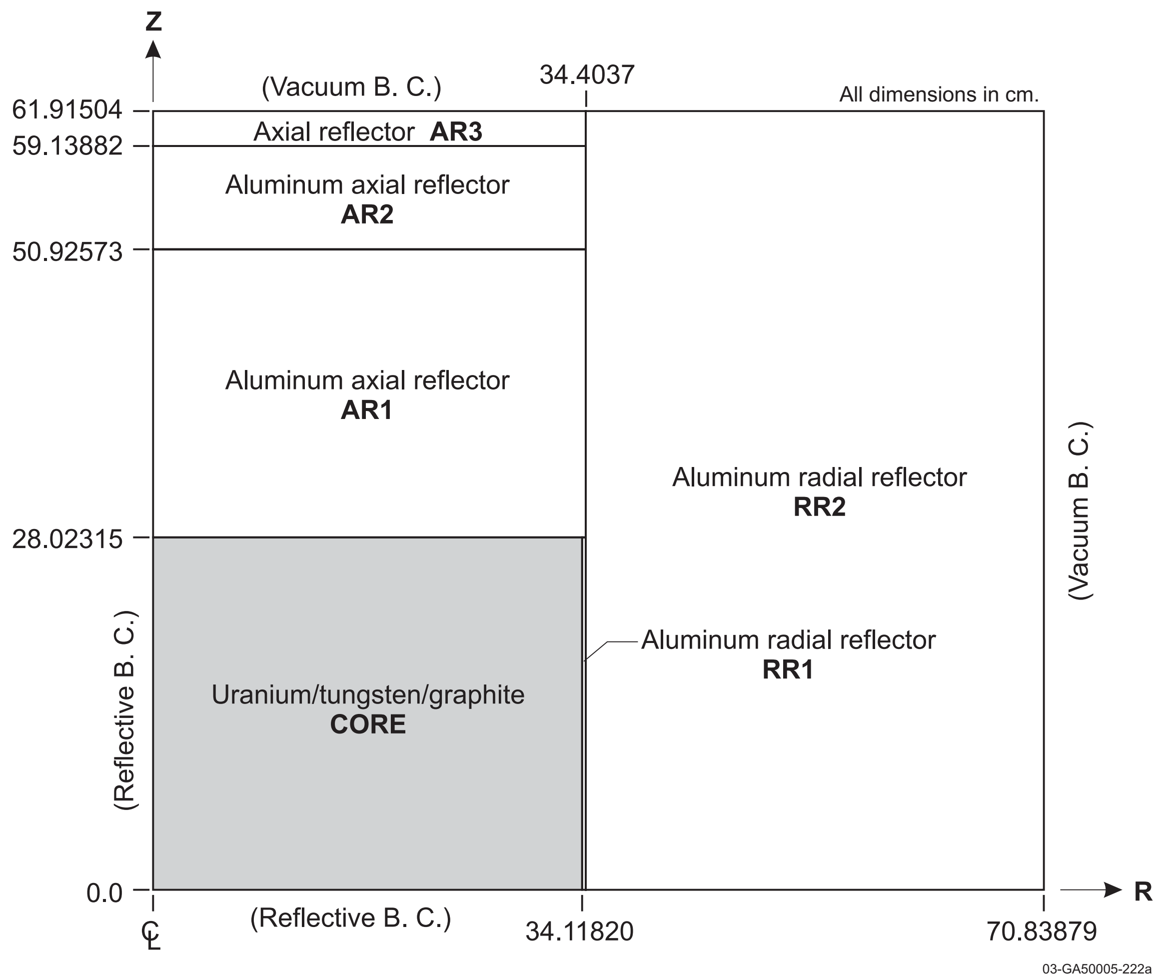

Figure 9. Benchmark-Model Geometry for ZPR-9/5.

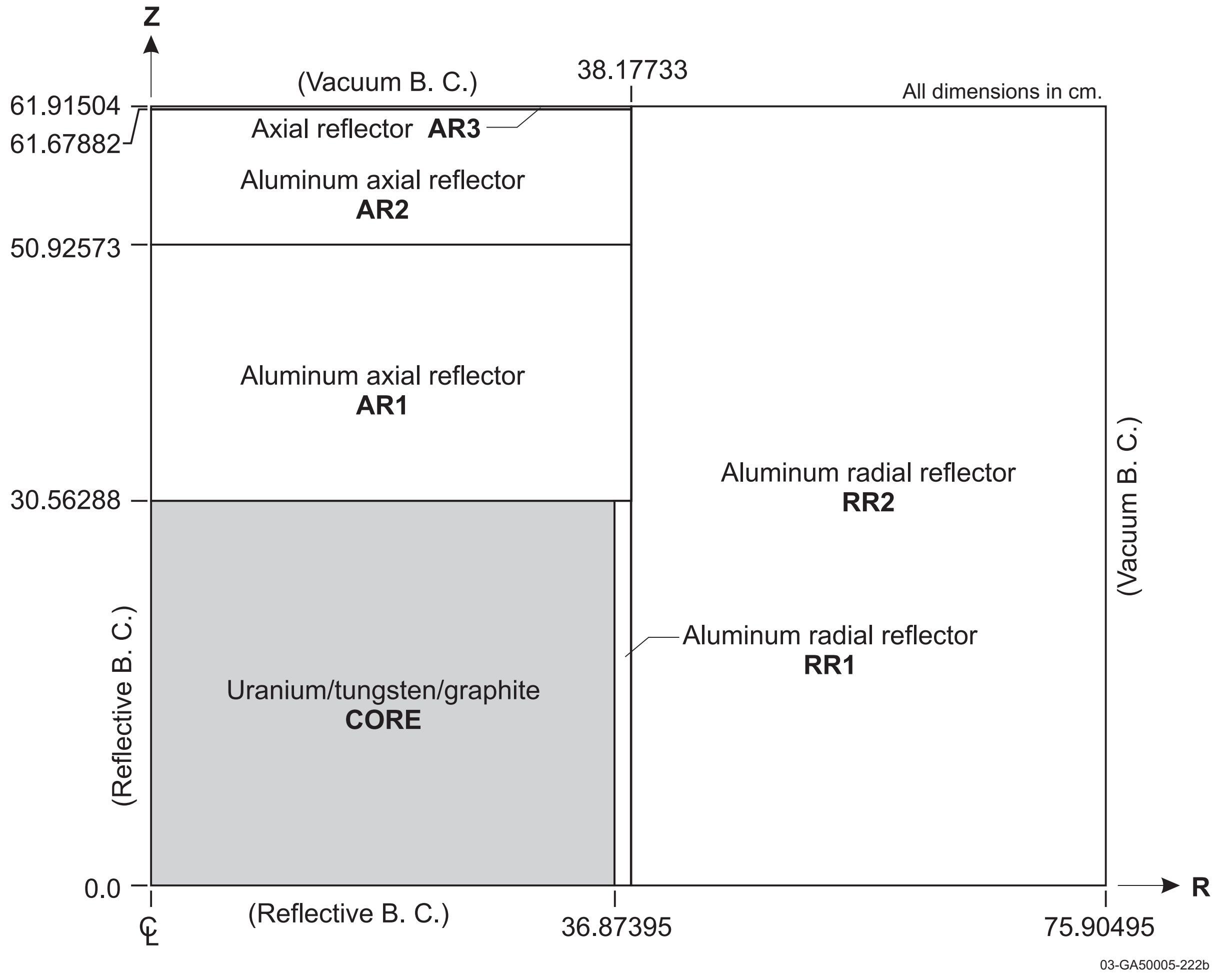

Figure 10. Benchmark-Model Geometry for ZPR-9/6.

Obvious simplifications made were the smoothing of jagged boundaries in the XY plane into circular boundaries, and the elimination of the empty matrix tubes and support structures beyond them. The simplification that yielded by far the greatest elimination of detail was the smearing of plates, drawers, and matrix tubes into cylindrical regions. The plate heterogeneity effects, which would require much effort to capture accurately in effective homogenized cross sections in a deterministic modeling approach, are included in the Monte Carlo-calculated transformation Δk.

Several minor simplifications of the experiments were made in developing the as-built model and these implicitly apply to the benchmark models as well. The small gap between the matrix halves was neglected. Impurities in the enriched uranium and in the tungsten were ignored. Finally, humid air was replaced by void in all the air gaps. All of these biases and their associated uncertainties were quantified in Section 2 and their impact on k_{eff} is summarized in Section 3.5.

3.2 Dimensions

The ZPR-9/5 benchmark model consists of six regions, as shown in Figure 9. The central region, CORE, is a cylindrical core with a radius of 34.11820 cm and a half-height of 28.02315 cm. Radially beyond the core is the first part of the aluminum radial reflector, RR1, which has an outer radius of 34.4037 cm. The RR1 region represents the contribution to the radial reflector from the partial core drawers. Radially beyond the RR1 region is the remainder of the aluminum radial reflector, RR2, which has an outer radius of 70.83879 cm. The back of the radial reflector goes to the end of the radial reflector drawer, at 61.91504 cm. The axial reflector is partitioned axially where the aluminum plate loading ended in the DP control drawers, at 50.92573 cm and at the end of the axial reflector plate loading, 59.13882 cm. Finally, an empty-drawer region, AR3, is included behind region AR2 to the same height as the end of the region RR2.

The ZPR-9/6 benchmark model consists of six regions, as shown in Figure 10. The central region, CORE, is a cylindrical core with a radius of 36.87395 cm and a half-height of 30.56288 cm. Radially beyond the core is the first part of the aluminum radial reflector, RR1, which has an outer radius of 38.17733 cm. The RR1 region represents the contribution to the radial reflector from the partial core drawers. Radially beyond the RR1 region is the remainder of the aluminum radial reflector, RR2, which has an outer radius of 75.90495 cm. The back of the radial reflector goes to the end of the radial reflector drawer, at 61.91504 cm. The axial reflector is partitioned axially where the aluminum plate loading ended in the DP control drawers, at 50.92573 cm and at the end of the axial reflector plate loading, 61.67882 cm. Finally, an empty-drawer region, AR3, is included behind region AR2 to the same height as the end of the region RR2.

3.3 Material Data

Table 26 shows the region-dependent composition data for the ZPR-9/5 benchmark model. Only aluminum plates, aluminum drawers, and aluminum matrix tubes contributed to the compositions for regions RR1 and RR2. The trace-level concentrations of elements other than aluminum in this region are from impurities in the drawers and matrix tubes. For instance, the core and axial reflector regions have steel from the DP control drawers. However, nowhere in the model is there much iron.

Table 27 shows the region-dependent composition data for the ZPR-9/6 benchmark model. This model is partitioned in approximately the same manner as the ZPR-9 Assembly 5 configuration discussed above. The major compositional difference between the two models is the substitution of perforated aluminum plates in ZPR-9/6 for the graphite plates in ZPR-9/5.

Table 26. Compositions by Region for ZPR-9/5 Benchmark Model (atoms/barn-cm).

Nuclide	CORE	AR1	AR2	AR3	RR1	RR2
^{235}U	4.50947E-03	0.0	0.0	0.0	0.0	0.0
^{238}U	2.61044E-04	0.0	0.0	0.0	0.0	0.0
^{234}U	4.46629E-05	0.0	0.0	0.0	0.0	0.0
^{236}U	2.14119E-05	0.0	0.0	0.0	0.0	0.0
Cr	5.19317E-05	4.90320E-05	4.90529E-05	4.90529E-05	5.85966E-06	6.25067E-06
Ni	1.89819E-05	1.75735E-05	1.76564E-05	1.76388E-05	0.0	0.0
Fe	1.74665E-04	3.08069E-04	6.95925E-04	5.13312E-04	9.43218E-06	6.59296E-05
Al	5.86832E-03	5.51390E-02	5.47063E-02	6.38535E-03	5.57230E-02	5.60063E-02
C	2.98022E-02	7.22959E-06	4.40231E-06	3.10124E-06	0.0	2.55604E-06
Mo	3.41200E-07	3.15881E-07	3.16470E-07	3.16470E-07	0.0	0.0
Mn	9.70810E-06	1.05374E-05	1.25539E-05	1.18051E-05	6.20712E-06	7.10273E-06
Cu	6.11835E-06	6.46318E-06	6.47664E-06	6.46035E-06	5.74351E-06	6.00084E-06
H	4.05183E-06	0.0	0.0	0.0	0.0	0.0
Ti	2.73840E-06	3.01802E-06	2.98271E-06	2.98271E-06	2.77784E-06	2.98857E-06
Si	2.83306E-05	3.00221E-05	3.00817E-05	3.00115E-05	2.75664E-05	2.87875E-05
Mg	1.34057E-04	1.56686E-04	1.53221E-04	1.53221E-04	1.37951E-04	1.56196E-04
Cl	7.07473E-06	0.0	0.0	0.0	0.0	0.0
F	2.09509E-05	0.0	0.0	0.0	0.0	0.0
W	2.13337E-02	0.0	0.0	0.0	0.0	0.0

Table 27. Compositions by Region for ZPR-9/6 Benchmark Model (atoms/barn-cm).

Nuclide	CORE	AR1	AR2	AR3	RR1	RR2
^{235}U	4.50657E-03	0.0	0.0	0.0	0.0	0.0
^{238}U	2.60887E-04	0.0	0.0	0.0	0.0	0.0
^{234}U	4.46358E-05	0.0	0.0	0.0	0.0	0.0
^{236}U	2.13983E-05	0.0	0.0	0.0	0.0	0.0
Cr	4.51216E-05	4.10691E-05	4.10258E-05	4.10258E-05	5.86474E-06	6.25067E-06
Ni	1.61740E-05	1.42675E-05	1.43351E-05	1.43241E-05	0.0	0.0
Fe	1.50232E-04	2.98772E-04	5.32030E-04	4.18763E-04	9.44106E-06	6.59296E-05
Al	1.51117E-02	5.49957E-02	5.51727E-02	6.40368E-03	5.57536E-02	5.60085E-02
C	1.47100E-05	8.00231E-06	3.32546E-06	2.51846E-06	0.0	2.55604E-06
Mo	2.90728E-07	2.56457E-07	2.56999E-07	2.56999E-07	0.0	0.0
Mn	9.17333E-06	1.01005E-05	1.13990E-05	1.09346E-05	6.19021E-06	7.10273E-06
Cu	6.07329E-06	6.43103E-06	6.40119E-06	6.39109E-06	5.75389E-06	6.00085E-06
H	4.04868E-06	0.0	0.0	0.0	0.0	0.0
Ti	2.74534E-06	3.06014E-06	2.99143E-06	2.99142E-06	2.77894E-06	2.98857E-06
Si	2.82693E-05	3.00395E-05	2.99042E-05	2.98606E-05	2.76181E-05	2.87875E-05
Mg	1.34332E-04	1.60836E-04	1.54081E-04	1.54081E-04	1.37651E-04	1.56196E-04
Cl	7.09986E-06	0.0	0.0	0.0	0.0	0.0
F	2.10256E-05	0.0	0.0	0.0	0.0	0.0
W	2.13477E-02	0.0	0.0	0.0	0.0	0.0

Tungsten is presented in Tables 26 and 27 in element form. Some neutron cross section data files contain tungsten data by isotope and not for the composite element. For ZPR-9/5 (Table 26), the decomposition of the tungsten element atom density into isotopic atom densities is 2.56004E-05, 5.65300E-03, 3.05371E-03, 6.53707E-03, and 6.06432E-03 for isotopes 180, 182, 183, 184 and 186, respectively.[a] The corresponding decomposition for ZPR-9/6 (Table 27) is 2.56172E-05, 5.65671E-03, 3.05571E-03, 6.54136E-03, and 6.06830E-03. However, there are no data for ^{180}W in the ENDF/B files. The ^{182}W cross sections should be a good substitute (see Section 3.5).

3.4 Temperature Data

The experimenters reported the excess reactivity corresponding to temperatures of 20.7°C and 14.0ºC for Assemblies 5 and 6, respectively, both of which are approximately room temperature. These are the temperatures used for the benchmark models. For any reasonable definition of room temperature, the temperature adjustment to k_{eff} is negligible.

3.5 Experimental and Benchmark-Model k_{eff}

The transformation Δk (bias) from the as-built configuration to the benchmark model was calculated using the VIM continuous-energy Monte Carlo code with ENDF/B-V data. The results are shown in Table 28. The uncertainties shown are just the statistical standard deviations from VIM using the combined track-length and analog estimators.

Table 28. Eigenvalues for Transformation From As-Built Model to RZ Benchmark Model.

Assembly	As-built Model k_{eff}	RZ Benchmark Model k_{eff}	Transformation Δk (Bias)
ZPR-9/5	1.0150 ± 0.0006	1.0086 ± 0.0004	-0.0064 ± 0.0007
ZPR-9/6	1.0196 ± 0.0005	1.0105 ± 0.0004	-0.0091 ± 0.0006

The transformation Δk comes primarily from two negative components. The largest component is due to plate cell heterogeneity. This, along with most other components, was estimated by the experimenters (Reference 5), since it was not practical to model these components using the calculational tools of that era. They estimated the plate heterogeneity effect to be 0.40 %Δk for both Assemblies 5 and 6. The second largest component is due to room return. This effect could not be estimated well by calculation or measurement in the 1960s. The room return effect for ZPR-9 Assemblies 2, 3 and 4 has been calculated to be approximately 0.2 %Δk. Since Assemblies 5 and 6 are similar cores, they should have approximately the same room return effect. Each of the remaining components, such as edge smoothing, is smaller.

An estimate of the *total* uncertainty in the transformation Δk from the as-built, platewise heterogeneous critical-assembly model to the homogeneous cylindrical model is needed. Since there are no significant geometric approximations in the as-built model and there are no cross section

[a] "Nuclides and Isotopes, Chart of the Nuclides", Fifteenth Edition, General Electric Co. and KAPL, Inc. (1996).

processing approximations associated with either model, the only sources of uncertainty added to the original experimental uncertainty come from the Monte Carlo statistical precision and the sensitivity of the calculated Δk values to uncertainties in the basic cross section data. The major cross section uncertainties in the assembly arise from fission production and absorption in ^{235}U and absorption in tungsten. Uncertainties in the k_{eff} of fast reactor critical assemblies due to calculations with ENDF/B-V data have been quantified.[a] In a set of about a dozen assemblies, the k_{eff} uncertainty ranges from 1.1% to 2.0%. The assumption is made that the high end of this range, 2.0% applies to the k_{eff} of these assemblies.

Because there is a strong correlation between the two calculations, the transformation Δk has a much smaller uncertainty than the uncertainty in either k_{eff}. The two calculations for the transformation Δk are based on the same code and on the same cross sections, with similar sensitivities of k_{eff} to the cross sections, and are thus highly correlated. The ensuing uncertainty in the transformation Δk is therefore assumed smaller by an order of magnitude, or ±0.20 %Δk. Adding in quadrature the uncertainties due to use of ENDF/B-V cross sections and the uncertainty from statistics on the difference of the two VIM calculations yields a total uncertainty in the transformation Δk of 0.21 %Δk.

This uncertainty estimate is believed to be conservative, but still sufficiently small for criticality-safety benchmark purposes. The actual correlations are likely higher than the values assumed in deriving the estimated uncertainty.

Several small adjustments to the measured k_{eff} are needed to account for differences between the actual experiment conditions and the as-built model. The matrix-interface gap, estimated by the experimenters to be 0.076 cm, was not included in the as-built model. As described in Section 2.2, removal of this gap increases k_{eff} by 0.011 %Δk for both Assemblies 5 and 6, based on the gap worth measurement data. No matrix pitch adjustment is needed because the best-estimate horizontal and vertical pitch values (2.179x2.186 inches) were used in the as-built model (unlike the use of 2.175-inch square pitch in previous ZPR benchmark models). Also, no room return adjustment is needed because the as-built model includes structural components beyond the matrix tubes. The next three adjustments are discussed in Section 2.3. Adjustments of +0.0412 %Δk and +0.0439 %Δk compensate for omission of enriched-uranium impurities from the Assembly 5 and Assembly 6 models, respectively. Adjustments of –0.0147 %Δk and –0.0134 %Δk compensate for omission of tungsten impurities and the thermocouple hardware adjustment from the Assembly 5 and Assembly 6 models, respectively. Finally, as noted in Section 2.3, the effect of omitting humid air from the models (replaced by void) is so small, 0.0001 %Δk, that effect was treated as an uncertainty rather than an adjustment. The uncertainty contributions from all of these adjustments were included in the uncertainty evaluations in Section 2.

There is one more adjustment issue. Natural tungsten includes a small amount of ^{180}W, 0.12 wt.%, but there are no ENDF/B cross section data for this isotope in the VIM code's cross section library. In the as-built models (and in some benchmark-model calculations) the ^{180}W atom density was added to the ^{182}W atom density and ^{182}W cross sections were used for this combination. No adjustment to k_{eff} is thought to be needed because the similarity of the nuclear properties of these

[a] Table IV in: D. N. Olsen, P. J. Collins and S. G. Carpenter, "Experiments of IFR Fuel Criticality in ZPPR-21," *ICNC '91 International Conference on Criticality Safety*, Oxford, UK, September 9-13, 1991.

two isotopes strongly suggests that their cross sections should be very similar.[a] However, an uncertainty estimate was made to account for this substitution. This was done by using ^{186}W cross sections, instead of ^{182}W cross sections, with the ^{180}W atom density in the TWODANT benchmark model. The resulting effect, 0.0098 %Δk for Assembly 5 and 0.0079 %Δk for Assembly 6, is believed to be a conservative uncertainty estimate because the nuclear properties of ^{186}W do not closely match those of ^{180}W and ^{182}W.

The data for the experimental and benchmark-model k_{eff} values are summarized in Table 29. The data in the table are in units of k_{eff}. The measured k_{eff} reflects the excess reactivity from Section 2.1. The three adjustments leading to the adjusted experimental k_{eff} were just discussed. The uncertainty in the adjusted value is the total uncertainty from Table 25, in Section 2.4. The uncertainty is the same, to the precision shown, whether or not the uncertainty from replacing ^{180}W is added in quadrature. Applying the Monte Carlo transformation to the adjusted experimental k_{eff} yields the benchmark model k_{eff} shown on the last line.

Table 29. Experimental and Benchmark-Model Eigenvalues.[(a)]

k_{eff} or Δk_{eff}	ZPR-9/5	ZPR-9/6
Measured k_{eff}	1.00188	1.00252
Remove Matrix-Interface Gap	+0.00011	+0.00011
Enriched-Uranium Impurity Adjustment	+0.00041	+0.00044
Tungsten Mass Impurity Adjustment	-0.00015	-0.00013
Adjusted Experimental k_{eff}	1.0023 ± 0.0011	1.0029 ± 0.0012
Monte Carlo Transformation of the Model	-0.0064 ± 0.0021	-0.0091 ± 0.0021
Benchmark-Model k_{eff}	0.9959 ± 0.0024	0.9938 ± 0.0024

(a) Each uncertainty estimate is one standard deviation.

[a] Private Communication, A. B. Smith, Argonne National Laboratory, July 2002.

4.0 RESULTS OF SAMPLE CALCULATIONS

Results of sample calculations of the benchmark models of ZPR-9 Assemblies 5 and 6 are given in Table 30. More details of the calculations, including input listings, are given in Appendix A. Additional results are given in Appendix B. Appendix C displays the calculated neutron spectrum and presents a detailed neutron balance.

Table 30.a. Sample Calculation Results (United States).

