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Civilian Radioactive Waste Management System
Management & Operating Contractor

Summary Report of Commercial Reactor Criticality Data for Catawba Unit 1

Revision 00

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1.0 INTRODUCTION

The "Summary Report of Commercial Reactor Criticality Data for Catawba Unit 1" contains the detailed information necessary to perform commercial reactor criticality (CRC) analyses for the Catawba Unit 1 reactor.

1.1 Background

The United States Department of Energy (DOE) Office of Civilian Radioactive Waste Management (OCRWM) is developing a methodology for criticality analysis to support disposal of commercial spent nuclear fuel in a geologic repository. A topical report on the disposal criticality analysis methodology is scheduled to be submitted to the United States Nuclear Regulatory Commission (NRC) for formal review in October 1998. This summary report provides data that will be used in analyses that will support the development of parts of the disposal criticality analysis methodology.

1.2 Objective

The objective of this report is to present the data required for performing analytical CRC evaluations for the Catawba Unit 1 reactor. Results from the CRC evaluations will support the development and validation of the neutronics models used for criticality analyses involving commercial spent nuclear fuel. These models and their validation will be discussed in the Disposal Criticality Analysis Methodology Topical Report.

1.3 Scope

The scope of this Summary Report is the presentation of data required to perform 3 statepoint calculations from cycles 1 and 5 of Catawba Unit 1. The only interface for the development of the information in this document is with Framatome Cogema Fuels (FCF). FCF is one of the teammates of the Civilian Radioactive Waste Management System Management and Operating Contractor (M&O). FCF independently requested and received permission from Duke Power Company, the owner/operator of Catawba Unit 1, to publish the information related to statepoint measurements that is recorded in this document. All the information contained in this report is documented in an FCF calculational file (Reference 5). The data provided in Reference 5 was obtained from various other reports, calculations, and drawings developed under an NRC accepted quality assurance program (Reference 1) and the data has supported prior licensing submittals. The data therefore will be considered acceptable for quality affecting activities and for use in analyses affecting procurement, construction, or fabrication.

1.4 Quality Assurance

The Quality Assurance (QA) program applies to the development of this report. The data provided in this report will indirectly be used to develop the methodology for evaluating the Monitored Geologic Repository (MGR) waste package and engineered barrier segment. The QAP-2-3 (*Classification of Permanent Items*) evaluation entitled *Classification of the*

Preliminary MGDS Repository Design (Reference 2, TBV-228) has identified the waste package as an MGR (formerly MGDS) item important to safety, waste isolation, and physical protection of materials. The Waste Package responsible manager has evaluated the technical document development activity in accordance with QAP-2-0, *Conduct of Activities*. The QAP-2-0 activity evaluation, *Develop Technical Documents* (Reference 3), has determined that the preparation and review of this technical document is subject to *Quality Assurance Requirements and Description* (Reference 4) requirements. As specified in NLP-3-18, *Documentation of QA Controls on Drawings, Specifications, Design Analyses, and Technical Documents*, this activity is subject to QA controls. No scientific and engineering software or computational software was used in the development of this report.

2.0 REACTOR DESIGN INFORMATION

This section provides general material and geometry data for modeling the Catawba Unit 1 reactor. Figures 2-1 through 2-11 provide pictorial representations of various components that must be modeled. A horizontal view of the vessel internals is presented in Figure 2-1. This includes the 193 fuel assemblies (FA) in the reactor core region. All dimensions in this figure are measured from the center of the reactor core. A radial view of the fuel assembly layout (along the core flat) and extending through the core liner is provided in Figure 2-2. The core liner, core barrel, neutron pad, and vessel weld liner are represented as stainless steel (SS304 from Reference 5 or A240, Type 304 from 1997 *Annual Book of ASTM Standards*, Vol. 01.03, Section 1, Iron and Steel Products, p. 37, Table 1). The pressure vessel is carbon steel (CS508 from Reference 5 or A508, Grade 2, Class 1 from *Annual Book of ASTM Standards*, Vol. 01.05, Section 1, Iron and Steel Products, p. 281, Table 1). Table 2-1 provides dimensions from the center of the core (along the core flat) to the outside surface of the pressure vessel.

Table 2-1. Dimensions from Core Center to Outside Surface of Pressure Vessel

Description	Thickness (cm)	Outer Radius (cm)
Core Center	-	00.00000
½ FA-1	10.70102	10.70102
Water	0.10160	10.80262
FA-2	21.40204	32.20466
Water	0.10160	32.30626
FA-3	21.40204	53.70830
Water	0.10160	53.80990
FA-4	21.40204	75.21194
Water	0.10160	75.31354
FA-5	21.40204	96.71558
Water	0.10160	96.81718
FA-6	21.40204	118.21922
Water	0.10160	118.32082
FA-7	21.40204	139.72286
Water	0.10160	139.82446
FA-8	21.40204	161.22650
Water	0.21350	161.44
Core Liner	2.85000	164.29
Water	23.67	187.96
Core Barrel	5.72	193.68
Water	25.47	219.15
Vessel Liner	0.56	219.71
Pressure Vessel	21.59	241.30

For Figure 2-1, the axial dimensions of the four symmetric neutron pads can be represented as the same as the active height of the fuel in the core.

Table 2-2 summarizes fuel assembly and reactor core data used for modeling the Catawba Unit 1 reactor for cycles 1 through 5. Additional fuel cycle design, core operations, and reactor criticality statepoint information will be provided in Sections 3 and 4.

Figure 2-3 presents a radial view of a single Westinghouse 17 x 17 optimized fuel assembly (OFA) showing the locations of the guide tubes, instrument tube, and fuel pins. Axial dimensions, by region, for the OFA fuel assembly are presented in Figure 2-4. This assembly contains 6 zircaloy intermediate spacer grids and two Inconel end spacer grids. The upper end spacer grid is above the active fuel region, whereas the lower end spacer grid and the 6 intermediate spacer grids are inside the active fuel region.

