MURR Upgrade Neutronics Analysis Using AMPX-II/BOLD VENTURE IV Computation System Benchmarked to the Destructive Analysis of Fuel Element 775F3

MURR Internal Report

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September 1, 1986

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1. INTRODUCTION

The University of Missouri Research Reactor (MURR) is the highest steady state powered, highest flux university research reactor in the United States. The reactor engages in various research with universities and industries providing an intense source of neutron and gamma irradiation. Presently, detailed plans are underway to upgrade the power from the current 10 MW up to 30 MW. As a part of the plan, a new fuel element has been designed with the fuel density varying between the 24 fuel plates. The new fuel element will contain 1270 gm of U-235 instead of 775 gm in the present fuel element. The purpose of the new design is to reduce the power peaking which will lower the fuel cycle cost and allow for an upgrade of the reactor power level.

In the past, MURR core analysis was performed using the 2D neutron diffusion theory code, EXTERMINATOR-II[1], which used neutron cross sections generated by LEOPARD[2] and/or XSDRN[3] computer codes. To perform all the necessary safety analysis for the new fuel design requires the use of a nucleonics code package that can handle up to three dimensional models with fuel depletion capability. This is due to mixing the present 775 gm elements with the new 1270 gm elements. Previous researchers used the CITATION code[4] to apply three dimensional modeling to MURR. However, due to the inherent limitation of CITATION, they could not fully utilize the 'restart' capability of the code which is essential to reduce the computation cost.

In September 1985, BOLD VENTURE computation system[5,6] was obtained from the Radiation Shielding Information Center(RSIC). It is known as an advanced and powerful computing tool which has been used for application

to power reactor and research reactors like HFIR at Oak Ridge National Laboratory(ORNL). BOLD VENTURE uses ISOTXS cross section data file which can be generated from AMPX-II computing system[7]. This package was also obtained in December 1985 from the RSIC along with CSRL[8], a 218 group neutron cross section reference library. The authors successfully converted the two big code packages from their FORTRAN and assembly language versions to the load modules working in the University of Missouri Computing System after a four month dogfight. Effort has been made to fully utilize the restart capability in BOLD VENTURE. The user can now save either the whole restart data file or the existing flux values to use in the next iterative procedure for rapid flux convergence.

The purpose of this report is to document the nucleonics analysis of the MURR upgrade core using the new MURR computational system, AMPX-II/BOLD VENTURE IV. Section 2 describes the use of AMPX-II to generate the cross section sets for the various nuclides in the MURR components. In Section 3, core models and benchmark calculations performed using BOLD VENTURE are presented. Analytical results for R-Z, and θ-R-Z calculations are contained in Section 4. Finally, Section 5 presents conclusions and discussions for further research; the Appendices are included to provide more detailed information regarding the input to the selected modules of AMPX-II and to BOLD VENTURE.

2. Cross Section Generation

Prior to the BOLD VENTURE calculations, the heterogeneous geometry of the MURR components must be simplified and homogenized to a form which would be handled by BOLD VENTURE. For the materials involved, a cross section library was developed. Periodic array of the fuel plates and the coolant in the core was divided into a number of identical homogenized

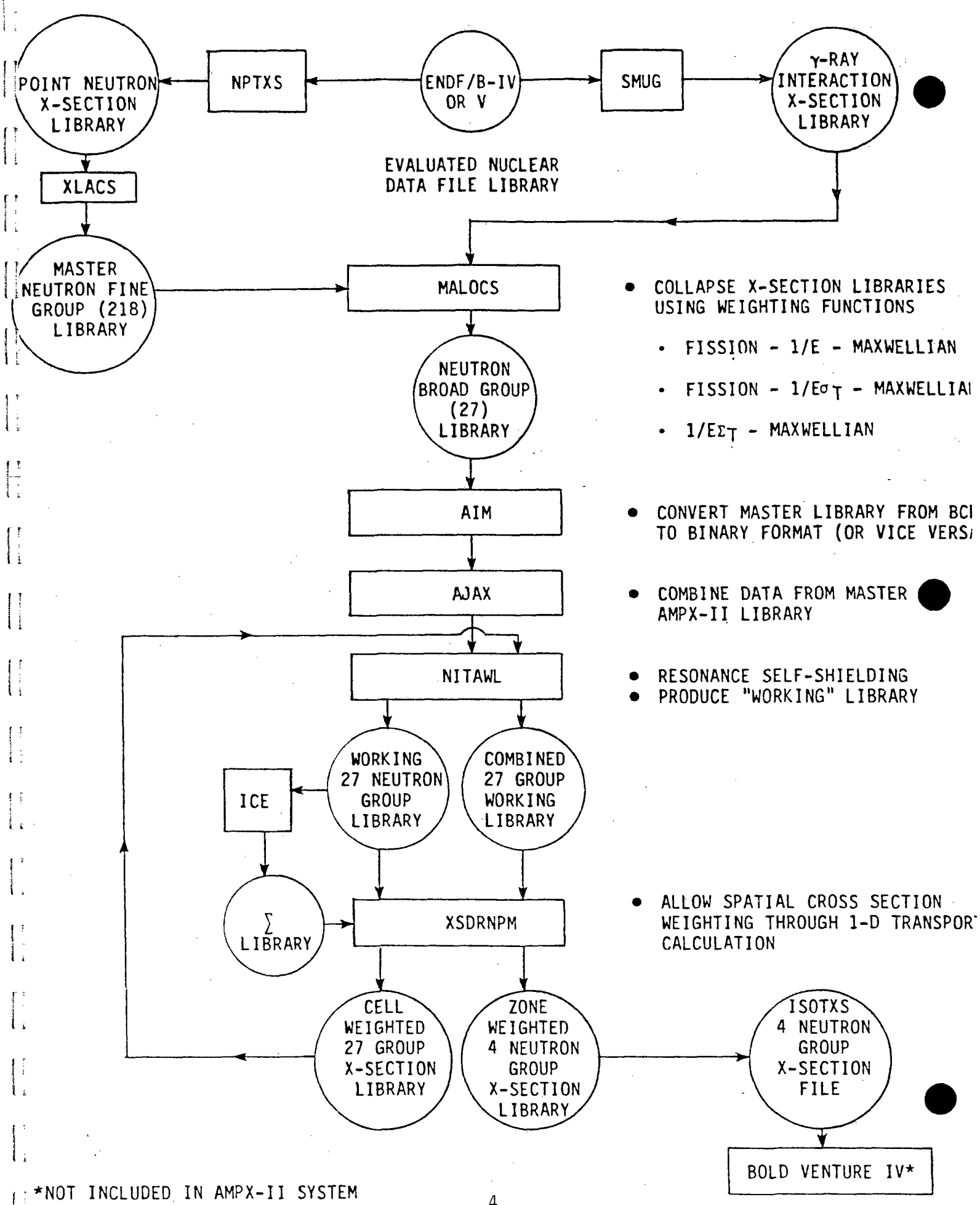
'unit fuel cells' which consist of the fuel meat, cladding, and the coolant. The MURR was then represented in the model as a multitude of homogenized zones starting from flux trap, pressure vessel, core section, control blade, beryllium and graphite reflectors, etc.

The cross section sets for various nuclides in the MURR system were generated using the CSRL library and the modules in AMPX-II. The AMPX-II system allows the user to choose an appropriate sequence from about 30 modules available in the system. Calculational sequence used to generate the cross section sets is shown in Fig. 1.

To briefly describe, starting with ENDF-formatted nuclear data files, NPTXS and XLACS can be used to produce a master 218 neutron fine group library. The CSRL is a P_3, 218 fine group cross section library generated using XLACS. MALOCS is then used to collapse 218 neutron group cross section library into 27 group library. Several weighting spectra are used in MALOCS to collapse the cross section data. The materials with resonance parameters are processed with a fission-1/E-Maxwellian weighting function. For non-resonance materials, a fission-$1/E\sigma_T$-Maxwellian is used. Some structural materials are usually weighted by a $1/E\Sigma_T$-Maxwellian function. Next, AIM converts BCD-formatted library to binary AMPX library and the selected data sets of the various nuclides are combined using AJAX. One of the AMPX modules, NITAWL, has two distinct features. It allows performing resonance self-shielding calculation as well as collecting cross section data into 'workable' arrangements for the one-dimensional discrete transport module, XSDRNPM.

Using XSDRNPM, cell and/or zone weighted cross section sets were obtained. The purpose of the cell weighting is to use a detail cell (e.g. water, clad, fuel meat regions) to generate cross sections which conserve

Fig. 1 Calculational Sequence of AMPX-II



*NOT INCLUDED IN AMPX-II SYSTEM

the reaction rates when the cell is modeled as homogenized (e.g. fuel cell). To perform zone weighting, the reactor is modeled as a set of homogeneous zones where the cell weighted cross sections are used where appropriate, e.g., fuel cell cross sections for the core zone. Zone weighting generates a unique set of cross sections which preserve reaction rates for each zone in the system when collapsing energy groups into broader energy groups. As shown in the figure, cell weighted 27 group cross section library was produced by the first path through XSDRNPM and this cell weighted working library was combined with other cross section sets through the second NITAWL run. This combined 27 group library is then input to XSDRNPM again to get zone weighted and collapsed cross section sets. For the MURR core analysis, the combined 27 group library is collapsed to a four neutron group microscopic cross section library--generated in the form of ISOTXS file--which is input to the BOLD VENTURE IV computational system. Energy limits along with fission spectrum fractions of the four group structure are shown in Table 1. For the benefit of later users, the sample input data for AIM, AJAX, NITAWL, and XSDRNPM are attached in the Appendix A.

The control blade cross section set was made as follows. First, the cell averaged cross sections were evaluated for the control blade materials using NITAWL and XSDRNPM. This set was then spatially weighted using zone dependent neutron spectrum. Using this data in a form of ISOTXS, the reactivity worth of the control blades in the BOLDVENTURE model was checked against their measured worth. The control blade cross section set was found to give too high of a total reactivity worth for the control blades. Next, internal black absorber constants were calculated for energy groups 3 and 4. The calculated reactivity worth was closer to the

Table 1

Group Structure and Fission Spectrum

Group	Upper Energy Bound (MeV)	Lower Energy Bound (MeV)	Fission Spectrum Fraction
1	2.0×10^{1}	9.0×10^{-1}	7.1496×10^{-1}
2	9.0×10^{-1}	3.0×10^{-3}	2.8496×10^{-1}
3	3.0×10^{-3}	8.0×10^{-7}	8.1064×10^{-5}
4	8.0×10^{-7}	0.0	3.5349×10^{-10}

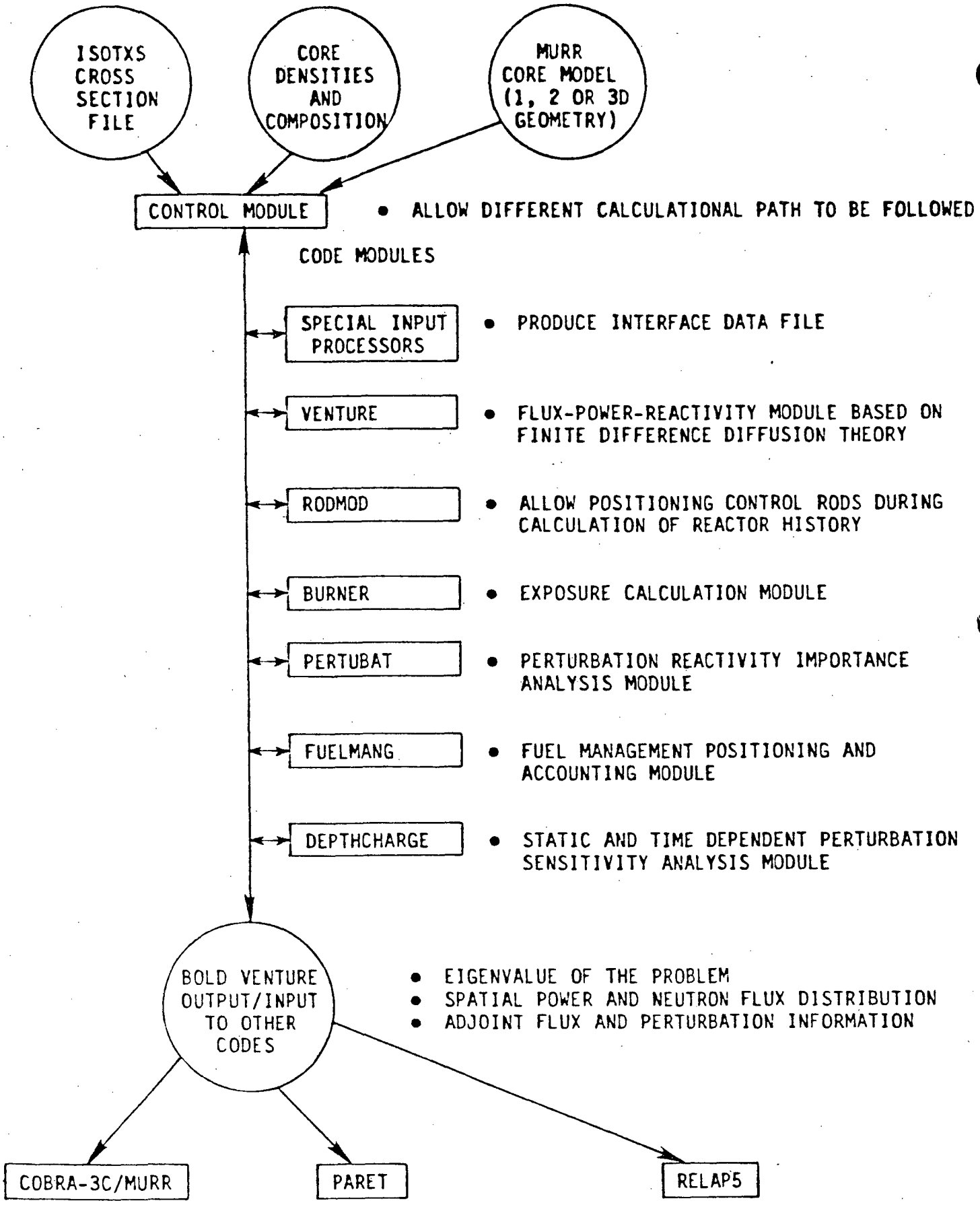
measured but still over predicted. The control blade black absorber constants were adjusted to give good agreement between calculated and measured values. Black absorber constants for group 3 and group 4 used in the rest of the analysis are 0.08406 and 0.2, respectively.

3. BOLD VENTURE IV Computation System

BOLD VENTURE is a modular system in which individual modules can be accessed in a desired sequence by a CONTROL module. The major components of the computational system are shown in Fig. 2. A brief description of the function of each module follows. Various interface data files are written via input and/or special processors for use by the other modules. VENTURE[9] module uses these generated interface data files to solve 1, 2, or 3 dimensional multigroup neutronics problems applying the Finite-Difference neutron diffusion or a simple P-1 theory approximation to neutron transport. It solves for the K_{eff}, forward and adjoint flux distribution, and spatial power distribution. It also solves fixed source, and criticality search problems.

RODMOD[10] module allows positioning control blades according to a prescribed schedule during the calculation of a reactor history. Control blades may be represented explicitly with or without internal black absorber conditions in selected energy groups, or fractional insertion may be done, or both in a problem. Time dependent depletion calculation is performed by BURNER[11]. The operating history of a reactor is followed over a period by solving the nuclide chain equations to estimate the nuclide concentrations at the end of an exposure time. FUELMANG[12] is a module used to position fuel during depletion calculation, maintain a mass

Fig. 2 Major components of BOLD VENTURE



balance history of the fuel movement, and calculates the unit fuel cycle component of the electric generation cost.

PERTUBAT[13] performs first order perturbation calculations using VENTURE results. Provision is made to calculate perturbations due to changes in microscopic cross section and nuclide densities. Nuclide importance data can also be calculated. In addition, perturbations due to a linear dependence of macroscopic cross sections on temperature may be obtained given temperature distribution and associated cross section data.

DEPTH-CHARGE[14] in BOLD VENTURE system provides a generalized first order perturbation/sensitivity theory capability for both static and time dependent analysis. Data sensitivity and uncertainty analysis can be performed evaluating derivative of the response with respect to the nuclide concentrations and/or nuclear data utilized in the model.

As depicted in the figure, key output of BOLD VENTURE such as the spatial power shape is finally used as an input to COBRA-3C/MURR which is a modified version of COBRA-3C/RERTR[15] for the steady state thermal-hydraulic study, to PARET[16] for the reactivity transient analysis, and to RELAP5[17] for the thermal-hydraulic transient analysis.

3.1 MURR Core Model

BOLD VENTURE has the facility to model up to the three-dimensional reactor system and up to 18 different types of reactor geometry. However, since the fuel element in the MURR core has curved fuel plates, only the R-Z, θ-R, and θ-R-Z geometric types were considered in the analysis. Presented in Table 2 is the material specification for each zone in the R-Z model. Figure 3 shows a diagram of the R-Z model of the MURR reactor used extensively in the BOLD VENTURE calculations. The symmetry axis in the

Table 2

MURR R-Z Zone Specification

Zone No.	Description
1	Flux Trap
2	Inner Al Pressure Vessel
3	Inner Coolant Channel
4	Reactor Core
5	Fuel Extension
6	Fuel Hanger
7	Water
8	Outer Coolant Channel
9	Outer Al Pressure Vessel
10	Water
11	Al Cladding of Control Blade
12	Control Blade Meat
13	Beryllium Reflector
14	Water
15	Upper Graphite Reflector
16	Lower Graphite Reflector
17	Water
18	Aluminum
19	Water

Fig. 3 R-Z Model of the MURR

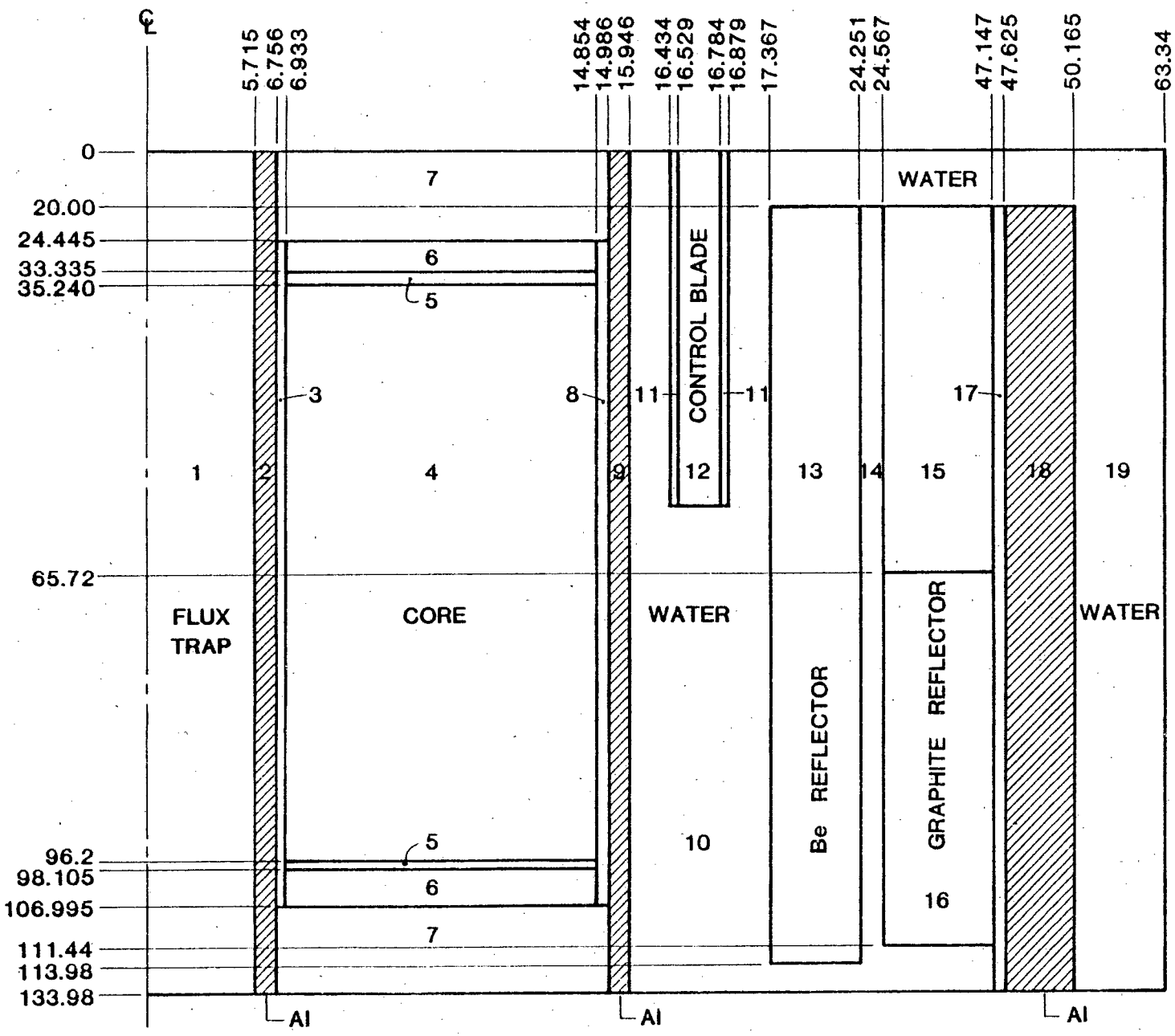


figure corresponds to the actual symmetry axis of the MURR. The numbers in the figure shows the MURR homogenized zones representing flux trap, core section, control blade, beryllium and graphite reflector, etc. The location of the zone boundaries are given in centimeters relative to the top of the model and center line of the reactor.

Also used in the analysis is a θ-R model to better describe the curved fuel plates and control blades. Figure 4 shows the top view of the MURR core and beryllium reflector modeled in the BOLD VENTURE calculations. There are a total five movable blades used in the reactor. Four of these, the control blades, each occupy approximately 72° of a circular arc around the pressure vessel and are made of boral. The fifth, the regulating blade covers 17.8° of the circular arc and is made of stainless steel. The user can easily combine the above R-Z and θ-R models to set up a three-dimensional θ-R-Z MURR reactor model. As previously described, the new fuel element is designed in such a way that the fuel loading between plates varies. U-235 loading for the 775 gm and the 1270 gram elements are given in Tables 3 and 4, respectively. In Table 3, nominal loading is given in column 2 and the actual uranium content in the 775-F3 fuel element which was used in the benchmark calculations is shown in column 3. In the new fuel element, fuel plates from 8 to 19 are loaded uniformly at the maximum level of 3.0 gm-U/cm^3. The uranium per cubic centimeter decreases going from Plate 8 to 1 and from Plate 19 to 24 in order to reduce power peaks on outside plates. Also noted is that the new fuel element contains boron in the form of boron carbide in the first five and last four plates to reduce the initial core reactivity.

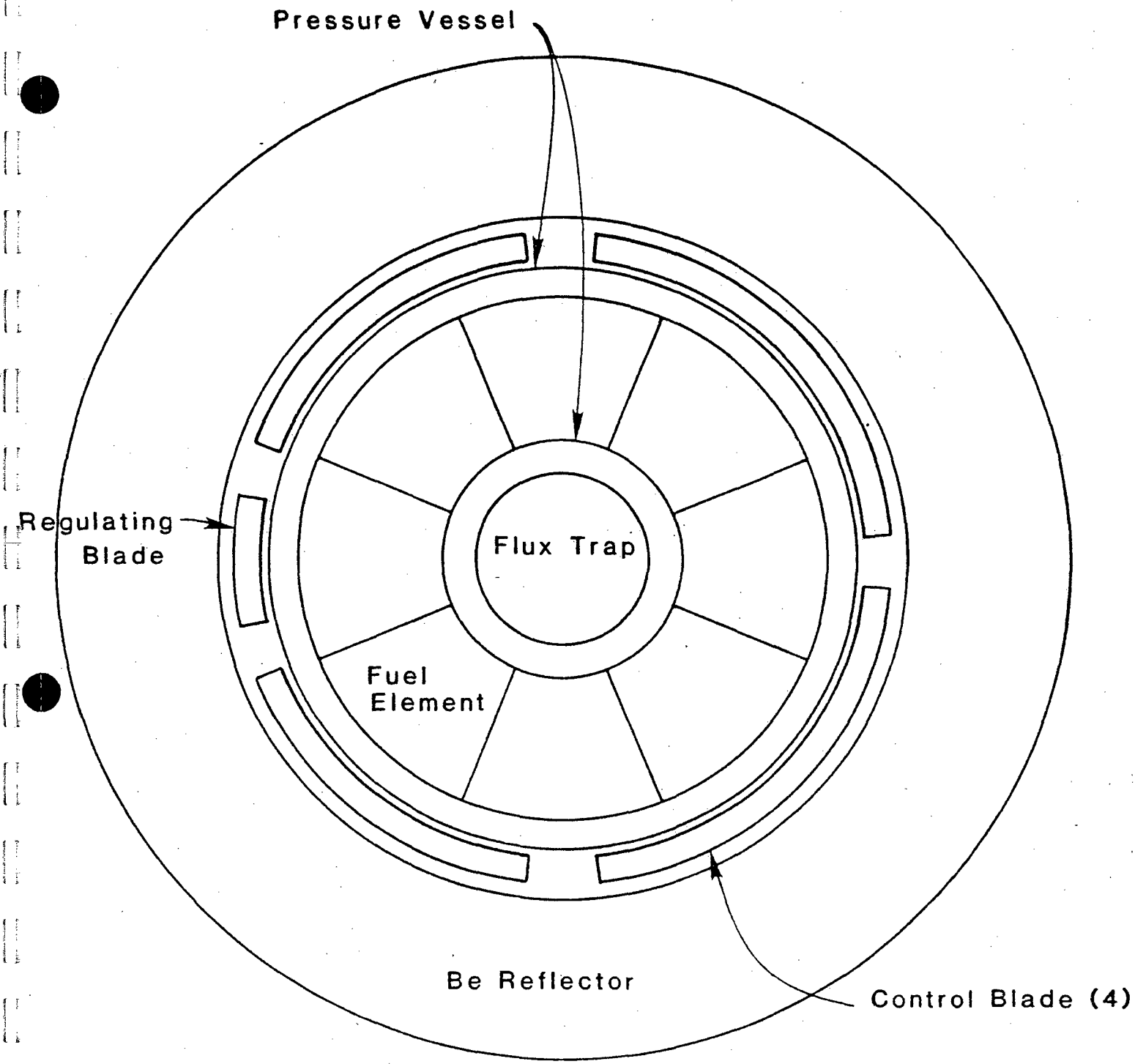


Fig. 4

θ-R Model of the MURR Core and Be Reflector

Table 3

U-235 Loading for MURR 775 Gram Elements

Plate Number	Nominal U-235 Content(gm)	U-235 Content in 775-F3(gm)	Difference from Nominal
1	19.260	18.95	- 0.31
2	20.393	20.23	- 0.16
3	21.526	21.13	- 0.40
4	22.659	22.47	- 0.19
5	23.793	23.59	- 0.20
6	24.926	24.72	- 0.21
7	26.059	25.80	- 0.26
8	27.192	27.05	- 0.14
9	28.325	28.13	- 0.20
10	29.459	29.33	- 0.13
11	30.592	30.25	- 0.34
12	31.725	31.33	- 0.40
13	32.858	32.66	- 0.20
14	33.992	33.73	- 0.26
15	35.125	34.89	- 0.24
16	36.258	36.02	- 0.24
17	37.391	37.06	- 0.33
18	38.524	38.00	- 0.52
19	39.658	39.28	- 0.38
20	40.791	40.51	- 0.28
21	41.924	41.72	- 0.20
22	43.057	42.64	- 0.42
23	44.191	43.90	- 0.29
24	45.324	44.74	- 0.58
	775 grams	768.13	

Table 4. Uranium and Boron Loading for 1270 gm Elements

Plate	U-235 Content	U-238 Content	Boron Content (Natural)
1	11.38	0.838	.08
2	15.11	1.113	.085
3	19.13	1.409	.088
4	28.12	2.071	.091
5	34.25	2.523	.095
6	43.15	3.178	
7	50.83	3.744	
8	53.06	3.908	
9	55.30	4.073	
10	57.54	4.238	
11	59.78	4.403	
12	62.02	4.568	
13	64.26	4.733	
14	66.52	4.899	
15	68.76	5.064	
16	70.99	5.229	
17	73.23	5.394	
18	75.47	5.559	
19	77.71	5.724	
20	75.82	5.584	
21	67.55	4.975	.155
22	57.08	4.204	.159
23	47.09	3.468	.163
24	36.22	2.668	.166
	1,270.37		1.082

3.2 Benchmark Calculations

The validity of the BOLD VENTURE core model was tested against the burnup data of the 775-F3 fuel element obtained by post-irradiation examination[18] performed in 1973. All 24 plates in 775-F3 were gamma scanned longitudinally along the center line to profile burnup in the element. In addition, five samples were analyzed for burnup employing the 145, 146, and 148 isotopes of Nd. Transverse gamma scans were also made at the burnup sample locations. The linear relationship between gamma activity and burnup was used to convert the longitudinal gamma scans to fissions per cubic centimeter values.