Code (Cross Section Set) → Case ↓	KENO VI (SCALE 4.3 27-group ENDF/B-IV)	KENO VI (SCALE 4.3 238-group ENDF/B-V)
ZPR-9/5	1.0213 ±0.0005	1.0216 ±0.0005
ZPR-9/6	1.0248 ±0.0004	1.0269 ±0.0006

Code (Cross Section Set) → Case ↓	MCNP 4C (Cont. Energy ENDF/B-V)	MCNP 4C (Cont. Energy ENDF/B-VI)	VIM (Cont. Energy ENDF/B-V)	VIM (Cont. Energy ENDF/B-VI)
ZPR-9/5	1.0057 ±0.0004	1.0015 ±0.0004	1.0086 ±0.0004	1.0128 ±0.0004
ZPR-9/6	1.0138 ±0.0004	1.0070 ±0.0004	1.0105 ±0.0004	1.0091 ±0.0005

Table 30.b. Sample Calculation Results (United Kingdom). [(a)]

Code (Cross Section Set) → Case ↓	MONK 8B (8220-Group UKNDL)	MONK 8B (13193-Group JEF-2.2)	MONK 8B (13193-Group ENDF/B-VI.3)	MONK 8B (13193-Group JENDL-3)
ZPR-9/5	0.9899 ±0.0004	1.0134 ±0.0004	1.0020 ±0.0004	1.0259 ±0.0004
ZPR-9/6	1.0378 ±0.0004	1.0248 ±0.0004	1.0068 ±0.0004	1.0093 ±0.0004

(a) Results supplied by R. D. McKnight (ANL).

Many of the calculated k_{eff} values are quite high. The most discrepant values are based on older (e.g., ENDF/B-IV and -V) data and/or multigroup methods. Furthermore, when comparing the benchmark results for the ZPR-9 Assemblies 2-6, there is a general trend of increasing calculated eigenvalue with increasing tungsten content in the assembly. This trend supports the hypothesis that there are significant deficiencies in the cross section data for tungsten. It is also noted that the eigenvalues for the tungsten-carbide-reflected oralloy spheres of HEU-MET-FAST-003 are overpredicted using ENDF/B-IV and -V data.

5.0 REFERENCES

1. R. C. Doerner et al., "Physics Measurements in Tungsten-Based, Aluminum-Reflected Fast Reactors," *Trans. Am. Nucl. Soc.*, **7**, 236 (November 1964).

2. R. C. Doerner et al., "Physics Measurements in Tungsten-Based, Aluminum-Reflected Fast Reactors," *Reactor Physics Divisional Annual Report, July 1, 1963 to June 30, 1964*, pp. 116-123, ANL-7101, Argonne National Laboratory (January 1965).

3. R. C. Doerner et al., "Experimental Physics Studies in Tungsten-Based Fast Reactors," *Reactor Physics Divisional Annual Report, July 1, 1964 to June 30, 1965*, pp. 215-221, ANL-7101, Argonne National Laboratory (December 1965).

4. D. K. Butler, R. C. Doerner, and W. G. Knapp, "Measurements and Analysis of Al-, Al_2O_3-, and BeO- reflected Fast Critical Experiments," *Proceedings of the International Conference on Fast Critical Experiments and Their Analysis, October 10-13, 1966*, pp. 186-194, ANL-7320, Argonne National Laboratory (1966).

5. W G. Knapp and R. C. Doerner, "Physics Measurements with Modified Diluent Compositions in Tungsten-Based, Aluminum-Reflected Fast Reactors," ANL-7207, Argonne National Laboratory (February 1967).

6. R. C. Doerner et al., "Physics Measurements in Tungsten-Based, Aluminum-Reflected Fast Reactors," ANL-7007, Argonne National Laboratory (March 1967).

APPENDIX A: TYPICAL INPUT LISTINGS

A.1 KENO Input Listings

Sample inputs for the SCALE/KENO VI 238-group calculations with ENDF/B-V data are shown below for the cylindrical benchmark models of ZPR-9 Assemblies 5 and 6. The KENO calculations were run with 240 generations and 10000 histories per generation, skipping the first 40 generations, for a total of 2 million active histories.

KENO Input Listing for Assembly 5 of Table 30.a.

```
=csas26    parm=size=900000
kzr9508v5-keno vi-zpr9-5/08-rz model-v5 xs
238groupndf5
infhommedium
u-235        1  0.0   4.50947E-03  294  end
u-238        1  0.0   2.61044E-04  294  end
u-234        1  0.0   4.46629E-05  294  end
u-236        1  0.0   2.14119E-05  294  end
cr           1  0.0   5.19317E-05  294  end
ni           1  0.0   1.89819E-05  294  end
fe           1  0.0   1.74665E-04  294  end
al           1  0.0   5.86832E-03  294  end
c            1  0.0   2.98022E-02  294  end
mo           1  0.0   3.41200E-07  294  end
mn           1  0.0   9.70810E-06  294  end
cu           1  0.0   6.11835E-06  294  end
h            1  0.0   4.05183E-06  294  end
ti           1  0.0   2.73840E-06  294  end
si           1  0.0   2.83306E-05  294  end
mg           1  0.0   1.34057E-04  294  end
cl           1  0.0   7.07473E-06  294  end
f            1  0.0   2.09509E-05  294  end
w-182        1  0.0   5.67861E-03  294  end
w-183        1  0.0   3.05370E-03  294  end
w-184        1  0.0   6.53706E-03  294  end
w-186        1  0.0   6.06431E-03  294  end
cr           2  0.0   4.90320E-05  294  end
ni           2  0.0   1.75735E-05  294  end
fe           2  0.0   3.08069E-04  294  end
al           2  0.0   5.51390E-02  294  end
c            2  0.0   7.22959E-06  294  end
mo           2  0.0   3.15881E-07  294  end
mn           2  0.0   1.05374E-05  294  end
cu           2  0.0   6.46318E-06  294  end
ti           2  0.0   3.01802E-06  294  end
si           2  0.0   3.00221E-05  294  end
mg           2  0.0   1.56686E-04  294  end
cr           3  0.0   4.90529E-05  294  end
ni           3  0.0   1.76564E-05  294  end
fe           3  0.0   6.95925E-04  294  end
al           3  0.0   5.47063E-02  294  end
c            3  0.0   4.40231E-06  294  end
mo           3  0.0   3.16470E-07  294  end
mn           3  0.0   1.25539E-05  294  end
cu           3  0.0   6.47664E-06  294  end
ti           3  0.0   2.98271E-06  294  end
si           3  0.0   3.00817E-05  294  end
mg           3  0.0   1.53221E-04  294  end
cr           4  0.0   4.90529E-05  294  end
ni           4  0.0   1.76388E-05  294  end
fe           4  0.0   5.13312E-04  294  end
al           4  0.0   6.38535E-03  294  end
c            4  0.0   3.10124E-06  294  end
mo           4  0.0   3.16470E-07  294  end
mn           4  0.0   1.18051E-05  294  end
```

KENO Input Listing for Assembly 5 of Table 30.a (cont'd).

```
cu           4  0.0   6.46035E-06  294  end
ti           4  0.0   2.98271E-06  294  end
si           4  0.0   3.00115E-05  294  end
mg           4  0.0   1.53221E-04  294  end
cr           5  0.0   5.85966E-06  294  end
fe           5  0.0   9.43218E-06  294  end
al           5  0.0   5.57230E-02  294  end
mn           5  0.0   6.20712E-06  294  end
cu           5  0.0   5.74351E-06  294  end
ti           5  0.0   2.77784E-06  294  end
si           5  0.0   2.75664E-05  294  end
mg           5  0.0   1.37951E-04  294  end
cr           6  0.0   6.25067E-06  294  end
fe           6  0.0   6.59296E-05  294  end
al           6  0.0   5.60063E-02  294  end
c            6  0.0   2.55604E-06  294  end
mn           6  0.0   7.10273E-06  294  end
cu           6  0.0   6.00084E-06  294  end
ti           6  0.0   2.98857E-06  294  end
si           6  0.0   2.87875E-05  294  end
mg           6  0.0   1.56196E-04  294  end
end comp
read para  tme=599.0  gen=240 npg=10000  nsk=40 run=yes  tba=3.0
end para
read geom
global unit 1
com='zpr9-5/08 rz model'
cylinder   1    34.11820    28.02315   -28.02315
cylinder   2    34.40370    28.02315   -28.02315
cylinder   3    34.40370    50.92573   -50.92573
cylinder   4    34.40370    59.13882   -59.13882
cylinder   5    34.40370    61.91504   -61.91504
cylinder   6    70.83879    61.91504   -61.91504
media      1   1   1
media      5   1   2  -1
media      2   1   3  -2
media      3   1   4  -3
media      4   1   5  -4
media      6   1   6  -5
boundary   6
end geom
read star
nst=0
xsm=-34.10
xsp=34.10
ysm=-34.10
ysp=34.10
zsm=-28.02
zsp=28.02
end star
end data
end
```

KENO Input Listing for Assembly 6 of Table 30.a.

```
=csas26    parm=size=900000
kzr9613v5-keno vi-zpr9-6/13-rz model-v5 xs
238groupndf5
infhommedium
u-235        1  0.0   4.50657E-03  287  end
u-238        1  0.0   2.60887E-04  287  end
u-234        1  0.0   4.46358E-05  287  end
u-236        1  0.0   2.13983E-05  287  end
cr           1  0.0   4.51216E-05  287  end
ni           1  0.0   1.61740E-05  287  end
fe           1  0.0   1.50232E-04  287  end
al           1  0.0   1.51117E-02  287  end
c            1  0.0   1.47100E-05  287  end
mo           1  0.0   2.90728E-07  287  end
mn           1  0.0   9.17333E-06  287  end
cu           1  0.0   6.07329E-06  287  end
h            1  0.0   4.04868E-06  287  end
ti           1  0.0   2.74534E-06  287  end
si           1  0.0   2.82693E-05  287  end
mg           1  0.0   1.34332E-04  287  end
cl           1  0.0   7.09986E-06  287  end
f            1  0.0   2.10256E-05  287  end
w-182        1  0.0   5.68234E-03  287  end
w-183        1  0.0   3.05572E-03  287  end
w-184        1  0.0   6.54137E-03  287  end
w-186        1  0.0   6.06831E-03  287  end
cr           2  0.0   4.10691E-05  287  end
ni           2  0.0   1.42675E-05  287  end
fe           2  0.0   2.98772E-04  287  end
al           2  0.0   5.49957E-02  287  end
c            2  0.0   8.00231E-06  287  end
mo           2  0.0   2.56457E-07  287  end
mn           2  0.0   1.01005E-05  287  end
cu           2  0.0   6.43103E-06  287  end
ti           2  0.0   3.06014E-06  287  end
si           2  0.0   3.00395E-05  287  end
mg           2  0.0   1.60836E-04  287  end
cr           3  0.0   4.10258E-05  287  end
ni           3  0.0   1.43351E-05  287  end
fe           3  0.0   5.32030E-04  287  end
al           3  0.0   5.51727E-02  287  end
c            3  0.0   3.32546E-06  287  end
mo           3  0.0   2.56999E-07  287  end
mn           3  0.0   1.13990E-05  287  end
cu           3  0.0   6.40119E-06  287  end
ti           3  0.0   2.99143E-06  287  end
si           3  0.0   2.99042E-05  287  end
mg           3  0.0   1.54081E-04  287  end
cr           4  0.0   4.10258E-05  287  end
ni           4  0.0   1.43241E-05  287  end
fe           4  0.0   4.18763E-04  287  end
al           4  0.0   6.40368E-03  287  end
c            4  0.0   2.51846E-06  287  end
mo           4  0.0   2.56999E-07  287  end
mn           4  0.0   1.09346E-05  287  end
cu           4  0.0   6.39109E-06  287  end
ti           4  0.0   2.99142E-06  287  end
si           4  0.0   2.98606E-05  287  end
mg           4  0.0   1.54081E-04  287  end
cr           5  0.0   5.86474E-06  287  end
fe           5  0.0   9.44106E-06  287  end
al           5  0.0   5.57536E-02  287  end
mn           5  0.0   6.19021E-06  287  end
cu           5  0.0   5.75389E-06  287  end
ti           5  0.0   2.77894E-06  287  end
si           5  0.0   2.76181E-05  287  end
mg           5  0.0   1.37651E-04  287  end
cr           6  0.0   6.25067E-06  287  end
fe           6  0.0   6.59296E-05  287  end
al           6  0.0   5.60085E-02  287  end
c            6  0.0   2.55604E-06  287  end
mn           6  0.0   7.10273E-06  287  end
cu           6  0.0   6.00085E-06  287  end
```

KENO Input Listing for Assembly 6 of Table 30.a (cont'd).

```
ti           6  0.0   2.98857E-06  287  end
si           6  0.0   2.87875E-05  287  end
mg           6  0.0   1.56196E-04  287  end
end comp
read para  tme=599.0  gen=240 npg=10000  nsk=40 run=yes  tba=3.0
end para
read geom
global unit 1
com='zpr9-6/13 rz model'
cylinder   1    36.87395    30.56288   -30.56288
cylinder   2    38.17733    30.56288   -30.56288
cylinder   3    38.17733    50.92573   -50.92573
cylinder   4    38.17733    61.67882   -61.67882
cylinder   5    38.17733    61.91504   -61.91504
cylinder   6    75.90495    61.91504   -61.91504
media      1   1   1
media      5   1   2  -1
media      2   1   3  -2
media      3   1   4  -3
media      4   1   5  -4
media      6   1   6  -5
boundary   6
end geom
read star
nst=0
xsm=-36.87
xsp=36.87
ysm=-36.87
ysp=36.87
zsm=-30.56
zsp=30.56
end star
end data
end
```

A.2 <u>MCNP Input Listings</u>

Sample MCNP4C inputs are listed below for the cylindrical benchmark models of ZPR-9 Assemblies 5 and 6. They invoke continuous energy ENDF/B-V cross sections for all nuclides by using the suffix 50c with the nuclide ID. The input for the calculations with continuous energy ENDF/B-VI cross sections is the same except that the nuclide ID suffix is 60c and some elements are replaced by their naturally occurring isotopes. The calculations used 10000 neutron histories per generation and 200 active generations, after skipping 40.

MCNP Input Listing for Assmebly 5 of Table 30.a.

```
mcr9508v5 - zpr9-5, loading 08 - rz model - vers 5 xs
c
c     zpr9-5, loading 08 - rz model from zpr9508v5
c     version 5 xs - mcnp4c
c
1     1  6.229972e-2  -1   4  -5  imp:n=1 $ core
2     5  5.591854e-2   1  -2   4  -5  imp:n=1 $ partials-rad ref
3     2  5.572795e-2  (-2 -4 6):(-2 5 -7)  imp:n=1 $ ax ref 1
4     3  5.567897e-2  (-2 -6 8):(-2 7 -9)  imp:n=1 $ ax ref 2
5     4  7.173252e-3  (-2 -8 10):(-2 9 -11)  imp:n=1 $ ax ref 3
6     6  5.628211e-2   2  -3  10 -11  imp:n=1 $ radial refl
7     0               (3:-10:11)  imp:n=0 $ external void

1     cz     34.11820
2     cz     34.40370
3     cz     70.83879
4     pz    -28.02315
5     pz     28.02315
6     pz    -50.92573
7     pz     50.92573
8     pz    -59.13882
9     pz     59.13882
10    pz    -61.91504
11    pz     61.91504

mode  n
kcode  10000  1.0  40  240  20000  0  8000  1
sdef   erg=d1 rad=d2 ext=d3 pos 0 0 0.0 axs 0 0 1
sp1    -2
si2    0.0  34.00
si3    -28.0  28.0
m1    92235.50c    4.50947E-03  92238.50c    2.61044E-04 $ core
      92234.50c    4.46629E-05  92236.50c    2.14119E-05
      24000.50c    5.19317E-05  28000.50c    1.89819E-05
      26000.50c    1.74665E-04  13027.50c    5.86832E-03
       6000.50c    2.98022E-02  42000.50c    3.41200E-07
      25055.50c    9.70810E-06  29000.50c    6.11835E-06
       1001.50c    4.05183E-06  22000.50c    2.73840E-06
      14000.50c    2.83306E-05  12000.50c    1.34057E-04
      17000.50c    7.07473E-06   9019.50c    2.09509E-05
      74182.50c    5.67861E-03  74183.50c    3.05370E-03
      74184.50c    6.53706E-03  74186.50c    6.06431E-03
m2    24000.50c    4.90320E-05  28000.50c    1.75735E-05 $ ax ref 1
      26000.50c    3.08069E-04  13027.50c    5.51390E-02
       6000.50c    7.22959E-06  42000.50c    3.15881E-07
      25055.50c    1.05374E-05  29000.50c    6.46318E-06
      22000.50c    3.01802E-06  14000.50c    3.00221E-05
      12000.50c    1.56686E-04
m3    24000.50c    4.90529E-05  28000.50c    1.76564E-05 $ ax ref 2
      26000.50c    6.95925E-04  13027.50c    5.47063E-02
       6000.50c    4.40231E-06  42000.50c    3.16470E-07
      25055.50c    1.25539E-05  29000.50c    6.47664E-06
      22000.50c    2.98271E-06  14000.50c    3.00817E-05
      12000.50c    1.53221E-04
m4    24000.50c    4.90529E-05  28000.50c    1.76388E-05 $ ax ref 3
      26000.50c    5.13312E-04  13027.50c    6.38535E-03
       6000.50c    3.10124E-06  42000.50c    3.16470E-07
```

MCNP Input Listing for Assmebly 5 of Table 30.a (cont’d).

```
      25055.50c    1.18051E-05  29000.50c    6.46035E-06
      22000.50c    2.98271E-06  14000.50c    3.00115E-05
      12000.50c    1.53221E-04
m5    24000.50c    5.85966E-06  26000.50c    9.43218E-06 $ part rad ref
      13027.50c    5.57230E-02  25055.50c    6.20712E-06
      29000.50c    5.74351E-06  22000.50c    2.77784E-06
      14000.50c    2.75664E-05  12000.50c    1.37951E-04
m6    24000.50c    6.25067E-06  26000.50c    6.59296E-05 $ rad ref
      13027.50c    5.60063E-02   6000.50c    2.55604E-06
      25055.50c    7.10273E-06  29000.50c    6.00084E-06
      22000.50c    2.98857E-06  14000.50c    2.87875E-05
      12000.50c    1.56196E-04
totnu
phys:n  20.0  0.0
prdmp      J   40
print
```

MCNP Input Listing for Assmebly 6 of Table 30.a.

```
mcr9613v5 - zpr9-6, loading 13 - rz model - vers 5 xs
c
c     zpr9-6, loading 13 - rz model from zpr9613v5
c     version 5 xs - mcnp4c
c
1     1  4.173222e-2  -1   4  -5  imp:n=1 $ core
2     5  5.594890e-2   1  -2   4  -5  imp:n=1 $ partials-rad ref
3     2  5.556854e-2  (-2 -4 6):(-2 5 -7)  imp:n=1 $ ax ref 1
4     3  5.596845e-2  (-2 -6 8):(-2 7 -9)  imp:n=1 $ ax ref 2
5     4  7.084827e-3  (-2 -8 10):(-2 9 -11)  imp:n=1 $ ax ref 3
6     6  5.628431e-2   2  -3  10 -11  imp:n=1 $ radial refl
7     0               (3:-10:11)  imp:n=0 $ external void

1     cz     36.87395
2     cz     38.17733
3     cz     75.90495
4     pz    -30.56288
5     pz     30.56288
6     pz    -50.92573
7     pz     50.92573
8     pz    -61.67882
9     pz     61.67882
10    pz    -61.91504
11    pz     61.91504

mode  n
kcode  10000  1.0  40  240  20000  0  8000  1
sdef   erg=d1 rad=d2 ext=d3 pos 0 0 0.0 axs 0 0 1
sp1    -2
si2    0.0  36.80
si3    -30.5  30.5
m1    92235.50c    4.50657E-03  92238.50c    2.60887E-04 $ core
      92234.50c    4.46358E-05  92236.50c    2.13983E-05
      24000.50c    4.51216E-05  28000.50c    1.61740E-05
      26000.50c    1.50232E-04  13027.50c    1.51117E-02
       6000.50c    1.47100E-05  42000.50c    2.90728E-07
      25055.50c    9.17333E-06  29000.50c    6.07329E-06
       1001.50c    4.04868E-06  22000.50c    2.74534E-06
      14000.50c    2.82693E-05  12000.50c    1.34332E-04
      17000.50c    7.09986E-06   9019.50c    2.10256E-05
      74182.50c    5.68234E-03  74183.50c    3.05572E-03
      74184.50c    6.54137E-03  74186.50c    6.06831E-03
m2    24000.50c    4.10691E-05  28000.50c    1.42675E-05 $ ax ref 1
      26000.50c    2.98772E-04  13027.50c    5.49957E-02
       6000.50c    8.00231E-06  42000.50c    2.56457E-07
      25055.50c    1.01005E-05  29000.50c    6.43103E-06
      22000.50c    3.06014E-06  14000.50c    3.00395E-05
      12000.50c    1.60836E-04
m3    24000.50c    4.10258E-05  28000.50c    1.43351E-05 $ ax ref 2
      26000.50c    5.32030E-04  13027.50c    5.51727E-02
       6000.50c    3.32546E-06  42000.50c    2.56999E-07
      25055.50c    1.13990E-05  29000.50c    6.40119E-06
      22000.50c    2.99143E-06  14000.50c    2.99042E-05
      12000.50c    1.54081E-04
m4    24000.50c    4.10258E-05  28000.50c    1.43241E-05 $ ax ref 3
      26000.50c    4.18763E-04  13027.50c    6.40368E-03
       6000.50c    2.51846E-06  42000.50c    2.56999E-07
      25055.50c    1.09346E-05  29000.50c    6.39109E-06
      22000.50c    2.99142E-06  14000.50c    2.98606E-05
      12000.50c    1.54081E-04
m5    24000.50c    5.86474E-06  26000.50c    9.44106E-06 $ part rad ref
      13027.50c    5.57536E-02  25055.50c    6.19021E-06
      29000.50c    5.75389E-06  22000.50c    2.77894E-06
      14000.50c    2.76181E-05  12000.50c    1.37651E-04
m6    24000.50c    6.25067E-06  26000.50c    6.59296E-05 $ rad ref
      13027.50c    5.60085E-02   6000.50c    2.55604E-06
      25055.50c    7.10273E-06  29000.50c    6.00085E-06
      22000.50c    2.98857E-06  14000.50c    2.87875E-05
      12000.50c    1.56196E-04
totnu
phys:n  20.0  0.0
prdmp      J   40
print
```

A.3 TWODANT Input Listings

A sample TWODANT input listings is not provided here because none of the TWODANT calculations utilized a standard multigroup cross section set. However, most of the sensitivity results presented in Section 2 were computed using TWODANT with a 20 group cross section set that was generated from ENDF/B-V data using the MC^2-2 code. Some TWODANT results and sample TWODANT input listings are presented in Appendix B.

A.4 MONK8B Input Listings

Sample MONK inputs are shown below for the cylindrical benchmark models of ZPR-9 Assemblies 5 and 6. MONK8B results were obtained using the UKNDL library (with 8220 groups), the JEF2.2 library (with 13193 groups), the ENDF/B-VI library (with 13193 groups) and the JENDL-3 library (with 13193 groups). Each calculation used 1000 superhistories per stage and was run to achieve a precision of 0.0005 and the results of 2 independent calculations were combined.