Figure 2-1. Horizontal View of Vessel Internals Along Core Midplane

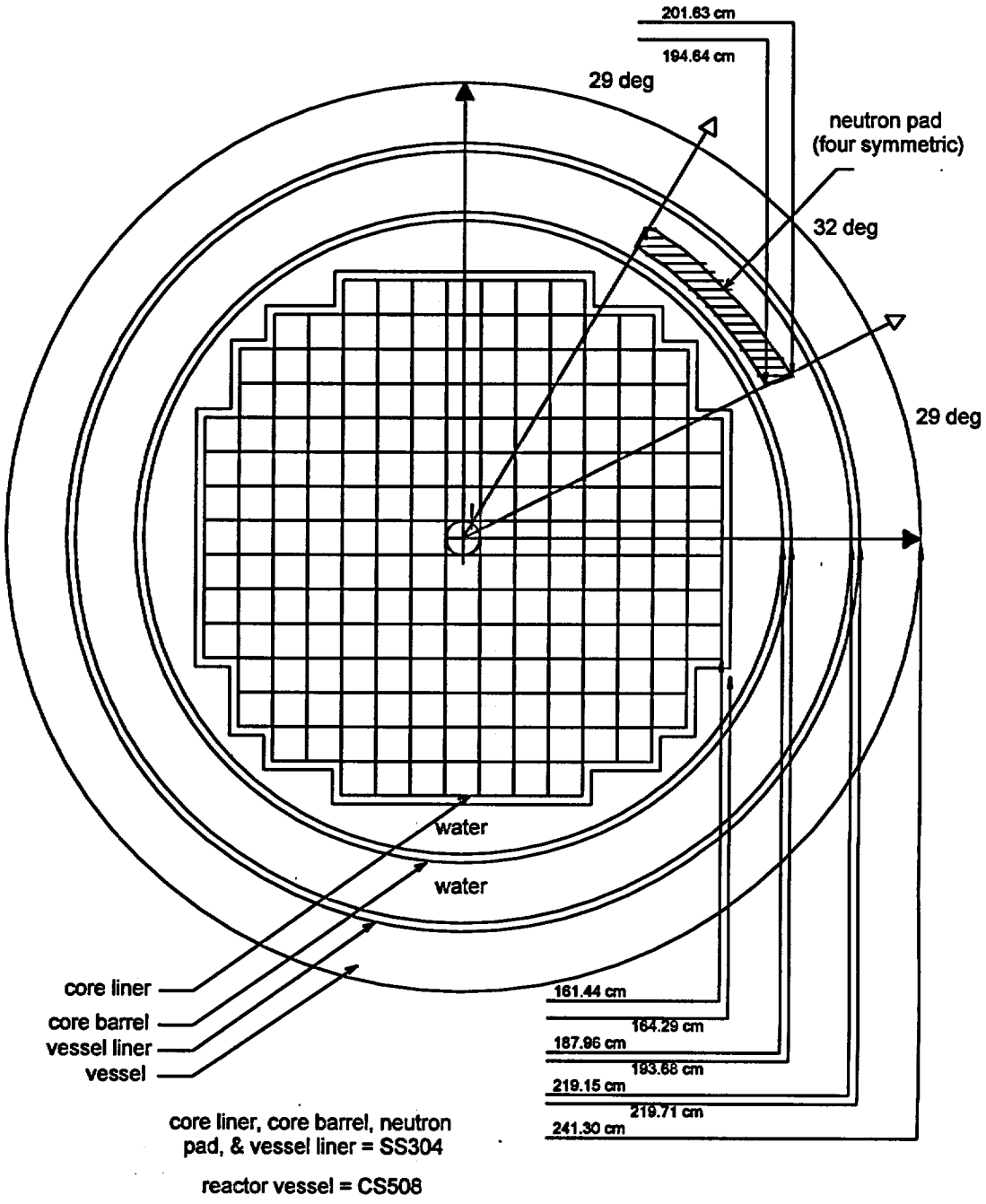


Figure 2-2. Radial View of Fuel Assembly Layout Along the Core Flat

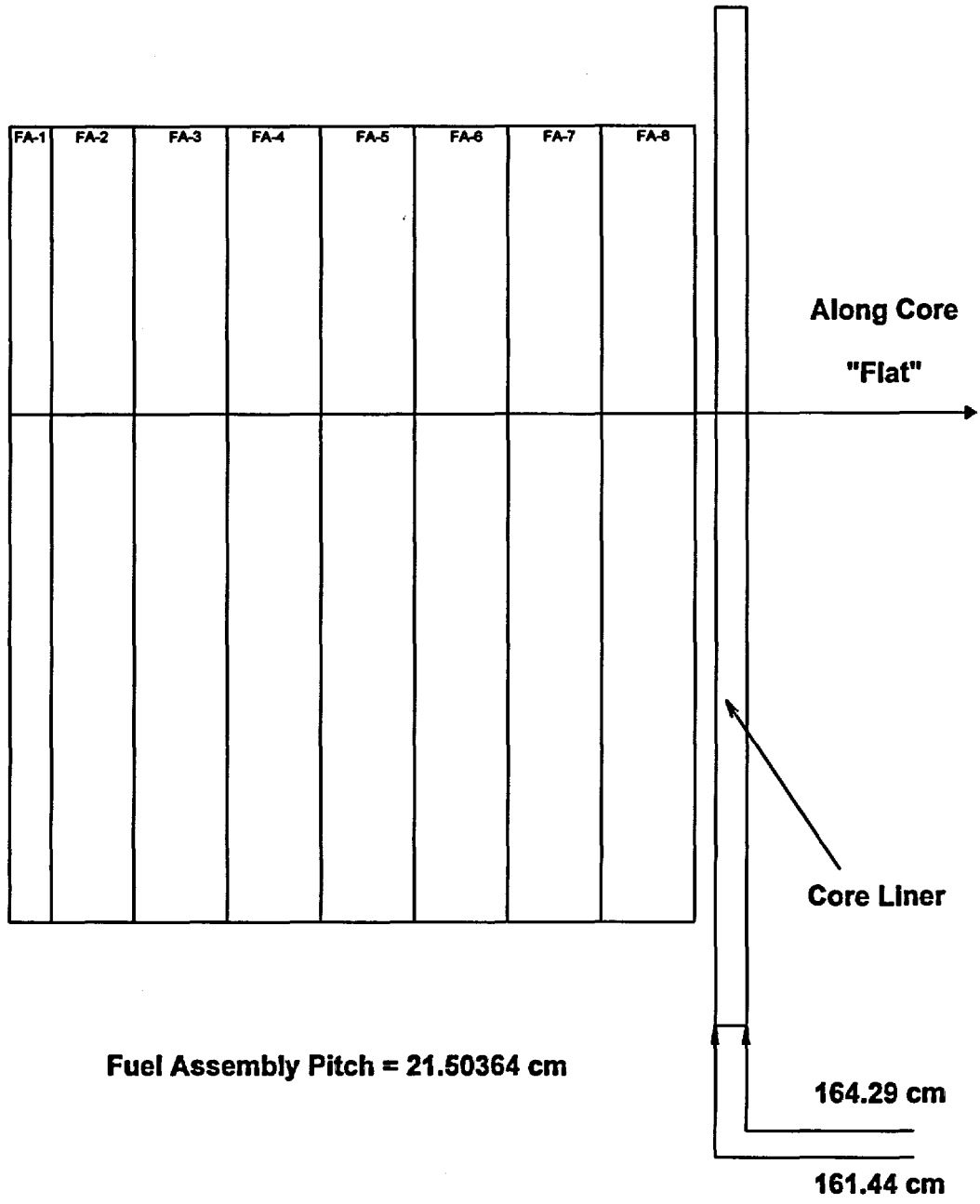


Table 2-2. Catawba 1 Fuel Assembly/Core Data

Fuel Assembly Array Size and Types	17 x 17 OFA
Number of Fuel Pins (N_R) / Assembly	264
Number of Guide Tubes (N_{GT}) / Assembly	24
Number of Instrument Tubes (N_{IT}) / Assembly	1
Number of Assemblies in Core	193
System Pressure	2250 psia/1.55132 x 10^7 Pa
Core Height (H)	365.76 cm
Pin Pitch	1.25984 cm
Fuel Pin Cladding OD (outer diameter - OD_C)	0.91440 cm
Fuel Cladding Material	zircaloy
Guide Tube Upper Region	
Length in Active Fuel Region (H_1)	310.9722 cm
Guide Tube OD (OD_{GT-U})	1.20396 cm
Guide Tube Lower Region	
Length in Active Fuel Region (H_2)	54.7878 cm
Guide Tube OD (OD_{GT-L})	1.08966 cm
Guide Tube Material	zircaloy
Instrument Tube OD (OD_{IT})	1.20396 cm
Instrument Tube Material	zircaloy
Assembly Pitch (P)	21.50364 cm
Intermediate Spacer Grid Material	zircaloy
Intermediate Spacer Grid Height	5.71500 cm
End Spacer Grid Material	Inconel
End Spacer Grid Height	3.35788 cm

Spacer Grid Volumes for Active Fuel Region in Single Assembly:

Six Intermediate Spacer Grids (zircaloy) V_{ZG} = 1066.690 cm^3
One Lower End Spacer Grid (Inconel) V_{IG} = 95.2336 cm^3
One Set Lower End Grid Sleeves (Stainless Steel) V_{SS} = 11.3366 cm^3

V_{M+G} = Volume of Moderator plus Grid in Fuel Assembly (excluding inside guide tubes and instrument tube)