The tested fuel element is one of the elements in CORE VII which was loaded with eight new elements and depleted up to a 650 MWD core burnup. The control blade bank movement scheme for CORE VII[19] is shown in Fig. 5 in which the bank position at the cold clean core condition is marked with *, whereas the bank position with equilibrium xenon is marked with +. It is to be noted that blade height in the figure is expressed in inches of withdrawal from the bottom of the core. The 775F3 fuel element was used when the reactor operated for 95-100 hours per week at 5 MW. Analytically, the average xenon reactivity worth can be calculated to be approximately 90 percent of the equilibrium xenon reactivity worth for this operating cycle. Therefore, the blade position at each depletion step was approximated using the following equation:

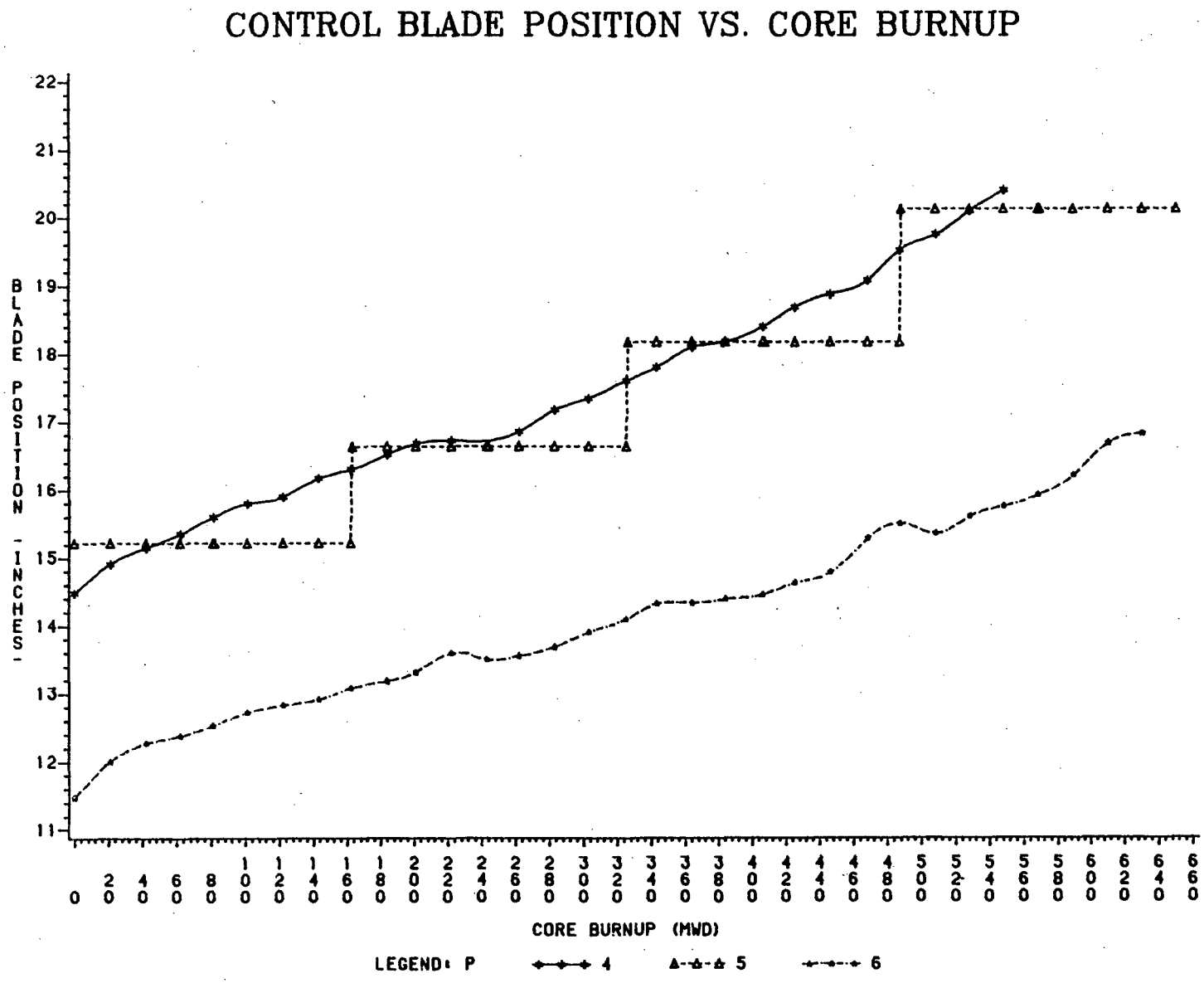


FIG. 5 CONTROL BLADE MOVEMENT SCHEME for CORE VII

$$BP_i = BP_{c,i} + 0.9\ (BP_{x,i} - BP_{c,i})$$

where

BP_i = blade position at step i,

$BP_{c,i}$ = blade position at cold clean, step i,

$BP_{x,i}$ = blade position at equilibrium xenon, at step i.

Since the BOLD VENTURE uses descrete time steps, the continuous control blade height change during depletion was simplified into four discrete steps in which the blade height remains at a given position for the specified depletion time step. These rod positions during a specified depletion step length were averaged to represent the rod position for the burnup step. This data is presented in Table 5 and displayed in Figure 5 with Δ symbol.

A R-Z MURR model was set up and depleted up to 650 MWD using VENTURE, RODMOD, and BURNER modules. In the R-Z model, the three barrel flux trap was incorporated as follows. Volume of the three tubes were combined into one big tube in such a way that a single ring of aluminum has the same volume as that in the three aluminum tubes of the flux trap. To represent the typical reactivity worth of a flux trap sample loading used in 1971 and 1972, the volume inside the ring was modeled as aluminium with a boron-10 number density of 1.0×10^{19} atoms/cm^3. The ring is located at the centerline of the R-Z MURR model with an inner radius of 0.974" and an outer radius of 1.261".

Since the BOLD VENTURE gives the output in a form of fission source per cubic centimeter of the homogenized zone volume per second, the following analytical formula was set up to convert fission source to fissions/cm^3 of fuel meat volume:

Table 5

Control Blade Height vs. Core Burnup

Cumulative Burnup (MWD)	Inches Withdrawn
0	15.21
81.25	15.21
162.5	16.62
243.75	16.62
325.0	18.16
406.25	18.16
487.5	20.11
568.75	20.11
650.0	20.11

$$BU_{ij} = \sum_{k=1}^{K} (FS)_{ijk} \times (\Delta t)_k \times (W_{cell}/W_{meat})_j \times (PCF)_j^{-1} \times \nu^{-1}$$

where

BU_{ij} = Fissions/cm^3 for mess interval i in Plate j,

FS_{ijk} = Fission source for mess interval i of Plate j during the burnup step k,

Δt_k = Time length for k burnup step (sec),

$(W_{cell}/W_{meat})_j$ = ratio of unit cell to meat radial thickness for Plate j,

PCF_j = Fraction of circular arc occupied by the fuel meat in Plate j,

ν = Number of neutrons emitted per fission.

Figure 6 compares the peak burnup calculated versus the measured values for each plate. Figures 7 through 30 give the axial burnup distributions comparisons for Plate 1 through 24, respectively. The BOLD VENTURE results are marked with □ , and the gamma scan derived values are marked ∇, Δ, and x. In the figures, the horizontal axis represents the distance from top of the fuel plate and it is to be noted that nominally the fuel meat starts at 3/4" below the top of the fuel plate and ends at 3/4" above the bottom of the plate. As shown in the figures, the BOLD VENTURE results are conservative in a sense that the calculated values tend to overestimate the test data. This probably reflects the conservatism of having indicated reactor power slightly greater than actual power level. In general, the BOLD VENTURE results are in good agreement with the test data, but shows some discrepancy due to the approximations used in the