MONK Input Listing for Assmebly 5 of Table 30.b.

```
*****************************************************************
*
*      ZPR 9, Assembly 5, Loading 08 - October 14, 1964
*
*      T = 20.7 degrees C
*
*      April 9, 2003
*
*      endf6
*
*****************************************************************

begin material specification

nmaterials 6

* material 1 - core
* material 2 - axial reflector 1
* material 3 - axial reflector 2
* material 4 - axial reflector 3
* material 5 - radial reflector partials
* material 6 - radial reflector

atoms
material 1 density 0.0
u235         prop   4.50947E-03
u238         prop   2.61044E-04
u234         prop   4.46629E-05
u236         prop   2.14119E-05
cr           prop   5.19317E-05
ni           prop   1.89819E-05
fe           prop   1.74665E-04
al           prop   5.86832E-03
c            prop   2.98022E-02
mo           prop   3.41200E-07
mn           prop   9.70810E-06
cu           prop   6.11835E-06
h            prop   4.05183E-06
ti           prop   2.73840E-06
si           prop   2.83306E-05
mg           prop   1.34057E-04
cl           prop   7.07473E-06
f19          prop   2.09509E-05
w182         prop   5.67861E-03
w183         prop   3.05370E-03
w184         prop   6.53706E-03
w186         prop   6.06431E-03

atoms
material 2 density 0.0
cr           prop   4.90320E-05
ni           prop   1.75735E-05
fe           prop   3.08069E-04
al           prop   5.51390E-02
c            prop   7.22959E-06
mo           prop   3.15881E-07
mn           prop   1.05374E-05
cu           prop   6.46318E-06
```

MONK Input Listing for Assmebly 5 of Table 30.b (cont'd).

```
ti          prop   3.01802E-06
si          prop   3.00221E-05
mg          prop   1.56686E-04

atoms
material 3 density 0.0
cr          prop   4.90529E-05
ni          prop   1.76564E-05
fe          prop   6.95925E-04
al          prop   5.47063E-02
c           prop   4.40231E-06
mo          prop   3.16470E-07
mn          prop   1.25539E-05
cu          prop   6.47664E-06
ti          prop   2.98271E-06
si          prop   3.00817E-05
mg          prop   1.53221E-04

atoms
material 4 density 0.0
cr          prop   4.90529E-05
ni          prop   1.76388E-05
fe          prop   5.13312E-04
al          prop   6.38535E-03
c           prop   3.10124E-06
mo          prop   3.16470E-07
mn          prop   1.18051E-05
cu          prop   6.46035E-06
ti          prop   2.98271E-06
si          prop   3.00115E-05
mg          prop   1.53221E-04

atoms
material 5 density 0.0
cr          prop   5.85966E-06
fe          prop   9.43218E-06
al          prop   5.57230E-02
mn          prop   6.20712E-06
cu          prop   5.74351E-06
ti          prop   2.77784E-06
si          prop   2.75664E-05
mg          prop   1.37951E-04

atoms
material 6 density 0.0
cr          prop   6.25067E-06
fe          prop   6.59296E-05
al          prop   5.60063E-02
c           prop   2.55604E-06
mn          prop   7.10273E-06
cu          prop   6.00084E-06
ti          prop   2.98857E-06
si          prop   2.87875E-05
mg          prop   1.56196E-04

use e6hh2o for h1 in all materials

end

*****************************************************************

begin material geometry

part 1            ! cylindrical boundaries
 zrod 1      0.0  0.0  -28.02315  34.11820   56.04630
 zrod 2      0.0  0.0  -28.02315  34.40370   56.04630
 zrod 3      0.0  0.0  -50.92573  34.40370  101.85146
 zrod 4      0.0  0.0  -59.13882  34.40370  118.27764
 zrod 5      0.0  0.0  -61.91504  34.40370  123.83008
 zrod 6      0.0  0.0  -61.91504  70.83879  123.83008
zones
/core/  m1   +1
/rrfp/  m5   +2  -1
```

MONK Input Listing for Assmebly 5 of Table 30.b (cont'd).

```
/arf1/  m2   +3  -2
/arf2/  m3   +4  -3
/arf3/  m4   +5  -4
/rref/  m6   +6  -5
end

****************************************************************

begin control data
stages -1  400  1000  stdv 0.0005
end

****************************************************************

begin source geometry
zonemat
 all / material 1
end
```

MONK Input Listing for Assmebly 6 of Table 30.b.

```
*****************************************************************
*
*      ZPR 9, Assembly 6, Loading 13 - January 4, 1965
*
*      T = 14.0 degrees C
*
*      April 9, 2003
*
*      endf6
*
*****************************************************************

begin material specification


nmaterials 6

* material 1 - core
* material 2 - axial reflector 1
* material 3 - axial reflector 2
* material 4 - axial reflector 3
* material 5 - radial reflector partials
* material 6 - radial reflector

atoms
material 1 density 0.0
u235          prop   4.50657E-03
u238          prop   2.60887E-04
u234          prop   4.46358E-05
u236          prop   2.13983E-05
cr            prop   4.51216E-05
ni            prop   1.61740E-05
fe            prop   1.50232E-04
al            prop   1.51117E-02
c             prop   1.47100E-05
mo            prop   2.90728E-07
mn            prop   9.17333E-06
cu            prop   6.07329E-06
h             prop   4.04868E-06
ti            prop   2.74534E-06
si            prop   2.82693E-05
mg            prop   1.34332E-04
cl            prop   7.09986E-06
f19           prop   2.10256E-05
w182          prop   5.68234E-03
w183          prop   3.05572E-03
w184          prop   6.54137E-03
w186          prop   6.06831E-03

atoms
material 2 density 0.0
cr            prop   4.10691E-05
ni            prop   1.42675E-05
fe            prop   2.98772E-04
al            prop   5.49957E-02
c             prop   8.00231E-06
mo            prop   2.56457E-07
mn            prop   1.01005E-05
cu            prop   6.43103E-06
ti            prop   3.06014E-06
si            prop   3.00395E-05
mg            prop   1.60836E-04

atoms
material 3 density 0.0
cr            prop   4.10258E-05
ni            prop   1.43351E-05
fe            prop   5.32030E-04
al            prop   5.51727E-02
c             prop   3.32546E-06
mo            prop   2.56999E-07
mn            prop   1.13990E-05
cu            prop   6.40119E-06
```

MONK Input Listing for Assmebly 6 of Table 30.b (cont'd).

```
ti           prop   2.99143E-06
si           prop   2.99042E-05
mg           prop   1.54081E-04

atoms
material 4 density 0.0
cr           prop   4.10258E-05
ni           prop   1.43241E-05
fe           prop   4.18763E-04
al           prop   6.40368E-03
c            prop   2.51846E-06
mo           prop   2.56999E-07
mn           prop   1.09346E-05
cu           prop   6.39109E-06
ti           prop   2.99142E-06
si           prop   2.98606E-05
mg           prop   1.54081E-04

atoms
material 5 density 0.0
cr           prop   5.86474E-06
fe           prop   9.44106E-06
al           prop   5.57536E-02
mn           prop   6.19021E-06
cu           prop   5.75389E-06
ti           prop   2.77894E-06
si           prop   2.76181E-05
mg           prop   1.37651E-04

atoms
material 6 density 0.0
cr           prop   6.25067E-06
fe           prop   6.59296E-05
al           prop   5.60085E-02
c            prop   2.55604E-06
mn           prop   7.10273E-06
cu           prop   6.00085E-06
ti           prop   2.98857E-06
si           prop   2.87875E-05
mg           prop   1.56196E-04

use e6hh2o for h1 in all materials

end

*****************************************************************

begin material geometry

part 1              ! cylindrical bundaries
 zrod 1      0.0  0.0  -30.56288  36.87395   61.12576
 zrod 2      0.0  0.0  -30.56288  38.17733   61.12576
 zrod 3      0.0  0.0  -50.92573  38.17733  101.85146
 zrod 4      0.0  0.0  -61.67882  38.17733  123.35764
 zrod 5      0.0  0.0  -61.91504  38.17733  123.83008
 zrod 6      0.0  0.0  -61.91504  75.90495  123.83008
zones
/core/  m1    +1
/rrfp/  m5    +2  -1
/arf1/  m2    +3  -2
/arf2/  m3    +4  -3
/arf3/  m4    +5  -4
/rref/  m6    +6  -5
end

*****************************************************************

begin control data
stages -4  400  1000  stdv 0.0005
end

*****************************************************************
```

MONK Input Listing for Assmebly 6 of Table 30.b (cont'd).

```
begin source geometry
zonemat
 all / material 1
end
```

A.5 VIM Input Listings

One sample VIM input is shown below for each of the two benchmark models. These inputs were used with continuous energy ENDF/B-V cross sections for all nuclides. The input for the calculations with continuous energy ENDF/B-VI cross sections is the same except that some elements are replaced by their naturally occurring isotopes. All the cross sections correspond to 300 K. All the calculations were run with VIM Version 4.0. In the examples shown here, there are 10,000 neutron histories per generation and 200 active generations.

VIM Input Listing for Assembly 5 of Table 30.a.

```
   397207447  rzr9508v5 - zpr9-5 -loading 08 - rz model - v5 xs
   200     3     0    40     0     0
 10000 10000     4     0     0     0
     1     1     0     0    50     0
    22     6     6    43     7 10000
 999999999.0 1.00000E-05 2.75000E+02 1.00000E+00 1.00000E-05 1.41910E+07
 9.50000E-01 0.00000E+00 1.00000E+00 0.00000E+00
     1     0     1     0     3     0     0     0     0     0     1     0
 30300 40300 60300 80300210300220300230300240300270300280300290300340300   08
350300370300380300450300540300570300600300610300620300630300               08


     0     0     1
   CYL    1   0.00000   0.00000 -28.02315  56.04630  34.11820
   CYL    2   0.00000   0.00000 -28.02315  56.04630  34.40370
   CYL    3   0.00000   0.00000 -50.92573 101.85146  34.40370
   CYL    4   0.00000   0.00000 -59.13882 118.27764  34.40370
   CYL    5   0.00000   0.00000 -61.91504 123.83008  34.40370
   CYL    6   0.00000   0.00000 -61.91504 123.83008  70.83879
   CYL    7   0.00000   0.00000    -200.0     400.0 150.00000
   END
   COR    6     +1
   CPR    6     +2     -1
   AR1    6     +3     -2
   AR2    6     +4     -3
   AR3    6     +5     -4
   RR1    6     +6     -5
   LEK    6     +7     -6
   END
     1 2.04960E+05     2 3.44455E+03     3 1.70324E+05     4 6.10797E+04
     5 2.06464E+04     6 1.49172E+06
     1   101   1           2   200   5           3   300   2
     4   400   3           5   500   4           6   600   6
     7        -1
 30300 40300 60300 80300210300220300230300240300270300280300290300340300
350300370300380300450300540300570300600300610300620300630300
210300220300230300240300270300280300290300340300370300380300450300

210300220300230300240300270300280300290300340300370300380300450300

210300220300230300240300270300280300290300340300370300380300450300

210300230300240300290300340300370300380300450300

210300230300240300270300290300340300370300380300450300

 4.50947E-03 2.61044E-04 4.46629E-05 2.14119E-05 5.19317E-05 1.89819E-05
 1.74665E-04 5.86832E-03 2.98022E-02 3.41200E-07 9.70810E-06 6.11835E-06
 4.05183E-06 2.73840E-06 2.83306E-05 1.34057E-04 7.07473E-06 2.09509E-05
 5.67861E-03 3.05370E-03 6.53706E-03 6.06431E-03
 4.90320E-05 1.75735E-05 3.08069E-04 5.51390E-02 7.22959E-06 3.15881E-07
 1.05374E-05 6.46318E-06 3.01802E-06 3.00221E-05 1.56686E-04
 4.90529E-05 1.76564E-05 6.95925E-04 5.47063E-02 4.40231E-06 3.16470E-07
 1.25539E-05 6.47664E-06 2.98271E-06 3.00817E-05 1.53221E-04
 4.90529E-05 1.76388E-05 5.13312E-04 6.38535E-03 3.10124E-06 3.16470E-07
 1.18051E-05 6.46035E-06 2.98271E-06 3.00115E-05 1.53221E-04
 5.85966E-06 9.43218E-06 5.57230E-02 6.20712E-06 5.74351E-06 2.77784E-06
 2.75664E-05 1.37951E-04
 6.25067E-06 6.59296E-05 5.60063E-02 2.55604E-06 7.10273E-06 6.00084E-06
```

VIM Input Listing for Assembly 5 of Table 30.a (cont'd).

```
 2.98857E-06 2.87875E-05 1.56196E-04
     0.25000     0.25000     0.25000     0.25000     0.25000     0.25000   51
     0.25000     0.25000     0.25000     0.25000     0.25000     0.25000   51
     0.25000     0.25000     0.25000     0.25000     0.25000     0.25000   51
     0.25000     0.20519     0.29481     0.25000     0.25000     0.25000   51
     0.25000     0.25000     0.25000     0.25000     0.25000     0.25000   51
     0.25000     0.25000     0.25000     0.25000     0.25000     0.25000   51
     0.25000     0.25000     0.75000     0.75000     0.75000     5.18812   51
    11.04292                                                               51
```

VIM Input Listing for Assembly 6 of Table 30.a.

```
   397207447  rzr9613v5 - zpr9-6 -loading 13 - rz model - v5 xs
   200     3     0    40     0     0
 10000 10000     4     0     0     0
     1     1     0     0    50     0
    22     6     6    43     7 10000
 999999999.0 1.00000E-05 2.75000E+02 1.00000E+00 1.00000E-05 1.41910E+07
 9.50000E-01 0.00000E+00 1.00000E+00 0.00000E+00
     1     0     1     0     3     0     0     0     0     0     1     0
 30300 40300 60300 80300210300220300230300240300270300280300290300340300   08
350300370300380300450300540300570300600300610300620300630300               08


     0     0     1
  CYL    1   0.00000   0.00000 -30.56288  61.12576  36.87395
  CYL    2   0.00000   0.00000 -30.56288  61.12576  38.17733
  CYL    3   0.00000   0.00000 -50.92573 101.85146  38.17733
  CYL    4   0.00000   0.00000 -61.67882 123.35764  38.17733
  CYL    5   0.00000   0.00000 -61.91504 123.83008  38.17733
  CYL    6   0.00000   0.00000 -61.91504 123.83008  75.90495
  CYL    7   0.00000   0.00000    -200.0     400.0 150.00000
  END
  COR    6      +1
  CPR    6      +2      -1
  AR1    6      +3      -2
  AR2    6      +4      -3
  AR3    6      +5      -4
  RR1    6      +6      -5
  LEK    6      +7      -6
  END
     1 2.61104E+05     2 1.87847E+04     3 1.86479E+05     4 9.84746E+04
     5 2.16326E+03     6 1.67438E+06
     1   101   1            2   200   5             3   300   2
     4   400   3            5   500   4             6   600   6
     7        -1
 30300 40300 60300 80300210300220300230300240300270300280300290300340300
350300370300380300450300540300570300600300610300620300630300
210300220300230300240300270300280300290300340300370300380300450300

210300220300230300240300270300280300290300340300370300380300450300

210300220300230300240300270300280300290300340300370300380300450300

210300230300240300290300340300370300380300450300

210300230300240300270300290300340300370300380300450300

 4.50657E-03 2.60887E-04 4.46358E-05 2.13983E-05 4.51216E-05 1.61740E-05
 1.50232E-04 1.51117E-02 1.47100E-05 2.90728E-07 9.17333E-06 6.07329E-06
 4.04868E-06 2.74534E-06 2.82693E-05 1.34332E-04 7.09986E-06 2.10256E-05
 5.68234E-03 3.05572E-03 6.54137E-03 6.06831E-03
 4.10691E-05 1.42675E-05 2.98772E-04 5.49957E-02 8.00231E-06 2.56457E-07
 1.01005E-05 6.43103E-06 3.06014E-06 3.00395E-05 1.60836E-04
 4.10258E-05 1.43351E-05 5.32030E-04 5.51727E-02 3.32546E-06 2.56999E-07
 1.13990E-05 6.40119E-06 2.99143E-06 2.99042E-05 1.54081E-04
 4.10258E-05 1.43241E-05 4.18763E-04 6.40368E-03 2.51846E-06 2.56999E-07
 1.09346E-05 6.39109E-06 2.99142E-06 2.98606E-05 1.54081E-04
 5.86474E-06 9.44106E-06 5.57536E-02 6.19021E-06 5.75389E-06 2.77894E-06
 2.76181E-05 1.37651E-04
 6.25067E-06 6.59296E-05 5.60085E-02 2.55604E-06 7.10273E-06 6.00085E-06
 2.98857E-06 2.87875E-05 1.56196E-04
     0.25000     0.25000     0.25000     0.25000     0.25000     0.25000   51
     0.25000     0.25000     0.25000     0.25000     0.25000     0.25000   51
     0.25000     0.25000     0.25000     0.25000     0.25000     0.25000   51
     0.25000     0.20519     0.29481     0.25000     0.25000     0.25000   51
     0.25000     0.25000     0.25000     0.25000     0.25000     0.25000   51
     0.25000     0.25000     0.25000     0.25000     0.25000     0.25000   51
     0.25000     0.25000     0.75000     0.75000     0.75000     5.18812   51
    11.04292                                                               51
```

APPENDIX B: ADDITIONAL MODELS OF ZPR-9 ASSEMBLIES 5 AND 6

Although none of the TWODANT calculations utilized a standard cross section set, the following two sample input listings are provided because most of the sensitivity results in Section 2 are based on TWODANT calculations. These calculations used ENDF/B-V-based 20 group cross sections generated with the cross-section processing code MC^2-2.[a] This code, developed at Argonne National Laboratory, is available from the RSICC code center. Nuclide identifiers ending with a "C" are appropriate in the core region, identifiers ending with either "A1", "A2", or "A3" are used in the three axial reflector regions, identifiers ending with "R1" are used in the radial reflector regions and identifiers ending with "M" are used beyond the reflectors. Cross sections for each of these regions were made separately for Assembly 5 and Assembly 6. Cross sections for non-fueled regions used the leakage source from an adjacent region as the MC^2-2 source. These inputs correspond to the RZ benchmark models specified in Section 3. They were used as reference models that were modified in a variety of ways to obtain the sensitivity results presented in Section 2. All the calculations used the standard S_{10} quadrature set, P_1 scattering order, a mesh spacing of about 1.0 cm, and convergence criteria of 10^{-7}.

The TWODANT calculations using these inputs yielded k_{eff} values of 1.0227 and 1.0316 for Assemblies 5 and 6, respectively.

```
1
        zpr9-5_L08 benchmark P1 calculation
 igeom=7, ngroup=20, isn=10,
 niso=106, mt=07,     nzone=07,
 im=4,    it= 142,
 jm=5,    jt= 120,
 maxlcm=15000000, maxscm=10000000
  t
 xmesh=0.0 34.11820 34.40370 70.83879 140.7420,
 ymesh=0.0 28.02315 50.92573 59.13882 61.91504 121.92,
 xints=34  2 36 70,
 yints=28 22  8  2 60,
 zones=1 2 3 4;
       5 5 3 4;
       6 6 3 4;
       7 7 3 4;
       4 4 4 4
  t
 lib=isotxs
  t
 matls=
core U235C  4.50947E-03, U238C  2.61044E-04, U234C  4.46629E-05,
     U236C  2.14119E-05, CR__C  5.19317E-05, NI__C  1.89819E-05,
     FE__C  1.74665E-04, AL__C  5.86832E-03, C12_C  2.98022E-02,
     MO__C  3.41200E-07, MN__C  9.70810E-06, CU__C  6.11835E-06,
     H___C  4.05183E-06, TI__C  2.73840E-06, SI__C  2.83306E-05,
     MG__C  1.34057E-04, CL__C  7.07473E-06, F___C  2.09509E-05,
     W182C  5.67861E-03, W183C  3.05370E-03, W184C  6.53706E-03,
     W186C  6.06431E-03;
axr1 CR_A1  4.90320E-05, NI_A1  1.75735E-05, FE_A1  3.08069E-04,
     AL_A1  5.51390E-02, C12A1  7.22959E-06, MO_A1  3.15881E-07,
     MN_A1  1.05374E-05, CU_A1  6.46318E-06, TI_A1  3.01802E-06,
     SI_A1  3.00221E-05, MG_A1  1.56686E-04;
axr2 CR_A2  4.90529E-05, NI_A2  1.76564E-05, FE_A2  6.95925E-04,
     AL_A2  5.47063E-02, C12A2  4.40231E-06, MO_A2  3.16470E-07,
     MN_A2  1.25539E-05, CU_A2  6.47664E-06, TI_A2  2.98271E-06,
     SI_A2  3.00817E-05, MG_A2  1.53221E-04;
axr3 CR_A3  4.90529E-05, NI_A3  1.76388E-05, FE_A3  5.13312E-04,
     AL_A3  6.38535E-03, C12A3  3.10124E-06, MO_A3  3.16470E-07,
     MN_A3  1.18051E-05, CU_A3  6.46035E-06, TI_A3  2.98271E-06,
     SI_A3  3.00115E-05, MG_A3  1.53221E-04;
```