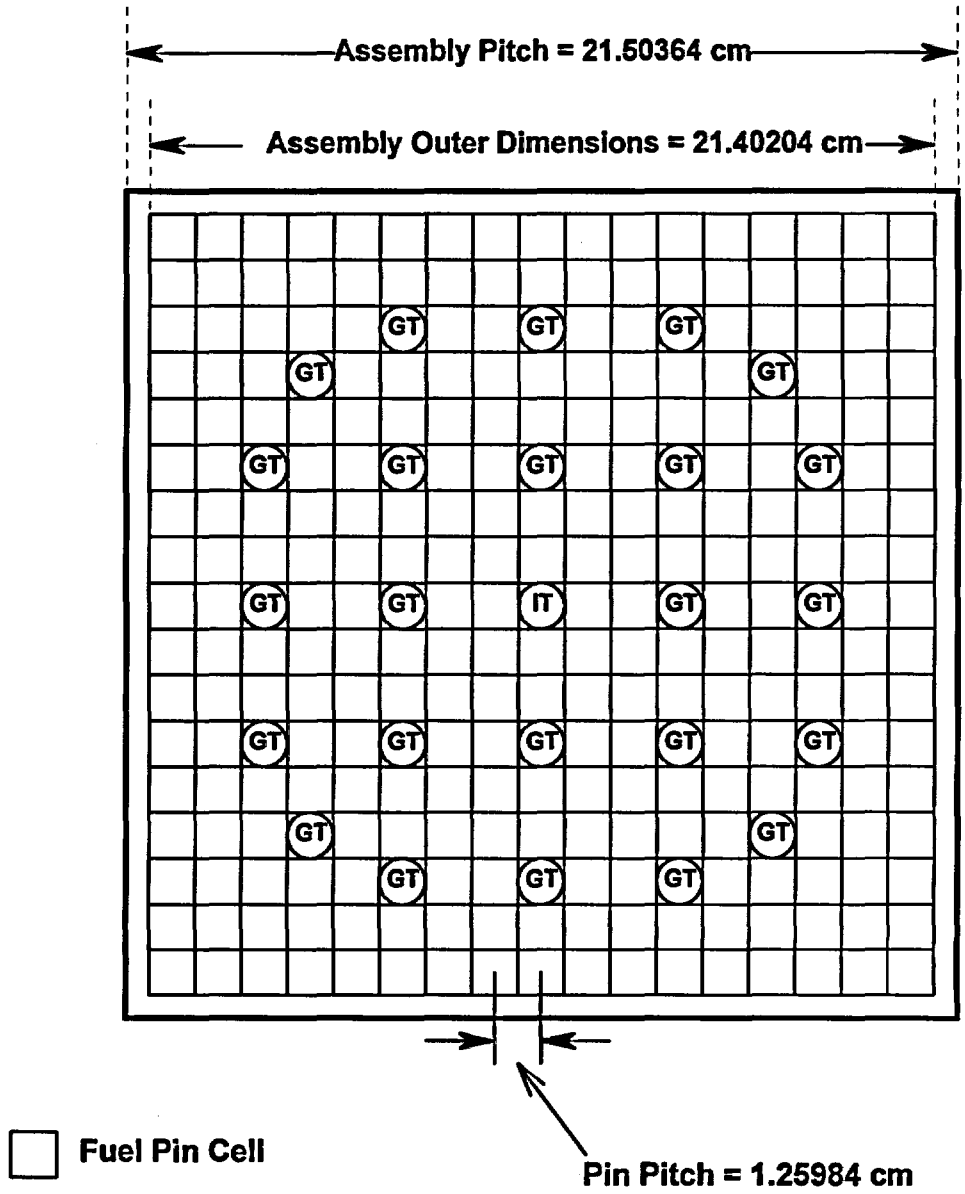
$$= P^2 \cdot H - H \cdot \frac{\pi}{4}\left[N_R \cdot OD_C^2 + N_{IT} \cdot OD_{IT}^2\right] - N_{GT} \cdot \frac{\pi}{4}\left[H_1 \cdot OD_{GT-U}^2 + H_2 \cdot OD_{GT-L}^2\right]$$

= 95,579.8799 cm^3

Assembly Volume Fraction of Inconel Grid = V_{IG}/V_{M+G} = 0.0009964
Assembly Volume Fraction of Zircaloy Grids = V_{ZG}/V_{M+G} = 0.0111602
Assembly Volume Fractions of Stainless Steel Sleeves = V_{SS}/V_{M+G} = 0.0001186

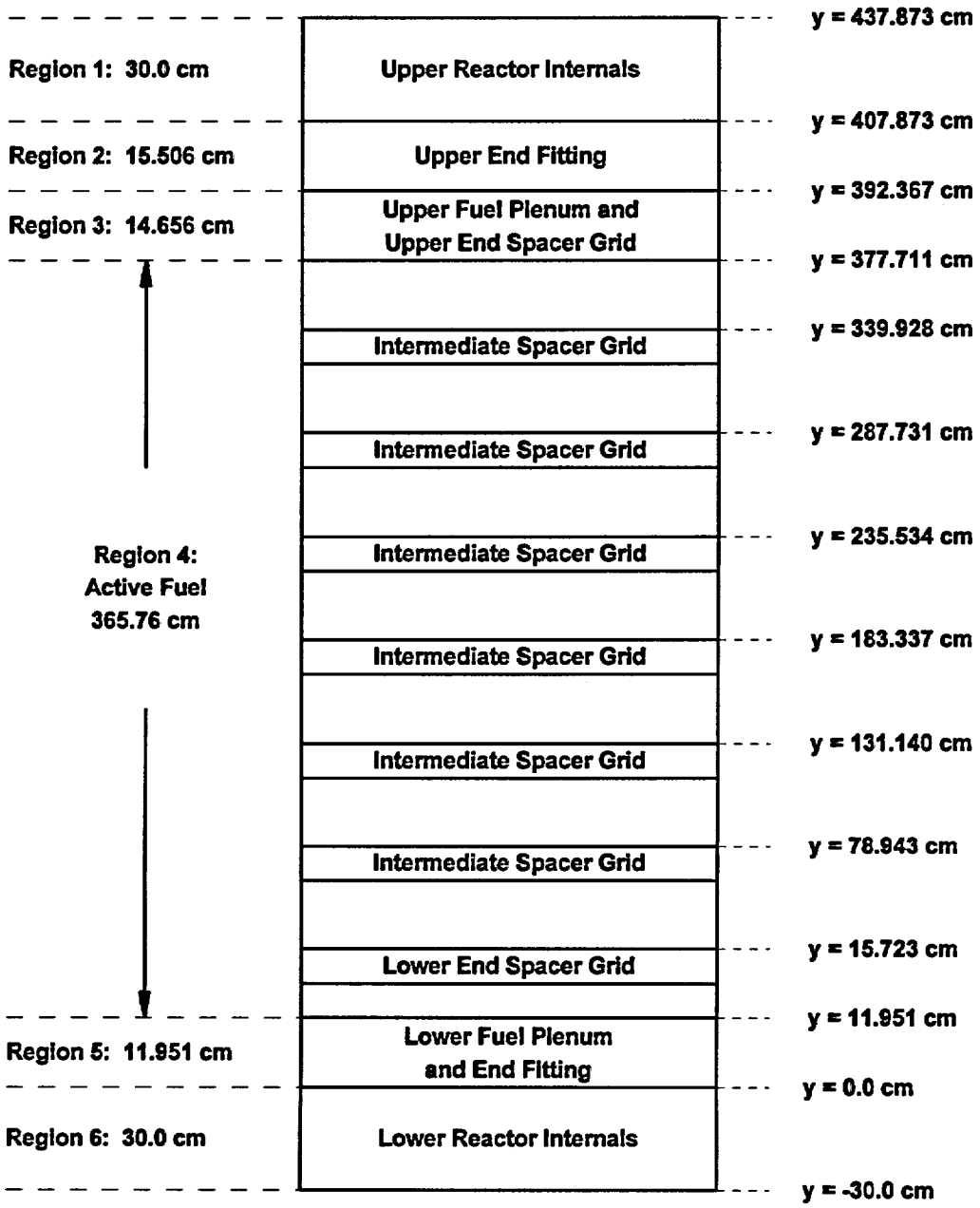
(Note: The number of digits shown above for volumes and volume fractions are an artifact of the computational process and are taken directly from Reference 5).