Fig. 6 Comparison of Peak Burnup in Each Fuel Plate for 775F3

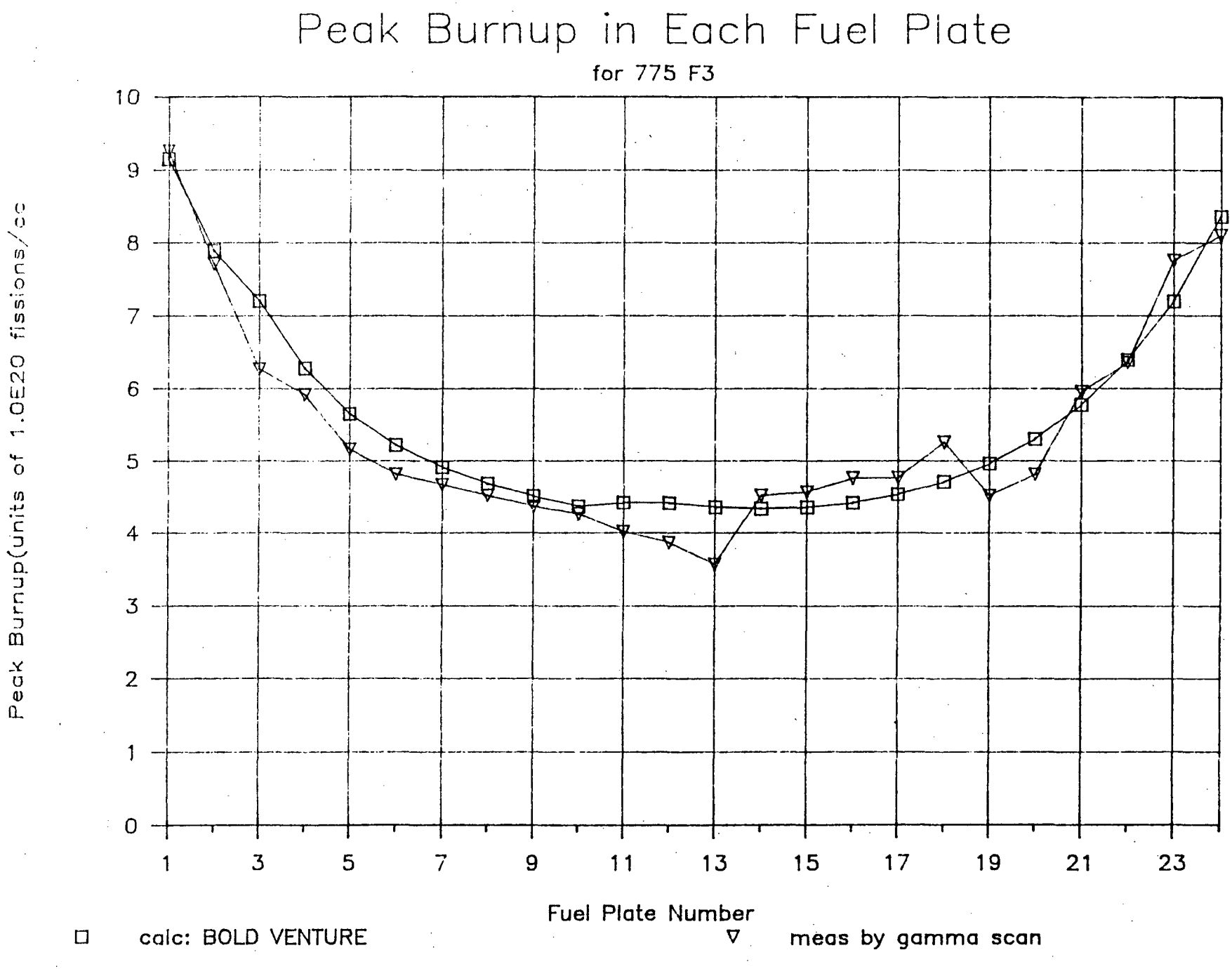


Fig. 7 Comparison of Axial Burnup Distribution in Plate 1

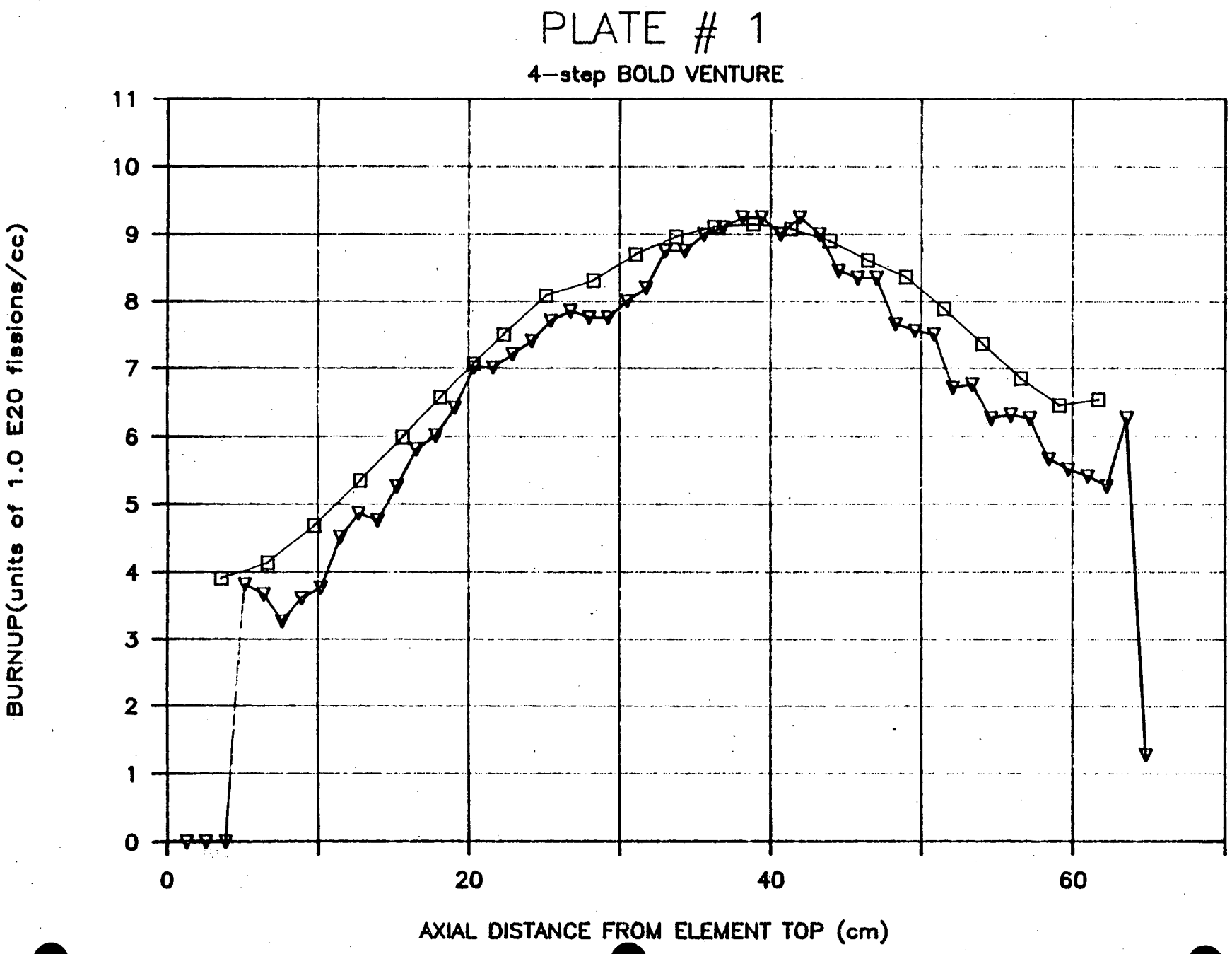


Fig. 8 Comparison of Axial Burnup Distribution in Plate 2

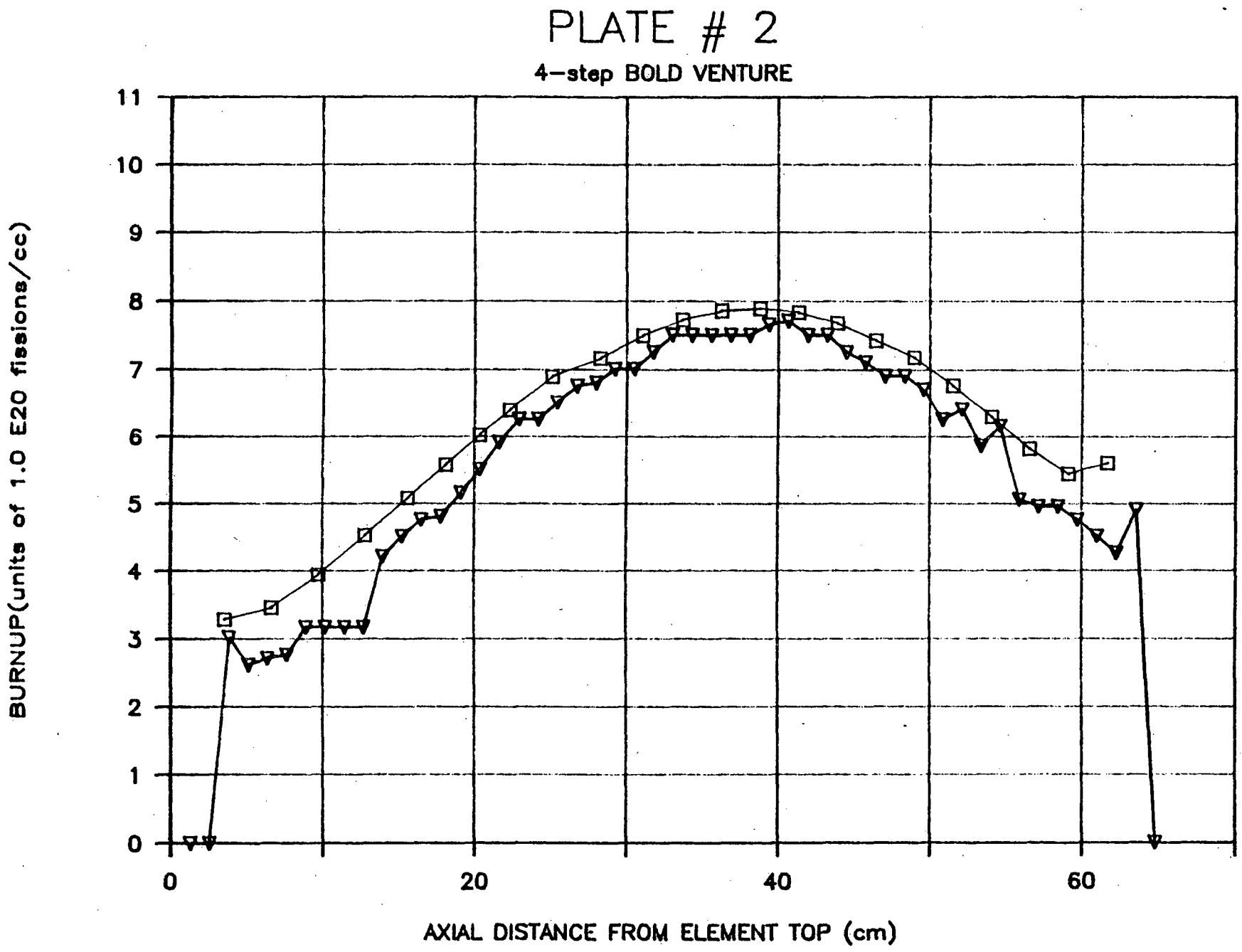


Fig. 9 Comparison of Axial Burnup Distribution in Plate 3

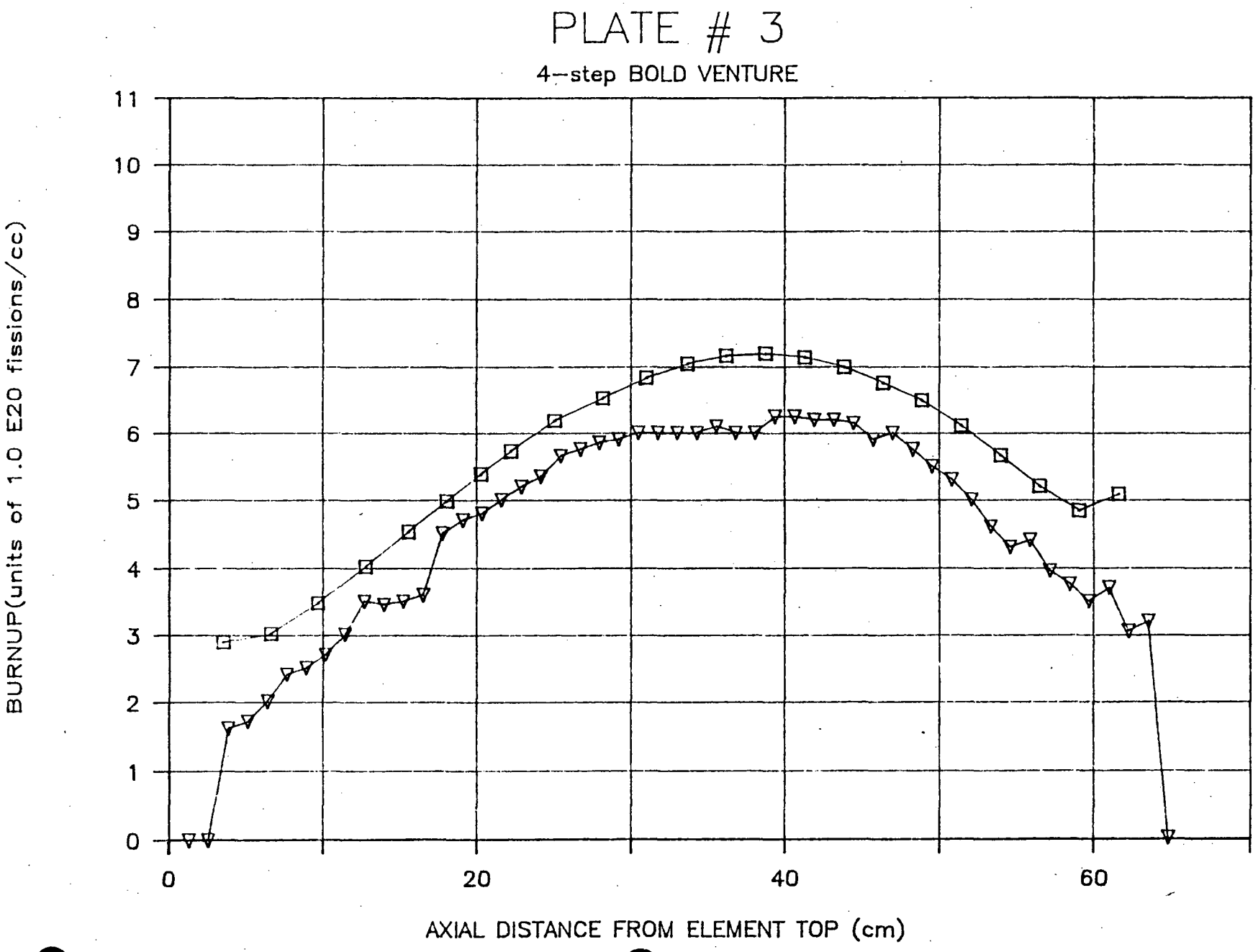


Fig. 10 Comparison of Axial Burnup Distribution in Plate 4

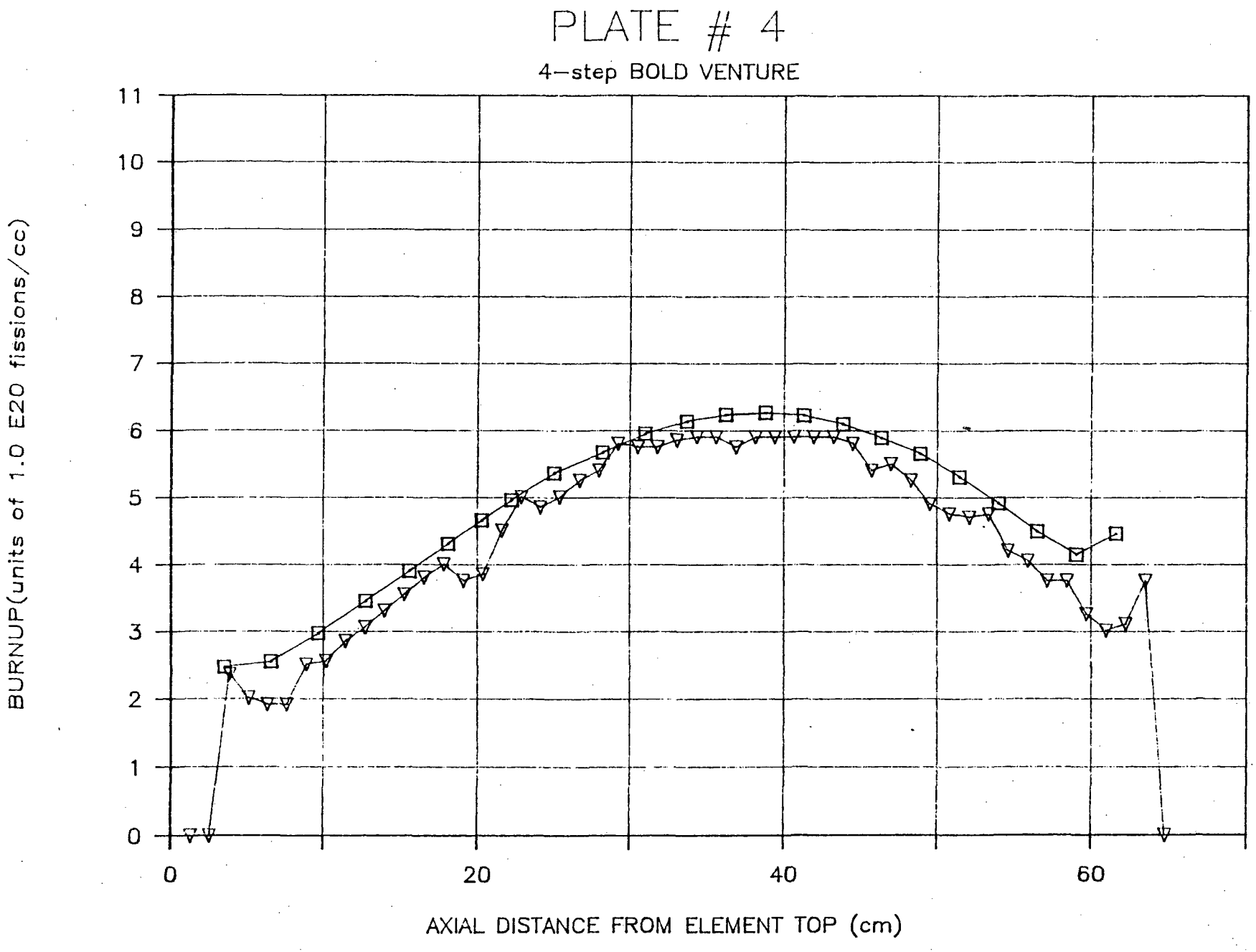


Fig. 11 Comparison of Axial Burnup Distribution in Plate 5

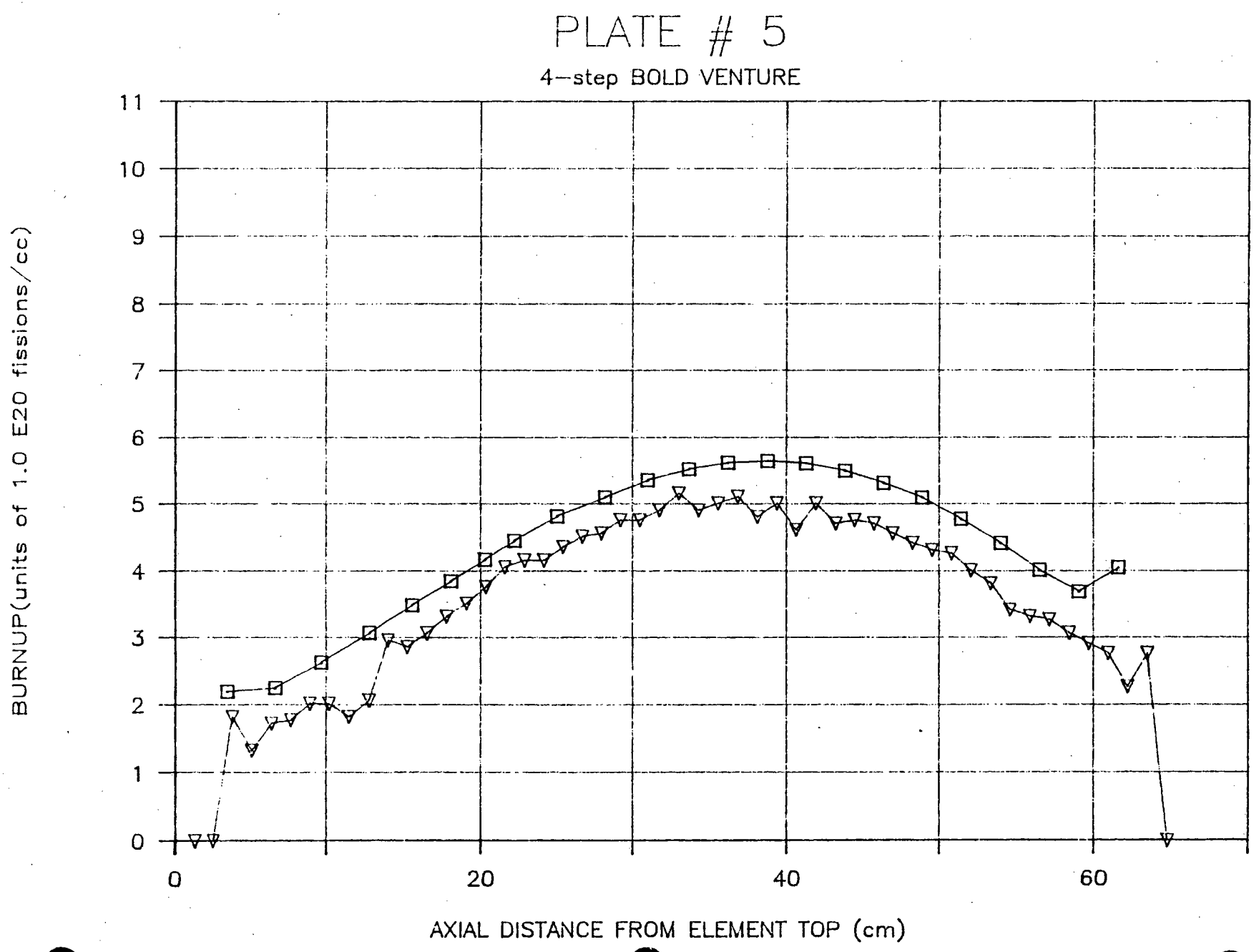


Fig. 12 Comparison of Axial Burnup Distribution in Plate 6

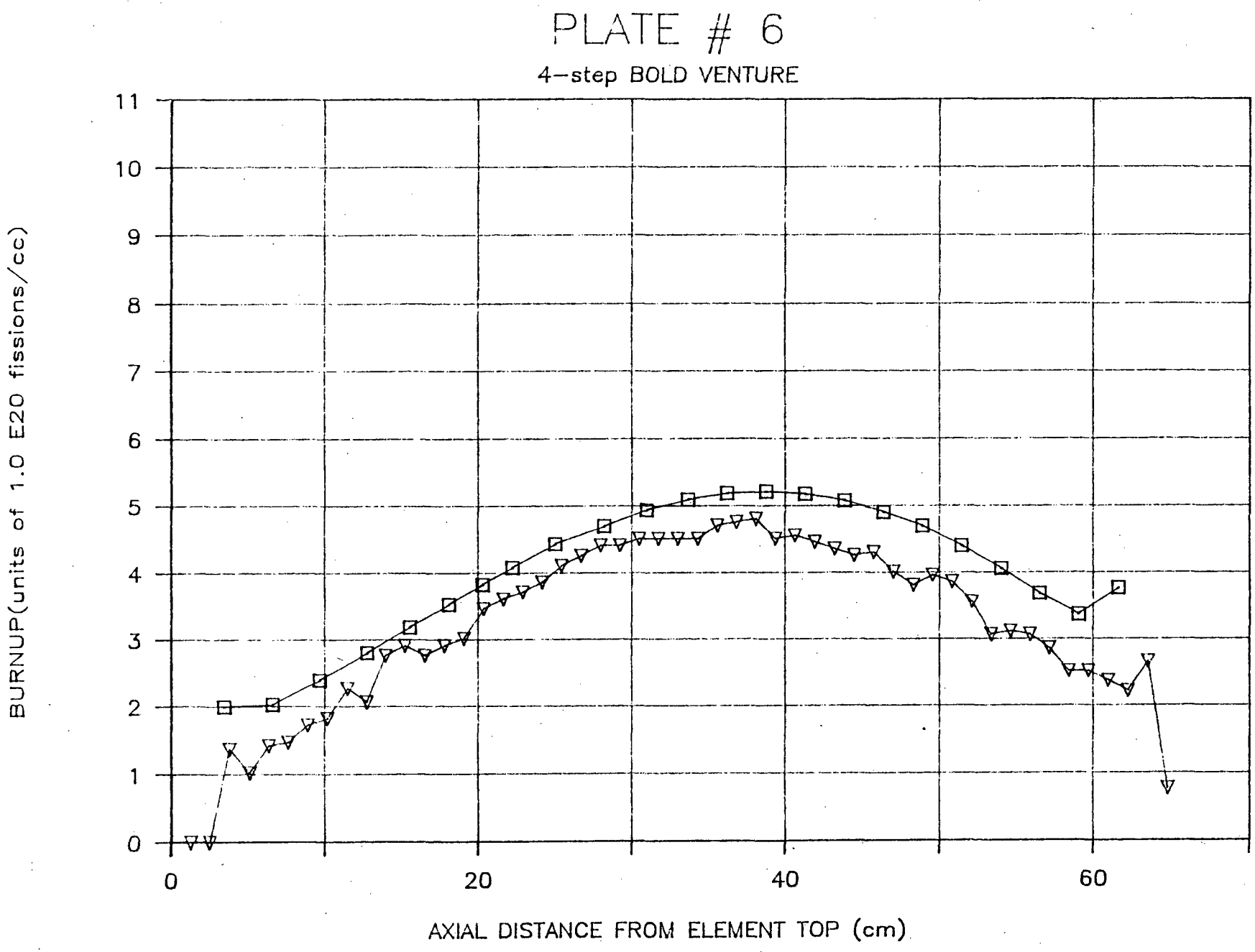


Fig. 13 Comparison of Axial Burnup Distribution in Plate 7

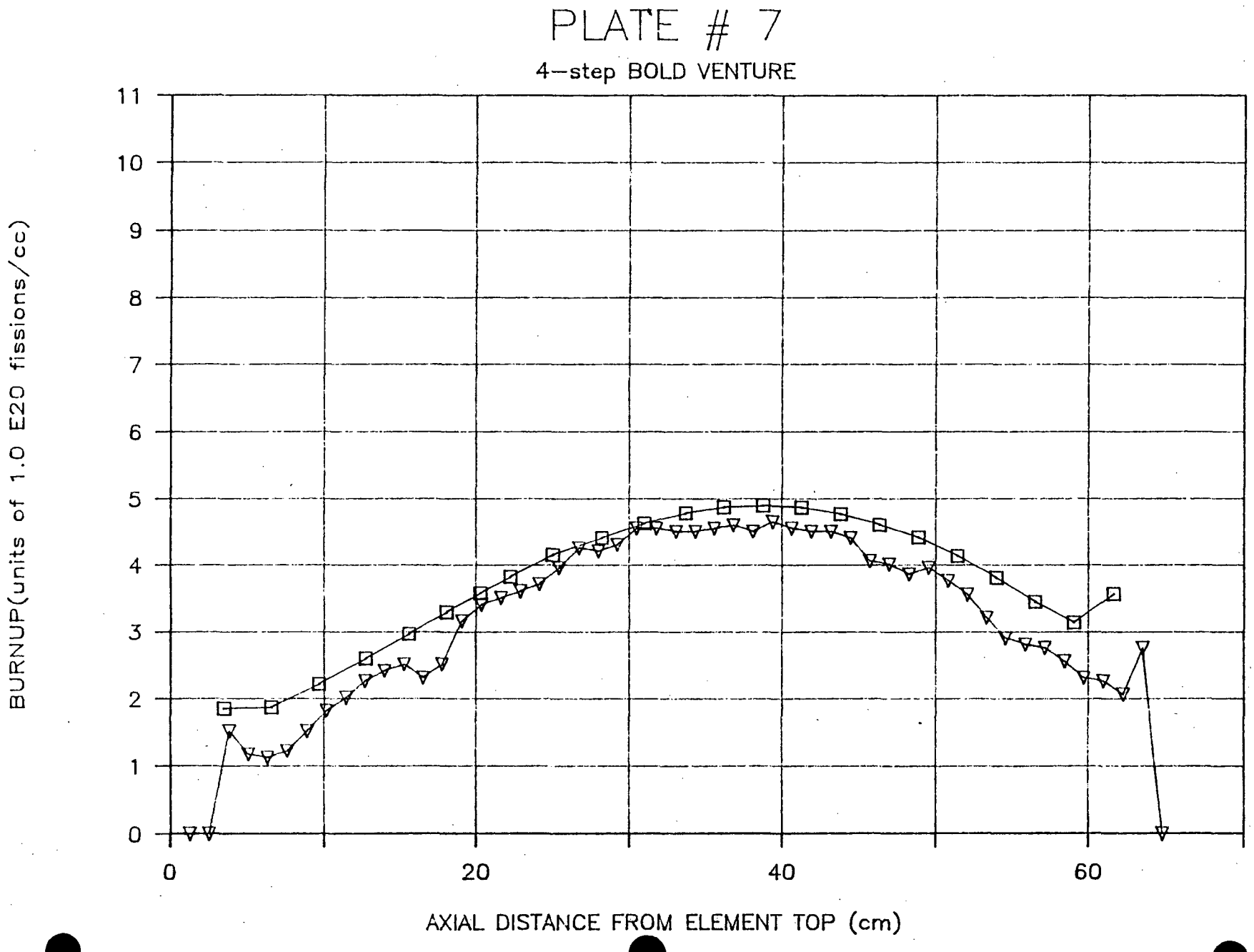


Fig. 14 Comparison of Axial Burnup Distribution in Plate 8