[a] H. Henryson II, B. J. Toppel, and C. G. Stenberg, "MC^2-2: A Code to Calculate Fast Neutron Spectra and Multigroup Cross Sections," Argonne National Laboratory Report ANL-8144 (1976).

```
part CR__C  5.85966E-06, FE__C  9.43218E-06, AL__C  5.57230E-02,
     MN__C  6.20712E-06, CU__C  5.74351E-06, TI__C  2.77784E-06,
     SI__C  2.75664E-05, MG__C  1.37951E-04;
rad1 CR_R1  6.25067E-06, FE_R1  6.59296E-05, AL_R1  5.60063E-02,
     C12R1  2.55604E-06, MN_R1  7.10273E-06, CU_R1  6.00084E-06,
     TI_R1  2.98857E-06, SI_R1  2.87875E-05, MG_R1  1.56196E-04;
matx CR__M  5.11404E-06, NI__M  2.93443E-07, FE__M  9.68464E-06,
     AL__M  4.13967E-03, C12_M  7.91442E-09, MO__M  8.58718E-09,
     MN__M  1.81378E-06, CU__M  5.02598E-06, TI__M  1.91571E-06,
     SI__M  2.43641E-05, MG__M  4.88673E-05
assign=CORE  core 1.0;
       PARTL part 1.0;
       RREFL rad1 1.0;
       MATRX matx 1.0;
       AXRF1 axr1 1.0;
       AXRF2 axr2 1.0;
       AXRF3 axr3 1.0
  t
 ievt= 1,
 ith=  0,
 epsi=1.0E-07, epso=1.0E-07, iitl=1, iitm=100, oitm=100,

 ibl=  1, ibr=0, ibb=1, ibt=0,
 isct= 1,

 fluxp=0, xsectp=1, fissrp=0, sourcp=0, angp=0, balp=1,
 raflux=0, rmflux=0,

 geomp=1, influx=0, norm=0.0
  t
 pted=1, zned=0, power=0.000001, ajed=0,
  t

1
        zpr9-6_L13 benchmark P1 calculation
 igeom=7, ngroup=20, isn=10,
 niso=106, mt=07,     nzone=07,
 im=4,    it= 141,
 jm=5,    jt= 124,
 maxlcm=15000000, maxscm=10000000
  t
 xmesh=0.0 36.87395 38.17733 75.90495 140.7420,
 ymesh=0.0 30.56288 50.92573 61.67882 61.91504 121.92,
 xints=36  2 38 65,
 yints=30 21 11  2 60,
 zones=1 2 3 4;
       5 5 3 4;
       6 6 3 4;
       7 7 3 4;
       4 4 4 4
  t
 lib=isotxs
  t
 matls=
core U235C  4.50657E-03, U238C  2.60887E-04, U234C  4.46358E-05,
     U236C  2.13983E-05, CR__C  4.51216E-05, NI__C  1.61740E-05,
     FE__C  1.50232E-04, AL__C  1.51117E-02, C12_C  1.47100E-05,
     MO__C  2.90728E-07, MN__C  9.17333E-06, CU__C  6.07329E-06,
     H___C  4.04868E-06, TI__C  2.74534E-06, SI__C  2.82693E-05,
     MG__C  1.34332E-04, CL__C  7.09986E-06, F___C  2.10256E-05,
     W182C  5.68234E-03, W183C  3.05572E-03, W184C  6.54137E-03,
     W186C  6.06831E-03;
axr1 CR_A1  4.10691E-05, NI_A1  1.42675E-05, FE_A1  2.98772E-04,
     AL_A1  5.49957E-02, C12A1  8.00231E-06, MO_A1  2.56457E-07,
     MN_A1  1.01005E-05, CU_A1  6.43103E-06, TI_A1  3.06014E-06,
     SI_A1  3.00395E-05, MG_A1  1.60836E-04;
axr2 CR_A2  4.10258E-05, NI_A2  1.43351E-05, FE_A2  5.32030E-04,
     AL_A2  5.51727E-02, C12A2  3.32546E-06, MO_A2  2.56999E-07,
     MN_A2  1.13990E-05, CU_A2  6.40119E-06, TI_A2  2.99143E-06,
     SI_A2  2.99042E-05, MG_A2  1.54081E-04;
axr3 CR_A3  4.10258E-05, NI_A3  1.43241E-05, FE_A3  4.18763E-04,
     AL_A3  6.40368E-03, C12A3  2.51846E-06, MO_A3  2.56999E-07,
     MN_A3  1.09346E-05, CU_A3  6.39109E-06, TI_A3  2.99142E-06,
     SI_A3  2.98606E-05, MG_A3  1.54081E-04;
part CR__C  5.86474E-06, FE__C  9.44106E-06, AL__C  5.57536E-02,
     MN__C  6.19021E-06, CU__C  5.75389E-06, TI__C  2.77894E-06,
     SI__C  2.76181E-05, MG__C  1.37651E-04;
rad1 CR_R1  6.25067E-06, FE_R1  6.59296E-05, AL_R1  5.60085E-02,
```

```
     C12R1  2.55604E-06, MN_R1  7.10273E-06, CU_R1  6.00085E-06,
     TI_R1  2.98857E-06, SI_R1  2.87875E-05, MG_R1  1.56196E-04;
matx CR__M  5.14029E-06, NI__M  2.99735E-07, FE__M  9.75559E-06,
     AL__M  4.15280E-03, C12_M  8.08410E-09, MO__M  8.77129E-09,
     MN__M  1.84410E-06, CU__M  5.03261E-06, TI__M  1.92195E-06,
     SI__M  2.43942E-05, MG__M  4.94557E-05
assign=CORE  core 1.0;
       PARTL part 1.0;
       RREFL rad1 1.0;
       MATRX matx 1.0;
       AXRF1 axr1 1.0;
       AXRF2 axr2 1.0;
       AXRF3 axr3 1.0
  t
 ievt= 1,
 ith=  0,
 epsi=1.0E-07, epso=1.0E-07, iitl=1, iitm=100, oitm=100,

 ibl=  1, ibr=0, ibb=1, ibt=0,
 isct= 1,

 fluxp=0, xsectp=1, fissrp=0, sourcp=0, angp=0, balp=1,
 raflux=0, rmflux=0,

 geomp=1, influx=0, norm=0.0
  t
 pted=1, zned=0, power=0.000001, ajed=0,
  t
```

APPENDIX C: SPECTRUM AND NEUTRON BALANCE FROM VIM

Figure C.1 shows the core-average spectra in ZPR-9 Assemblies 5 and 6 compared to that in Godiva (HEU-MET-FAST-001). All of these spectra were computed with the VIM code and continuous-energy ENDF/B-V data. Each energy bin width for the flux edits corresponds to a lethargy change of 0.25 ($E_{g-1}/E_g = 1.284$) from ~14 MeV to ~1 keV, except for one adjustment to get a boundary exactly at 100 keV. Below ~1 keV the bins are broader. The spectra are normalized so that the integral of the flux over all energies is unity. The Assembly 5 and 6 spectra are softer than that of Godiva because Godiva has no diluent materials. There is essentially no flux in the tungsten resolved resonance range, below 4 keV, but a substantial flux in the unresolved resonance range, up to 100 keV. The peaks near 25 keV and 70 keV in the ZPR-9/6 spectrum are the result of aluminum cross section resonances. The spectra plotted in Figure C.1 for ZPR-9 Assemblies 5 and 6 are based on the RZ (homogeneous) models. However, the spectra for these assemblies based on the as-built (heterogeneous) models are only very slightly different (e.g., see PU-MET-INTER-002, Appendix C).

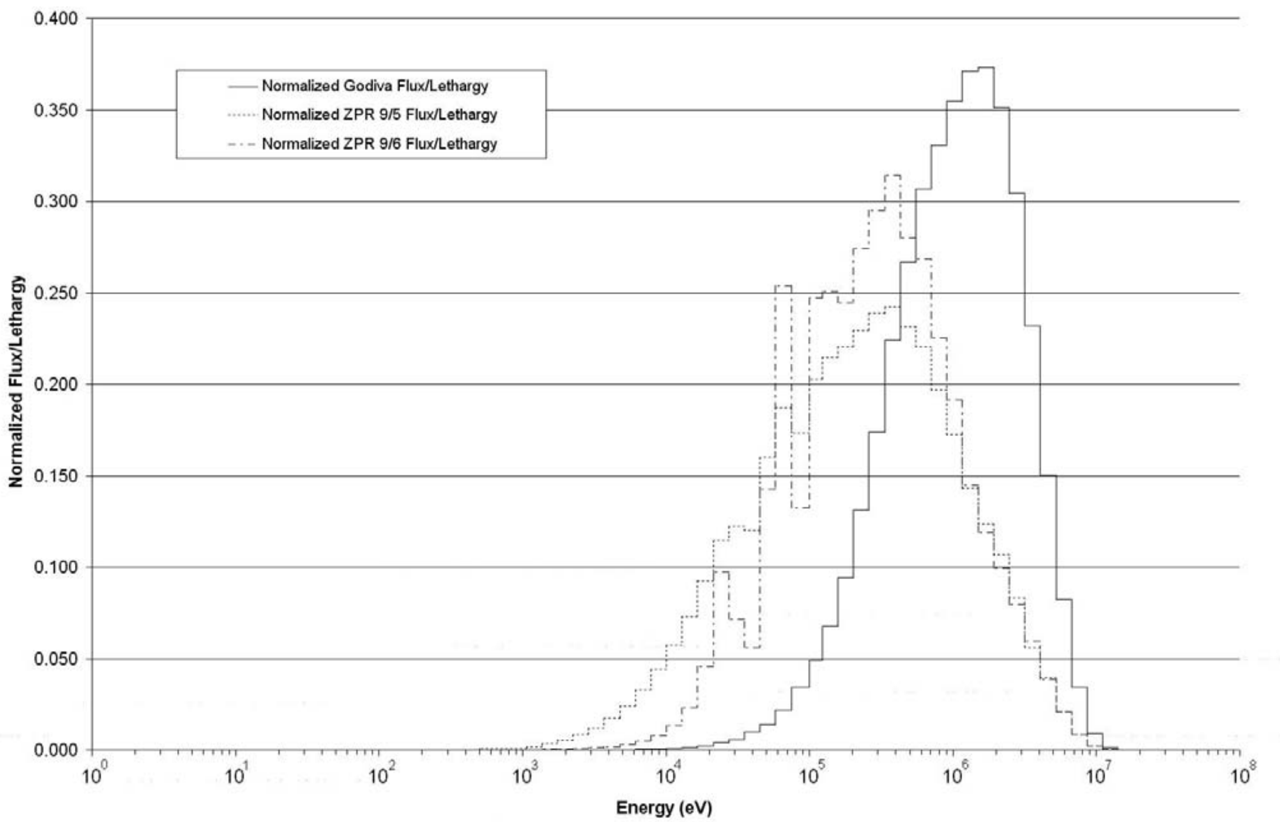

Figure C.1. Core-Average Neutron Spectra in ZPR-9 Assemblies 5 and 6, and Godiva.

The track-length-estimator neutron balance edits indicates that ZPR-9 Assemblies 5 and 6 fall into the fast-energy spectrum category (FAST) of ICSBEP benchmarks. The flux above 100 keV produced 61% and 75% of the fissions, essentially none was produced by the flux below 0.625 eV, and 39% and 25% was produced by the flux between these energies in Assemblies 5 and 6, respectively.

The following global neutron balance for ZPR-9/5 was obtained from the calculation with the VIM code using a preliminary version of the benchmark model. The track-length estimator provided the total production and losses for the entire model as follows:

Fission Production	1.0063 ± 0.0007
(n,2n) Production	0.0018 ± 0.995%
Absorption	0.6880 ± 0.0005
Leakage	0.3123 ± 0.0005
k_{eff}	1.0079 ± 0.0004

Two partial sums are unity: absorption plus leakage, and fission production/k_{eff} plus (n,2n) production. The ratio of leakage to fission production for this assembly is very high, ~31%. The corresponding neutron balance data for ZPR-9-6, which are similar, are as follows:

Fission Production	1.0080 ± 0.0007
(n,2n) Production	0.0021 ± 1.07%
Absorption	0.6497 ± 0.0005
Leakage	0.3500 ± 0.0005
k_{eff}	1.0104 ± 0.0004

The detailed, track-length-estimator neutron balances for ZPR-9/5 and ZPR-9/6 are summarized in Tables C.1 and C.2, respectively. They show, for each nuclide and region, the neutron production by fission and (n,2n) reactions, and the losses by neutron absorption and leakage. The model regions AR1 and AR2 have been combined and labeled Axial Reflector. The remaining model regions have been combined and labeled Radial Reflector. The reaction rates are integrated over the total volume of the region and the leakage is the net leakage over the surface of the region (i.e., the combination of the positive leakage out of the region and negative leakage of neutrons returning to the region). Note that the total leakage quoted above is the leakage for the full model. As shown in Table C.1, the fission rate is dominated by ^{235}U. The ^{235}U accounts for approximately 75% of the absorptions in these assemblies; 73% in ZPR-9/5 and 75% in ZPR-9/6. Virtually all of the remaining absorptions occur in W and Al: 25% and 1%, respectively, in ZPR-9/5, and 22% and 2%, respectively, in ZPR-9/6. The leakage from the core region is only slightly larger than the leakage from the entire model, which is consistent with small absorption values in the reflectors. This illustrates why there was concern about room return and it was decided to include the empty matrix and support structures beyond in the as-built model. Room return is accounted for in the transformation Δk.

Table C.1. Neutron Balance by Nuclide and Region for ZPR-9/5.[(a)]

Nuclide	Fission Production	Fission	Capture	Absorption	(n,2n) Production
Core					
U-235	1.0003E+00	4.0258E-01	9.9672E-02	5.0225E-01	3.3715E-04
U-238	2.6135E-03	9.4174E-04	3.3133E-03	4.2551E-03	3.7889E-05
U-234	2.9192E-03	1.1390E-03	1.0385E-03	2.1775E-03	6.3060E-07
U-236	4.7594E-04	1.8177E-04	4.8030E-04	6.6207E-04	1.6111E-06
Cr			4.4835E-05	4.4835E-05	8.7092E-08
Ni			3.4278E-05	3.4278E-05	3.6474E-09
Fe			9.0610E-05	9.0610E-05	5.3834E-08
Al			9.0507E-04	9.0507E-04	2.0492E-08
C			3.2943E-04	3.2943E-04	0.0000E+00
Mo			1.7719E-06	1.7719E-06	8.9550E-09
Mn			9.0808E-06	9.0808E-06	1.3633E-08
Cu			1.2913E-05	1.2913E-05	6.3161E-09
H			2.8908E-08	2.8908E-08	0.0000E+00
Ti			1.7872E-06	1.7872E-06	1.3307E-09
Si			6.5261E-06	6.5261E-06	6.7083E-09
Mg			1.1110E-05	1.1110E-05	3.7577E-08
Cl			4.4599E-06	4.4599E-06	4.4469E-11
F			5.8050E-06	5.8050E-06	9.8834E-10
W-182			5.1212E-02	5.1212E-02	1.8079E-04
W-183			4.6809E-02	4.6809E-02	4.3288E-04
W-184			3.9087E-02	3.9087E-02	3.7233E-04
W-186			3.2290E-02	3.2290E-02	4.3309E-04
Region Sum	1.0063E+00	4.0484E-01	2.7536E-01	6.8020E-01	1.7966E-03
Leakage	3.2004E-01				
Radial Reflector					
Cr			5.9308E-06	5.9308E-06	1.7605E-09
Fe			3.5328E-05	3.5328E-05	2.1984E-09
Al			5.8241E-03	5.8241E-03	5.5934E-09
C			5.1461E-09	5.1461E-09	0.0000E+00
Mn			1.1901E-05	1.1901E-05	1.5061E-09
Cu			1.5788E-05	1.5788E-05	9.1520E-10
Ti			2.3015E-06	2.3015E-06	2.0113E-10
Si			4.1866E-06	4.1866E-06	1.1001E-09
Mg			6.1473E-06	6.1473E-06	7.5260E-09
Region Sum	0.0000E+00	0.0000E+00	5.9057E-03	5.9057E-03	2.0801E-08
Leakage	-5.9057E-03				

Table C.1 (cont'd). Neutron Balance by Nuclide and Region for ZPR-9/5.

Axial Reflector					
Cr			1.3647E-05	1.3647E-05	6.9142E-09
Ni			7.6647E-06	7.6647E-06	2.5323E-10
Fe			5.6326E-05	5.6326E-05	7.1483E-09
Al			1.7621E-03	1.7621E-03	7.4837E-09
C			6.8935E-09	6.8935E-09	0.0000E+00
Mo			5.7787E-07	5.7787E-07	7.0000E-10
Mn			4.7549E-06	4.7549E-06	1.0826E-09
Cu			4.9173E-06	4.9173E-06	4.8300E-10
Ti			6.6826E-07	6.6826E-07	1.1082E-10
Si			1.4889E-06	1.4889E-06	5.6308E-10
Mg			2.1751E-06	2.1751E-06	3.7009E-09
Region Sum	0.0000E+00	0.0000E+00	1.8543E-03	1.8543E-03	2.8440E-08
Leakage	-1.8543E-03				
Total Over All Nuclides and Regions					
Assembly Sum	1.0063E+00	4.0484E-01	2.8312E-01	6.8796E-01	1.7967E-03
Leakage	3.1228E-01				
keff	1.0079				

(a) The normalization is such that (Absorption + Leakage) = (Fission Production) / k_{eff} + (n,2n) = 1.0.

Table C.2. Neutron Balance by Nuclide and Region for ZPR-9/6.[(a)]

Nuclide	Fission Production	Fission	Capture	Absorption	(n,2n) Production
Core					
U-235	1.0012E+00	4.0171E-01	8.6044E-02	4.8775E-01	3.7648E-04
U-238	2.8245E-03	1.0165E-03	2.7606E-03	3.7771E-03	4.3062E-05
U-234	3.4542E-03	1.3530E-03	9.2814E-04	2.2812E-03	7.3342E-07
U-236	5.2475E-04	2.0047E-04	4.3729E-04	6.3776E-04	1.8687E-06
Cr			3.3122E-05	3.3122E-05	8.8303E-08
Ni			2.7455E-05	2.7455E-05	3.6563E-09
Fe			7.8773E-05	7.8773E-05	5.5921E-08
Al			1.9352E-03	1.9352E-03	7.6398E-08
C			1.9310E-07	1.9310E-07	0.0000E+00
Mo			1.1987E-06	1.1987E-06	8.8133E-09
Mn			5.6720E-06	5.6720E-06	1.5095E-08
Cu			9.6308E-06	9.6308E-06	7.3793E-09
H			2.1655E-08	2.1655E-08	0.0000E+00
Ti			1.3576E-06	1.3576E-06	1.5692E-09
Si			7.2809E-06	7.2809E-06	7.7421E-09
Mg			1.2090E-05	1.2090E-05	4.3918E-08
Cl			4.3825E-06	4.3825E-06	6.1943E-11
F			6.1857E-06	6.1857E-06	1.1822E-09
W-182			4.5474E-02	4.5474E-02	2.0935E-04
W-183			3.4360E-02	3.4360E-02	4.9476E-04
W-184			3.4338E-02	3.4338E-02	4.3528E-04
W-186			3.0317E-02	3.0317E-02	5.0869E-04
Region Sum	1.0080E+00	4.0428E-01	2.3678E-01	6.4106E-01	2.0705E-03
Leakage	3.5860E-01				
Radial Reflector					
Cr			6.1485E-06	6.1485E-06	2.1285E-09
Fe			3.8400E-05	3.8400E-05	4.2265E-09
Al			6.4727E-03	6.4727E-03	8.7728E-08
C			5.5117E-09	5.5117E-09	0.0000E+00
Mn			8.8517E-06	8.8517E-06	2.0717E-09
Cu			1.4798E-05	1.4798E-05	1.3145E-09
Ti			2.5265E-06	2.5265E-06	3.0375E-10
Si			5.1166E-06	5.1166E-06	1.3563E-09
Mg			7.3204E-06	7.3204E-06	8.8930E-09
Region Sum			6.5559E-03	6.5559E-03	1.0802E-07
Leakage	-6.5558E-03				

Table C.2 (cont'd). Neutron Balance by Nuclide and Region for ZPR-9/6.

Axial Reflector					
Cr			1.1567E-05	1.1567E-05	6.9321E-09
Ni			6.7344E-06	6.7344E-06	2.6797E-10
Fe			6.1185E-05	6.1185E-05	1.0825E-08
Al			1.9410E-03	1.9410E-03	4.4376E-08
C			9.0069E-09	9.0069E-09	0.0000E+00
Mo			4.5377E-07	4.5377E-07	6.5011E-10
Mn			3.3663E-06	3.3663E-06	1.2709E-09
Cu			4.4056E-06	4.4056E-06	6.0361E-10
Ti			6.9440E-07	6.9440E-07	1.4549E-10
Si			1.8119E-06	1.8119E-06	6.5091E-10
Mg			2.6698E-06	2.6698E-06	4.4792E-09
Region Sum			2.0339E-03	2.0339E-03	7.0201E-08
Leakage	-2.0339E-03				
Total Over All Nuclides and Regions					
Assembly Sum	1.0080E+00	4.0428E-01	2.4537E-01	6.4965E-01	2.0707E-03
Leakage	3.5001E-01				
keff	1.0104				

(a) The normalization is such that (Absorption + Leakage) = (Fission Production) / k_{eff} + (n,2n) = 1.0.