Figure 2-3. Radial View of a Single 17 x 17 OFA Fuel Assembly



Note: Assembly outer dimension is less than 17 times the pin pitch. The outermost cells (except corners) are rectangular and not square like the other cells

Figure 2-4. Axial Dimensions by Region for 17 x 17 OFA Fuel Assembly



Figures 2-5 through 2-7 provide axial dimensions for the guide tubes, instrument tube, and fuel pins shown in Figure 2-3 for the Westinghouse 17 x 17 optimized fuel assembly. Figures 2-8 through 2-11 provide axial dimensions for rod cluster control assemblies (RCCAs) with rods at 0% withdrawn, pyrex burnable poison rod assemblies (BPRAs), wet annular burnable absorber (WABA) type BPRAs, and thimble plugs that are attached to BPRAs at empty locations.

Regions 1 and 6, in Figures 2-5 through 2-11, are represented as homogenized regions of stainless steel and water. Regions 2, 3, and 5 contain various combinations of guide tubes, instrument tube, and fuel rod assemblies (no fuel pellets), as well as other materials (stainless steel, Inconel, and water). The fraction of guide tubes, instrument tube, and fuel rod assemblies will be represented explicitly in these regions. (Note: the fuel rod assemblies do not extend to region 2.) The other materials will be homogenized within the remaining portions of the regions. The water inside the guide tubes and instrument tube will be represented explicitly within the respective tubes. The volume fractions of other materials, by region, for the Westinghouse 17 x 17 optimized fuel assembly are presented in Table 2-3.

Table 2-3. Volume Fractions for Non-Fuel Regions for Non-Control Assemblies (OFA)

	Volume Fractions*			
Region	SS	Inc	Zr	Water
1	0.1770	0.0	0.0	0.8230
2	0.1303	0.0178	0.0051	0.8469
3	0.0030	0.0249	0.0	0.9721
5	0.1439	0.0	0.0137	0.8424
6	0.1720	0.0	0.0	0.8280

* The volume fractions presented exclude the guide tubes, instrument tube, and fuel rod assembly portions of these regions.

Note: SS = Stainless Steel
Inc = Inconel
Zr = zircaloy

The fuel rods are contained in regions 2, 3, 4, and 5. Region 4 is modeled explicitly. Regions 2, 3, and 5 contain various amounts of stainless steel and zircaloy in the fuel rod assembly which represents plenum springs and end caps. In addition, these regions also contain helium and fission gases, as well as the zircaloy cladding. The fuel rod assembly volume fractions for materials in these regions for the Westinghouse 17 x 17 optimized fuel assembly are presented in Table 2-4.

Table 2-4. OFA Fuel Rod Assembly Volume Fractions for Regions 2, 3, and 5

Region	Fuel Rod Assembly Volume Fractions			
	SS	Zr	Cladding*	Gas
2	0.0703	0.4268	0.1720	0.3309
3	0.1342	0.0	0.2344	0.6314
5	-	Solid (diameter = 0.9144 cm)		-

* The zircaloy cladding extends from Y = 11.3157 cm to Y = 394.2309 cm. For all 264 rods, the 0.524 cm length of cladding is included in region 2, 14.656 cm in region 3, and 0.635 cm length is included in region 5. Region 5 may be modeled as a solid zircaloy rod of 1.748 cm length and 0.9144 cm diameter.