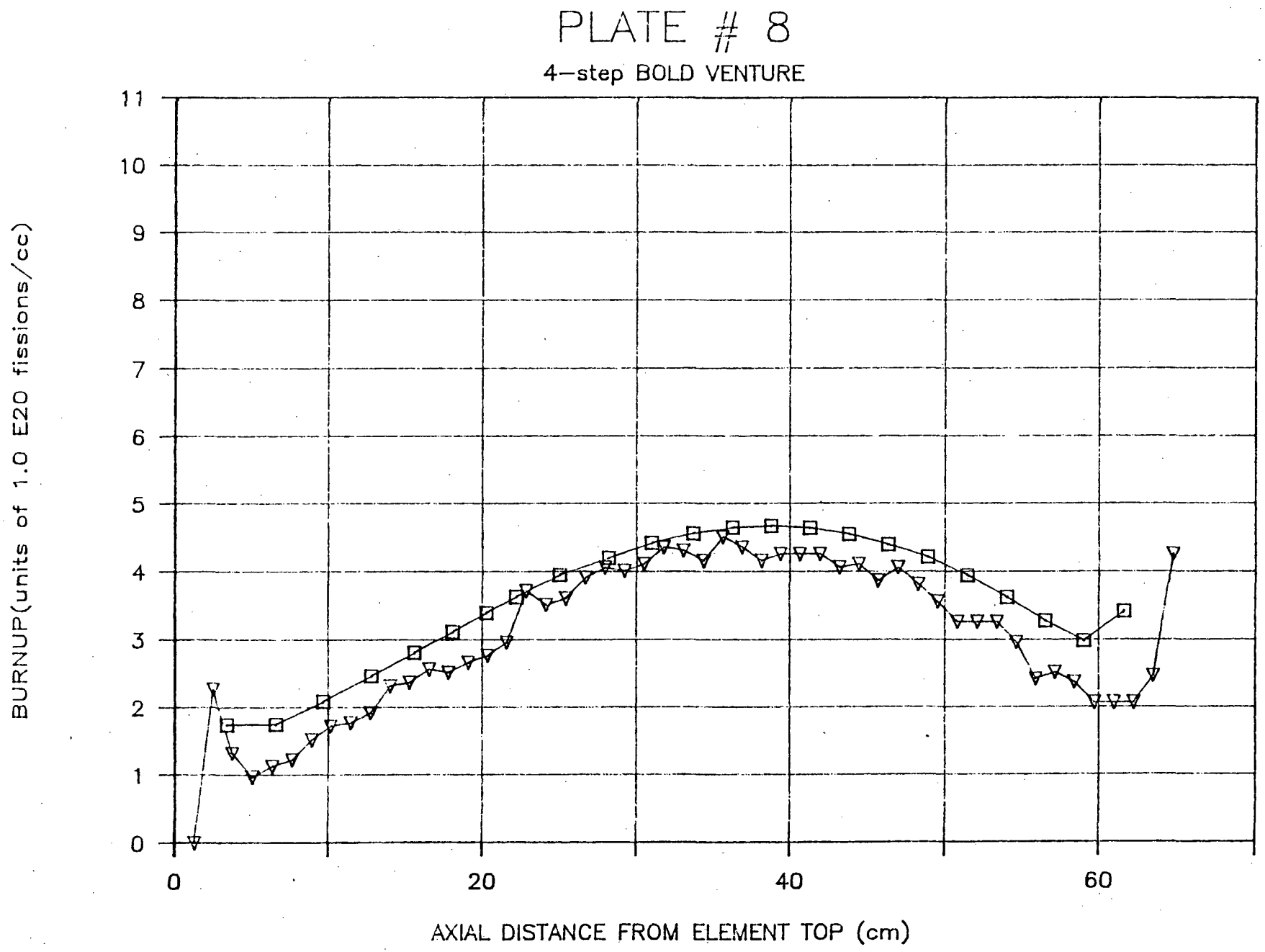


Fig. 15 Comparison of Axial Burnup Distribution in Plate 9

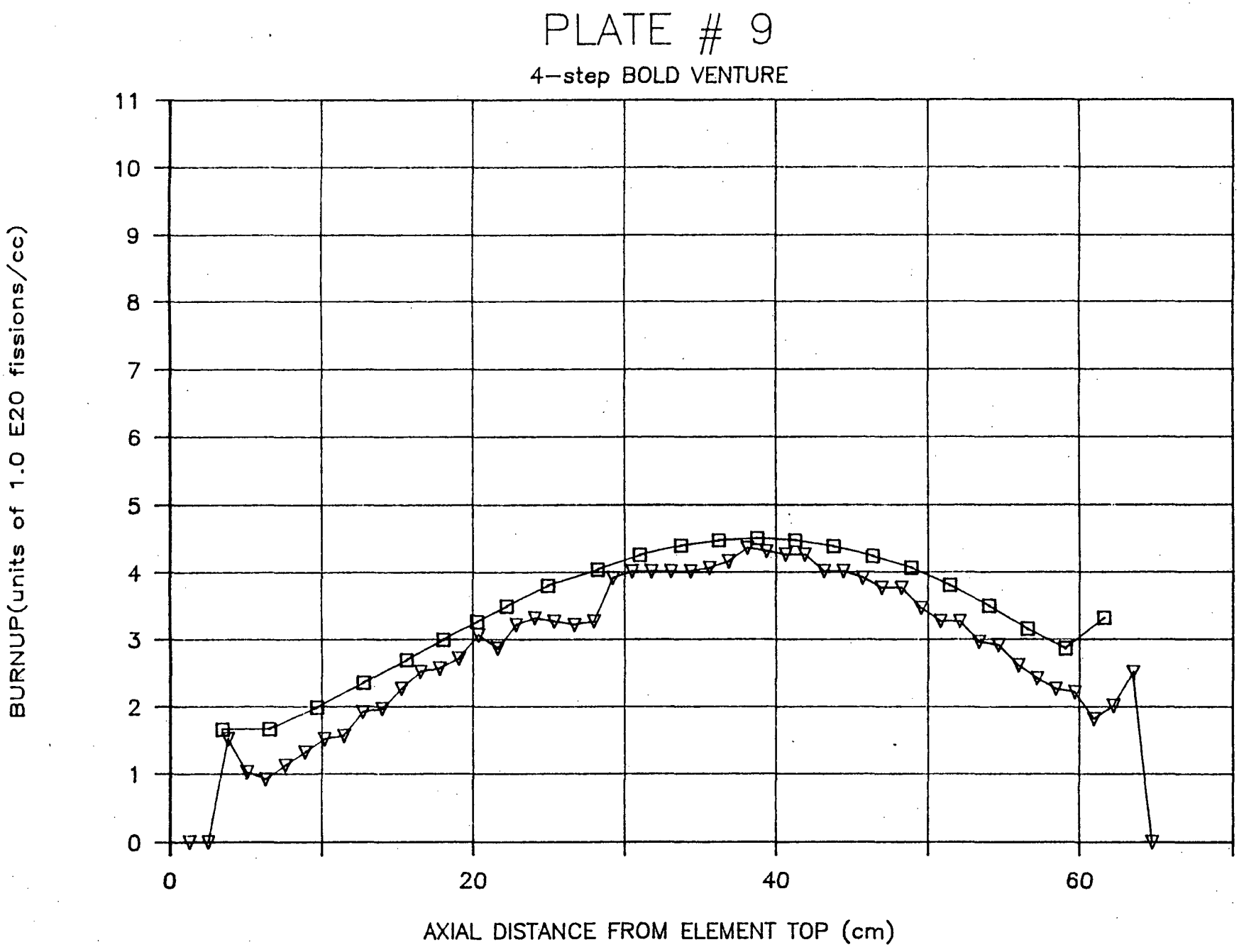


Fig. 16 Comparison of Axial Burnup Distribution in Plate 10

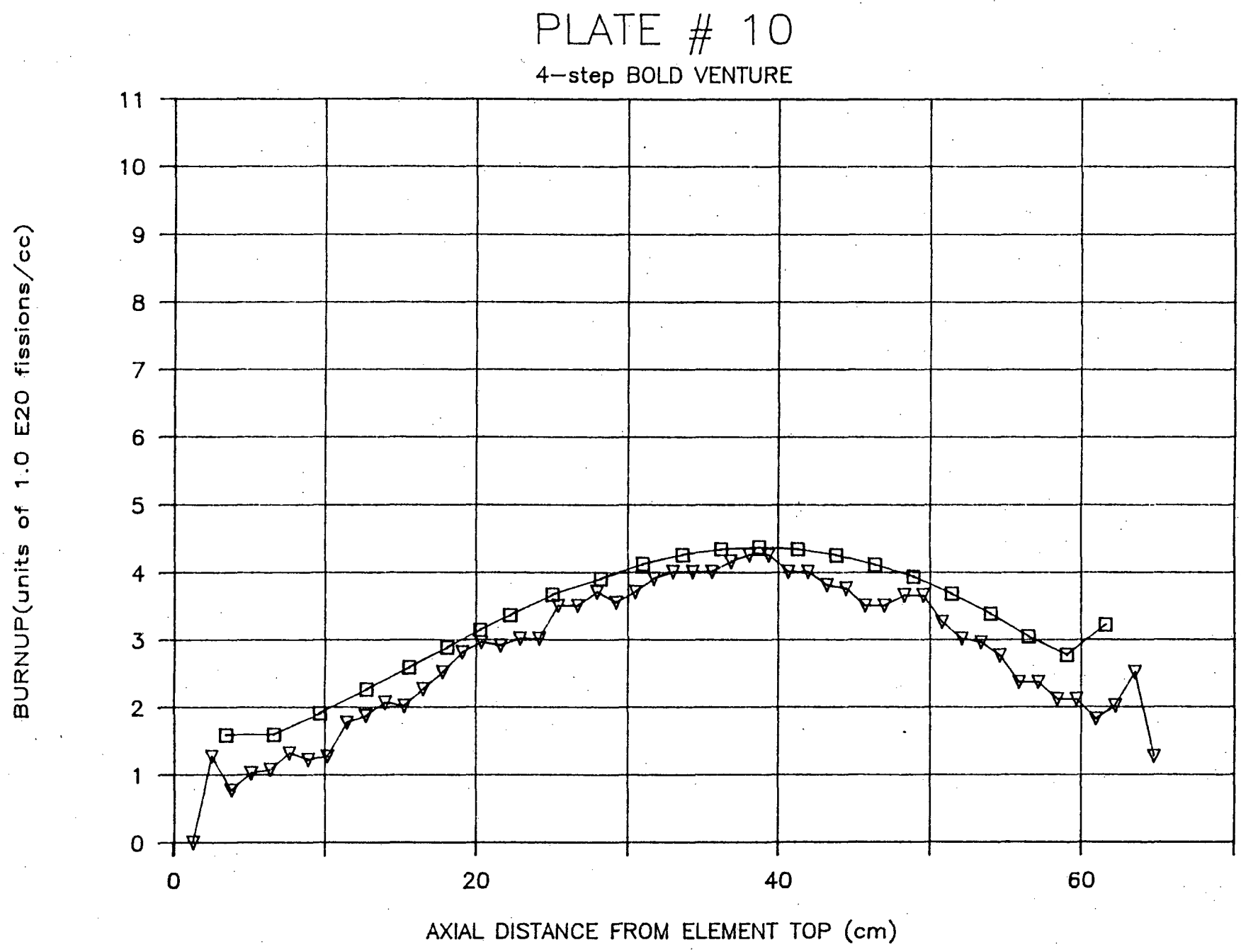


Fig. 17 Comparison of Axial Burnup Distribution in Plate 11

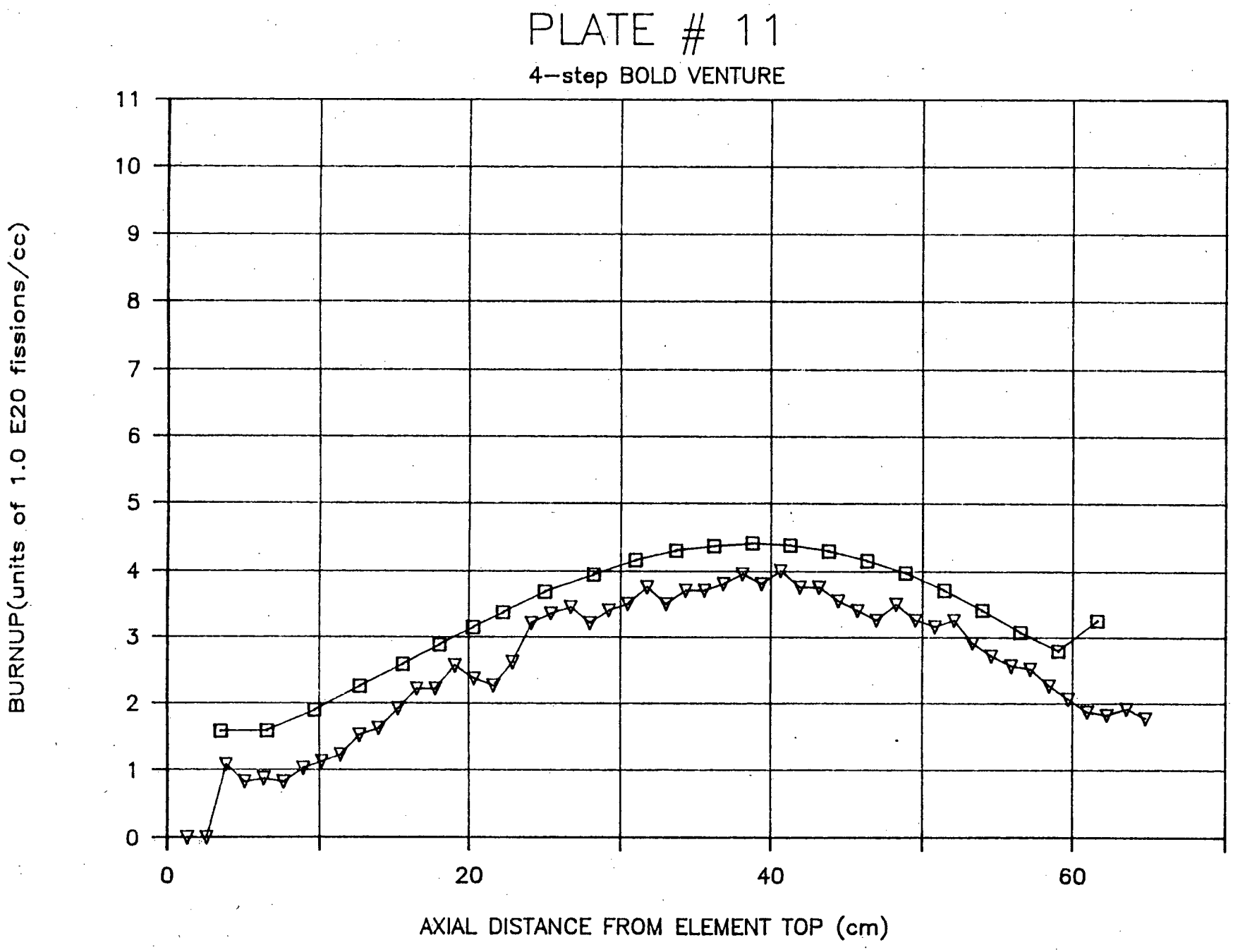


Fig. 18 Comparison of Axial Burnup Distribution in Plate 12

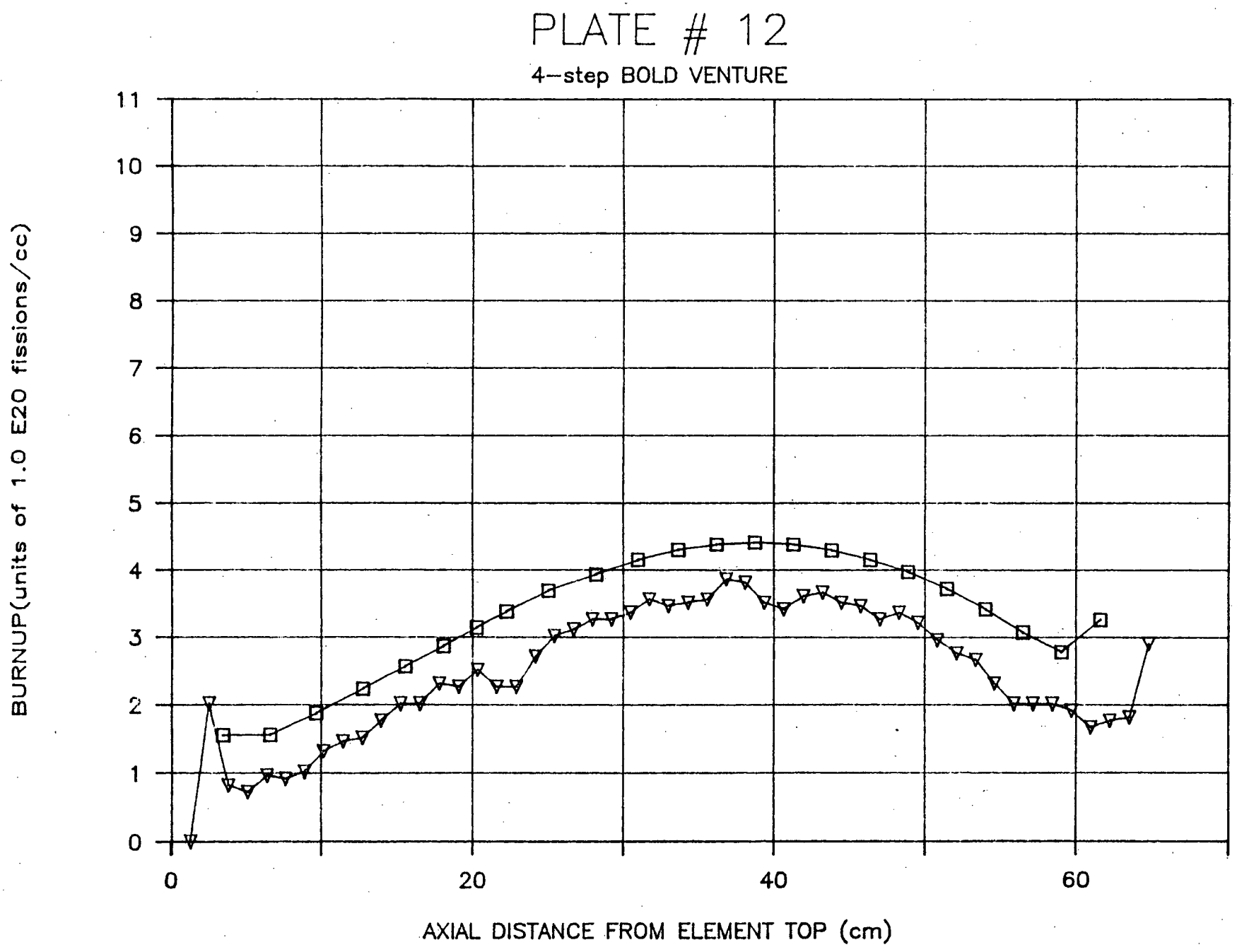


Fig. 19 Comparison of Axial Burnup Distribution in Plate 13

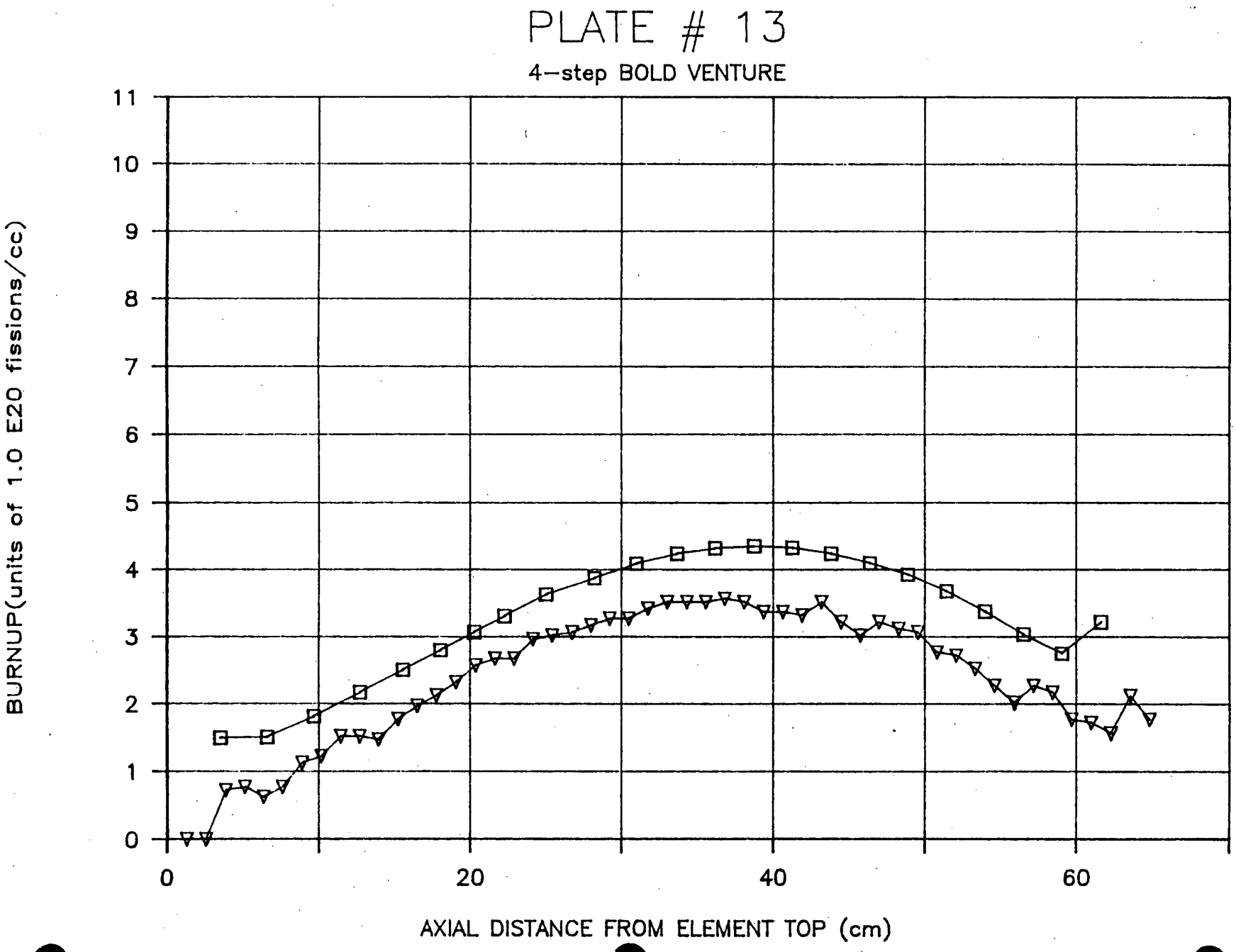


Fig. 20 Comparison of Axial Burnup Distribution in Plate 14

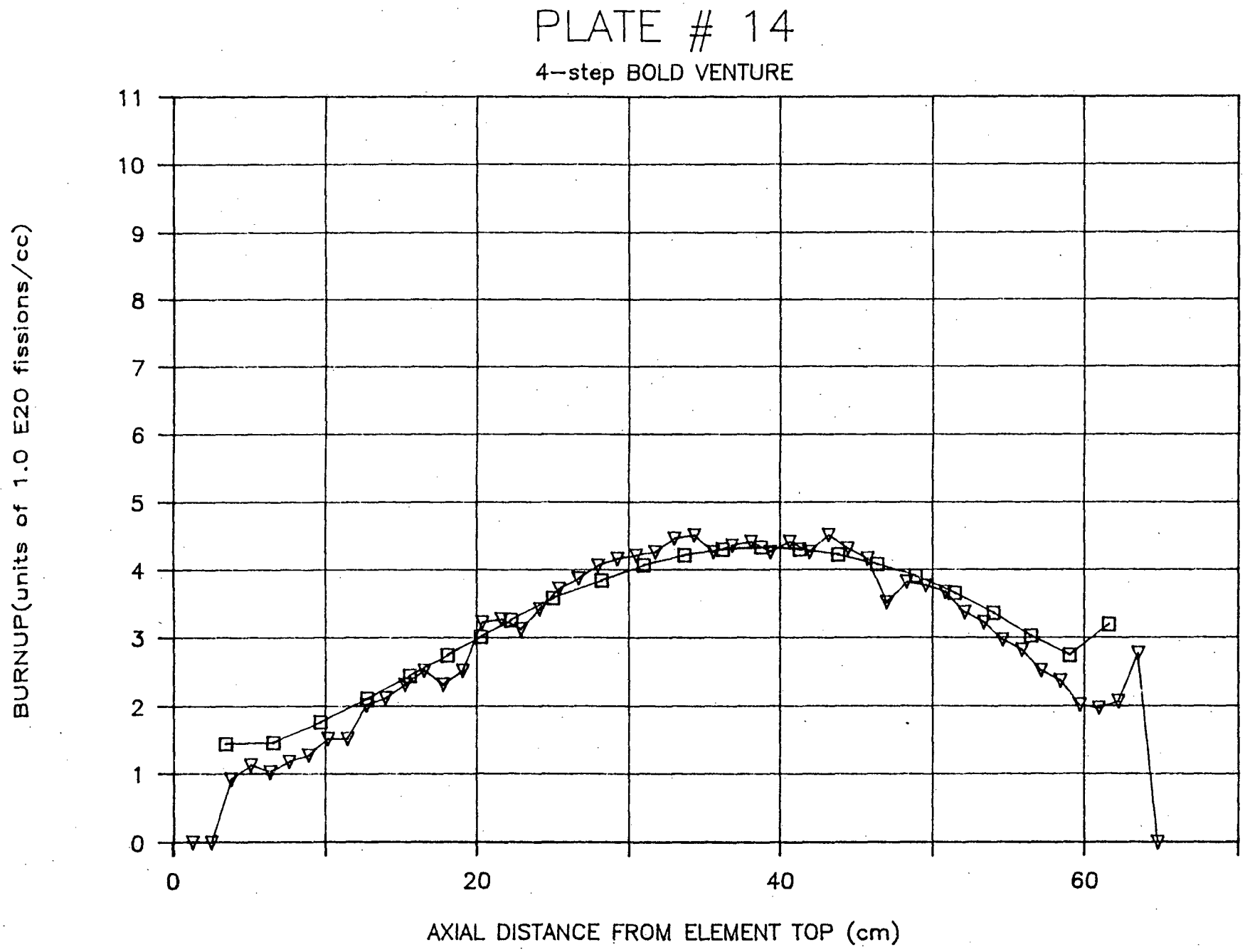


Fig. 21 Comparison of Axial Burnup Distribution in Plate 15

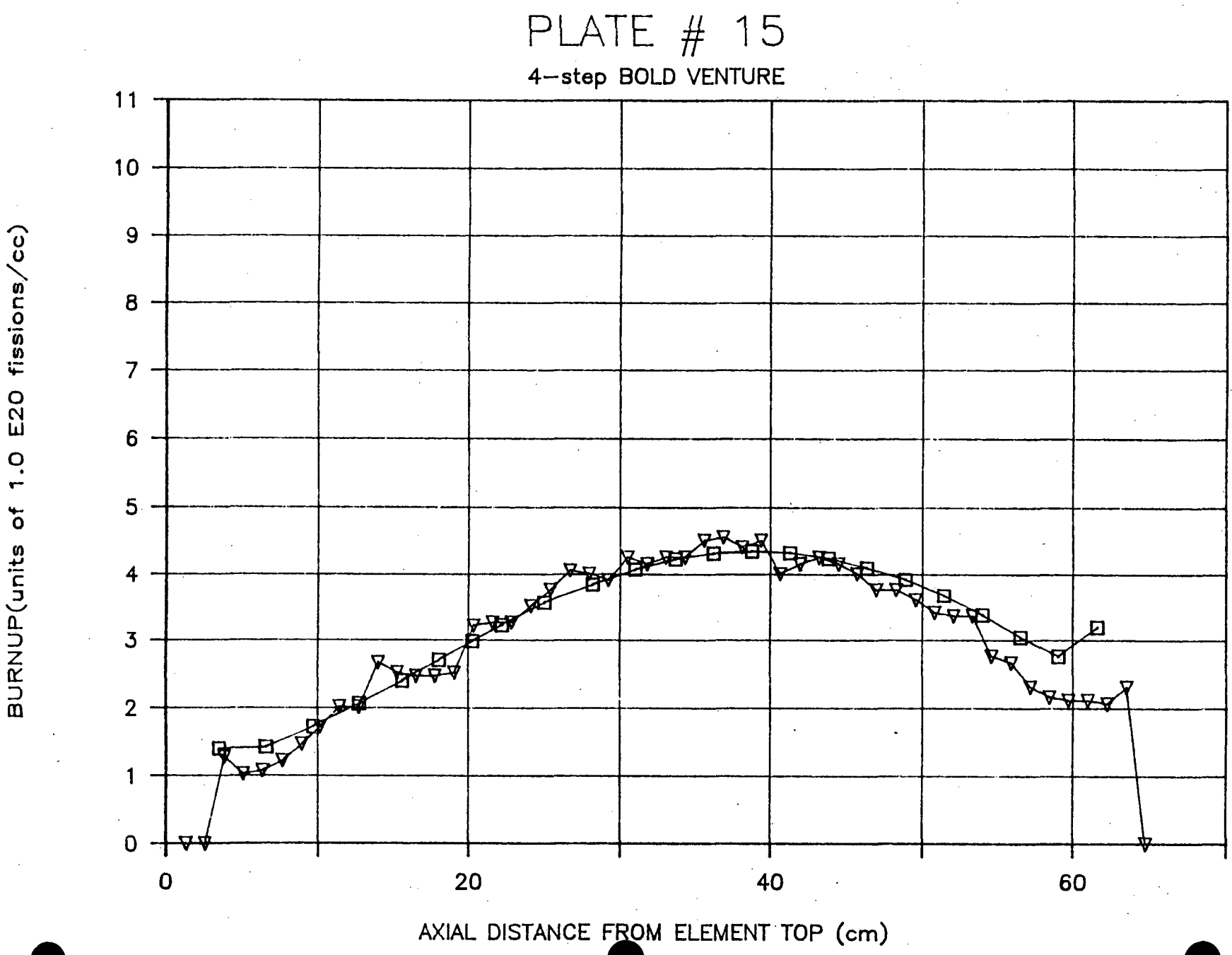


Fig. 22 Comparison of Axial Burnup Distribution in Plate 16

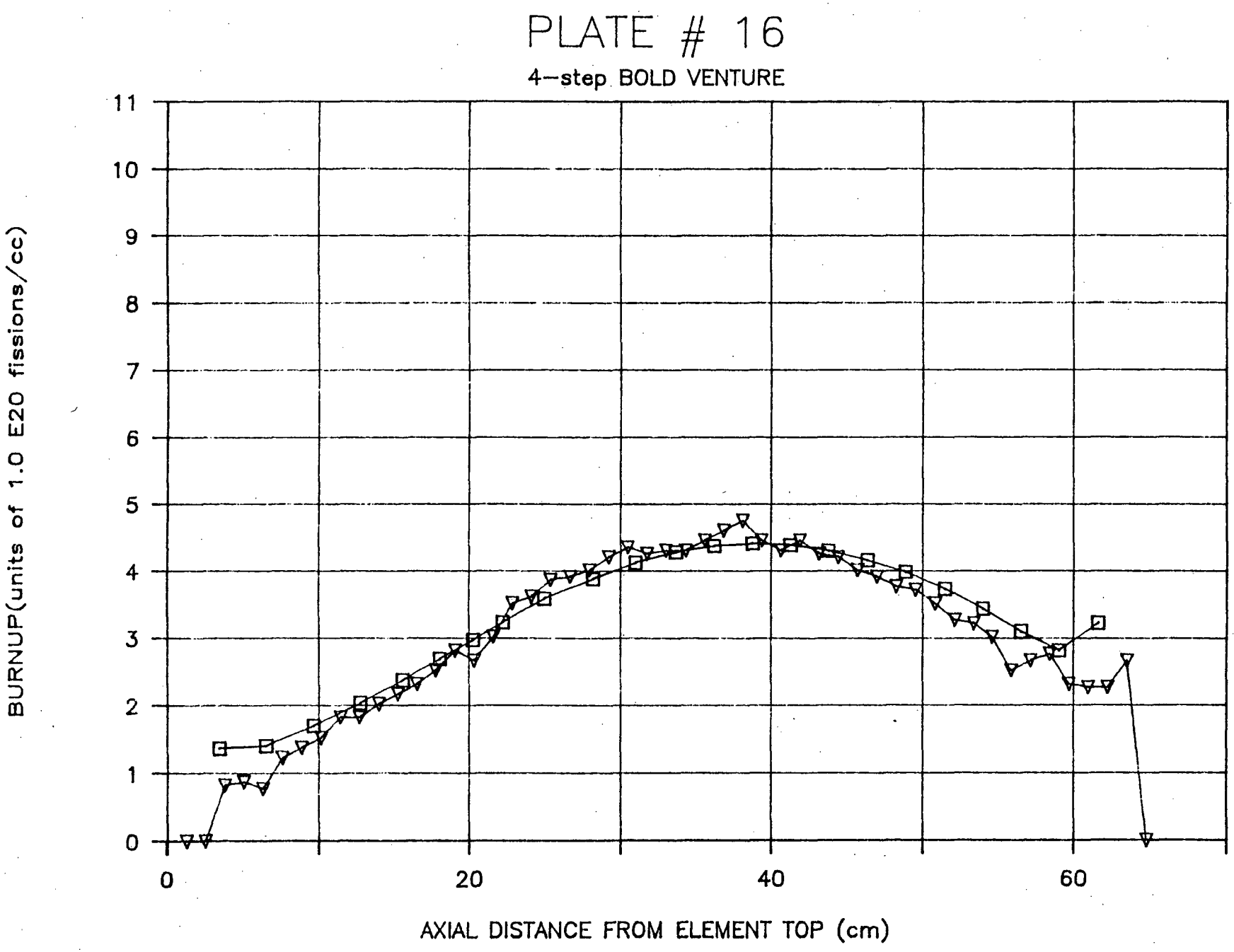


Fig. 23 Comparison of Axial Burnup Distribution in Plate 17