APPENDIX D: VIM MODEL OF AS-BUILT ZPR-9 ASSEMBLIES 5 AND 6

The VIM code inputs for the as-built models of ZPR-9 Assemblies 2 and 3 are shown below. These inputs were used with continuous energy ENDF/B-V cross sections for all nuclides. All the cross sections correspond to 300 K. The calculations were run with VIM Version 4.0. There were 10,000 neutron histories per generation and 200 active generations.

```
   574428347  zpr9508v5 - zpr9-5 loading 08 - as built - v5 xs             01
   200     3     0    40     0     0                                        02
 10000 10000     4     0     0     0                                        03
     0     1     0     0    50     0                                        04
    22    37     9    43  1403 10000
 1.00000E+09 1.00000E+00 2.75000E+02 1.00000E+00 1.00000E-05 1.41910E+07   06AN
 9.50000E-01 0.00000E+00 1.00000E+00 0.00000E+00                           06BN
     1     0     1     0     3     0     0     0     0     0     1     0     0
 30300 40300 60300 80300210300220300230300240300270300280300290300340300   08
350300370300380300450300540300570300600300610300620300630300               08
                                                                            09
                                                                            10
    31    59    53     2   127    60
     0     0     0  1068                                                    14
     5.53466      5.55244   197.58000
           0           2           0           2     0.00000     1.00000   16
  RPP    1   0.00000   5.53466   0.00000   0.10160   0.00000   2.54000     17
  RPP    2   0.00000   5.53466   5.45084   5.55244   0.00000   2.54000     17
  RPP    3   0.00000   0.10160   0.10160   5.45084   0.00000   2.54000     17
  RPP    4   5.43306   5.53466   0.10160   5.45084   0.00000   2.54000     17
  RPP    5   0.00000   5.53466   0.00000   0.10160   2.54000  28.02128     17
  RPP    6   0.00000   5.53466   5.45084   5.55244   2.54000  28.02128     17
  RPP    7   0.00000   0.10160   0.10160   5.45084   2.54000  28.02128     17
  RPP    8   5.43306   5.53466   0.10160   5.45084   2.54000  28.02128     17
  RPP    9   0.14351   5.39115   0.10160   5.34924   0.00000   0.08128     17
  RPP   10   0.14351   0.22479   0.18288   5.34924   0.08128  28.02128     17
  RPP   11   5.30987   5.39115   0.18288   5.34924   0.08128  28.02128     17
  RPP   12   0.14351   5.39115   0.10160   0.18288   0.08128  28.02128     17
  RPP   13   0.22479   0.54229   0.18288   5.26288   0.08128  22.94128     17
  RPP   14   0.22479   0.54229   0.18288   5.26288  22.94128  28.02128     17
  RPP   15   0.54229   0.85979   0.18288   5.26288   0.08128  22.94128     17
  RPP   16   0.54229   0.85979   0.18288   5.26288  22.94128  28.02128     17
  RPP   17   0.85979   1.01854   0.18288   5.26288   0.08128  22.94128     17
  RPP   18   0.85979   1.01854   0.18288   5.26288  22.94128  28.02128     17
  RPP   19   1.01854   1.33604   0.18288   5.26288   0.08128  22.94128     17
  RPP   20   1.01854   1.33604   0.18288   5.26288  22.94128  28.02128     17
  RPP   21   1.33604   1.65354   0.18288   5.26288   0.08128  22.94128     17
  RPP   22   1.33604   1.65354   0.18288   5.26288  22.94128  28.02128     17
  RPP   23   1.65354   1.97104   0.18288   5.26288   0.08128  22.94128     17
  RPP   24   1.65354   1.97104   0.18288   5.26288  22.94128  28.02128     17
  RPP   25   1.97104   2.28854   0.18288   5.26288   0.08128  22.94128     17
  RPP   26   1.97104   2.28854   0.18288   5.26288  22.94128  28.02128     17
  RPP   27   2.28854   2.44729   0.18288   5.26288   0.08128  22.94128     17
  RPP   28   2.28854   2.44729   0.18288   5.26288  22.94128  28.02128     17
  RPP   29   2.44729   2.76479   0.18288   5.26288   0.08128  22.94128     17
  RPP   30   2.44729   2.76479   0.18288   5.26288  22.94128  28.02128     17
  RPP   31   2.76479   3.08229   0.18288   5.26288   0.08128  22.94128     17
  RPP   32   2.76479   3.08229   0.18288   5.26288  22.94128  28.02128     17
  RPP   33   3.08229   3.39979   0.18288   5.26288   0.08128  22.94128     17
  RPP   34   3.08229   3.39979   0.18288   5.26288  22.94128  28.02128     17
  RPP   35   3.39979   3.55854   0.18288   5.26288   0.08128  22.94128     17
  RPP   36   3.39979   3.55854   0.18288   5.26288  22.94128  28.02128     17
  RPP   37   3.55854   3.87604   0.18288   5.26288   0.08128  22.94128     17
  RPP   38   3.55854   3.87604   0.18288   5.26288  22.94128  28.02128     17
  RPP   39   3.87604   4.19354   0.18288   5.26288   0.08128  22.94128     17
  RPP   40   3.87604   4.19354   0.18288   5.26288  22.94128  28.02128     17
  RPP   41   4.19354   4.51104   0.18288   5.26288   0.08128  22.94128     17
  RPP   42   4.19354   4.51104   0.18288   5.26288  22.94128  28.02128     17
  RPP   43   4.51104   4.82854   0.18288   5.26288   0.08128  22.94128     17
  RPP   44   4.51104   4.82854   0.18288   5.26288  22.94128  28.02128     17
  RPP   45   4.82854   4.98729   0.18288   5.26288   0.08128  22.94128     17
  RPP   46   4.82854   4.98729   0.18288   5.26288  22.94128  28.02128     17
  RPP   47   4.98729   5.30479   0.18288   5.26288   0.08128  22.94128     17
  RPP   48   4.98729   5.30479   0.18288   5.26288  22.94128  28.02128     17
  RPP   49   0.10160   0.14351   0.10160   5.34924   2.54000  28.02128     17
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RPP	50	5.39115	5.43306	0.10160	5.34924	2.54000	28.02128	17
RPP	51	0.10160	5.43306	5.34924	5.45084	0.00000	28.02128	17
RPP	52	0.22479	5.30987	5.26288	5.34924	0.08128	28.02128	17
RPP	53	5.30479	5.30987	0.18288	5.26288	0.08128	28.02128	17
RPP	54	5.39115	5.43306	0.10160	5.34924	0.00000	2.54000	17
RPP	55	0.10160	0.14351	0.10160	5.34924	0.00000	2.54000	17
RPP	56	0.00000	5.53466	0.00000	0.10160	28.02128	38.73754	17
RPP	57	0.00000	5.53466	5.45084	5.55244	28.02128	38.73754	17
RPP	58	0.00000	0.10160	0.10160	5.45084	28.02128	38.73754	17
RPP	59	5.43306	5.53466	0.10160	5.45084	28.02128	38.73754	17
RPP	60	0.14351	5.39115	0.10160	5.34924	38.65626	38.73754	17
RPP	61	0.14351	0.22479	0.18288	5.34924	28.02128	38.65626	17
RPP	62	5.30987	5.39115	0.18288	5.34924	28.02128	38.65626	17
RPP	63	0.14351	5.39115	0.10160	0.18288	28.02128	38.65626	17
RPP	64	0.22479	5.30479	0.18288	5.26288	28.02128	38.18128	17
RPP	65	0.22733	5.30733	0.18288	5.26288	38.18128	38.34003	17
RPP	66	0.10160	0.14351	0.10160	5.34924	28.02128	38.73754	17
RPP	67	5.39115	5.43306	0.10160	5.34924	28.02128	38.73754	17
RPP	68	0.10160	5.43306	5.34924	5.45084	28.02128	38.73754	17
RPP	69	0.22479	5.30987	5.26288	5.34924	28.02128	38.34003	17
RPP	70	5.30479	5.30987	0.18288	5.26288	28.02128	38.18128	17
RPP	71	0.22479	5.30987	0.18288	5.34924	38.34003	38.65626	17
RPP	72	0.22479	0.22733	0.18288	5.26288	38.18128	38.34003	17
RPP	73	5.30733	5.30987	0.18288	5.26288	38.18128	38.34003	17
RPP	74	0.00000	5.53466	0.00000	0.10160	38.73754	50.92573	17
RPP	75	0.00000	5.53466	5.45084	5.55244	38.73754	50.92573	17
RPP	76	0.00000	0.10160	0.10160	5.45084	38.73754	50.92573	17
RPP	77	5.43306	5.53466	0.10160	5.45084	38.73754	50.92573	17
RPP	78	0.14351	5.39115	0.10160	5.34924	38.73754	38.81882	17
RPP	79	0.14351	0.22479	0.18288	5.34924	38.81882	50.92573	17
RPP	80	5.30987	5.39115	0.18288	5.34924	38.81882	50.92573	17
RPP	81	0.14351	5.39115	0.10160	0.18288	38.81882	50.92573	17
RPP	82	0.22479	5.30479	0.18288	5.26288	38.81882	48.97882	17
RPP	83	0.22479	5.30479	0.18288	5.26288	48.97882	50.92573	17
RPP	84	0.10160	0.14351	0.10160	5.34924	38.73754	50.92573	17
RPP	85	5.39115	5.43306	0.10160	5.34924	38.73754	50.92573	17
RPP	86	0.10160	5.43306	5.34924	5.45084	38.73754	50.92573	17
RPP	87	0.22479	5.30987	5.26288	5.34924	38.81882	50.92573	17
RPP	88	5.30479	5.30987	0.18288	5.26288	38.81882	50.92573	17
RPP	89	0.00000	5.53466	0.00000	0.10160	50.92573	59.13882	17
RPP	90	0.00000	5.53466	5.45084	5.55244	50.92573	59.13882	17
RPP	91	0.00000	0.10160	0.10160	5.45084	50.92573	59.13882	17
RPP	92	5.43306	5.53466	0.10160	5.45084	50.92573	59.13882	17
RPP	93	0.14351	0.22479	0.18288	5.34924	50.92573	59.13882	17
RPP	94	5.30987	5.39115	0.18288	5.34924	50.92573	59.13882	17
RPP	95	0.14351	5.39115	0.10160	0.18288	50.92573	59.13882	17
RPP	96	0.22479	5.30479	0.18288	5.26288	50.92573	59.13882	17
RPP	97	0.10160	0.14351	0.10160	5.34924	50.92573	59.13882	17
RPP	98	5.39115	5.43306	0.10160	5.34924	50.92573	59.13882	17
RPP	99	0.10160	5.43306	5.34924	5.45084	50.92573	59.13882	17
RPP	100	0.22479	5.30987	5.26288	5.34924	50.92573	59.13882	17
RPP	101	5.30479	5.30987	0.18288	5.26288	50.92573	59.13882	17
RPP	102	0.00000	5.53466	0.00000	0.10160	59.13882	61.91504	17
RPP	103	0.00000	5.53466	5.45084	5.55244	59.13882	61.91504	17
RPP	104	0.00000	0.10160	0.10160	5.45084	59.13882	61.91504	17
RPP	105	5.43306	5.53466	0.10160	5.45084	59.13882	61.91504	17
RPP	106	0.14351	0.22479	0.18288	5.34924	59.13882	61.91504	17
RPP	107	5.30987	5.39115	0.18288	5.34924	59.13882	61.91504	17
RPP	108	0.14351	5.39115	0.10160	0.18288	59.13882	61.91504	17
RPP	109	0.10160	0.14351	0.10160	5.34924	59.13882	61.91504	17
RPP	110	5.39115	5.43306	0.10160	5.34924	59.13882	61.91504	17
RPP	111	0.10160	5.43306	5.34924	5.45084	59.13882	61.91504	17
RPP	112	0.22479	5.30987	0.18288	5.34924	59.13882	61.91504	17
RPP	113	0.00000	5.53466	0.00000	0.10160	61.91504	121.92000	17
RPP	114	0.00000	5.53466	5.45084	5.55244	61.91504	121.92000	17
RPP	115	0.00000	0.10160	0.10160	5.45084	61.91504	121.92000	17
RPP	116	5.43306	5.53466	0.10160	5.45084	61.91504	121.92000	17
RPP	117	0.14351	5.39115	0.10160	5.34924	97.87382	97.95510	17
RPP	118	0.14351	0.22479	0.18288	5.34924	61.91504	97.87382	17
RPP	119	5.30987	5.39115	0.18288	5.34924	61.91504	97.87382	17
RPP	120	0.14351	5.39115	0.10160	0.18288	61.91504	97.87382	17
RPP	121	0.10160	0.14351	0.10160	5.34924	61.91504	97.95510	17
RPP	122	5.39115	5.43306	0.10160	5.34924	61.91504	97.95510	17
RPP	123	0.10160	5.43306	5.34924	5.45084	61.91504	97.95510	17
RPP	124	0.22479	5.30987	0.18288	5.34924	61.91504	97.87382	17
RPP	125	0.10160	5.43306	0.10160	5.45084	97.95510	121.92000	17
RPP	126	0.00000	2.76479	0.00000	0.10160	0.00000	2.54000	17
RPP	127	2.76479	5.53466	0.00000	0.10160	0.00000	2.54000	17

RPP	128	0.00000	2.76479	5.45084	5.55244	0.00000	2.54000	17
RPP	129	2.76479	5.53466	5.45084	5.55244	0.00000	2.54000	17
RPP	130	0.00000	2.76479	0.00000	0.10160	2.54000	28.02128	17
RPP	131	2.76479	5.53466	0.00000	0.10160	2.54000	28.02128	17
RPP	132	0.00000	2.76479	5.45084	5.55244	2.54000	28.02128	17
RPP	133	2.76479	5.53466	5.45084	5.55244	2.54000	28.02128	17
RPP	134	0.14351	2.76479	0.10160	5.34924	0.00000	0.08128	17
RPP	135	2.76479	5.39115	0.10160	5.34924	0.00000	0.08128	17
RPP	136	0.14351	2.76479	0.10160	0.18288	0.08128	28.02128	17
RPP	137	2.76479	5.39115	0.10160	0.18288	0.08128	28.02128	17
RPP	138	2.76479	5.30479	0.18288	5.26288	22.94128	28.02128	17
RPP	139	2.76479	5.30479	0.18288	2.72288	0.08128	22.94128	17
RPP	140	2.76479	5.30479	2.72288	5.26288	0.08128	22.94128	17
RPP	141	0.10160	2.76479	5.34924	5.45084	0.00000	28.02128	17
RPP	142	2.76479	5.43306	5.34924	5.45084	0.00000	28.02128	17
RPP	143	0.22479	2.76479	5.26288	5.34924	0.08128	28.02128	17
RPP	144	2.76479	5.30987	5.26288	5.34924	0.08128	28.02128	17
RPP	145	5.30479	5.30987	0.18288	5.26288	2.54000	28.02128	17
RPP	146	5.30479	5.30987	0.18288	5.26288	0.08128	2.54000	17
RPP	147	0.22479	2.76479	0.18288	5.26288	22.94128	28.02128	17
RPP	148	0.22479	2.76479	0.18288	2.72288	0.08128	22.94128	17
RPP	149	0.22479	2.76479	2.72288	5.26288	0.08128	22.94128	17
RPP	150	4.99237	5.30987	0.18288	5.26288	0.08128	22.94128	17
RPP	151	4.99237	5.30987	0.18288	5.26288	22.94128	28.02128	17
RPP	152	4.83362	4.99237	0.18288	5.26288	0.08128	22.94128	17
RPP	153	4.83362	4.99237	0.18288	5.26288	22.94128	28.02128	17
RPP	154	4.51612	4.83362	0.18288	5.26288	0.08128	22.94128	17
RPP	155	4.51612	4.83362	0.18288	5.26288	22.94128	28.02128	17
RPP	156	4.19862	4.51612	0.18288	5.26288	0.08128	22.94128	17
RPP	157	4.19862	4.51612	0.18288	5.26288	22.94128	28.02128	17
RPP	158	3.88112	4.19862	0.18288	5.26288	0.08128	22.94128	17
RPP	159	3.88112	4.19862	0.18288	5.26288	22.94128	28.02128	17
RPP	160	3.56362	3.88112	0.18288	5.26288	0.08128	22.94128	17
RPP	161	3.56362	3.88112	0.18288	5.26288	22.94128	28.02128	17
RPP	162	3.40487	3.56362	0.18288	5.26288	0.08128	22.94128	17
RPP	163	3.40487	3.56362	0.18288	5.26288	22.94128	28.02128	17
RPP	164	3.08737	3.40487	0.18288	5.26288	0.08128	22.94128	17
RPP	165	3.08737	3.40487	0.18288	5.26288	22.94128	28.02128	17
RPP	166	2.76987	3.08737	0.18288	5.26288	0.08128	22.94128	17
RPP	167	2.76987	3.08737	0.18288	5.26288	22.94128	28.02128	17
RPP	168	2.45237	2.76987	0.18288	5.26288	0.08128	22.94128	17
RPP	169	2.45237	2.76987	0.18288	5.26288	22.94128	28.02128	17
RPP	170	2.29362	2.45237	0.18288	5.26288	0.08128	22.94128	17
RPP	171	2.29362	2.45237	0.18288	5.26288	22.94128	28.02128	17
RPP	172	1.97612	2.29362	0.18288	5.26288	0.08128	22.94128	17
RPP	173	1.97612	2.29362	0.18288	5.26288	22.94128	28.02128	17
RPP	174	1.65862	1.97612	0.18288	5.26288	0.08128	22.94128	17
RPP	175	1.65862	1.97612	0.18288	5.26288	22.94128	28.02128	17
RPP	176	1.34112	1.65862	0.18288	5.26288	0.08128	22.94128	17
RPP	177	1.34112	1.65862	0.18288	5.26288	22.94128	28.02128	17
RPP	178	1.02362	1.34112	0.18288	5.26288	0.08128	22.94128	17
RPP	179	1.02362	1.34112	0.18288	5.26288	22.94128	28.02128	17
RPP	180	0.86487	1.02362	0.18288	5.26288	0.08128	22.94128	17
RPP	181	0.86487	1.02362	0.18288	5.26288	22.94128	28.02128	17
RPP	182	0.54737	0.86487	0.18288	5.26288	0.08128	22.94128	17
RPP	183	0.54737	0.86487	0.18288	5.26288	22.94128	28.02128	17
RPP	184	0.22987	0.54737	0.18288	5.26288	0.08128	22.94128	17
RPP	185	0.22987	0.54737	0.18288	5.26288	22.94128	28.02128	17
RPP	186	0.22479	0.22987	0.18288	5.26288	0.08128	28.02128	17
RPP	187	0.22987	5.30987	0.18288	5.26288	28.02128	38.18128	17
RPP	188	0.22479	0.22987	0.18288	5.26288	28.02128	38.18128	17
RPP	189	0.22987	5.30987	0.18288	5.26288	38.81882	48.97882	17
RPP	190	0.22987	5.30987	0.18288	5.26288	48.97882	50.92573	17
RPP	191	0.22479	0.22987	0.18288	5.26288	38.81882	50.92573	17
RPP	192	0.22987	5.30987	0.18288	5.26288	50.92573	59.13882	17
RPP	193	0.22479	0.22987	0.18288	5.26288	50.92573	59.13882	17
RPP	194	0.00000	2.76987	0.00000	0.10160	0.00000	2.54000	17
RPP	195	2.76987	5.53466	0.00000	0.10160	0.00000	2.54000	17
RPP	196	0.00000	2.76987	5.45084	5.55244	0.00000	2.54000	17
RPP	197	2.76987	5.53466	5.45084	5.55244	0.00000	2.54000	17
RPP	198	0.00000	2.76987	0.00000	0.10160	2.54000	28.02128	17
RPP	199	2.76987	5.53466	0.00000	0.10160	2.54000	28.02128	17
RPP	200	0.00000	2.76987	5.45084	5.55244	2.54000	28.02128	17
RPP	201	2.76987	5.53466	5.45084	5.55244	2.54000	28.02128	17
RPP	202	0.14351	2.76987	0.10160	5.34924	0.00000	0.08128	17
RPP	203	2.76987	5.39115	0.10160	5.34924	0.00000	0.08128	17
RPP	204	0.14351	2.76987	0.10160	0.18288	0.08128	28.02128	17
RPP	205	2.76987	5.39115	0.10160	0.18288	0.08128	28.02128	17

RPP	206	0.22987	2.76987	0.18288	5.26288	22.94128	28.02128	17
RPP	207	0.22987	2.76987	0.18288	2.72288	0.08128	22.94128	17
RPP	208	0.22987	2.76987	2.72288	5.26288	0.08128	22.94128	17
RPP	209	0.10160	2.76987	5.34924	5.45084	0.00000	28.02128	17
RPP	210	2.76987	5.43306	5.34924	5.45084	0.00000	28.02128	17
RPP	211	0.22479	2.76987	5.26288	5.34924	0.08128	28.02128	17
RPP	212	2.76987	5.30987	5.26288	5.34924	0.08128	28.02128	17
RPP	213	0.22479	0.22987	0.18288	5.26288	2.54000	28.02128	17
RPP	214	0.22479	0.22987	0.18288	5.26288	0.08128	2.54000	17
RPP	215	2.76987	5.30987	0.18288	5.26288	22.94128	28.02128	17
RPP	216	2.76987	5.30987	0.18288	2.72288	0.08128	22.94128	17
RPP	217	2.76987	5.30987	2.72288	5.26288	0.08128	22.94128	17
RPP	218	0.00000	5.53466	0.00000	0.10160	2.54000	28.06573	17
RPP	219	0.00000	5.53466	5.45084	5.55244	2.54000	28.06573	17
RPP	220	0.00000	0.10160	0.10160	5.45084	2.54000	28.06573	17
RPP	221	5.43306	5.53466	0.10160	5.45084	2.54000	28.06573	17
RPP	222	0.14605	5.38861	0.10160	5.32130	0.00000	0.12573	17
RPP	223	0.14605	0.27178	0.22733	5.32130	0.12573	28.06573	17
RPP	224	5.26288	5.38861	0.22733	5.32130	0.12573	28.06573	17
RPP	225	0.14605	5.38861	0.10160	0.22733	0.12573	28.06573	17
RPP	226	0.27178	0.43053	0.22733	5.30733	0.12573	22.98573	17
RPP	227	0.27178	0.43053	0.22733	5.30733	22.98573	28.06573	17
RPP	228	0.43053	0.74803	0.22733	5.30733	0.12573	22.98573	17
RPP	229	0.43053	0.74803	0.22733	5.30733	22.98573	28.06573	17
RPP	230	0.74803	0.90678	0.22733	5.30733	0.12573	22.98573	17
RPP	231	0.74803	0.90678	0.22733	5.30733	22.98573	28.06573	17
RPP	232	0.90678	1.22428	0.22733	5.30733	0.12573	22.98573	17
RPP	233	0.90678	1.22428	0.22733	5.30733	22.98573	28.06573	17
RPP	234	1.22428	1.54178	0.22733	5.30733	0.12573	22.98573	17
RPP	235	1.22428	1.54178	0.22733	5.30733	22.98573	28.06573	17
RPP	236	1.54178	1.85928	0.22733	5.30733	0.12573	22.98573	17
RPP	237	1.54178	1.85928	0.22733	5.30733	22.98573	28.06573	17
RPP	238	1.85928	2.17678	0.22733	5.30733	0.12573	22.98573	17
RPP	239	1.85928	2.17678	0.22733	5.30733	22.98573	28.06573	17
RPP	240	2.17678	2.33553	0.22733	5.30733	0.12573	22.98573	17
RPP	241	2.17678	2.33553	0.22733	5.30733	22.98573	28.06573	17
RPP	242	2.33553	2.65303	0.22733	5.30733	0.12573	22.98573	17
RPP	243	2.33553	2.65303	0.22733	5.30733	22.98573	28.06573	17
RPP	244	2.65303	2.97053	0.22733	5.30733	0.12573	22.98573	17
RPP	245	2.65303	2.97053	0.22733	5.30733	22.98573	28.06573	17
RPP	246	2.97053	3.28803	0.22733	5.30733	0.12573	22.98573	17
RPP	247	2.97053	3.28803	0.22733	5.30733	22.98573	28.06573	17
RPP	248	3.28803	3.44678	0.22733	5.30733	0.12573	22.98573	17
RPP	249	3.28803	3.44678	0.22733	5.30733	22.98573	28.06573	17
RPP	250	3.44678	3.76428	0.22733	5.30733	0.12573	22.98573	17
RPP	251	3.44678	3.76428	0.22733	5.30733	22.98573	28.06573	17
RPP	252	3.76428	4.08178	0.22733	5.30733	0.12573	22.98573	17
RPP	253	3.76428	4.08178	0.22733	5.30733	22.98573	28.06573	17
RPP	254	4.08178	4.39928	0.22733	5.30733	0.12573	22.98573	17
RPP	255	4.08178	4.39928	0.22733	5.30733	22.98573	28.06573	17
RPP	256	4.39928	4.71678	0.22733	5.30733	0.12573	22.98573	17