Figure 2-5. Axial Dimensions for Guide Tubes for OFA Fuel Assembly

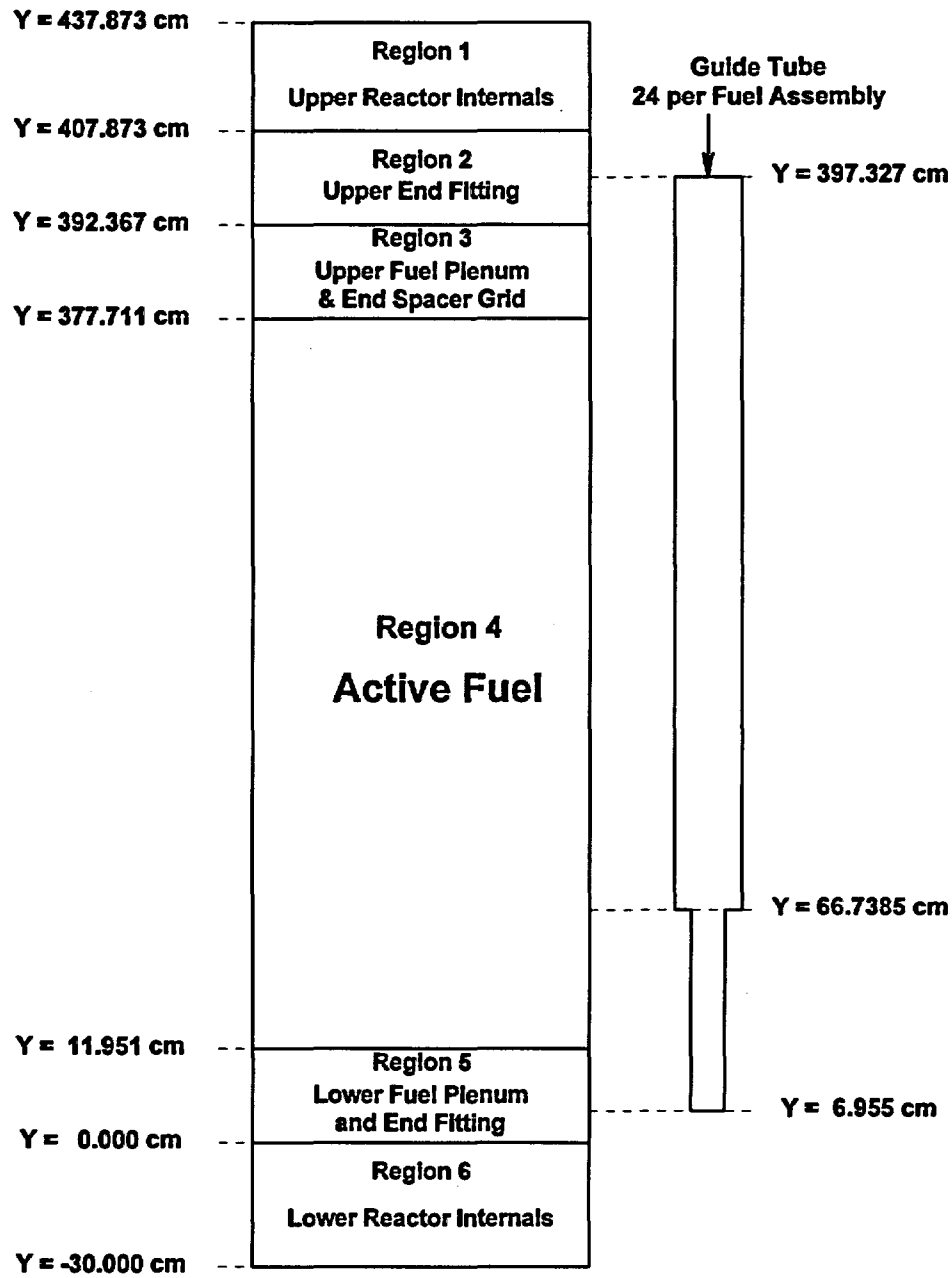


Figure 2-6. Instrument Tube Axial Dimensions for OFA Fuel Assembly

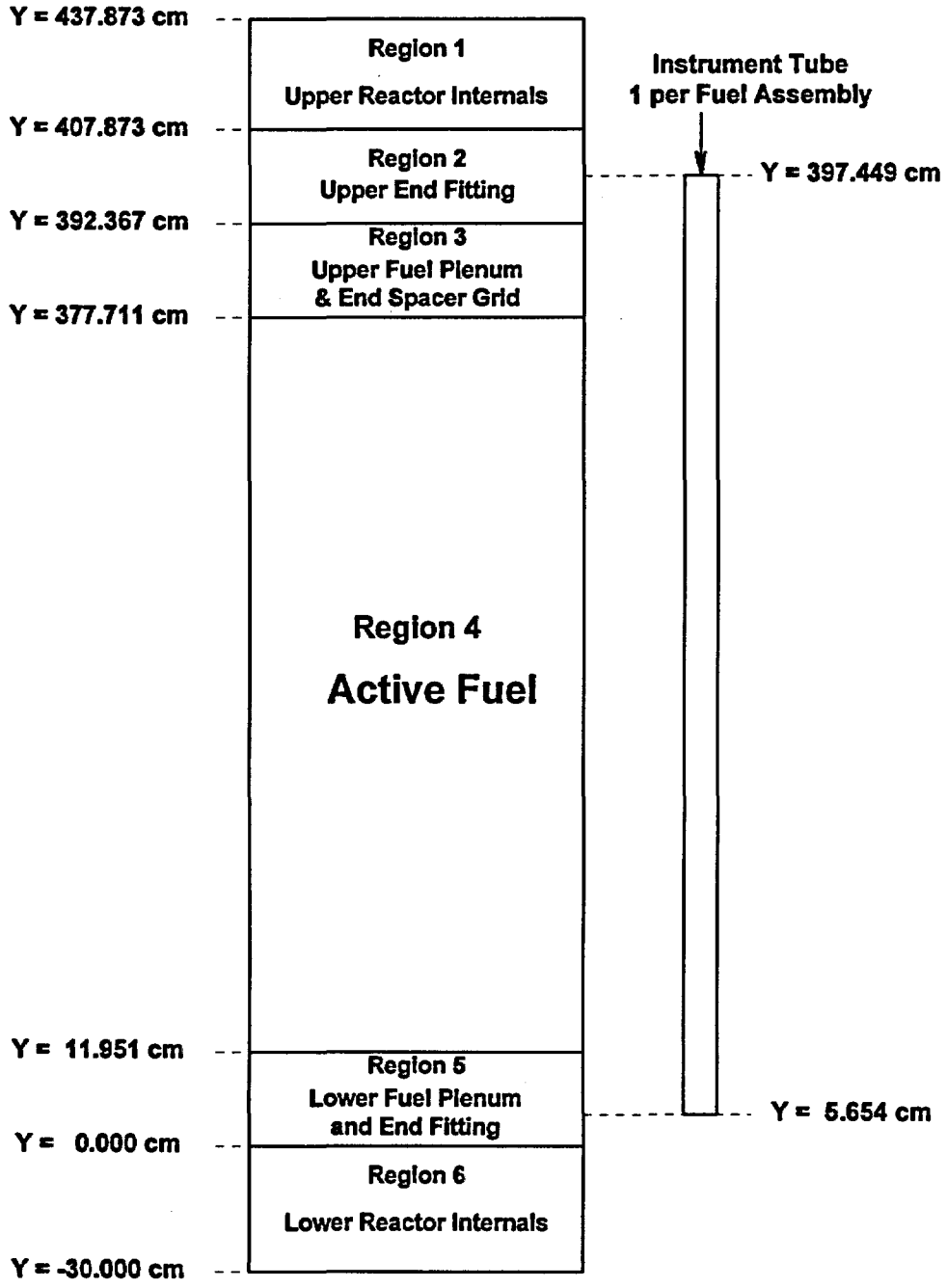


Figure 2-7. Fuel Rod Assembly Axial Dimensions for OFA Fuel Assembly

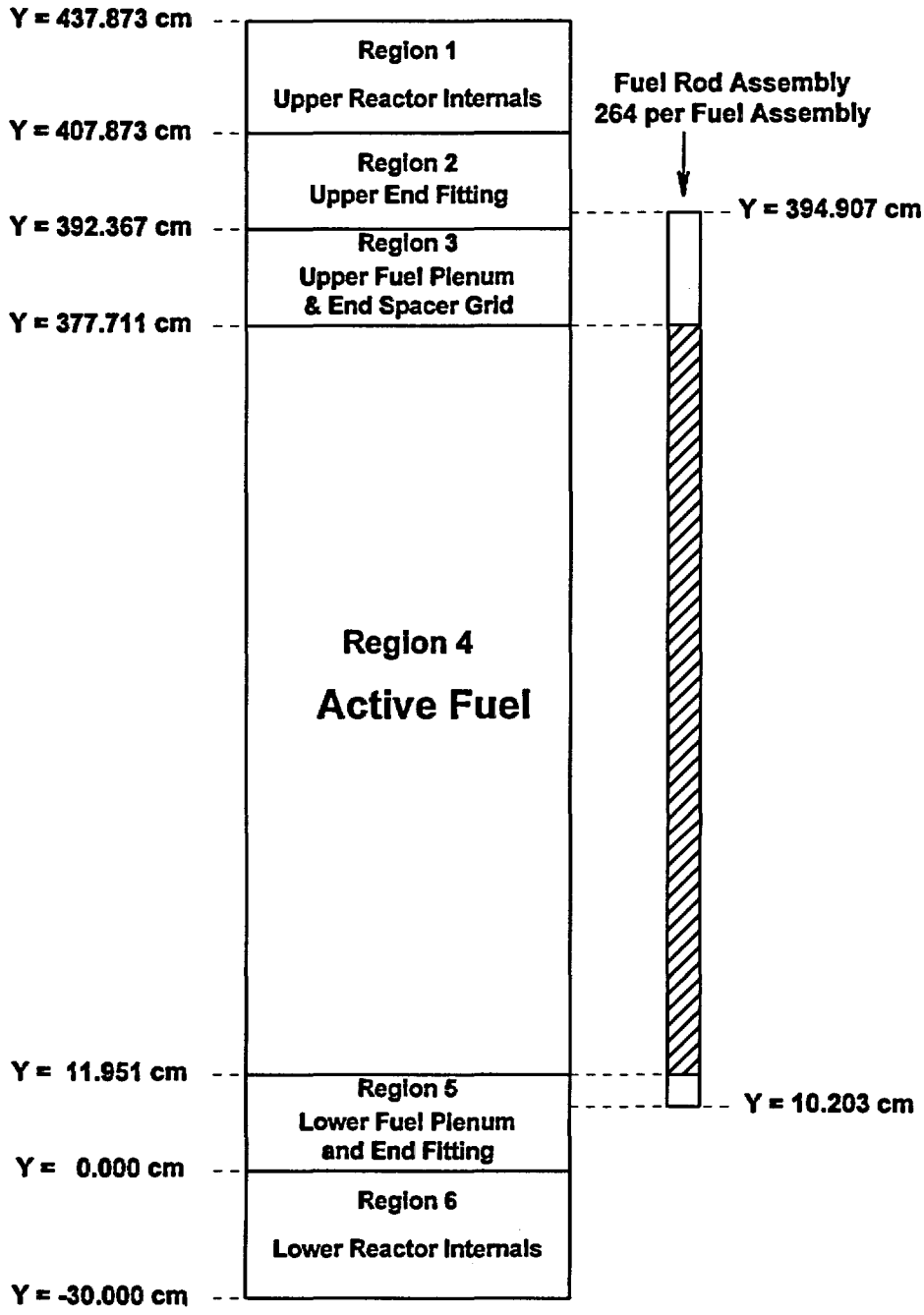


Figure 2-8 provides axial dimensions for a fully inserted (0% withdrawn) control rod for an OFA fuel assembly.

Hybrid RCCA Materials/Dimensions:

Lower cap - stainless steel (diameter = 0.96774 cm)

Cladding - stainless steel (Clad OD = 0.96774 cm, Clad ID = 0.77216 cm,
where OD = outer diameter, ID = inner diameter)

Top Absorber - B_4C (diameter = 0.74676 cm)

Bottom Absorber - Ag-In-Cd (diameter = 0.76454 cm)

Spacer - stainless steel (diameter = 0.7569 cm)

Upper plenum/spring area - Volume Fractions:
Clad - Stainless Steel = 0.3634
Spring - Inconel = 0.2712
Gas = 0.3654

Upper cap - stainless steel (diameter = 0.96774 cm)

Upper stem - stainless steel (diameter = 0.5563 cm)

Hybrid RCCA Volume Fractions:

The control rods are represented explicitly in regions 2, 3, and 4. The remainder of materials (excluding fuel rods, instrument tube, and guide tubes) are homogenized in regions 1, 2, and 3. The volume fractions of these materials (including non-RCCA materials) for RCCAs with rods at 0% withdrawn (WD) are given in Table 2-5.

Table 2-5. Volume Fractions for OFA Assemblies with Hybrid RCCAs (0% Withdrawn) for Regions 1 - 3

	Volume Fractions (Rods 0% WD)			
Region	SS	Inc	Zr	Water
1	0.1907	0.0035	0.0	0.8058
2	0.1516	0.0232	0.0051	0.8201
3*	0.0030	0.0249	0.0	0.9721

* Region 3 volume fractions are the same as for non-control assemblies (Table 2-3).