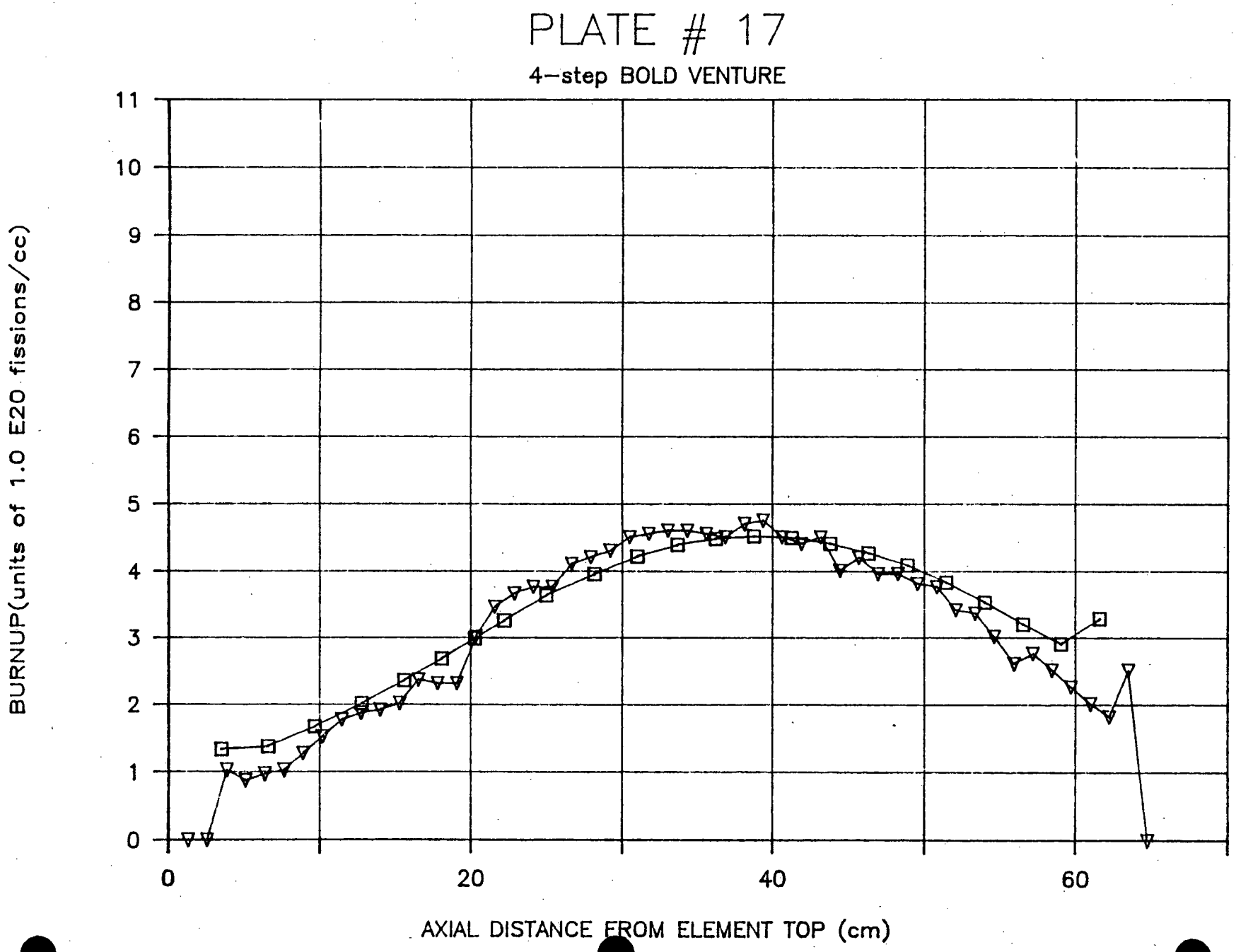


Fig. 24 Comparison of Axial Burnup Distribution in Plate 18

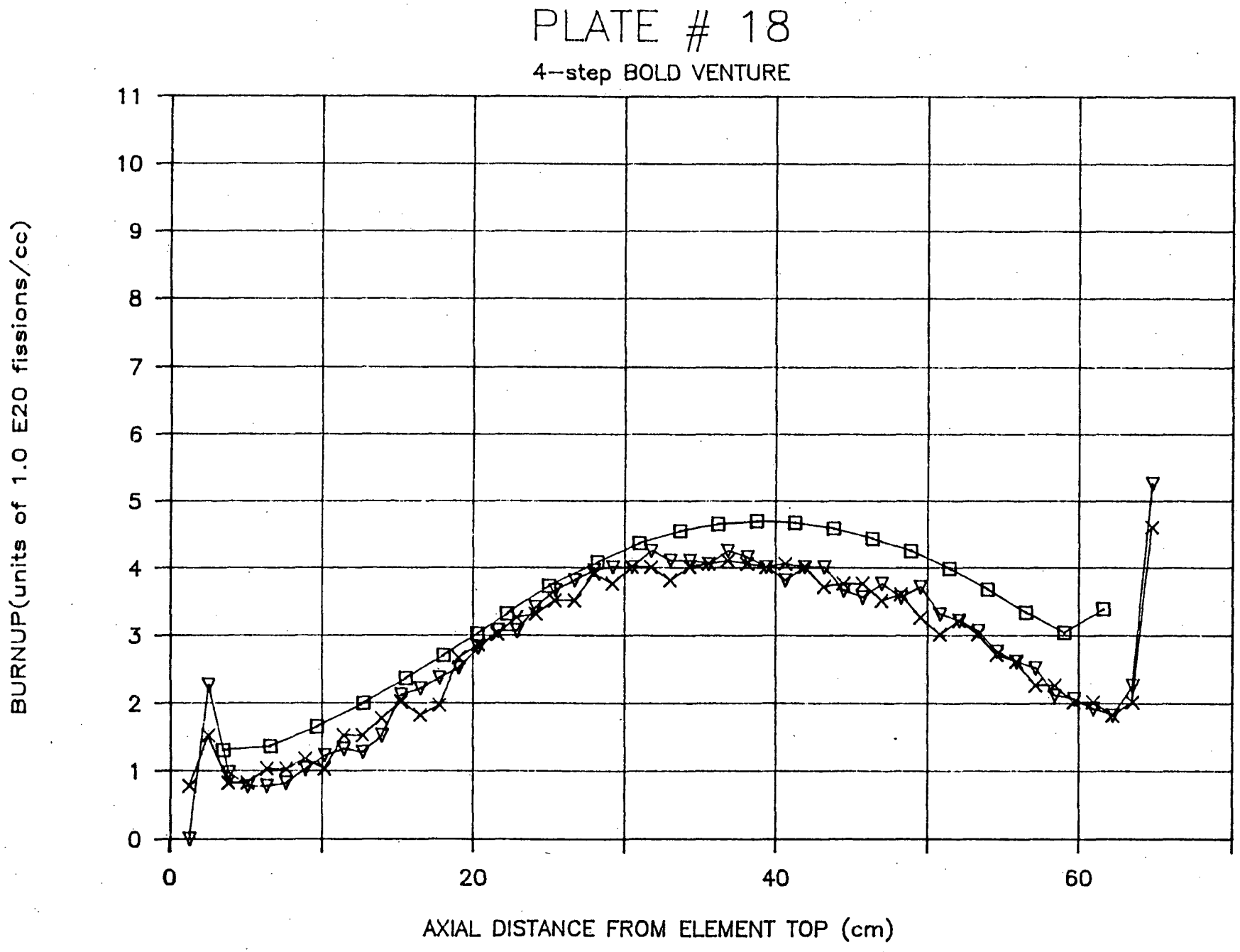


Fig. 25 Comparison of Axial Burnup Distribution in Plate 19

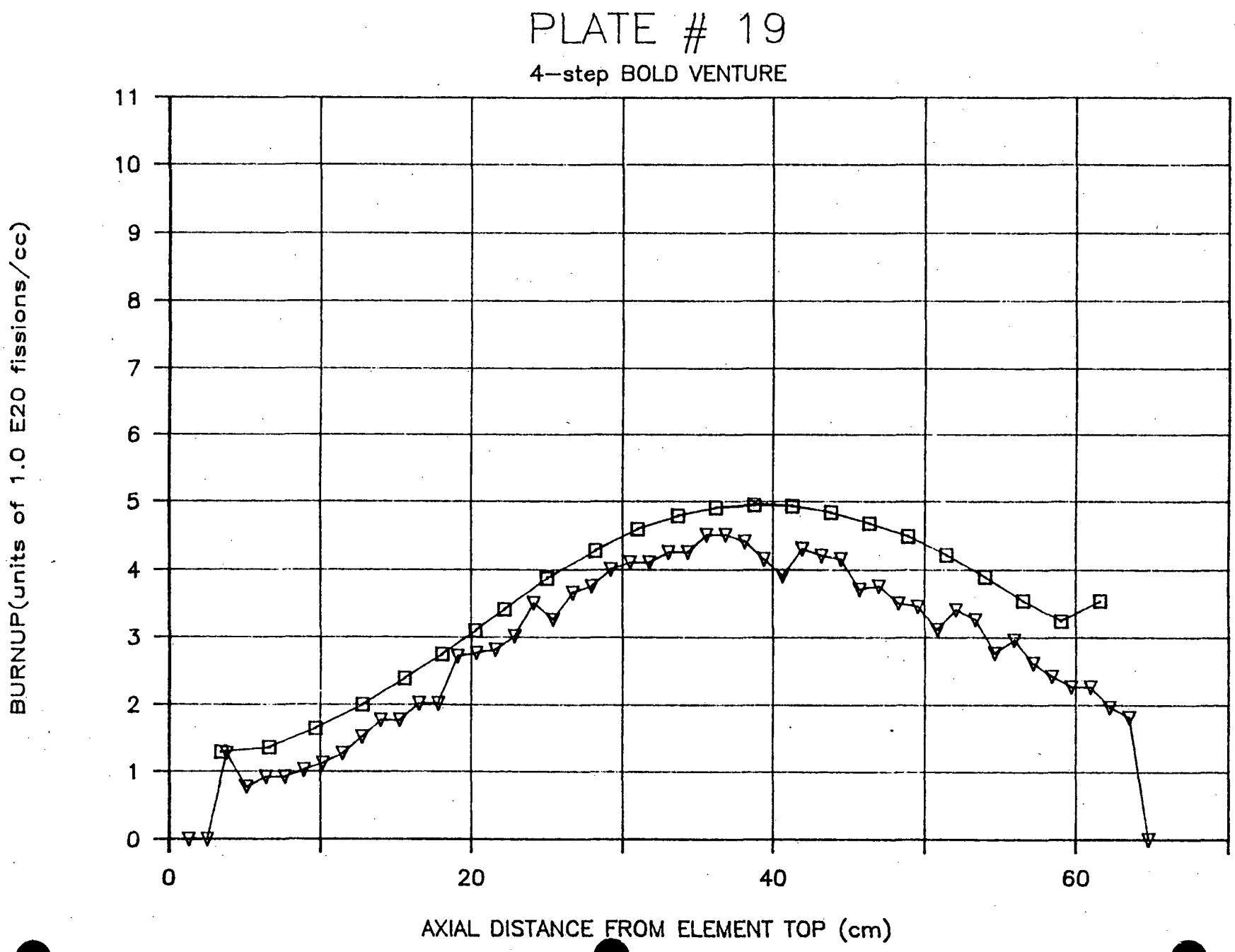


Fig. 26 Comparison of Axial Burnup Distribution in Plate 20

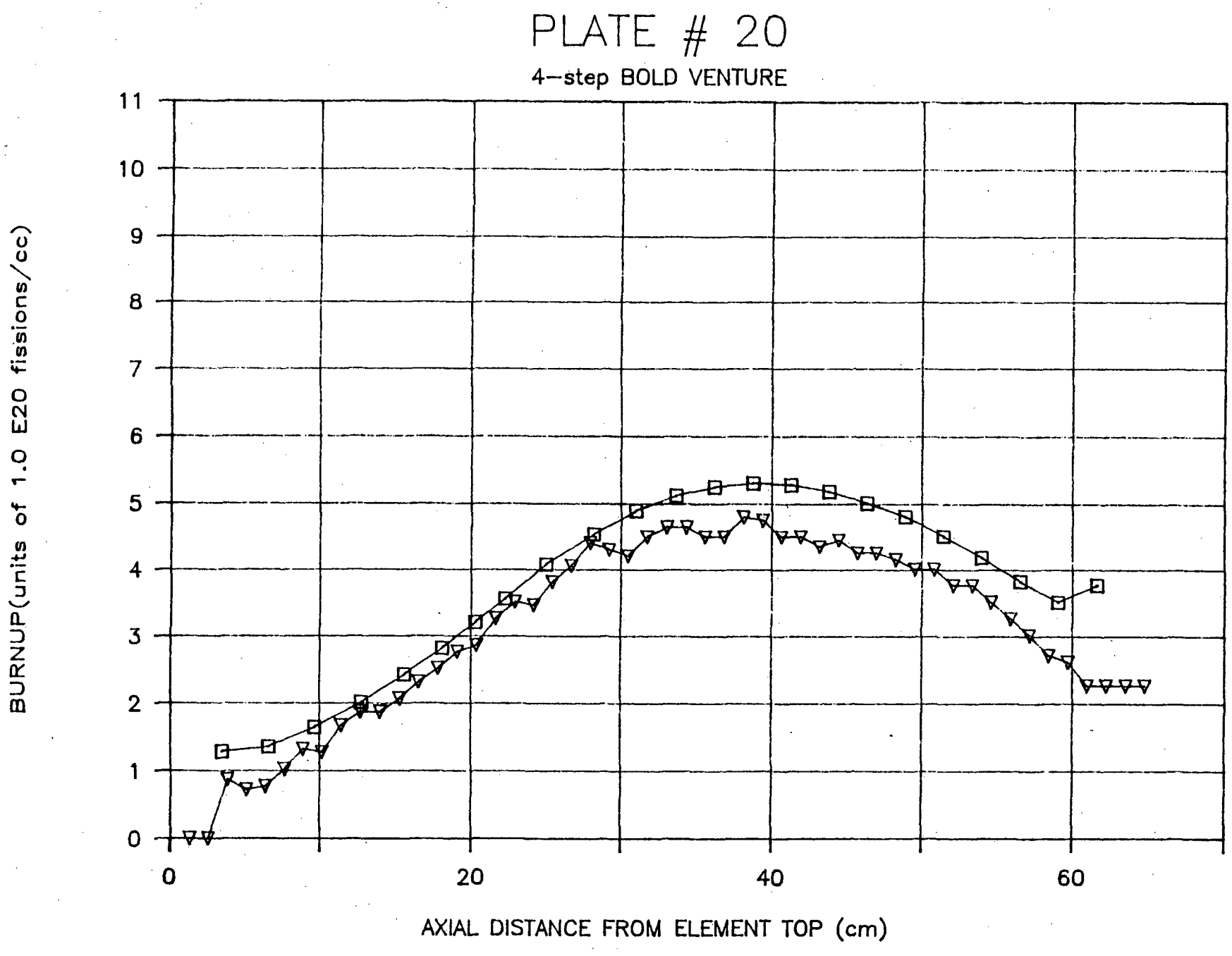


Fig. 27 Comparison of Axial Burnup Distribution in Plate 21

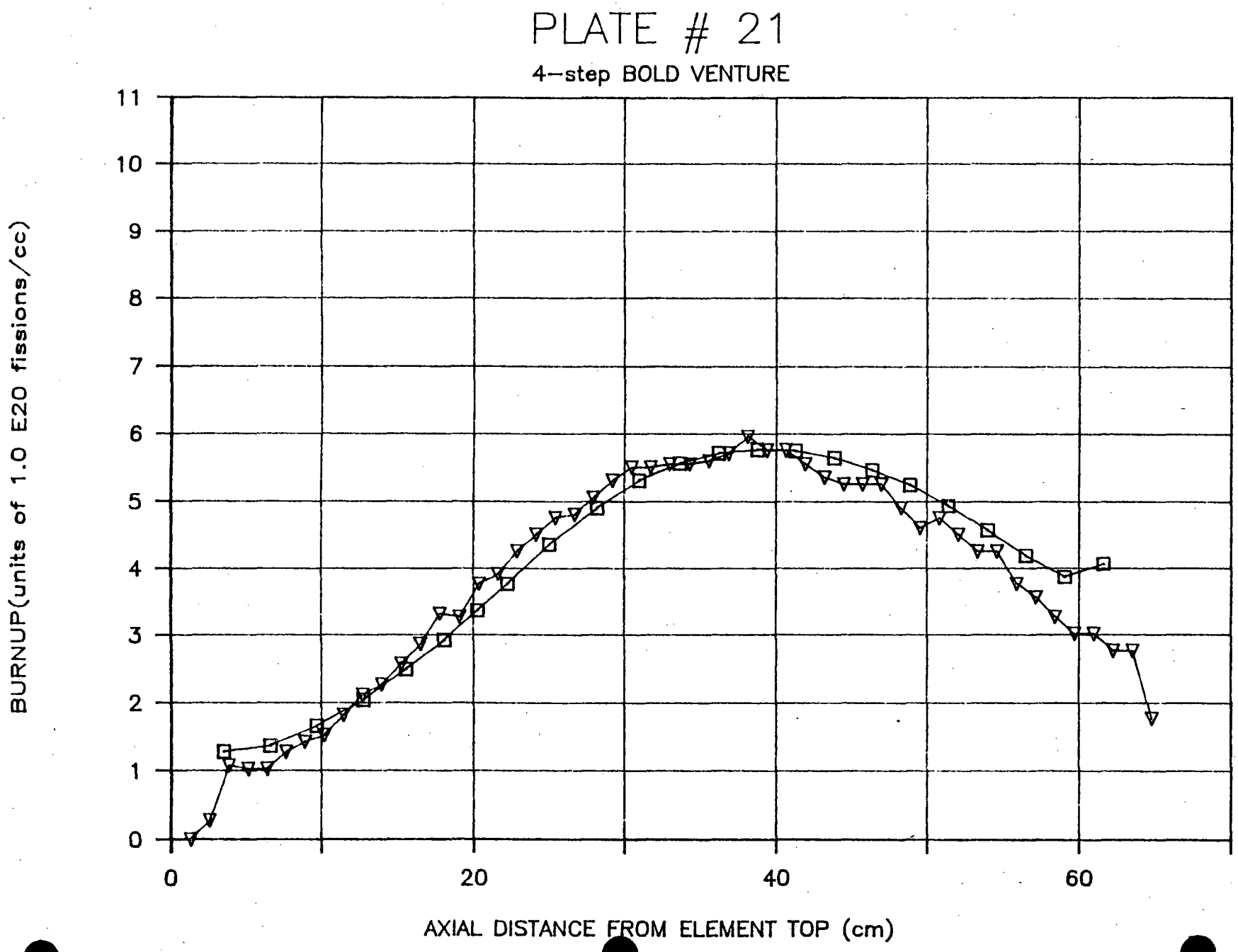


Fig. 28 Comparison of Axial Burnup Distribution in Plate 22

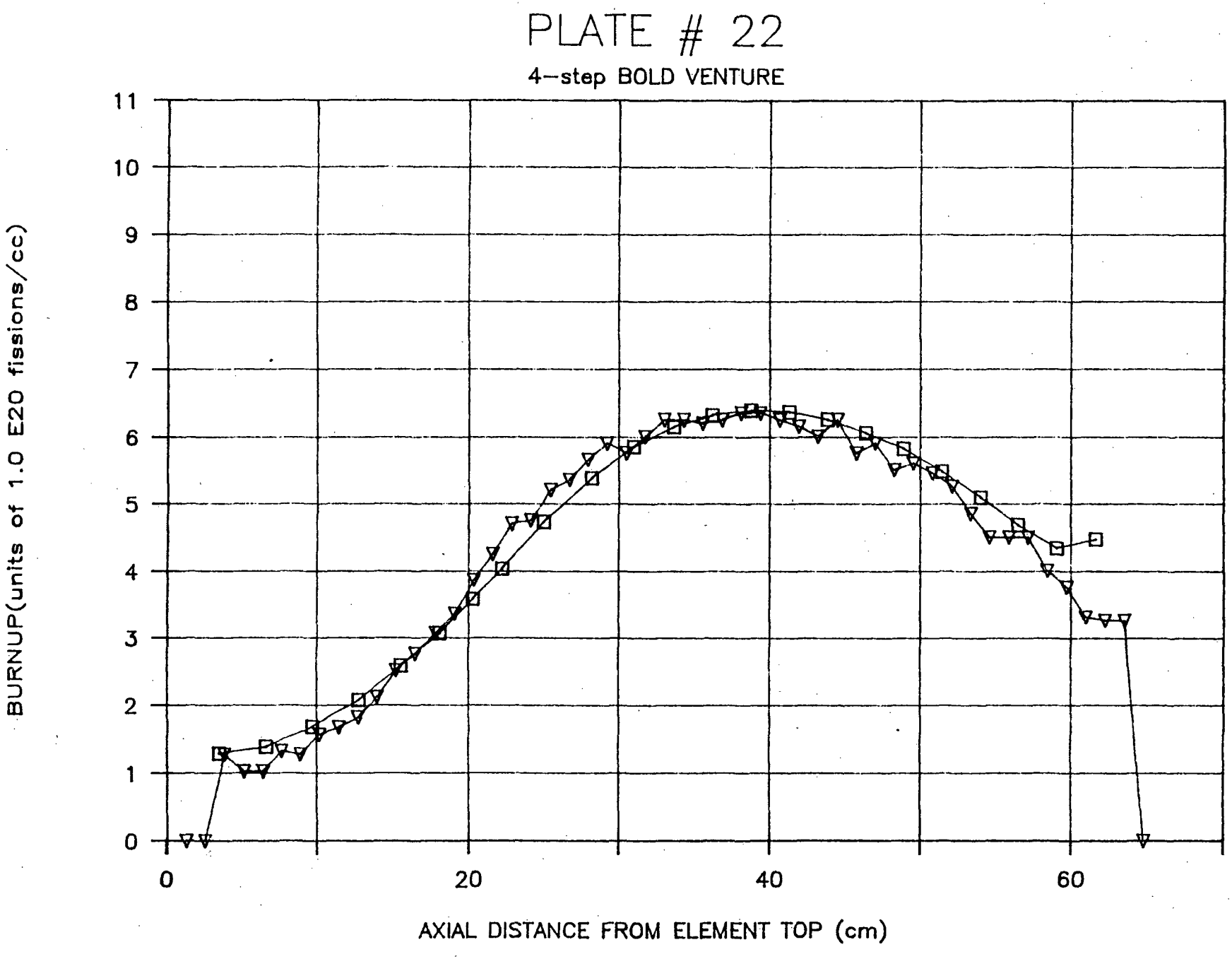


Fig. 29 Comparison of Axial Burnup Distribution in Plate 23

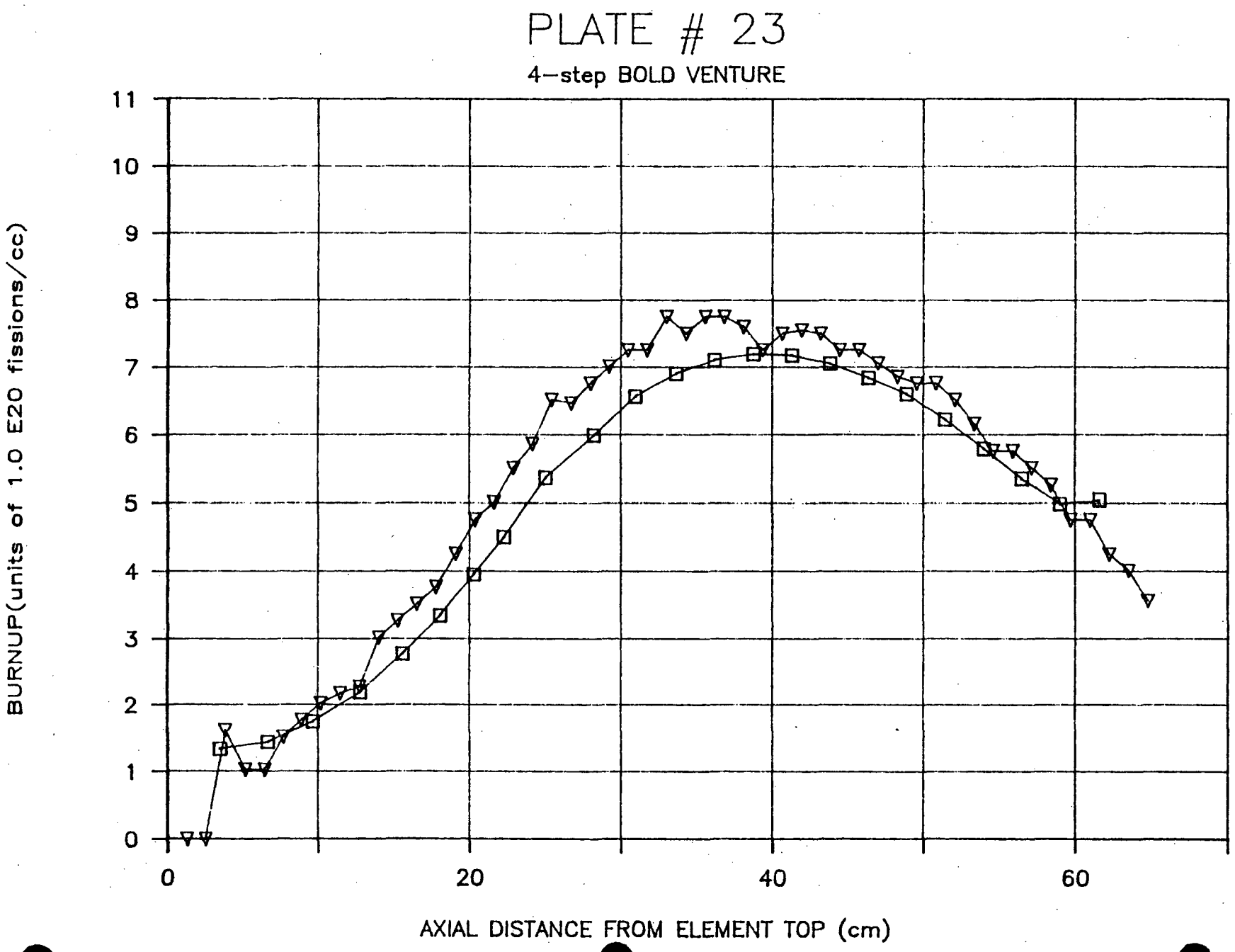
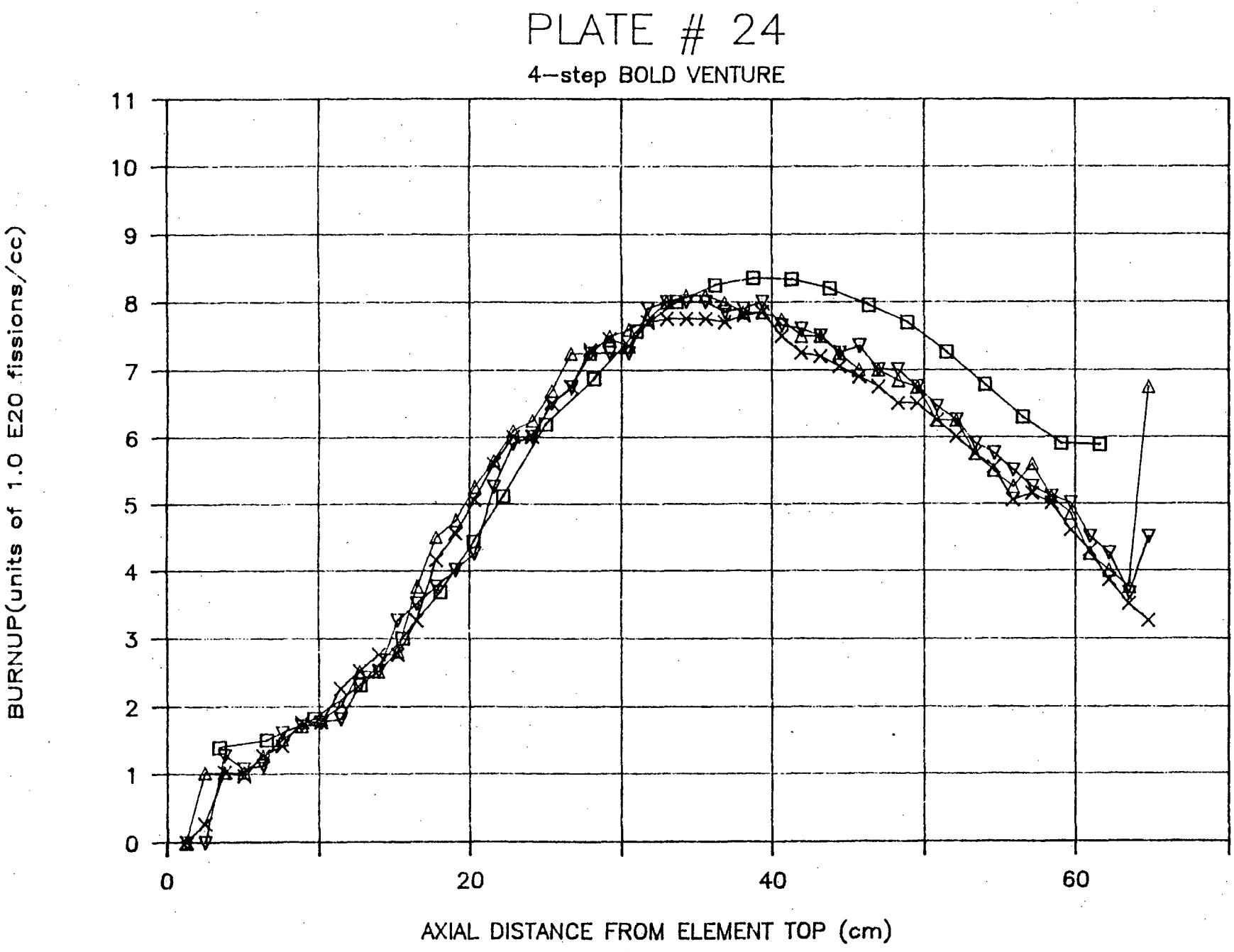


Fig. 30 Comparison of Axial Burnup Distribution in Plate 24



modeling, model based on nominal fuel loading instead of 775F3 specific loading, and interpretation of the gamma scans.