RPP	257	4.39928	4.71678	0.22733	5.30733	22.98573	28.06573	17
RPP	258	4.71678	4.87553	0.22733	5.30733	0.12573	22.98573	17
RPP	259	4.71678	4.87553	0.22733	5.30733	22.98573	28.06573	17
RPP	260	4.87553	5.19303	0.22733	5.30733	0.12573	22.98573	17
RPP	261	4.87553	5.19303	0.22733	5.30733	22.98573	28.06573	17
RPP	262	0.10160	0.14605	0.10160	5.32130	2.54000	28.06573	17
RPP	263	5.38861	5.43306	0.10160	5.32130	2.54000	28.06573	17
RPP	264	0.10160	5.43306	5.32130	5.45084	0.00000	28.06573	17
RPP	265	0.27178	5.26288	5.30733	5.32130	0.12573	28.06573	17
RPP	266	5.19303	5.26288	0.22733	5.30733	0.12573	28.06573	17
RPP	267	5.38861	5.43306	0.10160	5.32130	0.00000	2.54000	17
RPP	268	0.10160	0.14605	0.10160	5.32130	0.00000	2.54000	17
RPP	269	0.00000	5.53466	0.00000	0.10160	28.06573	50.92573	17
RPP	270	0.00000	5.53466	5.45084	5.55244	28.06573	50.92573	17
RPP	271	0.00000	0.10160	0.10160	5.45084	28.06573	50.92573	17
RPP	272	5.43306	5.53466	0.10160	5.45084	28.06573	50.92573	17
RPP	273	0.14605	0.27178	0.22733	5.32130	28.06573	50.92573	17
RPP	274	5.26288	5.38861	0.22733	5.32130	28.06573	50.92573	17
RPP	275	0.14605	5.38861	0.10160	0.22733	28.06573	50.92573	17
RPP	276	0.27178	5.19303	0.22733	5.30733	28.06573	50.92573	17
RPP	277	0.10160	0.14605	0.10160	5.32130	28.06573	50.92573	17
RPP	278	5.38861	5.43306	0.10160	5.32130	28.06573	50.92573	17
RPP	279	0.10160	5.43306	5.32130	5.45084	28.06573	50.92573	17
RPP	280	0.27178	5.26288	5.30733	5.32130	28.06573	50.92573	17
RPP	281	5.19303	5.26288	0.22733	5.30733	28.06573	50.92573	17
RPP	282	0.14605	0.27178	0.22733	5.32130	50.92573	59.13882	17
RPP	283	5.26288	5.38861	0.22733	5.32130	50.92573	59.13882	17

RPP	284	0.14605	5.38861	0.10160	0.22733	50.92573	59.13882	17
RPP	285	2.49428	3.12928	0.22733	5.30733	51.56073	59.13882	17
RPP	286	0.27178	5.19303	0.22733	5.30733	50.92573	51.56073	17
RPP	287	0.10160	0.14605	0.10160	5.32130	50.92573	59.13882	17
RPP	288	5.38861	5.43306	0.10160	5.32130	50.92573	59.13882	17
RPP	289	0.10160	5.43306	5.32130	5.45084	50.92573	59.13882	17
RPP	290	0.27178	5.26288	5.30733	5.32130	50.92573	59.13882	17
RPP	291	5.19303	5.26288	0.22733	5.30733	50.92573	51.56073	17
RPP	292	0.27178	2.49428	0.22733	5.30733	51.56073	59.13882	17
RPP	293	3.12928	5.26288	0.22733	5.30733	51.56073	59.13882	17
RPP	294	0.14605	0.27178	0.22733	5.32130	59.13882	61.91504	17
RPP	295	5.26288	5.38861	0.22733	5.32130	59.13882	61.91504	17
RPP	296	0.14605	5.38861	0.10160	0.22733	59.13882	61.91504	17
RPP	297	2.49428	3.12928	0.22733	5.30733	59.13882	61.91504	17
RPP	298	0.10160	0.14605	0.10160	5.32130	59.13882	61.91504	17
RPP	299	5.38861	5.43306	0.10160	5.32130	59.13882	61.91504	17
RPP	300	0.10160	5.43306	5.32130	5.45084	59.13882	61.91504	17
RPP	301	0.27178	5.26288	5.30733	5.32130	59.13882	61.91504	17
RPP	302	0.27178	2.49428	0.22733	5.30733	59.13882	61.91504	17
RPP	303	3.12928	5.26288	0.22733	5.30733	59.13882	61.91504	17
RPP	304	0.00000	5.53466	0.00000	0.10160	61.91504	103.50500	17
RPP	305	0.00000	5.53466	5.45084	5.55244	61.91504	103.50500	17
RPP	306	0.00000	0.10160	0.10160	5.45084	61.91504	103.50500	17
RPP	307	5.43306	5.53466	0.10160	5.45084	61.91504	103.50500	17
RPP	308	0.14605	0.27178	0.22733	5.32130	61.91504	103.50500	17
RPP	309	5.26288	5.38861	0.22733	5.32130	61.91504	103.50500	17
RPP	310	0.14605	5.38861	0.10160	0.22733	61.91504	103.50500	17
RPP	311	2.49428	3.12928	0.22733	5.30733	61.91504	102.36073	17
RPP	312	0.27178	5.19303	0.22733	5.30733	102.36073	102.99573	17
RPP	313	0.10160	0.14605	0.10160	5.32130	61.91504	103.50500	17
RPP	314	5.38861	5.43306	0.10160	5.32130	61.91504	103.50500	17
RPP	315	0.10160	5.43306	5.32130	5.45084	61.91504	103.50500	17
RPP	316	0.27178	5.26288	5.30733	5.32130	61.91504	102.99573	17
RPP	317	0.27178	5.26288	0.22733	5.32130	102.99573	103.50500	17
RPP	318	5.19303	5.26288	0.22733	5.30733	102.36073	102.99573	17
RPP	319	0.27178	2.49428	0.22733	5.30733	61.91504	102.36073	17
RPP	320	3.12928	5.26288	0.22733	5.30733	61.91504	102.36073	17
RPP	321	0.00000	5.53466	0.00000	0.10160	103.50500	121.92000	17
RPP	322	0.00000	5.53466	5.45084	5.55244	103.50500	121.92000	17
RPP	323	0.00000	0.10160	0.10160	5.45084	103.50500	121.92000	17
RPP	324	5.43306	5.53466	0.10160	5.45084	103.50500	121.92000	17
RPP	325	2.44475	3.07975	0.10160	5.18160	103.50500	121.92000	17
RPP	326	0.10160	5.43306	5.18160	5.45084	103.50500	121.92000	17
RPP	327	0.10160	2.44475	0.10160	5.18160	103.50500	121.92000	17
RPP	328	3.07975	5.43306	0.10160	5.18160	103.50500	121.92000	17
RPP	329	0.34163	0.50038	0.22733	5.30733	0.12573	22.98573	17
RPP	330	0.34163	0.50038	0.22733	5.30733	22.98573	28.06573	17
RPP	331	4.94538	5.26288	0.22733	5.30733	0.12573	22.98573	17
RPP	332	4.94538	5.26288	0.22733	5.30733	22.98573	28.06573	17
RPP	333	4.78663	4.94538	0.22733	5.30733	0.12573	22.98573	17
RPP	334	4.78663	4.94538	0.22733	5.30733	22.98573	28.06573	17
RPP	335	4.46913	4.78663	0.22733	5.30733	0.12573	22.98573	17
RPP	336	4.46913	4.78663	0.22733	5.30733	22.98573	28.06573	17
RPP	337	4.15163	4.46913	0.22733	5.30733	0.12573	22.98573	17
RPP	338	4.15163	4.46913	0.22733	5.30733	22.98573	28.06573	17
RPP	339	3.83413	4.15163	0.22733	5.30733	0.12573	22.98573	17
RPP	340	3.83413	4.15163	0.22733	5.30733	22.98573	28.06573	17
RPP	341	3.51663	3.83413	0.22733	5.30733	0.12573	22.98573	17
RPP	342	3.51663	3.83413	0.22733	5.30733	22.98573	28.06573	17
RPP	343	3.35788	3.51663	0.22733	5.30733	0.12573	22.98573	17
RPP	344	3.35788	3.51663	0.22733	5.30733	22.98573	28.06573	17
RPP	345	3.04038	3.35788	0.22733	5.30733	0.12573	22.98573	17
RPP	346	3.04038	3.35788	0.22733	5.30733	22.98573	28.06573	17
RPP	347	2.72288	3.04038	0.22733	5.30733	0.12573	22.98573	17
RPP	348	2.72288	3.04038	0.22733	5.30733	22.98573	28.06573	17
RPP	349	2.40538	2.72288	0.22733	5.30733	0.12573	22.98573	17
RPP	350	2.40538	2.72288	0.22733	5.30733	22.98573	28.06573	17
RPP	351	2.24663	2.40538	0.22733	5.30733	0.12573	22.98573	17
RPP	352	2.24663	2.40538	0.22733	5.30733	22.98573	28.06573	17
RPP	353	1.92913	2.24663	0.22733	5.30733	0.12573	22.98573	17
RPP	354	1.92913	2.24663	0.22733	5.30733	22.98573	28.06573	17
RPP	355	1.61163	1.92913	0.22733	5.30733	0.12573	22.98573	17
RPP	356	1.61163	1.92913	0.22733	5.30733	22.98573	28.06573	17
RPP	357	1.29413	1.61163	0.22733	5.30733	0.12573	22.98573	17
RPP	358	1.29413	1.61163	0.22733	5.30733	22.98573	28.06573	17
RPP	359	0.97663	1.29413	0.22733	5.30733	0.12573	22.98573	17
RPP	360	0.97663	1.29413	0.22733	5.30733	22.98573	28.06573	17
RPP	361	0.81788	0.97663	0.22733	5.30733	0.12573	22.98573	17

RPP	362	0.81788	0.97663	0.22733	5.30733	22.98573	28.06573	17
RPP	363	0.50038	0.81788	0.22733	5.30733	0.12573	22.98573	17
RPP	364	0.50038	0.81788	0.22733	5.30733	22.98573	28.06573	17
RPP	365	0.27178	0.34163	0.22733	5.30733	0.12573	28.06573	17
RPP	366	0.34163	5.26288	0.22733	5.30733	28.06573	50.92573	17
RPP	367	0.27178	0.34163	0.22733	5.30733	28.06573	50.92573	17
RPP	368	2.40538	3.04038	0.22733	5.30733	51.56073	59.13882	17
RPP	369	0.34163	5.26288	0.22733	5.30733	50.92573	51.56073	17
RPP	370	0.27178	0.34163	0.22733	5.30733	50.92573	51.56073	17
RPP	371	0.27178	2.40538	0.22733	5.30733	51.56073	59.13882	17
RPP	372	3.04038	5.26288	0.22733	5.30733	51.56073	59.13882	17
RPP	373	2.40538	3.04038	0.22733	5.30733	59.13882	61.91504	17
RPP	374	0.27178	2.40538	0.22733	5.30733	59.13882	61.91504	17
RPP	375	3.04038	5.26288	0.22733	5.30733	59.13882	61.91504	17
RPP	376	2.40538	3.04038	0.22733	5.30733	61.91504	102.36073	17
RPP	377	0.34163	5.26288	0.22733	5.30733	102.36073	102.99573	17
RPP	378	0.27178	0.34163	0.22733	5.30733	102.36073	102.99573	17
RPP	379	0.27178	2.40538	0.22733	5.30733	61.91504	102.36073	17
RPP	380	3.04038	5.26288	0.22733	5.30733	61.91504	102.36073	17
RPP	381	2.45491	3.08991	0.10160	5.18160	103.50500	121.92000	17
RPP	382	0.10160	2.45491	0.10160	5.18160	103.50500	121.92000	17
RPP	383	3.08991	5.43306	0.10160	5.18160	103.50500	121.92000	17
RPP	384	0.00000	5.53466	0.00000	0.10160	2.54000	61.91504	17
RPP	385	0.00000	5.53466	5.45084	5.55244	2.54000	61.91504	17
RPP	386	0.00000	0.10160	0.10160	5.45084	2.54000	61.91504	17
RPP	387	5.43306	5.53466	0.10160	5.45084	2.54000	61.91504	17
RPP	388	0.14351	5.39115	0.10160	5.34924	61.83376	61.91504	17
RPP	389	0.14351	0.22479	0.18288	5.34924	0.08128	61.83376	17
RPP	390	5.30987	5.39115	0.18288	5.34924	0.08128	61.83376	17
RPP	391	0.14351	5.39115	0.10160	0.18288	0.08128	61.83376	17
RPP	392	0.22479	5.30479	0.18288	5.26288	0.08128	61.04128	17
RPP	393	0.22733	5.30733	0.18288	5.26288	61.04128	61.20003	17
RPP	394	0.10160	0.14351	0.10160	5.34924	2.54000	61.91504	17
RPP	395	5.39115	5.43306	0.10160	5.34924	2.54000	61.91504	17
RPP	396	0.10160	5.43306	5.34924	5.45084	0.00000	61.91504	17
RPP	397	0.22479	5.30987	0.18288	5.34924	61.20003	61.83376	17
RPP	398	0.22479	5.30987	5.26288	5.34924	0.08128	61.20003	17
RPP	399	0.22479	0.22733	0.18288	5.26288	61.04128	61.20003	17
RPP	400	5.30733	5.30987	0.18288	5.26288	61.04128	61.20003	17
RPP	401	5.30479	5.30987	0.18288	5.26288	0.08128	61.04128	17
RPP	402	0.10160	5.43306	0.10160	5.45084	61.91504	121.92000	17
RPP	403	0.22479	5.30479	0.18288	2.14630	10.24128	12.78128	17
RPP	404	0.22479	5.30479	0.18288	5.26288	12.78128	20.40128	17
RPP	405	0.22479	5.30479	0.18288	5.26288	0.08128	10.24128	17
RPP	406	0.22479	5.30479	0.18288	5.26288	20.40128	61.04128	17
RPP	407	0.22479	5.30987	5.26288	5.34924	0.08128	10.24128	17
RPP	408	5.30479	5.30987	0.18288	5.26288	0.08128	10.24128	17
RPP	409	0.22479	5.30987	5.26288	5.34924	12.78128	61.20003	17
RPP	410	5.30479	5.30987	0.18288	5.26288	12.78128	61.04128	17
RPP	411	0.22479	5.30987	2.14630	5.34924	10.24128	12.78128	17
RPP	412	5.30479	5.30987	0.18288	2.14630	10.24128	12.78128	17
RPP	413	0.22987	5.30987	0.18288	5.26288	0.08128	61.04128	17
RPP	414	0.22479	0.22987	0.18288	5.26288	0.08128	61.04128	17
RPP	415	0.22987	5.30987	0.18288	2.14630	10.24128	12.78128	17
RPP	416	0.22987	5.30987	0.18288	5.26288	12.78128	20.40128	17
RPP	417	0.22987	5.30987	0.18288	5.26288	0.08128	10.24128	17
RPP	418	0.22987	5.30987	0.18288	5.26288	20.40128	61.04128	17
RPP	419	0.22479	0.22987	0.18288	5.26288	0.08128	10.24128	17
RPP	420	0.22479	0.22987	0.18288	5.26288	12.78128	61.04128	17
RPP	421	0.22479	0.22987	0.18288	2.14630	10.24128	12.78128	17
RPP	422	0.00000	5.53466	0.00000	0.10160	2.54000	121.92000	17
RPP	423	0.00000	5.53466	5.45084	5.55244	2.54000	121.92000	17
RPP	424	0.00000	0.10160	0.10160	5.45084	2.54000	121.92000	17
RPP	425	5.43306	5.53466	0.10160	5.45084	2.54000	121.92000	17
RPP	426	0.10160	5.43306	0.10160	5.45084	0.00000	121.92000	17
RPP	427	0.00000	5.53466	0.00000	5.55244	121.92	194.72	MX2BkP
RPP	428	0.00000	5.53466	0.00000	5.55244	194.72	197.58	BkPlate
RPP	429	0.00000	1.688	0.0	1.688	121.92	194.72	CRShaft
RPP	430	0.00000	1.688	1.688	5.55244	121.92	194.72	MX2BkP
RPP	431	1.688	5.53466	0.00000	5.55244	121.92	194.72	MX2BkP
RPP	432	0.00000	5.53466	0.00000	5.55244	121.92	197.58	MX2End
RPP	433	0.00000	5.53466	0.00000	5.55244	0.00	197.58	CL2EndF
RPP	434	0.00000	5.53466	0.00000	2.159	0.00	197.58	CL2EndL
RPP	435	0.00000	5.53466	2.159	5.55244	0.00	197.58	CL2EndU
RPP	436	0.00000	5.53466	0.00000	5.55244	0.000	1.905	CL2Kne
RPP	437	0.00000	5.53466	0.00000	5.55244	120.015	197.58	Kne2End
RPP	438	0.00000	5.53466	0.0	5.55244	1.905	13.335	vVd1
RPP	439	0.00000	5.53466	0.0	5.55244	13.335	17.145	vFe1

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  RPP  440   0.00000   5.53466   0.0       5.55244  17.145    59.055     vVd2
  RPP  441   0.00000   5.53466   0.0       5.55244  59.055    62.865     vFe2
  RPP  442   0.00000   5.53466   0.0       5.55244  62.865   104.775     vVd3
  RPP  443   0.00000   5.53466   0.0       5.55244 104.775   108.585     vFe3
  RPP  444   0.00000   5.53466   0.0       5.55244 108.585   120.015     vVd4
  RPP  445   0.00000   5.53466   0.0       2.3495    1.905    13.335     vhVd1
  RPP  446   0.00000   5.53466   2.3495    5.55244   1.905    13.335     vhFe1
  RPP  447   0.00000   5.53466   0.0       2.3495   17.145    59.055     vhVd2
  RPP  448   0.00000   5.53466   2.3495    5.55244  17.145    59.055     vhFe2
  RPP  449   0.00000   5.53466   0.0       2.3495   62.865   104.775     vhVd3
  RPP  450   0.00000   5.53466   2.3495    5.55244  62.865   104.775     vhFe3
  RPP  451   0.00000   5.53466   0.0       2.3495  108.585   120.015     vhVd4
  RPP  452   0.00000   5.53466   2.3495    5.55244 108.585   120.015     vhFe4
  RPP  453   0.00000   1.7145    0.0       5.55244   1.905    13.335     vRVd1
  RPP  454   1.7145    5.53466   0.0       5.55244   1.905    13.335     vRFe1
  RPP  455   0.00000   1.7145    0.0       5.55244  17.145    59.055     vRVd2
  RPP  456   1.7145    5.53466   0.0       5.55244  17.145    59.055     vRFe2
  RPP  457   0.00000   1.7145    0.0       5.55244  62.865   104.775     vRVd3
  RPP  458   1.7145    5.53466   0.0       5.55244  62.865   104.775     vRFe3
  RPP  459   0.00000   1.7145    0.0       5.55244 108.585   120.015     vRVd4
  RPP  460   1.7145    5.53466   0.0       5.55244 108.585   120.015     vRFe4
  RPP  461   0.00000   1.7145    0.0       2.3495    1.905    13.335     vhRVd1
  RPP  462   1.7145    5.53466   0.0       2.3495    1.905    13.335     vhRFe1
  RPP  463   0.00000   1.7145    0.0       2.3495   17.145    59.055     vhRVd2
  RPP  464   1.7145    5.53466   0.0       2.3495   17.145    59.055     vhRFe2
  RPP  465   0.00000   1.7145    0.0       2.3495   62.865   104.775     vhRVd3
  RPP  466   1.7145    5.53466   0.0       2.3495   62.865   104.775     vhRFe3
  RPP  467   0.00000   1.7145    0.0       2.3495  108.585   120.015     vhRVd4
  RPP  468   1.7145    5.53466   0.0       2.3495  108.585   120.015     vhRFe4
  RPP  469   3.81      5.53466   0.0       5.55244   1.905    13.335     vLVd1
  RPP  470   0.0       3.81      0.0       5.55244   1.905    13.335     vLFe1
  RPP  471   3.81      5.53466   0.0       5.55244  17.145    59.055     vLVd2
  RPP  472   0.0       3.81      0.0       5.55244  17.145    59.055     vLFe2
  RPP  473   3.81      5.53466   0.0       5.55244  62.865   104.775     vLVd3
  RPP  474   0.0       3.81      0.0       5.55244  62.865   104.775     vLFe3
  RPP  475   3.81      5.53466   0.0       5.55244 108.585   120.015     vLVd4
  RPP  476   0.0       3.81      0.0       5.55244 108.585   120.015     vLFe4
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  RPP  478   0.0       3.81      0.0       2.3495    1.905    13.335     vhLFe1
  RPP  479   3.81      5.53466   0.0       2.3495   17.145    59.055     vhLVd2
  RPP  480   0.0       3.81      0.0       2.3495   17.145    59.055     vhLFe2
  RPP  481   3.81      5.53466   0.0       2.3495   62.865   104.775     vhLVd3
  RPP  482   0.0       3.81      0.0       2.3495   62.865   104.775     vhLFe3
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10000 10000     4     0     0     0                                      03
    0     1     0     0    50     0                                      04
   22    38     9    43  1846 10000
1.00000E+09 1.00000E+00 2.75000E+02 1.00000E+00 1.00000E-05 1.41910E+07  06AN
9.50000E-01 0.00000E+00 1.00000E+00 0.00000E+00                          06BN
    1     0     1     0     3     0     0     0     0     0     1     0    0
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3503003703003803004503005403005703006003006103006203006303 00            08
                                                                         09
                                                                         10
   35    59    53     2   129    60
    0     0     0  1295                                                  14
    5.53466     5.55244   197.58000
          0           2           0           2     0.00000     1.00000  16
  RPP    1   0.00000   5.53466   0.00000   0.10160   0.00000   2.54000   17
  RPP    2   0.00000   5.53466   5.45084   5.55244   0.00000   2.54000   17
  RPP    3   0.00000   0.10160   0.10160   5.45084   0.00000   2.54000   17
  RPP    4   5.43306   5.53466   0.10160   5.45084   0.00000   2.54000   17
  RPP    5   0.00000   5.53466   0.00000   0.10160   2.54000  30.56128   17
  RPP    6   0.00000   5.53466   5.45084   5.55244   2.54000  30.56128   17
  RPP    7   0.00000   0.10160   0.10160   5.45084   2.54000  30.56128   17
  RPP    8   5.43306   5.53466   0.10160   5.45084   2.54000  30.56128   17
  RPP    9   0.14351   5.39115   0.10160   5.34924   0.00000   0.08128   17
  RPP   10   0.14351   0.22479   0.18288   5.34924   0.08128  30.56128   17
  RPP   11   5.30987   5.39115   0.18288   5.34924   0.08128  30.56128   17
  RPP   12   0.14351   5.39115   0.10160   0.18288   0.08128  30.56128   17
  RPP   13   0.22479   0.54229   0.18288   5.26288   0.08128  15.32128   17
  RPP   14   0.22479   0.54229   0.18288   5.26288  15.32128  30.56128   17
  RPP   15   0.54229   0.85979   0.18288   5.26288   0.08128  15.32128   17
  RPP   16   0.54229   0.85979   0.18288   5.26288  15.32128  30.56128   17
  RPP   17   0.85979   1.01854   0.18288   5.26288   0.08128  22.94128   17
  RPP   18   0.85979   1.01854   0.18288   5.26288  22.94128  28.02128   17
  RPP   19   0.85979   1.01854   0.18288   5.26288  28.02128  30.56128   17
  RPP   20   1.01854   1.33604   0.18288   5.26288   0.08128  15.32128   17
  RPP   21   1.01854   1.33604   0.18288   5.26288  15.32128  30.56128   17
  RPP   22   1.33604   1.65354   0.18288   5.26288   0.08128  15.32128   17
  RPP   23   1.33604   1.65354   0.18288   5.26288  15.32128  30.56128   17
  RPP   24   1.65354   1.97104   0.18288   5.26288   0.08128  15.32128   17
  RPP   25   1.65354   1.97104   0.18288   5.26288  15.32128  30.56128   17
  RPP   26   1.97104   2.28854   0.18288   5.26288   0.08128  15.32128   17
  RPP   27   1.97104   2.28854   0.18288   5.26288  15.32128  30.56128   17
  RPP   28   2.28854   2.44729   0.18288   5.26288   0.08128  22.94128   17
  RPP   29   2.28854   2.44729   0.18288   5.26288  22.94128  28.02128   17
  RPP   30   2.28854   2.44729   0.18288   5.26288  28.02128  30.56128   17
  RPP   31   2.44729   2.76479   0.18288   5.26288   0.08128  15.32128   17