According to the figures, the axial fission peaking in the fuel plate occurs below the mid-plane of the core, showing that the existence of the control blades in the upper part of the core forces the power peak to shift downward from the mid-plane.

4. Analytical Results

Extensive BOLD VENTURE runs have been made for the MURR system using R-Z, and θ-R-Z models. The purpose of the R-Z runs was 1) to evaluate the core reactivity and the power peaks at the cold clean core condition, and 2) to deplete the 6.2 Kg core and the new 10.16 Kg core. As a reference, three sample input data files of the R-Z, θ-R, and θ-R-Z MURR models are given in Appendix B. It is to be noted that the flux trap model was used only in the benchmark study given in the previous section. The other BOLD VENTURE calculations assumed that only water is in the flux trap region. This results in more thermal neutrons reaching the inside fuel plates which is conservative since the inside fuel plates have the highest power density.

4.1 R-Z Calculations

Table 6 summarizes the BOLD VENTURE results for the 6.2 Kg and the 10.16 Kg cores at the 10 MW thermal power. Two cases, with and without natural boron in the fuel meat, were also considered in the new core analysis to see the effect to the core characteristics. Excess core reactivity was evaluated performing R-Z runs for the MURR with the four control blades fully inserted in the core. As is seen in the table, the

Table 6

R-Z Results at Cold Clean Core Condition

		Control Blade Out			Control Blade In		
		6.2 Kg Core	10.16 Kg Core		6.2 Kg Core	10.16 Kg Core	
			W/Boron	W/O Boron		W/Boron	W/O Boron
K_{eff}		1.1124	1.09389	1.13560	0.9315	0.9234	0.9545
Peak Power Density	w/cc	673.7	462.7	468.7	909.8	548.6	574.2
	at	Plate 1	Plate 23	Plate 23	Plate 1	Plate 4	Plate 4

MURR with the new fuel has about 1.9 %Δk less reactivity than that of the 6.2 Kg core at the cold clean core condition. Elimination of natural boron in the new fuel will cause a 4.2 %Δk increase in the core reactivity. This large increase in reactivity results in only a 1.3% increase in the peak power density for the new fuel without boron.

The result of the new core for the all blades out case clearly shows in the table that the maximum power peaking is significantly reduced when compared to that of the 6.2 Kg core. According to the BOLD VENTURE result, the power peak of the new core occurs at Plate 23 when the control blades are fully out, but the peak moves to Plate 4 by the time the rods are inserted to the cold clean critical position. The total worth of the four control blades for the 6.2 Kg and the 10.16 Kg cores were calculated to be -0.1809Δk and -0.1705Δk, respectively. It is to be noted that the total worth of the four blades is reported[20] to be -0.1655 Δk. The overprediction of rod worth is due to the control rod constants used are based on the actual partial 288° control blade coverage, but the R-Z model applies them to a full 360° coverage.

The R-Z model was then depleted up to 1300 MWD. Table 7 shows BOLD VENTURE result for the five burnup steps. Column three in the table clearly indicates that increase in reactivity due to burnup of the boron in the new fuel compensate to some extent for the decrease in reactivity due to fuel burnup and accumulation of fission product poisons.

4.3 θ-R-Z Calculations

The 3D calculations are expensive, but essential to verify the results of the scoping θ-R 2D calculations. When the more detailed 3D information is necessary, the 3D runs are indispensable. Using BOLD VENTURE, the

Table 7

R-Z Depletion Result

Cumulative Burnup (MWD)	Control Blade Position (Inches Withdrawn)	10.16 Kg Core W/Boron	10.16 Kg Core W/O Boron	6.2 Kg Core
0	16.38	1.05092	1.08996	1.06697
325	17.61	1.01919	1.04071	1.02537
650	19.00	1.02415	1.03725	1.02588
970	20.50	1.02541	1.03374	1.02605
1300	20.50	1.01632	1.02142	1.01731

present 6.2 Kg core and the new 10.16 Kg core at cold clean core condition was analyzed using the 3D MURR model. The result in Table 8 shows that when the rods are fully withdrawn, core reactivity of the 10.16 Kg core is lower than that of the present 6.2 Kg core by about 1.9 %. This result came out to be the same in the 2D R-Z calculations, indicating that the 2D models are simpler but still gives the consistent values. For the all blades out condition, the 2D $K_{eff's}$ are in close agreement with the 3D values within the maximum error of 0.43 %.

The total control blade worth calculated from the R-Z and the θ-R-Z runs are summarized in Table 9. The 3D model gives better agreement due to the control rod constants used are based on the actual 288° coverage which can only be model in the θ-R-Z model. In both models, the rod worth for the new core is less than that of the present 6.2 Kg core. This is due to the larger macroscopic fission cross section for U-235 causing the same macroscopic absorption cross section for control blades to have less relative importance in the new core.

5. Conclusions

The major outcome of this work has been the development of an advanced and powerful computing tool, AMPX-II/BOLD VENTURE IV, to perform MURR upgrade core analysis and other necessary nucleonics studies. Four group cross section sets for various materials in the MURR system were generated in the form of ISOTXS data files using modules of the AMPX-II system. The files were then used in BOLD VENTURE to determine the core k-eff, spatial flux and power distributions.

Table 8

MURR 3D Result

		Control Blade Out		Control Blade In	
		6.2 Kg Core	10.16 Kg Core	6.2 Kg Core	10.16 Kg Core
k_{eff}		1.11725	1.09832	0.95340	0.94667
Peak Power Density	W/cc	702.9	459.3	901.3	546.7
	at	Plate 1	Plate 23	Plate 1	Plate 4

Table 9

Total Control Blade Worth

	R-Z Model	(in ΔK) θ-R-Z Model	Experimentally Measured
6.2 Kg Core	0.1813	0.1638	0.1655
10.16 Kg Core (With Boron in fuel)	0.1705	0.1516	---

Extensive R-Z runs were made to test the validity of the BOLD VENTURE model. Benchmark calculations were performed to compare the R-Z result against the burnup data of the destructively analyzed fuel element, 775-F3. The computational results agreed well with the destructive analysis data, showing that the BOLD VENTURE code system coupled with our MURR model gives excellent fuel depletion results. Since the fuel depletion is the integral over time of the power distribution, it also confirms our accuracy in predicting the power peaking factors.

Cold clean k_{eff} calculations for the 2D and the 3D models showed that the new 10.16 kg core has less reactivity than the present 6.2 kg core by about 1.9 %, and the resulting maximum power peak is reduced significantly. Elimination of the natural boron in the new fuel will increase reactivity by about 4.2 %. The 3D results showed that 2D calculations provide consistent results proving that the 2D runs can be substituted for some expensive 3D runs.

In the 3D model of the 6.2 Kg core, the two beamport holes and the impurities in the beryllium reflector were not taken into account. According to the previous study[21], the negative reactivity for these effects are -0.0034 ΔK. When considering this, the analytical K_{eff} at the cold clean core is 1.109 which is higher than the measured data of 1.095 by about 1.3 %. This difference may be accounted for due to other details not included in the model that cause negative reactivity, such as: the thermal column and impurities in the aluminum of the fuel elements and pressure vessels.

The reactivity worth of the four control blades was also calculated and the worth in the new core came out to be less than that of the present

core by about 7%. This is due to the less importance of the control blades in the new core when compared to that in the 6.2 Kg core.

At the time of this writing, reactivity worth measurements are being performed for the four control blades to compare against the measured data in 1971. The new control blade data will be included in the future 3D calculations such as differential blade worth and each control blade worth evaluations.

Various combinations of new and depleted 775 and 1270 fuel elements are being analyzed using the θ-R model to determine which fuel loading combinations have the worst power peaks. The worst power peak cases will then be modeled three dimensionally to determine the power distributions. These results will provide the input for COBRA-3C/MURR to determine the safety limits for steady state power. A safety limit analysis report will be issued giving the results of the θ-R, θ-R-Z, and COBRA studies.

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Appendix A

Sample Input Data for AIM, AJAX, NITAWL, and XSDRNPM

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//$0365FT JOB (0365LH,SSK),'KIM',CLASS=A,MSGLEVEL=(1,1),USER=6
/*JOBPARM LINES=2,T=5,R=3000
/*ROUTE PRINT RMT44
/*SETUP TAPE=2
/*MESSAGE       **TEMPORARY TAPE NAME:LANG01,NUMBER:65 FOR 'KIM'
/*MESSAGE       **PERM. TAPE X01341 FOR 'MCKIBBEN'
//GO  EXEC PGM=MERRY
//STEPLIB DD UNIT=UMCDA,DSN=$0365F.LAIMS.LOAD(MERRY),DISP=SHR
//GO.FT45F001 DD UNIT=(TAPE,,DEFER),DISP=(NEW,PASS),
// VOL=(,RETAIN,SER=X01341),LABEL=(3,SL),
// DSN=AIM.G27,
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=3520)
//GO.FT58F001 DD UNIT=(TAPE,,DEFER),DISP=(OLD,PASS),
// VOL=(,RETAIN,SER=LANG01),LABEL=(90,SL,,IN),
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=6400),DSN=PDC.SCALE.X27
//GO.FT17F001 DD SPACE=(TRK,(600,10),RLSE),UNIT=SYSDA,
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=1693,BUFL=2040)
//GO.FT06F001 DD SYSOUT=*
//GO.FT05F001 DD *
0$$ 45 58 1$$ 1 2$$ 0 -1 1 E T
```

```
//$0365FT JOB (0365LH,SSK),'KIM',CLASS=A,MSGLEVEL=(1,1),USER=6
/*JOBPARM LINES=2,T=5
/*ROUTE PRINT RMT44
/*SETUP TAPE=2
/*MESSAGE       ** PERMANENT TAPE NAME:X01341 FOR 'MCKIBBEN'
/*MESSAGE       **RING IN X00026 FOR 'KIM'
//GO  EXEC PGM=MERRY
//STEPLIB DD UNIT=UMCDA,DSN=$0365F.LAJAXS.LOAD(MERRY),DISP=SHR
//GO.FT15F001 DD UNIT=SYSDA,DISP=(NEW,DELETE),
// SPACE=(1693,(200,20)),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=1693,BUFL=2040)
//GO.FT16F001 DD UNIT=SYSDA,DISP=(NEW,DELETE),
// SPACE=(1693,(40,20)),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=1693,BUFL=2040)
//GO.FT18F001 DD UNIT=SYSDA,DISP=(NEW,DELETE),
// SPACE=(1693,(1600,20)),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=1693,BUFL=2040)
//GO.FT19F001 DD UNIT=SYSDA,DISP=(NEW,DELETE),
// SPACE=(1693,(40,20)),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=1693,BUFL=2040)
//GO.FT45F001 DD UNIT=(TAPE,,DEFER),DISP=(OLD,PASS),
// VOL=(,RETAIN,SER=X01341),LABEL=(3,SL,,IN),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=3520),
// DSN=AIM.G27
//GO.FT23F001 DD UNIT=(TAPE,,DEFER),DISP=(NEW,PASS),
// VOL=(,RETAIN,SER=X00026),LABEL=(44,SL),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=3520),
// DSN=AJAX.G27
//GO.FT06F001 DD SYSOUT=*
//GO.FT05F001 DD *
0$$ 23 45
1$$ 1 T
2$$ 45 37 T
3$$
999 1001 1002 2004 3007 4009 5010 5011 6012 8016 9019
11023 13027 14028 16032 17000 19039 24000 24304 24404
25055 26000 26304 28304 29000 47109 49115 92234 92235
92236 92238 93237 94238 94239 94240 94241 94242
T
```

```
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/*SETUP TAPE=2
/*MESSAGE       **PERMANENT TAPE NAME:X01341 FOR 'MCKIBBEN'
/*MESSAGE       **RING IN  X00026 FOR 'KIM'
//GO  EXEC PGM=MERRY
//STEPLIB DD UNIT=UMCDA,DSN=$0365F.NITAWL.LOAD(MERRY),DISP=SHR
//GO.FT04F001 DD UNIT=(TAPE,,DEFER),DISP=(NEW,PASS),
// VOL=(,RETAIN,,SER=X00026),LABEL=(45,SL),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=3520),
// DSN=NITAWL.G27
//GO.FT09F001 DD UNIT=SYSDA,SPACE=(CYL,(30,5),RLSE),
// DCB=(DSORG=DA,RECFM=F,BLKSIZE=3520)
//GO.FT10F001 DD UNIT=SYSDA,SPACE=(CYL,(30,5),RLSE),
// DCB=(DSORG=DA,RECFM=F,BLKSIZE=3520)
//GO.FT22F001 DD UNIT=(TAPE,,DEFER),DISP=(OLD,PASS),
// VOL=(,RETAIN,,SER=X01341),LABEL=(3,SL,,IN),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=3520),
// DSN=BONAMI.G27
//GO.FT18F001 DD UNIT=SYSDA,SPACE=(TRK,(900,50),RLSE),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=3520)
//GO.FT19F001 DD UNIT=SYSDA,SPACE=(TRK,(900,50),RLSE),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=3520)
//GO.FT06F001 DD SYSOUT=*
//GO.FT05F001 DD *
0$$ 22 E
1$$ 0 38 0 0 0 0 0 3 0 0 -1 0 T
2$$
999 1001 1002 2004 3007 4009 5010 5011 6012 8016 9019 11023
13027 130271 14028 16032 17000 19039 24000 24304 24404 25055
26000 26304 28304 29000 47109 49115 92234 92235 92236
92238 93237 94238 94239 94240 94241 94242
3**
92238 355.2 1 0.0254 0.407 9.2853+4 2.1288-4 1 26.98
319.86 1 235.05 145.6 1 0.0133
92235 355.2 1 0.0254 0.407 5.3+3 3.7354-3 1 26.98
18.2 1 238.05 0.473 1 0.0133
92234 355.2 1 0.0254 0.407 4.89+5 4.0358-5 1 26.98
1.687+3 1 235.05 768.2 1 0.0133
T
```

```
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/*ROUTE PRINT RMT44
/*SETUP TAPE=2
/*MESSAGE       **PERMANENT TAPE NAME:X01341 FOR 'MCKIBBEN'
/*MESSAGE       ** PERM.TAPE X00026 FOR 'KIM'
//GO  EXEC PGM=MERRY
//STEPLIB DD UNIT=UMCDA,DSN=$0365F.XSDRNPM.LOAD(MERRY),DISP=SHR
//GO.FT04F001 DD UNIT=(TAPE,,DEFER),DISP=(OLD,PASS),
// VOL=(,RETAIN,,SER=X00026),LABEL=(45,SL,,IN),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=3520),
// DSN=NITAWL.G27
//GO.FT08F001 DD UNIT=SYSDA,SPACE=(3520,(200,20))
//GO.FT09F001 DD UNIT=SYSDA,SPACE=(3520,(200,20))
//GO.FT10F001 DD UNIT=SYSDA,SPACE=(3520,(200,20))
//GO.FT16F001 DD UNIT=SYSDA,DISP=(,DELETE),SPACE=(1693,(40,20))
//GO.FT17F001 DD UNIT=SYSDA,DISP=(,DELETE),SPACE=(1693,(40,20))
//GO.FT18F001 DD UNIT=SYSDA,DISP=(,DELETE),SPACE=(1693,(40,20))
//GO.FT19F001 DD UNIT=SYSDA,DISP=(,DELETE),SPACE=(1693,(40,20))
//GO.FT20F001 DD DUMMY
//GO.FT03F001 DD UNIT=(TAPE,,DEFER),DISP=(NEW,PASS),
// VOL=(,RETAIN,,SER=X01341),LABEL=(4,SL),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=3520),
// DSN=XSDRNPM.G27
//GO.FT06F001 DD SYSOUT=*
//GO.FT05F001 DD *
XSDRNPM RUN 'FROM 27 TO 27'
1$$ 1 3 7 1 3 3 12 4 3 1 20 10 0 0 0
2$$ -2 0 1 E
3$$ 1 0 0 1 E
4$$ -1 27 0 -2 E
5** 1-3 1-3 1.0 A6 1.420892 60.96 16.0 E
T
13$$ 9R1 2 2R3
14$$ 92234 92235 92236 92238 94239 94240 94241 94242
130271 13027 1001 8016
15** 4.0358-5 3.7354-3 1.9169-5 2.1288-4 1-15 1-15
1-15 1-15 4.86-2 5.98-2 6.6-2 3.3-2
T
34** F1 T
35** 2I0.0 0.0254 2I 0.0635 0.1651
36$$ 3R1 2 3R3
39$$ 1 2 3
40$$ F3
47** F1
51$$ 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
19 20 21 22 23 24 25 26 27
T
```

```
//$0365FT JOB (0365LH,SSK),'KIM',CLASS=A,MSGLEVEL=(1,1),USER=6
/*JOBPARM LINES=4,T=1,R=4000
/*ROUTE PRINT RMT44
/*SETUP TAPE=1
/*MESSAGE       **PERMANENT TAPE NAME:X02096 FOR 'MCKIBBEN'
//GO  EXEC PGM=MERRY
//STEPLIB DD UNIT=UMCDA,DSN=$0365F.XSDRNPM.LOAD(MERRY),DISP=SHR
//GO.FT04F001 DD UNIT=(TAPE,,DEFER),DISP=(OLD,PASS),
// VOL=(,RETAIN,,SER=X02096),LABEL=(1,SL,,IN),
// DCB=(RECFM=VBS,LRECL=X,BLKSIZE=3520),
// DSN=COM.NITAWL
//GO.FT08F001 DD UNIT=SYSDA,SPACE=(3520,(200,20))
//GO.FT09F001 DD UNIT=SYSDA,SPACE=(3520,(200,20))
//GO.FT10F001 DD UNIT=SYSDA,SPACE=(3520,(200,20))
//GO.FT16F001 DD UNIT=SYSDA,DISP=(,DELETE),SPACE=(1693,(40,20))
//GO.FT17F001 DD UNIT=SYSDA,DISP=(,DELETE),SPACE=(1693,(40,20))
//GO.FT03F001 DD UNIT=SYSDA,DISP=(,DELETE),
// SPACE=(1693,(40,20))
//GO.FT18F001 DD UNIT=SYSDA,DISP=(,DELETE),SPACE=(1693,(40,20))
//GO.FT19F001 DD UNIT=SYSDA,DISP=(,DELETE),SPACE=(1693,(40,20))
//GO.FT20F001 DD UNIT=UMCTS,DISP=(NEW,CATLG),
// SPACE=(TRK,(50,50),RLSE),
// DSN=$0365F.AMPXII.ISOTXS,DCB=(RECFM=VBS,LRECL=X,BLKSIZE=3520)
//GO.FT06F001 DD SYSOUT=*
//GO.FT05F001 DD *
XSDRNPM RUN TO MAKE AN 'ISOTXS' FOR THE X27 LIBRARY
1$$ 2 17 43 1 0 17 56 4 1 1 20 10 0 0 0
2$$ -2 0 1 E
3$$ 1 0 0 1 E
4$$ 0 4 20 -2 56 A8 1 E
5** 1-4 1-4 1.0 A6 1.420892 60.96 0.0 E
T
13$$ 8R1 2 3R3 11R4 3R5 6 2R7 8 8R9 10 2R11 2R12
2R13 5R14 3R15 16 2R17
14$$ 1001 8016 16032 17000 19039 29000 47109 49115
13027 1001 8016 13027 92234 92235 92236
92238 94239 94240 94241 94242 130271 1001 8016
13027 1001 8016
13027 1001 8016 13027 5010 5011 13027 6012 26304
24304 28304 25055 13027 1001 8016 4009 3007
1001 8016 6012 13027 1001 8016 1002 1001 8016 14028
13027 1001 8016
15** 6.6852-2 3.3426-2 1-15 1-15 1-15 1-15 1-15 1-15
6.0243-2 6.297-2 3.147-2 3.005-3
4.0358-6 3.7354-4 1.9169-6 2.1288-5 1-15 1-15 1-15
1-15 5.98-2 6.68-2 3.34-2 3.005-3 6.297-2 3.147-2
6.0243-2 6.6852-2 3.3426-2
6.0243-2 1-15 1-15 1-15 1-15 1-15 1-15 1-15 1-15 1-15
6.6852-2 3.3426-2 1.23-1 1-15 6.6852-2 3.3426-2
4.9-2 1.3-2 3.35-3 1.675-3 1-15 6.6852-2 3.3428-2
1-15 6.0243-2 6.6852-2 3.3426-2
16$$ 11001 18016 116032 117000 119039 129000 147109
149115 213027 31001 38016 313027 492234 492235 492236
492238 494239 494240 494241 494242 4130271 41001 48016
```

```
513027 51001 58016 613027 71001 78016 813027 95010
95011 913027 96012 926304 924304 928304 925055
1013027 111001 118016 124009 123007 131001 138016
146012 1413027 141001 148016 141002 151001 158016
1514028 1613027 171001 178016
T
34** F1 T
35** 1I 0.0 5.72 6.76 5I 6.93 14.85 14.98
3I 15.94 2I 16.4 4I 16.53 2I 16.78 3I 16.88
17.36 24.25 3I 24.57 47.14 1I 47.63 2I 50.17 63.34
36$$ 2R1 2 3 6R4 5 6 4R7 3R8 5R9 3R10 4R11 12 13
4R14 15 2R16 3R17
39$$ 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
40$$ F1
51$$ 5R1 4R2 10R3 8R4
T
```

Appendix B

Sample BOLD VENTURE Input Data for the R-Z, θ-R, and θ-R-Z Geometry

```
//*$0365FU JOB (0365LH,XXX),'KIM',MSGLEVEL=(1,1),USER=6
//$0365FG JOB (6365LH,     ),'KIM',MSGLEVEL=(1,1)
/*JOBPARM T=29,LINES=48,R=4400
/*XEQ IDLE
//*  X-SECTIONS FROM ISOTXS 'THIS IS A TEST FOR DEPLETION'
/*ROUTE PRINT RMT12
//BOLDVENT PROC GOSIZE=4326K,MODULE=SCALE,
// NB1=1,NB2=1,B1=3520,B2=32000,NX=2,NS=50,N1=100,
// N2=436,N3=10,N4=1,N5=192,N6=10,N7=12,N8=12,N9=109,
// N10=109,N11=165,N12=1,N13=109,N14=1,N15=10,
// N16=436
//GO     EXEC  PGM=&MODULE,REGION=&GOSIZE    PUBLIC.
//STEPLIB  DD DISP=SHR,UNIT=UMCTS,DSN=$0365F.BOLD.VENTURE.LOAD
//    DD DSN=UM.FORTRAN.COMPLIB,DISP=SHR
//PRINT    DD  SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=1100)
//FT01F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),
//             DCB=(RECFM=VBS,LRECL=X,BUFNO=&NB1,BLKSIZE=&B1)
//FT02F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT03F001 DD UNIT=SYSDA,SPACE=(80,(10)),DCB=(RECFM=F,BLKSIZE=80)
//FT04F001 DD UNIT=SYSDA,SPACE=(3200,(&N1,&NX)),
//             DCB=(RECFM=FBS,LRECL=80,BLKSIZE=3200)
//FT05F001 DD UNIT=SYSDA,SPACE=(3120,(200,100)),
//             DCB=(RECFM=FB,BUFNO=1,LRECL=80,BLKSIZE=3120)
//FT06F001 DD  SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=1100)
//FT07F001 DD SYSOUT=B,DCB=(RECFM=F,BLKSIZE=80)
//FT08F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT09F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT10F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS 1)),DCB=*.FT01F001
//FT11F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT12F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT13F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT14F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT15F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NS)),DCB=*.FT01F001
//FT16F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT17F001 DD UNIT=SYSDA,SPACE=(&B1,(&N16,1)),DCB=*.FT01F001
//FT18F001 DD UNIT=SYSDA,SPACE=(&B1,(&N16,1)),DCB=*.FT01F001
//FT19F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT20F001 DD UNIT=SYSDA,SPACE=(&B1,(&N13,1)),DCB=*.FT01F001
//FT21F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT22F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT23F001 DD UNIT=SYSDA,SPACE=(&B1,(&N3,1)),DCB=(RECFM=FB,BUFNO=&NB1)
//FT24F001 DD UNIT=SYSDA,SPACE=(&B1,(&N2,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT25F001 DD UNIT=SYSDA,SPACE=(&B1,(&N12,1)),DCB=(RECFM=FB,BUFNO=&NB1)
//FT26F001 DD UNIT=SYSDA,SPACE=(&B1,(&N12,1)),DCB=(RECFM=FB,BUFNO=&NB1)
//FT27F001 DD UNIT=SYSDA,SPACE=(&B1,(&N2,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT28F001 DD UNIT=SYSDA,SPACE=(&B1,(&N2,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT29F001 DD UNIT=SYSDA,SPACE=(&B1,(&N14,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT30F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT31F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT32F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT33F001 DD UNIT=SYSDA,SPACE=(&B1,(&N4,1)),DCB=*.FT01F001
//FT34F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT35F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT36F001 DD UNIT=SYSDA,SPACE=(&B1,(&N6,2)),DCB=*.FT01F001
```