  RPP   32   2.44729   2.76479   0.18288   5.26288  15.32128  30.56128   17
  RPP   33   2.76479   3.08229   0.18288   5.26288   0.08128  15.32128   17
  RPP   34   2.76479   3.08229   0.18288   5.26288  15.32128  30.56128   17
  RPP   35   3.08229   3.39979   0.18288   5.26288   0.08128  15.32128   17
  RPP   36   3.08229   3.39979   0.18288   5.26288  15.32128  30.56128   17
  RPP   37   3.39979   3.55854   0.18288   5.26288   0.08128  15.32128   17
  RPP   38   3.39979   3.55854   0.18288   5.26288  15.32128  30.56128   17
  RPP   39   3.55854   3.87604   0.18288   5.26288   0.08128  15.32128   17
  RPP   40   3.55854   3.87604   0.18288   5.26288  15.32128  30.56128   17
  RPP   41   3.87604   4.19354   0.18288   5.26288   0.08128  15.32128   17
  RPP   42   3.87604   4.19354   0.18288   5.26288  15.32128  30.56128   17
  RPP   43   4.19354   4.51104   0.18288   5.26288   0.08128  15.32128   17
  RPP   44   4.19354   4.51104   0.18288   5.26288  15.32128  30.56128   17
  RPP   45   4.51104   4.82854   0.18288   5.26288   0.08128  15.32128   17
  RPP   46   4.51104   4.82854   0.18288   5.26288  15.32128  30.56128   17
  RPP   47   4.82854   4.98729   0.18288   5.26288   0.08128  15.32128   17
  RPP   48   4.82854   4.98729   0.18288   5.26288  15.32128  30.56128   17
  RPP   49   4.98729   5.30479   0.18288   5.26288   0.08128  15.32128   17
  RPP   50   4.98729   5.30479   0.18288   5.26288  15.32128  30.56128   17
  RPP   51   0.10160   0.14351   0.10160   5.34924   2.54000  30.56128   17
  RPP   52   5.39115   5.43306   0.10160   5.34924   2.54000  30.56128   17
  RPP   53   0.10160   5.43306   5.34924   5.45084   0.00000  30.56128   17
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RPP	54	0.22479	5.30987	5.26288	5.34924	0.08128	30.56128	17
RPP	55	5.30479	5.30987	0.18288	5.26288	0.08128	30.56128	17
RPP	56	5.39115	5.43306	0.10160	5.34924	0.00000	2.54000	17
RPP	57	0.10160	0.14351	0.10160	5.34924	0.00000	2.54000	17
RPP	58	0.00000	5.53466	0.00000	0.10160	30.56128	38.73754	17
RPP	59	0.00000	5.53466	5.45084	5.55244	30.56128	38.73754	17
RPP	60	0.00000	0.10160	0.10160	5.45084	30.56128	38.73754	17
RPP	61	5.43306	5.53466	0.10160	5.45084	30.56128	38.73754	17
RPP	62	0.14351	5.39115	0.10160	5.34924	38.65626	38.73754	17
RPP	63	0.14351	0.22479	0.18288	5.34924	30.56128	38.65626	17
RPP	64	5.30987	5.39115	0.18288	5.34924	30.56128	38.65626	17
RPP	65	0.14351	5.39115	0.10160	0.18288	30.56128	38.65626	17
RPP	66	0.22479	5.30479	0.18288	5.26288	30.56128	38.18128	17
RPP	67	0.22733	5.30733	0.18288	5.26288	38.18128	38.34003	17
RPP	68	0.10160	0.14351	0.10160	5.34924	30.56128	38.73754	17
RPP	69	5.39115	5.43306	0.10160	5.34924	30.56128	38.73754	17
RPP	70	0.10160	5.43306	5.34924	5.45084	30.56128	38.73754	17
RPP	71	0.22479	5.30987	5.26288	5.34924	30.56128	38.34003	17
RPP	72	5.30479	5.30987	0.18288	5.26288	30.56128	38.18128	17
RPP	73	5.30733	5.30987	0.18288	5.26288	38.18128	38.34003	17
RPP	74	0.22479	5.30987	0.18288	5.34924	38.34003	38.65626	17
RPP	75	0.22479	0.22733	0.18288	5.26288	38.18128	38.34003	17
RPP	76	0.00000	5.53466	0.00000	0.10160	38.73754	50.92573	17
RPP	77	0.00000	5.53466	5.45084	5.55244	38.73754	50.92573	17
RPP	78	0.00000	0.10160	0.10160	5.45084	38.73754	50.92573	17
RPP	79	5.43306	5.53466	0.10160	5.45084	38.73754	50.92573	17
RPP	80	0.14351	5.39115	0.10160	5.34924	38.73754	38.81882	17
RPP	81	0.14351	0.22479	0.18288	5.34924	38.81882	50.92573	17
RPP	82	5.30987	5.39115	0.18288	5.34924	38.81882	50.92573	17
RPP	83	0.14351	5.39115	0.10160	0.18288	38.81882	50.92573	17
RPP	84	0.22479	5.30479	0.18288	5.26288	38.81882	48.97882	17
RPP	85	0.22479	5.30479	0.18288	5.26288	48.97882	50.92573	17
RPP	86	0.10160	0.14351	0.10160	5.34924	38.73754	50.92573	17
RPP	87	5.39115	5.43306	0.10160	5.34924	38.73754	50.92573	17
RPP	88	0.10160	5.43306	5.34924	5.45084	38.73754	50.92573	17
RPP	89	0.22479	5.30987	5.26288	5.34924	38.81882	50.92573	17
RPP	90	5.30479	5.30987	0.18288	5.26288	38.81882	50.92573	17
RPP	91	0.00000	5.53466	0.00000	0.10160	50.92573	61.67882	17
RPP	92	0.00000	5.53466	5.45084	5.55244	50.92573	61.67882	17
RPP	93	0.00000	0.10160	0.10160	5.45084	50.92573	61.67882	17
RPP	94	5.43306	5.53466	0.10160	5.45084	50.92573	61.67882	17
RPP	95	0.14351	0.22479	0.18288	5.34924	50.92573	61.67882	17
RPP	96	5.30987	5.39115	0.18288	5.34924	50.92573	61.67882	17
RPP	97	0.14351	5.39115	0.10160	0.18288	50.92573	61.67882	17
RPP	98	0.22479	5.30479	0.18288	5.26288	50.92573	61.67882	17
RPP	99	0.10160	0.14351	0.10160	5.34924	50.92573	61.67882	17
RPP	100	5.39115	5.43306	0.10160	5.34924	50.92573	61.67882	17
RPP	101	0.10160	5.43306	5.34924	5.45084	50.92573	61.67882	17
RPP	102	0.22479	5.30987	5.26288	5.34924	50.92573	61.67882	17
RPP	103	5.30479	5.30987	0.18288	5.26288	50.92573	61.67882	17
RPP	104	0.00000	5.53466	0.00000	0.10160	61.67882	61.91504	17
RPP	105	0.00000	5.53466	5.45084	5.55244	61.67882	61.91504	17
RPP	106	0.00000	0.10160	0.10160	5.45084	61.67882	61.91504	17
RPP	107	5.43306	5.53466	0.10160	5.45084	61.67882	61.91504	17
RPP	108	0.14351	0.22479	0.18288	5.34924	61.67882	61.91504	17
RPP	109	5.30987	5.39115	0.18288	5.34924	61.67882	61.91504	17
RPP	110	0.14351	5.39115	0.10160	0.18288	61.67882	61.91504	17
RPP	111	0.10160	0.14351	0.10160	5.34924	61.67882	61.91504	17
RPP	112	5.39115	5.43306	0.10160	5.34924	61.67882	61.91504	17
RPP	113	0.10160	5.43306	5.34924	5.45084	61.67882	61.91504	17
RPP	114	0.22479	5.30987	0.18288	5.34924	61.67882	61.91504	17
RPP	115	0.00000	5.53466	0.00000	0.10160	61.91504	121.92000	17
RPP	116	0.00000	5.53466	5.45084	5.55244	61.91504	121.92000	17
RPP	117	0.00000	0.10160	0.10160	5.45084	61.91504	121.92000	17
RPP	118	5.43306	5.53466	0.10160	5.45084	61.91504	121.92000	17
RPP	119	0.14351	5.39115	0.10160	5.34924	97.87382	97.95510	17
RPP	120	0.14351	0.22479	0.18288	5.34924	61.91504	97.87382	17
RPP	121	5.30987	5.39115	0.18288	5.34924	61.91504	97.87382	17
RPP	122	0.14351	5.39115	0.10160	0.18288	61.91504	97.87382	17
RPP	123	0.10160	0.14351	0.10160	5.34924	61.91504	97.95510	17
RPP	124	5.39115	5.43306	0.10160	5.34924	61.91504	97.95510	17
RPP	125	0.10160	5.43306	5.34924	5.45084	61.91504	97.95510	17
RPP	126	0.22479	5.30987	0.18288	5.34924	61.91504	97.87382	17
RPP	127	0.10160	5.43306	0.10160	5.45084	97.95510	121.92000	17
RPP	128	0.00000	2.76479	0.00000	0.10160	0.00000	2.54000	17
RPP	129	2.76479	5.53466	0.00000	0.10160	0.00000	2.54000	17
RPP	130	0.00000	2.76479	5.45084	5.55244	0.00000	2.54000	17
RPP	131	2.76479	5.53466	5.45084	5.55244	0.00000	2.54000	17

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RPP  132   0.00000   2.76479   0.00000   0.10160   2.54000  30.56128      17
RPP  133   2.76479   5.53466   0.00000   0.10160   2.54000  30.56128      17
RPP  134   0.00000   2.76479   5.45084   5.55244   2.54000  30.56128      17
RPP  135   2.76479   5.53466   5.45084   5.55244   2.54000  30.56128      17
RPP  136   0.14351   2.76479   0.10160   5.34924   0.00000   0.08128      17
RPP  137   2.76479   5.39115   0.10160   5.34924   0.00000   0.08128      17
RPP  138   0.14351   2.76479   0.10160   0.18288   0.08128  30.56128      17
RPP  139   2.76479   5.39115   0.10160   0.18288   0.08128  30.56128      17
RPP  140   0.54229   0.85979   0.18288   5.26288   0.08128  30.56128      17
RPP  141   0.85979   1.01854   0.18288   5.26288   0.08128  30.56128      17
RPP  142   1.33604   1.65354   0.18288   5.26288   0.08128  30.56128      17
RPP  143   1.97104   2.28854   0.18288   5.26288   0.08128  30.56128      17
RPP  144   2.28854   2.44729   0.18288   5.26288   0.08128  30.56128      17
RPP  145   2.76479   5.30479   0.18288   2.72288   0.08128  30.56128      17
RPP  146   2.76479   5.30479   2.72288   5.26288   0.08128  30.56128      17
RPP  147   0.10160   2.76479   5.34924   5.45084   0.00000  30.56128      17
RPP  148   2.76479   5.43306   5.34924   5.45084   0.00000  30.56128      17
RPP  149   0.22479   2.76479   5.26288   5.34924   0.08128  30.56128      17
RPP  150   2.76479   5.30987   5.26288   5.34924   0.08128  30.56128      17
RPP  151   5.30479   5.30987   0.18288   5.26288  15.32128  30.56128      17
RPP  152   5.30479   5.30987   0.18288   5.26288   0.08128   2.54000      17
RPP  153   5.30479   5.30987   0.18288   5.26288   2.54000  15.32128      17
RPP  154   0.22479   2.76479   0.18288   2.72288   0.08128  30.56128      17
RPP  155   0.22479   2.76479   2.72288   5.26288   0.08128  30.56128      17
RPP  156   2.76479   3.08229   0.18288   5.26288   0.08128  30.56128      17
RPP  157   3.39979   3.55854   0.18288   5.26288   0.08128  30.56128      17
RPP  158   3.55854   3.87604   0.18288   5.26288   0.08128  30.56128      17
RPP  159   4.19354   4.51104   0.18288   5.26288   0.08128  30.56128      17
RPP  160   4.82854   4.98729   0.18288   5.26288   0.08128  30.56128      17
RPP  161   4.98729   5.30479   0.18288   5.26288   0.08128  30.56128      17
RPP  162   5.30479   5.30987   2.72288   5.26288   0.08128  30.56128      17
RPP  163   5.30479   5.30987   0.18288   2.72288   0.08128  30.56128      17
RPP  164   0.00000   0.10160   0.10160   2.72288   0.00000   2.54000      17
RPP  165   0.00000   0.10160   2.72288   5.45084   0.00000   2.54000      17
RPP  166   5.43306   5.53466   0.10160   2.72288   0.00000   2.54000      17
RPP  167   5.43306   5.53466   2.72288   5.45084   0.00000   2.54000      17
RPP  168   0.00000   0.10160   0.10160   2.72288   2.54000  30.56128      17
RPP  169   0.00000   0.10160   2.72288   5.45084   2.54000  30.56128      17
RPP  170   5.43306   5.53466   0.10160   2.72288   2.54000  30.56128      17
RPP  171   5.43306   5.53466   2.72288   5.45084   2.54000  30.56128      17
RPP  172   0.14351   5.39115   0.10160   2.72288   0.00000   0.08128      17
RPP  173   0.14351   5.39115   2.72288   5.34924   0.00000   0.08128      17
RPP  174   0.14351   0.22479   0.18288   2.72288   0.08128  30.56128      17
RPP  175   0.14351   0.22479   2.72288   5.34924   0.08128  30.56128      17
RPP  176   5.30987   5.39115   0.18288   2.72288   0.08128  30.56128      17
RPP  177   5.30987   5.39115   2.72288   5.34924   0.08128  30.56128      17
RPP  178   0.22479   5.30479   2.72288   3.04038   0.08128  15.32128      17
RPP  179   0.22479   5.30479   2.72288   3.04038  15.32128  30.56128      17
RPP  180   0.22479   5.30479   3.04038   3.19913   0.08128  30.56128      17
RPP  181   0.22479   5.30479   3.19913   3.51663   0.08128  30.56128      17
RPP  182   0.22479   5.30479   3.51663   3.83413   0.08128  15.32128      17
RPP  183   0.22479   5.30479   3.51663   3.83413  15.32128  30.56128      17
RPP  184   0.22479   5.30479   3.83413   4.15163   0.08128  30.56128      17
RPP  185   0.22479   5.30479   4.15163   4.46913   0.08128  15.32128      17
RPP  186   0.22479   5.30479   4.15163   4.46913  15.32128  30.56128      17
RPP  187   0.22479   5.30479   4.46913   4.62788   0.08128  30.56128      17
RPP  188   0.22479   5.30479   4.62788   4.94538   0.08128  30.56128      17
RPP  189   0.22479   5.30479   4.94538   5.26288   0.08128  15.32128      17
RPP  190   0.22479   5.30479   4.94538   5.26288  15.32128  30.56128      17
RPP  191   0.10160   0.14351   0.10160   2.72288   2.54000  30.56128      17
RPP  192   0.10160   0.14351   2.72288   5.34924   2.54000  30.56128      17
RPP  193   5.39115   5.43306   0.10160   2.72288   2.54000  30.56128      17
RPP  194   5.39115   5.43306   2.72288   5.34924   2.54000  30.56128      17
RPP  195   5.30479   5.30987   2.72288   5.26288  15.32128  30.56128      17
RPP  196   5.30479   5.30987   2.72288   5.26288   0.08128   2.54000      17
RPP  197   5.39115   5.43306   0.10160   2.72288   0.00000   2.54000      17
RPP  198   5.39115   5.43306   2.72288   5.34924   0.00000   2.54000      17
RPP  199   0.10160   0.14351   0.10160   2.72288   0.00000   2.54000      17
RPP  200   0.10160   0.14351   2.72288   5.34924   0.00000   2.54000      17
RPP  201   5.30479   5.30987   2.72288   5.26288   2.54000  15.32128      17
RPP  202   0.22479   5.30479   0.18288   0.50038   0.08128  30.56128      17
RPP  203   0.22479   5.30479   0.50038   0.65913   0.08128  30.56128      17
RPP  204   0.22479   5.30479   0.65913   0.97663   0.08128  15.32128      17
RPP  205   0.22479   5.30479   0.65913   0.97663  15.32128  30.56128      17
RPP  206   0.22479   5.30479   0.97663   1.29413   0.08128  30.56128      17
RPP  207   0.22479   5.30479   1.29413   1.61163   0.08128  15.32128      17
RPP  208   0.22479   5.30479   1.29413   1.61163  15.32128  30.56128      17
RPP  209   0.22479   5.30479   1.61163   1.92913   0.08128  30.56128      17
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RPP	210	0.22479	5.30479	1.92913	2.08788	0.08128	30.56128	17
RPP	211	0.22479	5.30479	2.08788	2.40538	0.08128	15.32128	17
RPP	212	0.22479	5.30479	2.08788	2.40538	15.32128	30.56128	17
RPP	213	0.22479	5.30479	2.40538	2.72288	0.08128	30.56128	17
RPP	214	5.30479	5.30987	0.65913	2.72288	15.32128	30.56128	17
RPP	215	5.30479	5.30987	0.18288	2.72288	0.08128	2.54000	17
RPP	216	5.30479	5.30987	0.65913	2.72288	2.54000	15.32128	17
RPP	217	5.30479	5.30987	0.18288	0.65913	2.54000	30.56128	17
RPP	218	4.99237	5.30987	0.18288	5.26288	0.08128	15.32128	17
RPP	219	4.99237	5.30987	0.18288	5.26288	15.32128	30.56128	17
RPP	220	4.83362	4.99237	0.18288	5.26288	0.08128	22.94128	17
RPP	221	4.83362	4.99237	0.18288	5.26288	22.94128	28.02128	17
RPP	222	4.83362	4.99237	0.18288	5.26288	28.02128	30.56128	17
RPP	223	4.51612	4.83362	0.18288	5.26288	0.08128	15.32128	17
RPP	224	4.51612	4.83362	0.18288	5.26288	15.32128	30.56128	17
RPP	225	4.19862	4.51612	0.18288	5.26288	0.08128	15.32128	17
RPP	226	4.19862	4.51612	0.18288	5.26288	15.32128	30.56128	17
RPP	227	3.88112	4.19862	0.18288	5.26288	0.08128	15.32128	17
RPP	228	3.88112	4.19862	0.18288	5.26288	15.32128	30.56128	17
RPP	229	3.56362	3.88112	0.18288	5.26288	0.08128	15.32128	17
RPP	230	3.56362	3.88112	0.18288	5.26288	15.32128	30.56128	17
RPP	231	3.40487	3.56362	0.18288	5.26288	0.08128	22.94128	17
RPP	232	3.40487	3.56362	0.18288	5.26288	22.94128	28.02128	17
RPP	233	3.40487	3.56362	0.18288	5.26288	28.02128	30.56128	17
RPP	234	3.08737	3.40487	0.18288	5.26288	0.08128	15.32128	17
RPP	235	3.08737	3.40487	0.18288	5.26288	15.32128	30.56128	17
RPP	236	2.76987	3.08737	0.18288	5.26288	0.08128	15.32128	17
RPP	237	2.76987	3.08737	0.18288	5.26288	15.32128	30.56128	17
RPP	238	2.45237	2.76987	0.18288	5.26288	0.08128	15.32128	17
RPP	239	2.45237	2.76987	0.18288	5.26288	15.32128	30.56128	17
RPP	240	2.29362	2.45237	0.18288	5.26288	0.08128	15.32128	17
RPP	241	2.29362	2.45237	0.18288	5.26288	15.32128	30.56128	17
RPP	242	1.97612	2.29362	0.18288	5.26288	0.08128	15.32128	17
RPP	243	1.97612	2.29362	0.18288	5.26288	15.32128	30.56128	17
RPP	244	1.65862	1.97612	0.18288	5.26288	0.08128	15.32128	17
RPP	245	1.65862	1.97612	0.18288	5.26288	15.32128	30.56128	17
RPP	246	1.34112	1.65862	0.18288	5.26288	0.08128	15.32128	17
RPP	247	1.34112	1.65862	0.18288	5.26288	15.32128	30.56128	17
RPP	248	1.02362	1.34112	0.18288	5.26288	0.08128	15.32128	17
RPP	249	1.02362	1.34112	0.18288	5.26288	15.32128	30.56128	17
RPP	250	0.86487	1.02362	0.18288	5.26288	0.08128	15.32128	17
RPP	251	0.86487	1.02362	0.18288	5.26288	15.32128	30.56128	17
RPP	252	0.54737	0.86487	0.18288	5.26288	0.08128	15.32128	17
RPP	253	0.54737	0.86487	0.18288	5.26288	15.32128	30.56128	17
RPP	254	0.22987	0.54737	0.18288	5.26288	0.08128	15.32128	17
RPP	255	0.22987	0.54737	0.18288	5.26288	15.32128	30.56128	17
RPP	256	0.22479	0.22987	0.18288	5.26288	0.08128	30.56128	17
RPP	257	0.22987	5.30987	0.18288	5.26288	30.56128	38.18128	17
RPP	258	0.22479	0.22987	0.18288	5.26288	30.56128	38.18128	17
RPP	259	0.22987	5.30987	0.18288	5.26288	38.81882	48.97882	17
RPP	260	0.22987	5.30987	0.18288	5.26288	48.97882	50.92573	17
RPP	261	0.22479	0.22987	0.18288	5.26288	38.81882	50.92573	17
RPP	262	0.22987	5.30987	0.18288	5.26288	50.92573	61.67882	17
RPP	263	0.22479	0.22987	0.18288	5.26288	50.92573	61.67882	17
RPP	264	0.00000	2.76987	0.00000	0.10160	0.00000	2.54000	17
RPP	265	2.76987	5.53466	0.00000	0.10160	0.00000	2.54000	17
RPP	266	0.00000	2.76987	5.45084	5.55244	0.00000	2.54000	17
RPP	267	2.76987	5.53466	5.45084	5.55244	0.00000	2.54000	17
RPP	268	0.00000	2.76987	0.00000	0.10160	2.54000	30.56128	17
RPP	269	2.76987	5.53466	0.00000	0.10160	2.54000	30.56128	17
RPP	270	0.00000	2.76987	5.45084	5.55244	2.54000	30.56128	17
RPP	271	2.76987	5.53466	5.45084	5.55244	2.54000	30.56128	17
RPP	272	0.14351	2.76987	0.10160	5.34924	0.00000	0.08128	17
RPP	273	2.76987	5.39115	0.10160	5.34924	0.00000	0.08128	17
RPP	274	0.14351	2.76987	0.10160	0.18288	0.08128	30.56128	17
RPP	275	2.76987	5.39115	0.10160	0.18288	0.08128	30.56128	17
RPP	276	4.99237	5.30987	0.18288	5.26288	0.08128	30.56128	17
RPP	277	4.83362	4.99237	0.18288	5.26288	0.08128	30.56128	17
RPP	278	4.19862	4.51612	0.18288	5.26288	0.08128	30.56128	17
RPP	279	3.56362	3.88112	0.18288	5.26288	0.08128	30.56128	17
RPP	280	3.40487	3.56362	0.18288	5.26288	0.08128	30.56128	17
RPP	281	2.76987	3.08737	0.18288	5.26288	0.08128	30.56128	17
RPP	282	0.22987	2.76987	0.18288	2.72288	0.08128	30.56128	17
RPP	283	0.22987	2.76987	2.72288	5.26288	0.08128	30.56128	17
RPP	284	0.10160	2.76987	5.34924	5.45084	0.00000	30.56128	17
RPP	285	2.76987	5.43306	5.34924	5.45084	0.00000	30.56128	17
RPP	286	0.22479	2.76987	5.26288	5.34924	0.08128	30.56128	17
RPP	287	2.76987	5.30987	5.26288	5.34924	0.08128	30.56128	17

RPP	288	0.22479	0.22987	0.18288	5.26288	15.32128	30.56128	17
RPP	289	0.22479	0.22987	0.18288	5.26288	0.08128	2.54000	17
RPP	290	0.22479	0.22987	0.18288	5.26288	2.54000	15.32128	17
RPP	291	2.76987	5.30987	0.18288	2.72288	0.08128	30.56128	17
RPP	292	2.76987	5.30987	2.72288	5.26288	0.08128	30.56128	17
RPP	293	2.29362	2.45237	0.18288	5.26288	0.08128	30.56128	17
RPP	294	1.97612	2.29362	0.18288	5.26288	0.08128	30.56128	17
RPP	295	1.34112	1.65862	0.18288	5.26288	0.08128	30.56128	17
RPP	296	0.86487	1.02362	0.18288	5.26288	0.08128	30.56128	17
RPP	297	0.54737	0.86487	0.18288	5.26288	0.08128	30.56128	17