```
//FT37F001 DD UNIT=SYSDA,SPACE=(&B1,(&N15,2)),DCB=*.FT01F001
//FT38F001 DD UNIT=SYSDA,SPACE=(&B1,(&N15,2)),DCB=*.FT01F001
//FT39F001 DD UNIT=SYSDA,SPACE=(&B1,(&N15,2)),DCB=*.FT01F001
//FT40F001 DD UNIT=SYSDA,SPACE=(&B2,(&N5,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT41F001 DD UNIT=SYSDA,SPACE=(&B1,(&N4,1)),DCB=*.FT01F001
//FT42F001 DD UNIT=SYSDA,SPACE=(&B2,(&N7,1)),
//              DCB=(RECFM=VBS,LRECL=X,BUFNO=&NB2,BLKSIZE=&B2)
//FT43F001 DD UNIT=SYSDA,SPACE=(&B2,(&N8,1)),DCB=*.FT42F001
//FT44F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT45F001 DD UNIT=SYSDA,SPACE=(&B1,(&N9,1)),DCB=*.FT01F001
//FT46F001 DD UNIT=SYSDA,SPACE=(&B1,(&N10,1)),DCB=*.FT01F001
//FT47F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT48F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT49F001 DD UNIT=SYSDA,SPACE=(&B1,(&N11,1)),DCB=*.FT01F001
//FT50F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT51F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT52F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT53F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT54F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT55F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT56F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT70F001 DD UNIT=SYSDA,SPACE=(&B1,(&N4,1)),DCB=*.FT01F001
//FT71F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT72F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT73F001 DD UNIT=SYSDA,SPACE=(&B1,(&N4,1)),DCB=*.FT01F001
//FT74F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT75F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT76F001 DD UNIT=SYSDA,SPACE=(&B1,(&N6,2)),DCB=*.FT01F001
//FT77F001 DD UNIT=SYSDA,SPACE=(&B1,(&N15,2)),DCB=*.FT01F001
//FT78F001 DD UNIT=SYSDA,SPACE=(&B1,(&N15,2)),DCB=*.FT01F001
//FT79F001 DD UNIT=SYSDA,SPACE=(&B1,(&N15,2)),DCB=*.FT01F001
//FT80F001 DD UNIT=SYSDA,SPACE=(&B2,(&N5,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT81F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT82F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT83F001 DD UNIT=SYSDA,SPACE=(&B1,(&N4,1)),DCB=*.FT01F001
//FT84F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT85F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT86F001 DD UNIT=SYSDA,SPACE=(&B1,(&N6,2)),DCB=*.FT01F001
//FT87F001 DD UNIT=SYSDA,SPACE=(&B1,(&N15,2)),DCB=*.FT01F001
//FT88F001 DD UNIT=SYSDA,SPACE=(&B1,(&N15,2)),DCB=*.FT01F001
//FT89F001 DD UNIT=SYSDA,SPACE=(&B1,(&N15,2)),DCB=*.FT01F001
//FT90F001 DD UNIT=SYSDA,SPACE=(&B2,(&N5,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT91F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT92F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT93F001 DD UNIT=SYSDA,SPACE=(&B1,(&N4,1)),DCB=*.FT01F001
//FT94F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT95F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT96F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT97F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT98F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT99F001 DD  SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=1100)
//         PEND
//BURN EXEC BOLDVENT,
// NB1=1,NB2=1,B1=3520,B2=32000,N1=100,N2=436,
```

```
// N3=10,N4=1,N5=192,N6=10,N7=12,N8=12,N9=109,
// N10=109,N11=165,N12=1,N13=109,N14=1,N15=10,
// N16=436,GOSIZE=4326K
//FT11F001 DD UNIT=UMCTS,DISP=SHR,
// DSN=$0365F.GRUPXS.FINAL
//*FT15F001 DD UNIT=UMCTS,DISP=(NEW,CATLG),
//* DSN=$0365F.OZARK.RTMARCH,SPACE=(TRK,(10,10),RLSE),
//* DCB=(RECFM=VBS,LRECL=X,BLKSIZE=3520)
//*FT12F001 DD UNIT=UMCTS,DISP=(OLD,PASS),
//* DSN=$0365F.RTMARCH
//GO.SYSIN DD *
=CONTROL1
  R-Z MURR K CALCULATION 360 DEG  C.R. AT 26 3GP X-SECT
999999                                  1                    1
  2  6  1  2  7  2  1  2  1  9  3  2 12  7  9  3 13  7  9  3  2 12  7  9
  3 13  7  9  3  2 12  7  9  3 13  7  9  3  2 12  7  9  3 13  7  9  3  0
  GRUPXS
END
DCRSPR
           0
END
INPUT PROCESSOR
0V RODSET
1D
 $NCRN NFRN NCR NERT NSRPS NCYD NSE NOE ISV MRW MRI NSH I1$
   4     2   1   12     5    1    0   0   0   0  0  0 0 8R
2D  $HNR  HNF  ADR  ADF$
 *B10C  * *B11C  * *C12A  * *AL7   *
 *H1E   * *016E  *
 4.5982-3 1.8649-2 0.6614-2 3.6-2
 6.6852-2 3.3426-2
3D $NRZ$
 9 42 43 44 45 46 47 48 49 50 51 0
4D $FEH NOP J1$
 0.0   0    0 10R
5D $IF NOP IS 0 THEN NZI IS THE LAST ZONE IS SET J$
  47
4D 0.25    1    0 10R
5D +1
4D 0.5    1    0 10R
5D +1
4D 0.75    1    0 10R
5D +1
4D 1.    1    0 10R
5D +0
STOP
END
DVENTR
001
                                0.0       0.5   +07    1.0       1.0
                                                    0.000005  0.000005

  1  0  0  0  0  0  0           0  0
  1  1  0  0  0                 0          0  0  0  2  2
```

```
 42 51  2 23  1.0
  0
 013
  27
  27
 H1A   O16A  AL1   H1B   O16B  AL2   U234  U235  U236  U238  AL3   H1C
 O16C  AL4   HID   O16D  PU239 PU240 PU241 PU242 XE135 PM148 PM147 PM148M
 SM149 SSFP  NSFP
  24
 AL5   H1E   O16E  BE9   HIG   O16G  C12B  AL9   H1H   O16H  H1I   O16I
 AL10  HIJ   O16J  AL6   B10C  B11C  AL7   AL8   HIF   O16F  C12A  LI6
 020
   1  1
 H1A   6.6852    -2O16A  3.3426    -2
   2  2
 AL1   6.0243    -2
   3  3
 H1B   6.297     -2O16B  3.147     -2AL2   3.005     -3
   4  4
 U234  5.191     -6U235  4.8050    -4U236  2.466     -6U238  2.739     -5
 PU239  1.0     -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
 XE135  1.0     -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
 SM149  1.0     -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
 H1C    3.7049  -2O16C   1.8525   -2
   5  5
 AL4   3.005     -3HID   6.297     -2O16D  3.147     -2
   6  6
 AL5   6.0243    -2
   7  7
 H1E   6.6852    -2O16E  3.3426    -2
   8  8
 AL6   6.0243    -2
   9  9
 B10C  4.5982    -3B11C  1.8649    -2AL7   3.60      -2C12A  0.66      -2

  10 10
 AL8   6.0243    -2
  11 11
 HIF   6.685     -2O16F  3.34      -2
  12 12
 BE9   1.236     -1LI6   1.31      -6
  13 13
 HIG   6.6852    -2O16G  3.3426    -2
  14 14
 C12B  4.9       -2AL9   1.3       -2H1H   3.35      -3O16H  1.675     -3

  15 15
 H1I   6.68      -2O16I  3.34      -2
  16 16
 AL10  6.0243    -2
  17 17
 HIJ   6.685     -2O16J  3.34      -2
  18 18
 H1A   6.685     -2O16A  3.34      -2
```

```
003
  7  1  2  2  2                4 11
  0.0          0.0          0.08406       0.2
  9 42 43 44 45 46 47 48 49 50 51
004                R-Z GEOMETRY MESH
  4 5.715      1 1.041      1 .1741      1 .3302      1 .3302      8 2.6416
  1 .3302     11 3.6322     1 .3302      1 .3302      1 .1311      1 .96
  2 .488       1 .0963      3 .255       1 .0963      2 .488       4 6.884
  1 .316       4 22.58      1 .478       2 2.54       4 13.176
  1 20.0       1 4.445      2 8.89       1 1.905      2 5.710      2 5.710
  1 3.83       1 3.518      1 3.132      6 18.74      8 20.32      1 1.905
  1 1.905      2 6.985      1 4.445      1 2.54       3 20.0
005
  1  2 18 18 18 18 18 18 18 18 18  6  7  9  9  9 11 11 13 13 15 15 17
  1  2 18 18 18 18 18 18 18 18 18  6  7  9  9  9 11 12 13 14 15 16 17
  1  2  3 19 19 19 19 19 19 19  5  6  7  9  9  9 11 12 13 14 15 16 17
  1  2  3 20 20 20 20 20 20 20  5  6  7 42 42 42 11 12 13 14 15 16 17
  1  2  3  4 24 27 30 33 36 39  5  6  7 43 43 43 11 12 13 14 15 16 17
  1  2  3  4 24 27 30 33 36 39  5  6  7 44 44 44 11 12 13 14 15 16 17
  1  2  3  4 24 27 30 33 36 39  5  6  7 45 45 45 11 12 13 14 15 16 17
  1  2  3  4 24 27 30 33 36 39  5  6  7 46 46 46 11 12 13 14 15 16 17
  1  2  3  4 24 27 30 33 36 39  5  6  7 47 47 47 11 12 13 14 15 16 17
  1  2  3 22 25 28 31 34 37 40  5  6  7 48 48 48 11 12 13 14 15 16 17
  1  2  3 23 26 29 32 35 38 41  5  6  7 49 49 49 11 12 13 14 15 16 17
  1  2  3 20 20 20 20 20 20 20  5  6  7 50 50 50 11 12 13 21 15 16 17
  1  2  3 19 19 19 19 19 19 19  5  6  7 51 51 51 11 12 13 21 15 16 17
  1  2  3 19 19 19 19 19 19 19  5  6  7  7  7  7  7 12 13 21 15 16 17
  1  2 18 18 18 18 18 18 18 18 18  6  7  7  7  7  7 12 13 21 15 16 17
  1  2 18 18 18 18 18 18 18 18 18  6  7  7  7  7  7 12 13 13 15 16 17
  1  2 18 18 18 18 18 18 18 18 18  6  7  7  7  7  7 11 13 13 15 16 17
012
  0
  1  1  1  1  1.0
  2  2  1  2  1.0
  3  3  1  3  1.0
  4  4  1  4  1.0
  5  5  1  5  1.0
  6  6  2  6  1.0
  7  7  2  7  1.0
  8  8  2  8  1.0
  9  9  2  9  1.0
 10 10  2 10  1.0
 11 11  2 11  1.0
 12 12  2 12  1.0
 13 13  2 13  1.0
 14 14  2 14  1.0
 15 15  2 15  1.0
 16 16  2 16  1.0
 17 17  2 17  1.0
 18 18  1 18  1.0
 19 19  1 19  1.0
 20 20  1 20  1.0
 21 21  2 21  1.0
 22 41  1 22  1.0
```

```
 19 19
H1C   5.971     -2016C  2.985     -2AL3   5.98      -3
 20 20
H1C   3.748     -2016C  1.874     -2AL1   2.60      -2
 21 21
C12B  4.404     -2AL9   1.4669    -2H1H   4.847     -3016H  2.423     -3

 22 41
U234  5.191     -6U235  4.8050    -4U236  2.466     -6U238  2.739     -5
PU239  1.0     -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0     -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0     -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C   1.8525   -2
 42 51
B10C  4.5982    -3B11C  1.8649    -2AL7   3.60      -2C12A  0.66      -2


END
DUTLIN
RRTINS        0  1  0 48
 0.5      +7
                 1           1  0                                  2  2  7

BLANK
END
 INPUT PROCESSOR
0V FPRINT
 1D 2 0 0 1
 2D *PWDINT* 0 0 0
 2D *FISSOR* 0 0 0
STOP
END
DUTLIN
EXPINS        0 51  0 40
      32.5          0.0



                                        0.0000


     0  3     1  1                  0     0  0
                 1     1         0           0  0
BLANK
END
INPUT PROCESSOR
0V EXPOSE
1D /  FILE REFERENCE INFORMATION
0 19 0 1 0  3 5 5 0 0 0 12 0 43 0 6R
2D / TITLE AND NUCLIDE NAMES
*     DEPLETION MODULE TEST WITH 8 HEAVY METALS + 7 FP'S                *
*U234  * *U235  * *U236  * *U238  * *PU239 * *PU240 * *PU241 * *PU242 *
```

```
*XE135 * *PM147 * *PM148 * *PM148M* *SM149 * *NSFP  * *SSFP  * *B10C  *
*B11C  * *BE9   * *LI6   *
3D /  REFERENCE DATA
 0.0 /
2 5 7
9 10 13  14 15 /
7 9 10 11 12
4D /  DECAY DATA
1.495-09 2.118-05 8.378-09 1.488-06 1.943-07
5D /  FISSION PRODUCT YIELD DATA
0.0641 0.072 0.065
0.027  0.027 0.027
0.013  0.013 0.013
1.5466 1.5466 1.5011
0.0134 3R
6D /  CHAIN DATA FOR MATRIX EXPONENTIAL
1 2 2  2 3 2     4 5 1  5 6 2  6 7 2  7 8 2     11 13 2
    15 14 2   10 11 100002    10 12 900002
16 17 2  18 19 3
8D / BASIC DATA
4 2 5 2 6 2 7 2 8 0  /
1 2 2 2 3 0  /
9 0  /
10 900002 12 2 13 0  /
10 100002 11 2 -13 0  /
15 2 14 0  /
16 2 17 0  /
18 3 19 0 0  /
STOP
END
DUTLIN
RODINS        0  6  0 24

        3              1                  1
BLANK
END
DUTLIN
RODINS        0  6  0 24

        3              2                  1
BLANK
END
DUTLIN
RODINS        0  6  0 24

        3              3                  1
BLANK
END
DUTLIN
RODINS        0  6  0 24

        3              4                  1
BLANK
END
```

```
//*//*$0365FR JOB (6365LH,     ,'KIM',MSGLEVEL=(1,1)
//**JOBPARM T=56,LINES=30,R=4400
//**XEQ IDLE
//$0365FZ JOB (0365LH,  ..),'KIM',MSGLEVEL=(1,1),USER=6
/*JOBPARM T=3,LINES=6,R=4400
/*ROUTE PRINT RMT44
//BOLDVENT PROC GOSIZE=4326K,MODULE=SCALE,
// NB1=1,NB2=1,B1=3520,B2=32000,NX=2,NS=50,N1=100,
// N2=436,N3=10,N4=1,N5=192,N6=10,N7=12,N8=12,N9=109,
// N10=109,N11=165,N12=1,N13=109,N14=1,N15=10,
// N16=436
//GO     EXEC  PGM=&MODULE,REGION=&GOSIZE
//STEPLIB  DD DISP=SHR,UNIT=UMCTS,DSN=$0365F.BOLD.VENTURE.LOAD
//    DD DSN=UM.FORTRAN.COMPLIB,DISP=SHR
//PRINT    DD  SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=1100)
//FT01F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),
//             DCB=(RECFM=VBS,LRECL=X,BUFNO=&NB1,BLKSIZE=&B1)
//FT02F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT03F001 DD UNIT=SYSDA,SPACE=(80,(10)),DCB=(RECFM=F,BLKSIZE=80)
//FT04F001 DD UNIT=SYSDA,SPACE=(3200,(&N1,&NX)),
//             DCB=(RECFM=FBS,LRECL=80,BLKSIZE=3200)
//FT05F001 DD UNIT=SYSDA,SPACE=(3120,(200,100)),
//             DCB=(RECFM=FB,BUFNO=1,LRECL=80,BLKSIZE=3120)
//FT06F001 DD  SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=1100)
//FT07F001 DD SYSOUT=B,DCB=(RECFM=F,BLKSIZE=80)
//FT08F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT09F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT10F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT11F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT12F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT13F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT14F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT15F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT16F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT17F001 DD UNIT=SYSDA,SPACE=(&B1,(&N16,1)),DCB=*.FT01F001
//FT18F001 DD UNIT=SYSDA,SPACE=(&B1,(&N16,1)),DCB=*.FT01F001
//FT19F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT20F001 DD UNIT=SYSDA,SPACE=(&B1,(&N13,1)),DCB=*.FT01F001
//FT21F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT22F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT23F001 DD UNIT=SYSDA,SPACE=(&B1,(&N3,1)),DCB=(RECFM=FB,BUFNO=&NB1)
//FT24F001 DD UNIT=SYSDA,SPACE=(&B1,(&N2,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT25F001 DD UNIT=SYSDA,SPACE=(&B1,(&N12,1)),DCB=(RECFM=FB,BUFNO=&NB1)
//FT26F001 DD UNIT=SYSDA,SPACE=(&B1,(&N12,1)),DCB=(RECFM=FB,BUFNO=&NB1)
//FT27F001 DD UNIT=SYSDA,SPACE=(&B1,(&N2,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT28F001 DD UNIT=SYSDA,SPACE=(&B1,(&N2,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT29F001 DD UNIT=SYSDA,SPACE=(&B1,(&N14,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT30F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT31F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT32F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT33F001 DD UNIT=SYSDA,SPACE=(&B1,(&N4,1)),DCB=*.FT01F001
//FT34F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT35F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT36F001 DD UNIT=SYSDA,SPACE=(&B1,(&N6,2)),DCB=*.FT01F001
```

```
//FT37F001 DD UNIT=SYSDA,SPACE=(&B1,(&N15,2)),DCB=*.FT01F001
//FT38F001 DD UNIT=SYSDA,SPACE=(&B1,(&N15,2)),DCB=*.FT01F001
//FT39F001 DD UNIT=SYSDA,SPACE=(&B1,(&N15,2)),DCB=*.FT01F001
//FT40F001 DD UNIT=SYSDA,SPACE=(&B2,(&N5,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT41F001 DD UNIT=SYSDA,SPACE=(&B1,(&N4,1)),DCB=*.FT01F001
//FT42F001 DD UNIT=SYSDA,SPACE=(&B2,(&N7,1)),
//             DCB=(RECFM=VBS,LRECL=X,BUFNO=&NB2,BLKSIZE=&B2)
//FT43F001 DD UNIT=SYSDA,SPACE=(&B2,(&N8,1)),DCB=*.FT42F001
//FT44F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT45F001 DD UNIT=SYSDA,SPACE=(&B1,(&N9,1)),DCB=*.FT01F001
//FT46F001 DD UNIT=SYSDA,SPACE=(&B1,(&N10,1)),DCB=*.FT01F001
//FT47F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT48F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT49F001 DD UNIT=SYSDA,SPACE=(&B1,(&N11,1)),DCB=*.FT01F001
//FT50F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT51F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT52F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT53F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT54F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT55F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT56F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT96F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT97F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT98F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT99F001 DD  SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=1100)
//         PEND
//BURN EXEC BOLDVENT,
// NB1=1,NB2=1,B1=3520,B2=32000,N1=100,N2=436,
// N3=10,N4=1,N5=192,N6=10,N7=12,N8=12,N9=109,
// N10=109,N11=165,N12=1,N13=109,N14=1,N15=10,
// N16=436,GOSIZE=4326K
//GO.FT11F001 DD UNIT=UMCTS,DISP=SHR,
// DSN=$0365F.GRUPXS.FINAL
//GO.SYSIN DD *
=CONTROL1
THETA-R CASE 'FRESH 1270 + DEPLETED(1600) 775',180 DEGREE
999999                                    1                    1
  2  6  2  7  2  1 13  0
  GRUPXS
END
DCRSPR
          0
END
DVENTR
001
                              0.00        1.0    +07     0.0       0.008200
                                                      0.000005     0.000005

  1  0  0  0  0  0  0            0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
003
  8  3  3  1  2  1  1  1     0  0
 2.2685   -3
004              THETA-R GEOMETRY MESH
```

```
  2 .2618     2 .2618     2 .2618     2 .2618     2 .2618     2 .2618
  2 .2618     2 .2618     2 .2618     2 .2618     2 .2618     2 .2618

  4 5.715     1 1.041     1 .1741     1 .3302     1 .3302     1 .3302
  1 .3302     1 .3302     1 .3302     1 .3302     1 .3302     1 .3302
  1 .3302     1 .3302     1 .3302     1 .3302     1 .3302     1 .3302
  1 .3302     1 .3302     1 .3302     1 .3302     1 .3302     1 .3302
  1 .3302     1 .3302     1 .3302     1 .1311     1 .96       2 .488
  1 .0963     3 .255      1 .0963     2 .488      4 6.884     1 .316
  4 22.58     1 .478      2 2.54      4 13.176
005
289289289289289289289289289289289
290290290290290290290290290290290
291291291291291291291291291291291
  1  2  3 73 74 75145146147217218219
  4  5  6 76 77 78148149150220221222
  7  8  9 79 80 81151152153223224225
 10 11 12 82 83 84154155156226227228
 13 14 15 85 86 87157158159229230231
 16 17 18 88 89 90160161162232233234
 19 20 21 91 92 93163164165235236237
 22 23 24 94 95 96166167168238239240
 25 26 27 97 98 99169170171241242243
 28 29 30100101102172173174244245246
 31 32 33103104105175176177247248249
 34 35 36106107108178179180250251252
 37 38 39109110111181182183253254255
 40 41 42112113114184185186256257258
 43 44 45115116117187188189259260261
 46 47 48118119120190191192262263264
 49 50 51121122123193194195265266267
 52 53 54124125126196197198268269270
 55 56 57127128129199200201271272273
 58 59 60130131132202203204274275276
 61 62 63133134135205206207277278279
 64 65 66136137138208209210280281282
 67 68 69139140141211212213283284285
 70 71 72142143144214215216286287288
292292292292292292292292292292292
293293293293293293293293293293293
294294294294294294294294294294294
295295295295295295295295295295295
296296296296296296296296296296296
297297297297297297297297297297297
298298298298298298298298298298298
299299299299299299299299299299299
300300300300300300300300300300300
301301301301301301301301301301301
302302302302302302302302302302302
303303303303303303303303303303303
304304304304304304304304304304304
012
  0
  1144  1  1  1.0
```

```
145288  1  2  1.0
289289  1  3  1.0
290290  1  4  1.0
291291  1  5  1.0
292292  1  6  1.0
293293  2  7  1.0
294294  2  8  1.0
295295  2  9  1.0
296296  2 10  1.0
297297  2 11  1.0
298298  2 12  1.0
299299  2 13  1.0
300300  2 14  1.0
301301  2 15  1.0
302302  2 16  1.0
303303  2 17  1.0
304304  2 18  1.0
  0
013
 29
 29
H1A   O16A  AL1   H1B   O16B  AL2   U234  U235  U236  U238  AL3   H1C
O16C  AL4   HID   O16D  PU239 PU240 PU241 PU242 XE135 PM148 PM147 PM148M
SM149 SSFP  NSFP  B10A  B11A
 24
AL5   H1E   O16E  BE9   HIG   O16G  C12B  AL9   H1H   O16H  H1I   O16I
AL10  HIJ   O16J  AL6   B10C  B11C  AL7   AL8   HIF   O16F  C12A  LI6
020
  1  3
U234  2.8077    -6U235  2.5994    -4U236  1.2941    -6U238  1.4866    -5
PU239  1.0     -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0     -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0     -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643   -2
H1C    3.7049   -2016C   1.8525   -2B10A   7.8452   -6B11A   3.1870   -5

  4  6
U234  3.5642    -6U235  3.2975    -4U236  1.6430    -6U238  1.[illegible]0    -5
PU239  1.0     -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0     -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0     -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643   -2
H1C    3.7049   -2016C   1.8525   -2B10A   7.9649   -6B11A   3.2356   -5

  7  9
U234  4.3188    -6U235  3.9975    -4U236  1.9913    -6U238  2.2863    -5
PU239  1.0     -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0     -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0     -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643   -2
H1C    3.7049   -2016C   1.8525   -2B10A   7.8949   -6B11A   3.2071   -5

 10 12
U234  6.0888    -6U235  5.6360    -4U236  2.8080    -6U238  3.2233    -5
PU239  1.0     -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0     -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0     -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643   -2
```

```
H1C     3.7049    -2016C    1.8525    -2B10A    7.8307    -6B11A    3.1810    -5

 13 15
U234   7.1264     -6U235   6.5955     -4U236   3.2866     -6U238   3.7720     -5
PU239  1.0       -15PU240  1.0       -15PU241  1.0       -15PU242  1.0       -15
XE135  1.0       -15PM148  1.0       -15PM147  1.0       -15PM148M 1.0       -15
SM149  1.0       -15SSFP   1.0       -15NSFP   1.0       -15AL3    2.5643    -2
H1C     3.7049    -2016C    1.8525    -2B10A    7.8541    -6B11A    3.1906    -5