RPP	298	0.22479	0.22987	2.72288	5.26288	0.08128	30.56128	17
RPP	299	0.22479	0.22987	0.18288	2.72288	0.08128	30.56128	17
RPP	300	0.22987	5.30987	2.72288	3.04038	0.08128	30.56128	17
RPP	301	0.22987	5.30987	3.04038	3.35788	0.08128	15.32128	17
RPP	302	0.22987	5.30987	3.04038	3.35788	15.32128	30.56128	17
RPP	303	0.22987	5.30987	3.35788	3.51663	0.08128	30.56128	17
RPP	304	0.22987	5.30987	3.51663	3.83413	0.08128	30.56128	17
RPP	305	0.22987	5.30987	3.83413	4.15163	0.08128	15.32128	17
RPP	306	0.22987	5.30987	3.83413	4.15163	15.32128	30.56128	17
RPP	307	0.22987	5.30987	4.15163	4.46913	0.08128	30.56128	17
RPP	308	0.22987	5.30987	4.46913	4.78663	0.08128	15.32128	17
RPP	309	0.22987	5.30987	4.46913	4.78663	15.32128	30.56128	17
RPP	310	0.22987	5.30987	4.78663	4.94538	0.08128	30.56128	17
RPP	311	0.22987	5.30987	4.94538	5.26288	0.08128	30.56128	17
RPP	312	0.22479	0.22987	3.04038	5.26288	15.32128	30.56128	17
RPP	313	0.22479	0.22987	0.18288	2.72288	0.08128	2.54000	17
RPP	314	0.22479	0.22987	2.72288	5.26288	0.08128	2.54000	17
RPP	315	0.22479	0.22987	3.04038	5.26288	2.54000	15.32128	17
RPP	316	0.22479	0.22987	0.18288	2.72288	2.54000	30.56128	17
RPP	317	0.22479	0.22987	2.72288	3.04038	2.54000	30.56128	17
RPP	318	0.22987	5.30987	0.18288	0.50038	0.08128	15.32128	17
RPP	319	0.22987	5.30987	0.18288	0.50038	15.32128	30.56128	17
RPP	320	0.22987	5.30987	0.50038	0.65913	0.08128	30.56128	17
RPP	321	0.22987	5.30987	0.65913	0.97663	0.08128	30.56128	17
RPP	322	0.22987	5.30987	0.97663	1.29413	0.08128	15.32128	17
RPP	323	0.22987	5.30987	0.97663	1.29413	15.32128	30.56128	17
RPP	324	0.22987	5.30987	1.29413	1.61163	0.08128	30.56128	17
RPP	325	0.22987	5.30987	1.61163	1.92913	0.08128	15.32128	17
RPP	326	0.22987	5.30987	1.61163	1.92913	15.32128	30.56128	17
RPP	327	0.22987	5.30987	1.92913	2.08788	0.08128	30.56128	17
RPP	328	0.22987	5.30987	2.08788	2.40538	0.08128	30.56128	17
RPP	329	0.22987	5.30987	2.40538	2.72288	0.08128	15.32128	17
RPP	330	0.22987	5.30987	2.40538	2.72288	15.32128	30.56128	17
RPP	331	0.22479	0.22987	0.18288	2.72288	15.32128	30.56128	17
RPP	332	0.22479	0.22987	2.72288	5.26288	15.32128	30.56128	17
RPP	333	0.22479	0.22987	0.18288	2.72288	2.54000	15.32128	17
RPP	334	0.22479	0.22987	2.72288	5.26288	2.54000	15.32128	17
RPP	335	0.00000	5.53466	0.00000	0.10160	2.54000	30.60573	17
RPP	336	0.00000	5.53466	5.45084	5.55244	2.54000	30.60573	17
RPP	337	0.00000	0.10160	0.10160	5.45084	2.54000	30.60573	17
RPP	338	5.43306	5.53466	0.10160	5.45084	2.54000	30.60573	17
RPP	339	0.14605	5.38861	0.10160	5.32130	0.00000	0.12573	17
RPP	340	0.14605	0.27178	0.22733	5.32130	0.12573	30.60573	17
RPP	341	5.26288	5.38861	0.22733	5.32130	0.12573	30.60573	17
RPP	342	0.14605	5.38861	0.10160	0.22733	0.12573	30.60573	17
RPP	343	0.27178	0.43053	0.22733	5.30733	0.12573	15.36573	17
RPP	344	0.27178	0.43053	0.22733	5.30733	15.36573	30.60573	17
RPP	345	0.43053	0.74803	0.22733	5.30733	0.12573	30.60573	17
RPP	346	0.74803	0.90678	0.22733	5.30733	0.12573	30.60573	17
RPP	347	0.90678	1.22428	0.22733	5.30733	0.12573	15.36573	17
RPP	348	0.90678	1.22428	0.22733	5.30733	15.36573	30.60573	17
RPP	349	1.22428	1.54178	0.22733	5.30733	0.12573	30.60573	17
RPP	350	1.54178	1.85928	0.22733	5.30733	0.12573	15.36573	17
RPP	351	1.54178	1.85928	0.22733	5.30733	15.36573	30.60573	17
RPP	352	1.85928	2.17678	0.22733	5.30733	0.12573	30.60573	17
RPP	353	2.17678	2.33553	0.22733	5.30733	0.12573	30.60573	17
RPP	354	2.33553	2.65303	0.22733	5.30733	0.12573	15.36573	17
RPP	355	2.33553	2.65303	0.22733	5.30733	15.36573	30.60573	17
RPP	356	2.65303	2.97053	0.22733	5.30733	0.12573	30.60573	17
RPP	357	2.97053	3.28803	0.22733	5.30733	0.12573	15.36573	17
RPP	358	2.97053	3.28803	0.22733	5.30733	15.36573	30.60573	17
RPP	359	3.28803	3.44678	0.22733	5.30733	0.12573	30.60573	17
RPP	360	3.44678	3.76428	0.22733	5.30733	0.12573	30.60573	17
RPP	361	3.76428	4.08178	0.22733	5.30733	0.12573	15.36573	17
RPP	362	3.76428	4.08178	0.22733	5.30733	15.36573	30.60573	17
RPP	363	4.08178	4.39928	0.22733	5.30733	0.12573	30.60573	17
RPP	364	4.39928	4.71678	0.22733	5.30733	0.12573	15.36573	17
RPP	365	4.39928	4.71678	0.22733	5.30733	15.36573	30.60573	17

RPP	366	4.71678	4.87553	0.22733	5.30733	0.12573	30.60573	17
RPP	367	4.87553	5.19303	0.22733	5.30733	0.12573	30.60573	17
RPP	368	0.10160	0.14605	0.10160	5.32130	2.54000	30.60573	17
RPP	369	5.38861	5.43306	0.10160	5.32130	2.54000	30.60573	17
RPP	370	0.10160	5.43306	5.32130	5.45084	0.00000	30.60573	17
RPP	371	0.27178	5.26288	5.30733	5.32130	0.12573	30.60573	17
RPP	372	5.19303	5.26288	0.22733	5.30733	0.12573	30.60573	17
RPP	373	5.38861	5.43306	0.10160	5.32130	0.00000	2.54000	17
RPP	374	0.10160	0.14605	0.10160	5.32130	0.00000	2.54000	17
RPP	375	0.00000	5.53466	0.00000	0.10160	30.60573	50.92573	17
RPP	376	0.00000	5.53466	5.45084	5.55244	30.60573	50.92573	17
RPP	377	0.00000	0.10160	0.10160	5.45084	30.60573	50.92573	17
RPP	378	5.43306	5.53466	0.10160	5.45084	30.60573	50.92573	17
RPP	379	0.14605	0.27178	0.22733	5.32130	30.60573	50.92573	17
RPP	380	5.26288	5.38861	0.22733	5.32130	30.60573	50.92573	17
RPP	381	0.14605	5.38861	0.10160	0.22733	30.60573	50.92573	17
RPP	382	0.27178	5.19303	0.22733	5.30733	30.60573	50.92573	17
RPP	383	0.10160	0.14605	0.10160	5.32130	30.60573	50.92573	17
RPP	384	5.38861	5.43306	0.10160	5.32130	30.60573	50.92573	17
RPP	385	0.10160	5.43306	5.32130	5.45084	30.60573	50.92573	17
RPP	386	0.27178	5.26288	5.30733	5.32130	30.60573	50.92573	17
RPP	387	5.19303	5.26288	0.22733	5.30733	30.60573	50.92573	17
RPP	388	0.14605	0.27178	0.22733	5.32130	50.92573	61.67882	17
RPP	389	5.26288	5.38861	0.22733	5.32130	50.92573	61.67882	17
RPP	390	0.14605	5.38861	0.10160	0.22733	50.92573	61.67882	17
RPP	391	2.49428	3.12928	0.22733	5.30733	51.56073	61.67882	17
RPP	392	0.27178	5.19303	0.22733	5.30733	50.92573	51.56073	17
RPP	393	0.10160	0.14605	0.10160	5.32130	50.92573	61.67882	17
RPP	394	5.38861	5.43306	0.10160	5.32130	50.92573	61.67882	17
RPP	395	0.10160	5.43306	5.32130	5.45084	50.92573	61.67882	17
RPP	396	0.27178	5.26288	5.30733	5.32130	50.92573	61.67882	17
RPP	397	5.19303	5.26288	0.22733	5.30733	50.92573	51.56073	17
RPP	398	0.27178	2.49428	0.22733	5.30733	51.56073	61.67882	17
RPP	399	3.12928	5.26288	0.22733	5.30733	51.56073	61.67882	17
RPP	400	0.14605	0.27178	0.22733	5.32130	61.67882	61.91504	17
RPP	401	5.26288	5.38861	0.22733	5.32130	61.67882	61.91504	17
RPP	402	0.14605	5.38861	0.10160	0.22733	61.67882	61.91504	17
RPP	403	2.49428	3.12928	0.22733	5.30733	61.67882	61.91504	17
RPP	404	0.10160	0.14605	0.10160	5.32130	61.67882	61.91504	17
RPP	405	5.38861	5.43306	0.10160	5.32130	61.67882	61.91504	17
RPP	406	0.10160	5.43306	5.32130	5.45084	61.67882	61.91504	17
RPP	407	0.27178	5.26288	5.30733	5.32130	61.67882	61.91504	17
RPP	408	0.27178	2.49428	0.22733	5.30733	61.67882	61.91504	17
RPP	409	3.12928	5.26288	0.22733	5.30733	61.67882	61.91504	17
RPP	410	0.00000	5.53466	0.00000	0.10160	61.91504	103.50500	17
RPP	411	0.00000	5.53466	5.45084	5.55244	61.91504	103.50500	17
RPP	412	0.00000	0.10160	0.10160	5.45084	61.91504	103.50500	17
RPP	413	5.43306	5.53466	0.10160	5.45084	61.91504	103.50500	17
RPP	414	0.14605	0.27178	0.22733	5.32130	61.91504	103.50500	17
RPP	415	5.26288	5.38861	0.22733	5.32130	61.91504	103.50500	17
RPP	416	0.14605	5.38861	0.10160	0.22733	61.91504	103.50500	17
RPP	417	2.49428	3.12928	0.22733	5.30733	61.91504	102.36073	17
RPP	418	0.27178	5.19303	0.22733	5.30733	102.36073	102.99573	17
RPP	419	0.10160	0.14605	0.10160	5.32130	61.91504	103.50500	17
RPP	420	5.38861	5.43306	0.10160	5.32130	61.91504	103.50500	17
RPP	421	0.10160	5.43306	5.32130	5.45084	61.91504	103.50500	17
RPP	422	0.27178	5.26288	5.30733	5.32130	61.91504	102.99573	17
RPP	423	0.27178	5.26288	0.22733	5.32130	102.99573	103.50500	17
RPP	424	5.19303	5.26288	0.22733	5.30733	102.36073	102.99573	17
RPP	425	0.27178	2.49428	0.22733	5.30733	61.91504	102.36073	17
RPP	426	3.12928	5.26288	0.22733	5.30733	61.91504	102.36073	17
RPP	427	0.00000	5.53466	0.00000	0.10160	103.50500	121.92000	17
RPP	428	0.00000	5.53466	5.45084	5.55244	103.50500	121.92000	17
RPP	429	0.00000	0.10160	0.10160	5.45084	103.50500	121.92000	17
RPP	430	5.43306	5.53466	0.10160	5.45084	103.50500	121.92000	17
RPP	431	2.44475	3.07975	0.10160	5.18160	103.50500	121.92000	17
RPP	432	0.10160	5.43306	5.18160	5.45084	103.50500	121.92000	17
RPP	433	0.10160	2.44475	0.10160	5.18160	103.50500	121.92000	17
RPP	434	3.07975	5.43306	0.10160	5.18160	103.50500	121.92000	17
RPP	435	0.34163	0.50038	0.22733	5.30733	0.12573	15.36573	17
RPP	436	0.34163	0.50038	0.22733	5.30733	15.36573	30.60573	17
RPP	437	4.94538	5.26288	0.22733	5.30733	0.12573	30.60573	17
RPP	438	4.78663	4.94538	0.22733	5.30733	0.12573	30.60573	17
RPP	439	4.46913	4.78663	0.22733	5.30733	0.12573	15.36573	17
RPP	440	4.46913	4.78663	0.22733	5.30733	15.36573	30.60573	17
RPP	441	4.15163	4.46913	0.22733	5.30733	0.12573	30.60573	17
RPP	442	3.83413	4.15163	0.22733	5.30733	0.12573	15.36573	17
RPP	443	3.83413	4.15163	0.22733	5.30733	15.36573	30.60573	17

RPP	444	3.51663	3.83413	0.22733	5.30733	0.12573	30.60573	17
RPP	445	3.35788	3.51663	0.22733	5.30733	0.12573	30.60573	17
RPP	446	3.04038	3.35788	0.22733	5.30733	0.12573	15.36573	17
RPP	447	3.04038	3.35788	0.22733	5.30733	15.36573	30.60573	17
RPP	448	2.72288	3.04038	0.22733	5.30733	0.12573	30.60573	17
RPP	449	2.40538	2.72288	0.22733	5.30733	0.12573	15.36573	17
RPP	450	2.40538	2.72288	0.22733	5.30733	15.36573	30.60573	17
RPP	451	2.24663	2.40538	0.22733	5.30733	0.12573	30.60573	17
RPP	452	1.92913	2.24663	0.22733	5.30733	0.12573	30.60573	17
RPP	453	1.61163	1.92913	0.22733	5.30733	0.12573	15.36573	17
RPP	454	1.61163	1.92913	0.22733	5.30733	15.36573	30.60573	17
RPP	455	1.29413	1.61163	0.22733	5.30733	0.12573	30.60573	17
RPP	456	0.97663	1.29413	0.22733	5.30733	0.12573	15.36573	17
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RPP	458	0.81788	0.97663	0.22733	5.30733	0.12573	30.60573	17
RPP	459	0.50038	0.81788	0.22733	5.30733	0.12573	30.60573	17
RPP	460	0.27178	0.34163	0.22733	5.30733	0.12573	30.60573	17
RPP	461	0.34163	5.26288	0.22733	5.30733	30.60573	50.92573	17
RPP	462	0.27178	0.34163	0.22733	5.30733	30.60573	50.92573	17
RPP	463	2.40538	3.04038	0.22733	5.30733	51.56073	61.67882	17
RPP	464	0.34163	5.26288	0.22733	5.30733	50.92573	51.56073	17
RPP	465	0.27178	0.34163	0.22733	5.30733	50.92573	51.56073	17
RPP	466	0.27178	2.40538	0.22733	5.30733	51.56073	61.67882	17
RPP	467	3.04038	5.26288	0.22733	5.30733	51.56073	61.67882	17
RPP	468	2.40538	3.04038	0.22733	5.30733	61.67882	61.91504	17
RPP	469	0.27178	2.40538	0.22733	5.30733	61.67882	61.91504	17
RPP	470	3.04038	5.26288	0.22733	5.30733	61.67882	61.91504	17
RPP	471	2.40538	3.04038	0.22733	5.30733	61.91504	102.36073	17
RPP	472	0.34163	5.26288	0.22733	5.30733	102.36073	102.99573	17
RPP	473	0.27178	0.34163	0.22733	5.30733	102.36073	102.99573	17
RPP	474	0.27178	2.40538	0.22733	5.30733	61.91504	102.36073	17
RPP	475	3.04038	5.26288	0.22733	5.30733	61.91504	102.36073	17
RPP	476	2.45491	3.08991	0.10160	5.18160	103.50500	121.92000	17
RPP	477	0.10160	2.45491	0.10160	5.18160	103.50500	121.92000	17
RPP	478	3.08991	5.43306	0.10160	5.18160	103.50500	121.92000	17
RPP	479	0.00000	5.53466	0.00000	0.10160	2.54000	61.91504	17
RPP	480	0.00000	5.53466	5.45084	5.55244	2.54000	61.91504	17
RPP	481	0.00000	0.10160	0.10160	5.45084	2.54000	61.91504	17
RPP	482	5.43306	5.53466	0.10160	5.45084	2.54000	61.91504	17
RPP	483	0.14351	5.39115	0.10160	5.34924	61.83376	61.91504	17
RPP	484	0.14351	0.22479	0.18288	5.34924	0.08128	61.83376	17
RPP	485	5.30987	5.39115	0.18288	5.34924	0.08128	61.83376	17
RPP	486	0.14351	5.39115	0.10160	0.18288	0.08128	61.83376	17
RPP	487	0.22479	5.30479	0.18288	5.26288	0.08128	61.04128	17
RPP	488	0.22733	5.30733	0.18288	5.26288	61.04128	61.20003	17
RPP	489	0.10160	0.14351	0.10160	5.34924	2.54000	61.91504	17
RPP	490	5.39115	5.43306	0.10160	5.34924	2.54000	61.91504	17
RPP	491	0.10160	5.43306	5.34924	5.45084	0.00000	61.91504	17
RPP	492	0.22479	5.30987	0.18288	5.34924	61.20003	61.83376	17
RPP	493	0.22479	5.30987	5.26288	5.34924	0.08128	61.20003	17
RPP	494	0.22479	0.22733	0.18288	5.26288	61.04128	61.20003	17
RPP	495	5.30733	5.30987	0.18288	5.26288	61.04128	61.20003	17
RPP	496	5.30479	5.30987	0.18288	5.26288	0.08128	61.04128	17
RPP	497	0.10160	5.43306	0.10160	5.45084	61.91504	121.92000	17
RPP	498	0.22479	5.30479	0.18288	2.14630	10.24128	12.78128	17
RPP	499	0.22479	5.30479	0.18288	5.26288	12.78128	20.40128	17
RPP	500	0.22479	5.30479	0.18288	5.26288	0.08128	10.24128	17
RPP	501	0.22479	5.30479	0.18288	5.26288	20.40128	61.04128	17
RPP	502	0.22479	5.30987	5.26288	5.34924	0.08128	10.24128	17
RPP	503	5.30479	5.30987	0.18288	5.26288	0.08128	10.24128	17
RPP	504	0.22479	5.30987	5.26288	5.34924	12.78128	61.20003	17
RPP	505	5.30479	5.30987	0.18288	5.26288	12.78128	61.04128	17
RPP	506	0.22479	5.30987	2.14630	5.34924	10.24128	12.78128	17
RPP	507	5.30479	5.30987	0.18288	2.14630	10.24128	12.78128	17
RPP	508	0.22987	5.30987	0.18288	5.26288	0.08128	61.04128	17
RPP	509	0.22479	0.22987	0.18288	5.26288	0.08128	61.04128	17
RPP	510	0.22987	5.30987	0.18288	2.14630	10.24128	12.78128	17
RPP	511	0.22987	5.30987	0.18288	5.26288	12.78128	20.40128	17
RPP	512	0.22987	5.30987	0.18288	5.26288	0.08128	10.24128	17
RPP	513	0.22987	5.30987	0.18288	5.26288	20.40128	61.04128	17
RPP	514	0.22479	0.22987	0.18288	5.26288	0.08128	10.24128	17
RPP	515	0.22479	0.22987	0.18288	5.26288	12.78128	61.04128	17
RPP	516	0.22479	0.22987	0.18288	2.14630	10.24128	12.78128	17
RPP	517	0.00000	5.53466	0.00000	0.10160	2.54000	121.92000	17
RPP	518	0.00000	5.53466	5.45084	5.55244	2.54000	121.92000	17
RPP	519	0.00000	0.10160	0.10160	5.45084	2.54000	121.92000	17
RPP	520	5.43306	5.53466	0.10160	5.45084	2.54000	121.92000	17
RPP	521	0.10160	5.43306	0.10160	5.45084	0.00000	121.92000	17

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  RPP  522  0.00000   5.53466   0.00000   5.55244 121.92    194.72     MX2BkP
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  RPP  524  0.00000   1.688     0.0       1.688   121.92    194.72     CRShaft
  RPP  525  0.00000   1.688     1.688     5.55244 121.92    194.72     MX2BkP
  RPP  526  1.688     5.53466   0.00000   5.55244 121.92    194.72     MX2BkP
  RPP  527  0.00000   5.53466   0.00000   5.55244 121.92    197.58     MX2End
  RPP  528  0.00000   5.53466   0.00000   5.55244   0.00    197.58     CL2EndF
  RPP  529  0.00000   5.53466   0.00000   2.159     0.00    197.58     CL2EndL
  RPP  530  0.00000   5.53466   2.159     5.55244   0.00    197.58     CL2EndU
  RPP  531  0.00000   5.53466   0.00000   5.55244   0.000     1.905    CL2Kne
  RPP  532  0.00000   5.53466   0.00000   5.55244 120.015   197.58     Kne2End
  RPP  533  0.00000   5.53466   0.0       5.55244   1.905    13.335    vVd1
  RPP  534  0.00000   5.53466   0.0       5.55244  13.335    17.145    vFe1
  RPP  535  0.00000   5.53466   0.0       5.55244  17.145    59.055    vVd2
  RPP  536  0.00000   5.53466   0.0       5.55244  59.055    62.865    vFe2
  RPP  537  0.00000   5.53466   0.0       5.55244  62.865   104.775    vVd3
  RPP  538  0.00000   5.53466   0.0       5.55244 104.775   108.585    vFe3
  RPP  539  0.00000   5.53466   0.0       5.55244 108.585   120.015    vVd4
  RPP  540  0.00000   5.53466   0.0       2.3495    1.905    13.335    vhVd1
  RPP  541  0.00000   5.53466   2.3495    5.55244   1.905    13.335    vhFe1
  RPP  542  0.00000   5.53466   0.0       2.3495   17.145    59.055    vhVd2
  RPP  543  0.00000   5.53466   2.3495    5.55244  17.145    59.055    vhFe2
  RPP  544  0.00000   5.53466   0.0       2.3495   62.865   104.775    vhVd3
  RPP  545  0.00000   5.53466   2.3495    5.55244  62.865   104.775    vhFe3
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  RPP  549  1.7145    5.53466   0.0       5.55244   1.905    13.335    vRFe1
  RPP  550  0.00000   1.7145    0.0       5.55244  17.145    59.055    vRVd2
  RPP  551  1.7145    5.53466   0.0       5.55244  17.145    59.055    vRFe2
  RPP  552  0.00000   1.7145    0.0       5.55244  62.865   104.775    vRVd3
  RPP  553  1.7145    5.53466   0.0       5.55244  62.865   104.775    vRFe3
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  RPP  555  1.7145    5.53466   0.0       5.55244 108.585   120.015    vRFe4
  RPP  556  0.00000   1.7145    0.0       2.3495    1.905    13.335    vhRVd1
  RPP  557  1.7145    5.53466   0.0       2.3495    1.905    13.335    vhRFe1
  RPP  558  0.00000   1.7145    0.0       2.3495   17.145    59.055    vhRVd2
  RPP  559  1.7145    5.53466   0.0       2.3495   17.145    59.055    vhRFe2
  RPP  560  0.00000   1.7145    0.0       2.3495   62.865   104.775    vhRVd3
  RPP  561  1.7145    5.53466   0.0       2.3495   62.865   104.775    vhRFe3
  RPP  562  0.00000   1.7145    0.0       2.3495  108.585   120.015    vhRVd4
  RPP  563  1.7145    5.53466   0.0       2.3495  108.585   120.015    vhRFe4
  RPP  564  3.81      5.53466   0.0       5.55244   1.905    13.335    vLVd1
  RPP  565  0.0       3.81      0.0       5.55244   1.905    13.335    vLFe1
  RPP  566  3.81      5.53466   0.0       5.55244  17.145    59.055    vLVd2
  RPP  567  0.0       3.81      0.0       5.55244  17.145    59.055    vLFe2
  RPP  568  3.81      5.53466   0.0       5.55244  62.865   104.775    vLVd3
  RPP  569  0.0       3.81      0.0       5.55244  62.865   104.775    vLFe3
  RPP  570  3.81      5.53466   0.0       5.55244 108.585   120.015    vLVd4
  RPP  571  0.0       3.81      0.0       5.55244 108.585   120.015    vLFe4
  RPP  572  3.81      5.53466   0.0       2.3495    1.905    13.335    vhLVd1
  RPP  573  0.0       3.81      0.0       2.3495    1.905    13.335    vhLFe1
  RPP  574  3.81      5.53466   0.0       2.3495   17.145    59.055    vhLVd2
  RPP  575  0.0       3.81      0.0       2.3495   17.145    59.055    vhLFe2
  RPP  576  3.81      5.53466   0.0       2.3495   62.865   104.775    vhLVd3
  RPP  577  0.0       3.81      0.0       2.3495   62.865   104.775    vhLFe3
  RPP  578  3.81      5.53466   0.0       2.3495  108.585   120.015    vhLVd4
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