 16 18
U234   8.6379     -6U235   7.9952     -4U236   3.9833     -6U238   4.5728     -5
PU239  1.0       -15PU240  1.0       -15PU241  1.0       -15PU242  1.0       -15
XE135  1.0       -15PM148  1.0       -15PM147  1.0       -15PM148M 1.0       -15
SM149  1.0       -15SSFP   1.0       -15NSFP   1.0       -15AL3    2.5643    -2
H1C     3.7049    -2016C    1.8525    -2
 19 21
U234   9.8048     -6U235   9.0756     -4U236   4.5216     -6U238   5.1908     -5
PU239  1.0       -15PU240  1.0       -15PU241  1.0       -15PU242  1.0       -15
XE135  1.0       -15PM148  1.0       -15PM147  1.0       -15PM148M 1.0       -15
SM149  1.0       -15SSFP   1.0       -15NSFP   1.0       -15AL3    2.5643    -2
H1C     3.7049    -2016C    1.8525    -2
 22 24
U234   9.8765     -6U235   9.1416     -4U236   4.5550     -6U238   5.2284     -5
PU239  1.0       -15PU240  1.0       -15PU241  1.0       -15PU242  1.0       -15
XE135  1.0       -15PM148  1.0       -15PM147  1.0       -15PM148M 1.0       -15
SM149  1.0       -15SSFP   1.0       -15NSFP   1.0       -15AL3    2.5643    -2
H1C     3.7049    -2016C    1.8525    -2
 25 27
U234   9.9444     -6U235   9.2044     -4U236   4.5860     -6U238   5.2643     -5
PU239  1.0       -15PU240  1.0       -15PU241  1.0       -15PU242  1.0       -15
XE135  1.0       -15PM148  1.0       -15PM147  1.0       -15PM148M 1.0       -15
SM149  1.0       -15SSFP   1.0       -15NSFP   1.0       -15AL3    2.5643    -2
H1C     3.7049    -2016C    1.8525    -2
 28 30
U234   10.007     -6U235   9.2630     -4U236   4.6151     -6U238   5.2978     -5
PU239  1.0       -15PU240  1.0       -15PU241  1.0       -15PU242  1.0       -15
XE135  1.0       -15PM148  1.0       -15PM147  1.0       -15PM148M 1.0       -15
SM149  1.0       -15SSFP   1.0       -15NSFP   1.0       -15AL3    2.5643    -2
H1C     3.7049    -2016C    1.8525    -2
 31 33
U234   10.067     -6U235   9.3172     -4U236   4.6409     -6U238   5.3294     -5
PU239  1.0       -15PU240  1.0       -15PU241  1.0       -15PU242  1.0       -15
XE135  1.0       -15PM148  1.0       -15PM147  1.0       -15PM148M 1.0       -15
SM149  1.0       -15SSFP   1.0       -15NSFP   1.0       -15AL3    2.5643    -2
H1C     3.7049    -2016C    1.8525    -2
 34 36
U234   10.123     -6U235   9.3699     -4U236   4.6681     -6U238   5.3589     -5
PU239  1.0       -15PU240  1.0       -15PU241  1.0       -15PU242  1.0       -15
XE135  1.0       -15PM148  1.0       -15PM147  1.0       -15PM148M 1.0       -15
SM149  1.0       -15SSFP   1.0       -15NSFP   1.0       -15AL3    2.5643    -2
H1C     3.7049    -2016C    1.8525    -2
 37 39
U234   10.175     -6U235   9.4182     -4U236   4.6920     -6U238   5.3865     -5
PU239  1.0       -15PU240  1.0       -15PU241  1.0       -15PU242  1.0       -15
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XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2
 40 42
U234  10.228    -6U235  9.4670    -4U236  4.7162    -6U238  5.4146    -5
PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2
 43 45
U234  10.273    -6U235  9.5094    -4U236  4.7372    -6U238  5.3652    -5
PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2
 46 48
U234  10.316    -6U235  9.5487    -4U236  4.7575    -6U238  5.4611    -5
PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2
 49 51
U234  10.359    -6U235  9.5878    -4U236  4.7768    -6U238  5.4831    -5
PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2
 52 54
U234  10.397    -6U235  9.6240    -4U236  4.7947    -6U238  5.5043    -5
PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2
 55 57
U234  10.436    -6U235  9.6589    -4U236  4.8122    -6U238  5.5243    -5
PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2
 58 60
U234  9.9310    -6U235  9.1916    -4U236  4.5798    -6U238  5.2570    -5
PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2
 61 63
U234  8.6334    -6U235  7.9909    -4U236  3.9814    -6U238  4.5704    -5
PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2B10A    7.8726   -6B11A    3.1981   -5

 64 66
U234  7.2406    -6U235  6.5939    -4U236  3.3382    -6U238  3.8328    -5
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PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2B10A    7.8857   -6B11A    3.2034   -5

 67 69
U234  5.7422    -6U235  5.3146    -4U236  2.6478    -6U238  3.0396    -5
PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2B10A    7.8982   -6B11A    3.2085   -5

 70 72
U234  4.3177    -6U235  3.9954    -4U236  1.9906    -6U238  2.2850    -5
PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2B10A    7.8627   -6B11A    3.1941   -5

 73 75
U234  2.8077    -6U235  2.5994    -4U236  1.2941    -6U238  1.4866    -5
PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2B10A    7.8452   -6B11A    3.1870   -5

 76 78
U234  3.5642    -6U235  3.2975    -4U236  1.6430    -6U238  1.8860    -5
PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2B10A    7.9649   -6B11A    3.2356   -5

 79 81
U234  4.3188    -6U235  3.9975    -4U236  1.9913    -6U238  2.2863    -5
PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2B10A    7.8949   -6B11A    3.2071   -5

 82 84
U234  6.0888    -6U235  5.6360    -4U236  2.8080    -6U238  3.2233    -5
PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2B10A    7.8307   -6B11A    3.1810   -5

 85 87
U234  7.1264    -6U235  6.5955    -4U236  3.2866    -6U238  3.7720    -5
PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2B10A    7.8541   -6B11A    3.1906   -5
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PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2
 91 93
U234  9.8048    -6U235  9.0756    -4U236  4.5216    -6U238  5.1908    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2
 94 96
U234  9.8765    -6U235  9.1416    -4U236  4.5550    -6U238  5.2284    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2
 97 99
U234  9.9444    -6U235  9.2044    -4U236  4.5860    -6U238  5.2643    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2
100102
U234  10.007    -6U235  9.2630    -4U236  4.6151    -6U238  5.2978    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2
103105
U234  10.067    -6U235  9.3172    -4U236  4.6409    -6U238  5.3294    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2
106108
U234  10.123    -6U235  9.3699    -4U236  4.6681    -6U238  5.3589    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2
109111
U234  10.175    -6U235  9.4182    -4U236  4.6920    -6U238  5.3865    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2
112114
U234  10.228    -6U235  9.4670    -4U236  4.7162    -6U238  5.4146    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2
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115117
U234  10.273    -6U235  9.5094    -4U236  4.7372    -6U238  5.3652    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2
118120
U234  10.316    -6U235  9.5487    -4U236  4.7575    -6U238  5.4611    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2
121123
U234  10.359    -6U235  9.5878    -4U236  4.7768    -6U238  5.4831    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2
124126
U234  10.397    -6U235  9.6240    -4U236  4.7947    -6U238  5.5043    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2
127129
U234  10.436    -6U235  9.6589    -4U236  4.8122    -6U238  5.5243    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2
130132
U234  9.9310    -6U235  9.1916    -4U236  4.5798    -6U238  5.2570    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2
133135
U234  8.6334    -6U235  7.9909    -4U236  3.9814    -6U238  4.5704    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2B10A  7.8726    -6B11A    3.1981  -5

136138
U234  7.2406    -6U235  6.5939    -4U236  3.3382    -6U238  3.8328    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
SM149  1.0      -15SSFP   1.0     -15NSFP   1.0     -15AL3    2.5643  -2
H1C    3.7049   -2016C    1.8525  -2B10A  7.8857    -6B11A    3.2034  -5

139141
U234  5.7422    -6U235  5.3146    -4U236  2.6478    -6U238  3.0396    -5
PU239  1.0      -15PU240  1.0     -15PU241  1.0     -15PU242  1.0     -15
XE135  1.0      -15PM148  1.0     -15PM147  1.0     -15PM148M 1.0     -15
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SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
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142144
U234  4.3177    -6U235  3.9954    -4U236  1.9906    -6U238  2.2850    -5
PU239  1.0      -15PU240  1.0      -15PU241  1.0      -15PU242  1.0      -15
XE135  1.0      -15PM148  1.0      -15PM147  1.0      -15PM148M 1.0      -15
SM149  1.0      -15SSFP   1.0      -15NSFP   1.0      -15AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2B10A    7.8627   -6B11A    3.1941   -5

145147
U234  4.1153    -6U235  1.9069    -4U236  4.7487    -5U238  2.5999    -5
PU239  5.3343  -07PU240  1.4256  -07PU241  7.3103  -08PU242  1.4381  -08
XE135  1.1     -16PM148  9.6916  -09PM147  4.4267  -06PM148M 6.8104  -08
SM149  4.8592  -08SSFP   3.2284  -06NSFP   3.7915  -04AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2
148150
U234  4.2015    -6U235  2.2104    -4U236  4.3536    -5U238  2.6013    -5
PU239  5.9791  -07PU240  1.3420  -07PU241  6.9478  -08PU242  1.1057  -08
XE135  1.1     -19PM148  8.3634  -09PM147  4.0820  -06PM148M 6.6306  -08
SM149  5.2029  -08SSFP   2.8838  -06NSFP   3.3795  -04AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2
151174
U234  4.3780    -6U235  2.9518    -4U236  3.3694    -5U238  2.6048    -5
PU239  7.7435  -07PU240  1.0467  -07PU241  5.5084  -08PU242  4.9605  -09
XE135  1.1     -19PM148  5.3315  -09PM147  3.0624  -06PM148M 5.8659  -08
SM149  6.0443  -08SSFP   2.0406  -06NSFP   2.3818  -04AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2
175177
U234  4.4420    -6U235  3.2415    -4U236  2.9753    -5U238  2.6074    -5
PU239  8.4231  -07PU240  8.9370  -08PU241  4.6942  -08PU242  3.2514  -09
XE135  1.1     -19PM148  4.2555  -09PM147  2.6165  -06PM148M 5.4147  -08
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H1C    3.7049   -2016C    1.8525   -2
178210
U234  4.4312    -6U235  3.0953    -4U236  3.1568    -5U238  2.6119    -5
PU239  7.7178  -07PU240  9.4940  -08PU241  4.7861  -08PU242  3.8137  -09
XE135  1.1     -19PM148  4.7478  -09PM147  2.8699  -06PM148M 5.5675  -08
SM149  6.1181  -08SSFP   1.8806  -06NSFP   2.1931  -04AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2
211213
U234  4.3174    -6U235  2.4992    -4U236  3.9434    -5U238  2.6148    -5
PU239  6.0530  -07PU240  1.1773  -07PU241  5.6651  -08PU242  7.3203  -09
XE135  1.1     -19PM148  7.0505  -09PM147  3.7749  -06PM148M 6.2221  -08
SM149  5.3796  -08SSFP   2.5621  -06NSFP   2.9957  -04AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2
214216
U234  4.2578    -6U235  2.2549    -4U236  4.2668    -5U238  2.6144    -5
PU239  5.5261  -07PU240  1.2526  -07PU241  5.9363  -08PU242  9.2153  -09
XE135  1.1     -19PM148  8.0737  -09PM147  4.0993  -06PM148M 6.4379  -08
SM149  5.1209  -08SSFP   2.8400  -06NSFP   3.3254  -04AL3    2.5643   -2
H1C    3.7049   -2016C    1.8525   -2
217219
U234  4.1153    -6U235  1.9069    -4U236  4.7487    -5U238  2.5999    -5
```

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PU239  5.3343  -07PU240  1.4256  -07PU241  7.3103  -08PU242  1.4381  -08
XE135  1.1     -16PM148  9.6916  -09PM147  4.4267  -06PM148M 6.8104  -08
SM149  4.8592  -08SSFP   3.2284  -06NSFP   3.7915  -04AL3    2.5643   -2
H1C    3.7049   -2016C   1.8525   -2
220222
U234  4.2015    -6U235  2.2104    -4U236  4.3536    -5U238  2.6013    -5
PU239  5.9791  -07PU240  1.3420  -07PU241  6.9478  -08PU242  1.1057  -08
XE135  1.1     -19PM148  8.3634  -09PM147  4.0820  -06PM148M 6.6306  -08
SM149  5.2029  -08SSFP   2.8838  -06NSFP   3.3795  -04AL3    2.5643   -2
H1C    3.7049   -2016C   1.8525   -2
223246
U234  4.3780    -6U235  2.9518    -4U236  3.3694    -5U238  2.6048    -5
PU239  7.7435  -07PU240  1.0467  -07PU241  5.5084  -08PU242  4.9605  -09
XE135  1.1     -19PM148  5.3315  -09PM147  3.0624  -06PM148M 5.8659  -08
SM149  6.0443  -08SSFP   2.0406  -06NSFP   2.3818  -04AL3    2.5643   -2
H1C    3.7049   -2016C   1.8525   -2
247249
U234  4.4420    -6U235  3.2415    -4U236  2.9753    -5U238  2.6074    -5
PU239  8.4231  -07PU240  8.9370  -08PU241  4.6942  -08PU242  3.2514  -09
XE135  1.1     -19PM148  4.2555  -09PM147  2.6165  -06PM148M 5.4147  -08
SM149  6.4070  -08SSFP   1.7109  -06NSFP   1.9945  -04AL3    2.5643   -2
H1C    3.7049   -2016C   1.8525   -2
250282
U234  4.4312    -6U235  3.0953    -4U236  3.1568    -5U238  2.6119    -5
PU239  7.7178  -07PU240  9.4940  -08PU241  4.7861  -08PU242  3.8137  -09
XE135  1.1     -19PM148  4.7478  -09PM147  2.8699  -06PM148M 5.5675  -08
SM149  6.1181  -08SSFP   1.8806  -06NSFP   2.1931  -04AL3    2.5643   -2
H1C    3.7049   -2016C   1.8525   -2
283285
U234  4.3174    -6U235  2.4992    -4U236  3.9434    -5U238  2.6148    -5
PU239  6.0530  -07PU240  1.1773  -07PU241  5.6651  -08PU242  7.3203  -09
XE135  1.1     -19PM148  7.0505  -09PM147  3.7749  -06PM148M 6.2221  -08
SM149  5.3796  -08SSFP   2.5621  -06NSFP   2.9957  -04AL3    2.5643   -2
H1C    3.7049   -2016C   1.8525   -2
286288
U234  4.2578    -6U235  2.2549    -4U236  4.2668    -5U238  2.6144    -5
PU239  5.5261  -07PU240  1.2526  -07PU241  5.9863  -08PU242  9.2153  -09
XE135  1.1     -19PM148  8.0737  -09PM147  4.0993  -06PM148M 6.4379  -08
SM149  5.1209  -08SSFP   2.8400  -06NSFP   3.3254  -04AL3    2.5643   -2
H1C    3.7049   -2016C   1.8525   -2
289289
H1A   6.6852    -2016A  3.3426    -2
290290
AL1   6.0243    -2
291291
H1B   6.297     -2016B  3.147     -2AL2   3.005     -3
292292
AL4   3.005     -3HID   6.297     -2016D  3.147     -2
293293
AL5   6.0243    -2
294294
H1E   6.6852    -2016E  3.3426    -2
295295
H1E   6.6852    -2016E  3.3426    -2
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296296
H1E   6.6852    -2016E  3.3426    -2
297297
H1E   6.6852    -2016E  3.3426    -2
298298
HIF   6.685     -2016F  3.34      -2
299299
BE9   1.236     -1
300300
HIG   6.6852    -2016G  3.3426    -2
301301
C!2B  4.9       -2AL9   1.3       -2H1H   3.35      -3016H  1.675     -3

302302
H1I   6.68      -2016I  3.34      -2
303303
AL10  6.0243    -2
304304
HIJ   6.685     -2016J  3.34      -2

END
DUTLIN
EXPINS        0  1  0 40
     2.0000
     0  1     0  3                  1     0  0
                1     1        0           0  0
BLANK
END
INPUT PROCESSOR
0V EXPOSE
1D /  FILE REFERENCE INFORMATION
0 15 0 1 0  8 5 12 0 0 0 13 0 8R
2D / TITLE AND NUCLIDE NAMES
*     DEPLETION MODULE TEST WITH 8 HEAVY METALS + 7 FP'S                *
*U234  * *U235  * *U236  * *U238  * *PU239 * *PU240 * *PU241 * *PU242 *
*XE135 * *PM147 * *PM148 * *PM148M* *SM149 * *NSFP  * *SSFP  *
3D /  REFERENCE DATA
 0.0 /
1 2 3 4 5 6 7 8
9 10 13  14 15 /
1 2 3 4 5 6 7 8 9 10 11 12
4D /  DECAY DATA
9.000-14 3.122-17 9.385-16 4.919-18 9.116-13 3.362-12 1.495-09 5.836-14
2.118-05 8.378-09 4.093-09 1.943-07
5D /  FISSION PRODUCT YIELD DATA
0.06  0.0715  0.06  0.06  0.0715  0.06  0.0715  0.06
0.03  0.027   0.03  0.03  0.027   0.03  0.027   0.03
0.02  0.013   0.02  0.02  0.013   0.02  0.013   0.02
1.5466 1.5011 1.5466 1.5466 1.5011 1.5466 1.5011 1.5466
0.0134 8R
6D /  CHAIN DATA FOR MATRIX EXPONENTIAL
1 2 2  2 3 2  3 3 8  4 5 1  5 6 2  6 7 2  7 8 2  9 9 2  11 13 1
14 14 2   15 15 2   10 11 100002    10 12 900002
STOP
END
```

```
//$0365FU JOB (0365LH,    ),'KIM',MSGLEVEL=(1,1),USER=6
//*$0365FG JOB (6365LH,XXX),'KIM',MSGLEVEL=(1,1)
/*JOBPARM T=3,LINES=5,R=4400
/*ROUTE PRINT RMT44
//BOLDVENT PROC GOSIZE=4326K,MODULE=SCALE,
// NB1=1,NB2=1,B1=3520,B2=32000,NX=2,NS=50,N1=100,
// N2=474,N3=10,N4=1,N5=211,N6=10,N7=14,N8=14,N9=120,
// N10=120,N11=186,N12=1,N13=1,N14=1,N15=10,
// N16=477
//GO     EXEC  PGM=&MODULE,REGION=&GOSIZE
//STEPLIB  DD DISP=SHR,UNIT=UMCTS,DSN=$0365F.BOLD.VENTURE.LOAD
//    DD DSN=UM.FORTRAN.COMPLIB,DISP=SHR
//PRINT    DD  SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=1100)
//FT01F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),
//             DCB=(RECFM=VBS,LRECL=X,BUFNO=&NB1,BLKSIZE=&B1)
//FT02F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT03F001 DD UNIT=SYSDA,SPACE=(80,(10)),DCB=(RECFM=F,BLKSIZE=80)
//FT04F001 DD UNIT=SYSDA,SPACE=(3200,(&N1,&NX)),
//             DCB=(RECFM=FBS,LRECL=80,BLKSIZE=3200)
//FT05F001 DD UNIT=SYSDA,SPACE=(3120,(200,100)),
//             DCB=(RECFM=FB,BUFNO=1,LRECL=80,BLKSIZE=3120)
//FT06F001 DD  SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=1100)
//FT07F001 DD SYSOUT=B,DCB=(RECFM=F,BLKSIZE=80)
//FT08F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT09F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT10F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT11F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT12F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT13F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT14F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT15F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT16F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT17F001 DD UNIT=SYSDA,SPACE=(&B1,(&N16,1)),DCB=*.FT01F001
//FT18F001 DD UNIT=SYSDA,SPACE=(&B1,(&N16,1)),DCB=*.FT01F001
//FT19F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT20F001 DD UNIT=SYSDA,SPACE=(&B1,(&N13,1)),DCB=*.FT01F001
//FT21F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT22F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT23F001 DD UNIT=SYSDA,SPACE=(&B1,(&N3,1)),DCB=(RECFM=FB,BUFNO=&NB1)
//FT24F001 DD UNIT=SYSDA,SPACE=(&B1,(&N2,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT25F001 DD UNIT=SYSDA,SPACE=(&B1,(&N12,1)),DCB=(RECFM=FB,BUFNO=&NB1)
//FT26F001 DD UNIT=SYSDA,SPACE=(&B1,(&N12,1)),DCB=(RECFM=FB,BUFNO=&NB1)
//FT27F001 DD UNIT=SYSDA,SPACE=(&B1,(&N2,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT28F001 DD UNIT=SYSDA,SPACE=(&B1,(&N2,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT29F001 DD UNIT=SYSDA,SPACE=(&B1,(&N14,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT30F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT31F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT32F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT33F001 DD UNIT=SYSDA,SPACE=(&B1,(&N4,1)),DCB=*.FT01F001
//FT34F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,&NX)),DCB=*.FT01F001
//FT35F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT36F001 DD UNIT=SYSDA,SPACE=(&B1,(&N6,2)),DCB=*.FT01F001
//FT37F001 DD UNIT=SYSDA,SPACE=(&B1,(&N15,2)),DCB=*.FT01F001
//FT38F001 DD UNIT=SYSDA,SPACE=(&B1,(&N15,2)),DCB=*.FT01F001
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//FT39F001 DD UNIT=SYSDA,SPACE=(&B1,(&N15,2)),DCB=*.FT01F001
//FT40F001 DD UNIT=SYSDA,SPACE=(&B2,(&N5,1)),DCB=(RECFM=FB,BUFNO=&NB2)
//FT41F001 DD UNIT=SYSDA,SPACE=(&B1,(&N4,1)),DCB=*.FT01F001
//FT42F001 DD UNIT=SYSDA,SPACE=(&B2,(&N7,1)),
//              DCB=(RECFM=VBS,LRECL=X,BUFNO=&NB2,BLKSIZE=&B2)
//FT43F001 DD UNIT=SYSDA,SPACE=(&B2,(&N8,1)),DCB=*.FT42F001
//FT44F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT45F001 DD UNIT=SYSDA,SPACE=(&B1,(&N9,1)),DCB=*.FT01F001
//FT46F001 DD UNIT=SYSDA,SPACE=(&B1,(&N10,1)),DCB=*.FT01F001
//FT47F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT48F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT49F001 DD UNIT=SYSDA,SPACE=(&B1,(&N11,1)),DCB=*.FT01F001
//FT50F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT51F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT52F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT53F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT54F001 DD UNIT=SYSDA,SPACE=(&B1,(&N1,2)),DCB=*.FT01F001
//FT55F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT56F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT96F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT97F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT98F001 DD UNIT=SYSDA,SPACE=(&B1,(&NS,1)),DCB=*.FT01F001
//FT99F001 DD  SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=1100)
//         PEND
//BURN EXEC BOLDVENT,
// NB1=1,NB2=1,B1=3520,B2=32000,N1=100,N2=474,
// N3=10,N4=1,N5=211,N6=10,N7=14,N8=14,N9=120,
// N10=120,N11=186,N12=1,N13=1,N14=1,N15=10,
// N16=477,GOSIZE=4326K
//GO.FT11F001 DD UNIT=UMCTS,DISP=SHR,
// DSN=$0365F.GRUPXS.FINAL
//*GO.FT12F001 DD UNIT=UMCTS,DISP=SHR,
//* DSN=$0365F.B18RX26.FLUX,
//* SPACE=(TRK,(30,10),RLSE),
//* DCB=(RECFM=VBS,LRECL=X,BUFNO=1,BLKSIZE=3520)
//GO.FT18F001 DD UNIT=UMCTS,DISP=(NEW,CATLG),
// DSN=$0365F.MIXXED.RTFLUX,
// SPACE=(TRK,(30,10),RLSE),
// DCB=(RECFM=VBS,LRECL=X,BUFNO=1,BLKSIZE=3520)
//GO.SYSIN DD *
=CONTROL1
3-D MURR CORE 'MIXED FUEL, FRESH 775 + DEPLETED 1270, 5/23/86
999999                                    1                    1
  2  6  1  2  2 12  7  0
  GRUPXS
END
DCRSPR
          0
END
INPUT PROCESSOR
OV RODSET
1D
 $NCRN NFRN NCR NERT NSRPS NCYD NSE NOE ISV MRW MRI NSH I1$
   4     2   1   12     5    1    0   0   0   0  0  0 0 8R
```

```
2D  $HNR  HNF  ADR  ADF$
 *B10C  * *B11C  * *C12A  * *AL7   *
 *H1E   * *O16E  *
 5.7478-3 2.3311-2 0.8267-2 4.5-2
 6.6852-2 3.3426-2
3D $NRZ$
 9 64 65 66 67 68 69 70 71 72 73 0
4D $FEH NOP J1$
 0.0   0    0 10R
5D $IF NOP IS 0 THEN NZI IS THE LAST ZONE IS SET J$
  9
4D 0.2185    1    0 10R
5D +1
4D 0.4662    1    0 10R
5D +1
4D 0.72    1    0 10R
5D +1
4D 1.    1    0 10R
5D +0
STOP
END
DVENTR
001
                              0.00       3.0   +07    1.0        0.5


  1  0  0  0  0  0  0                1
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2  0  0  0  0
003
 15  1  1  1  2  2  2        4 11
  0.0        0.0         0.08406      0.2
  9 64 65 66 67 68 69 70 71 72 73
004                THETA-R-Z GEOMETRY MESH
  1 .0989     3 .2938     4 .7854     2 .1891     1 .1986     4 .3977
  4 .7854     1 .0853     1 .1521     2 .1553
  4 5.715     1 1.041     1 .1741     1 .3302     1 .3302     1 .3302
  1 .3302     1 .3302     1 .3302     1 .3302     1 .3302     1 .3302
  1 .3302     1 .3302     1 .3302     1 .3302     1 .3302     1 .3302
  1 .3302     1 .3302     1 .3302     1 .3302     1 .3302     1 .3302
  1 .3302     1 .3302     1 .3302     1 .1311     1 .96       2 .488
  1 .0963     3 .255      1 .0963     2 .488      4 6.884     1 .316
  4 22.58     1 .478      2 2.54      4 13.176
  1 20.0      1 4.445     2 8.89      1 1.905     2 5.710     2 5.710
  1 3.83      1 3.518     1 3.132     3 8.58     12 30.48     1 1.905
  1 1.905     2 6.985     1 4.445     1 2.54      3 20.0
005
  1  1  1  1  1  1  1  1  1  1
  2  2  2  2  2  2  2  2  2  2
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6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7
7	9	9	9	7	9	9	9	7	22
7	9	9	9	7	9	9	9	7	22
7	9	9	9	7	9	9	9	7	22
11	11	11	11	11	11	11	11	11	11
11	11	11	11	11	11	11	11	11	11
13	13	13	13	13	13	13	13	13	13
13	13	13	13	13	13	13	13	13	13
15	15	15	15	15	15	15	15	15	15
15	15	15	15	15	15	15	15	15	15
17	17	17	17	17	17	17	17	17	17
1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2
18	18	18	18	18	18	18	18	18	18
18	18	18	18	18	18	18	18	18	18
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