For fully withdrawn control rods (100% withdrawn) the volume fractions presented in Table 2-3 (for OFA non-control assemblies) should be used.

Figure 2-8. Axial Dimensions for Hybrid RCCAs (Rods 0% Withdrawn) for OFA Fuel Assembly

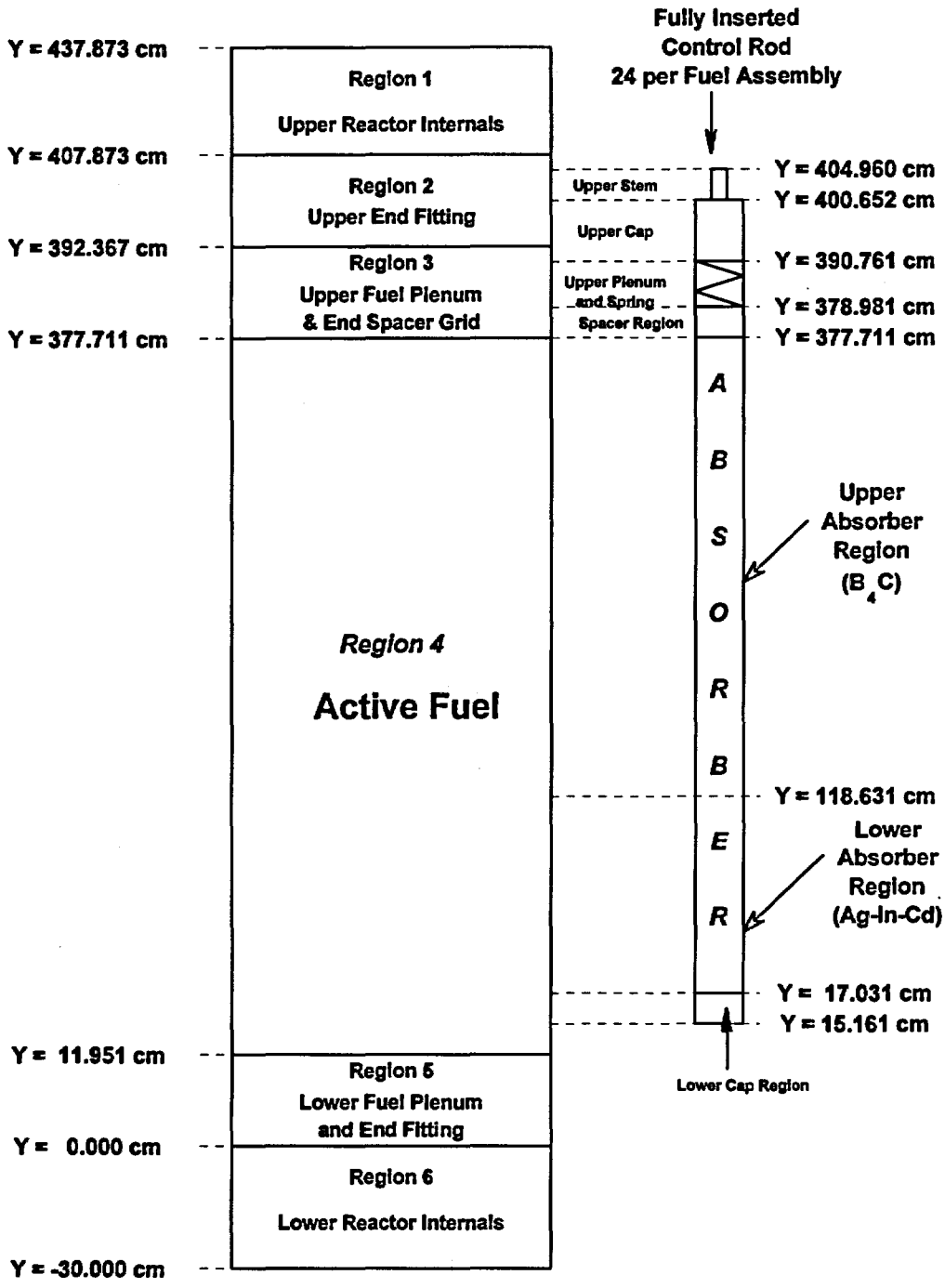


Figure 2-9 provides axial dimensions for the pyrex burnable absorber rod assembly. Figure 2-10 provides axial dimensions for the wet annular burnable absorber (WABA) rod assembly. These dimensions are applicable for the OFA fuel assembly.

Pyrex BPRA Materials/Dimensions:

Lower cap - stainless steel (diameter = 0.96774 cm)

Cladding - stainless steel Outer tube - OD = 0.96774 cm, ID = 0.87376 cm
Inner tube - OD = 0.46101 cm, ID = 0.42799 cm

Absorber - B_2O_3-SiO_2 Pyrex tube - OD = 0.85344 cm, ID = 0.48260 cm

Upper plenum region - stainless steel clad (outer tube), helium gas in annulus

Upper cap - stainless steel (diameter = 0.96774 cm)

Upper stem - stainless steel (diameter = 0.54356 cm)

WABA Materials/Dimensions:

Lower cap - zircaloy (OD = 0.96774 cm, ID = 0.254 cm)
Water annulus (diameter = 0.254 cm)

Cladding - zircaloy Outer tube - OD = 0.96774 cm, ID = 0.8357 cm
Inner tube - OD = 0.6782 cm, ID = 0.5715 cm

Absorber - B_4C-Al_2O_3 WABA - OD = 0.8077 cm, ID = 0.7061 cm
Helium in gap between absorber and cladding

Water annulus - diameter = 0.5715 cm

Upper plenum region - zircaloy clad OD = 0.96774 cm, Volume Fractions: zircaloy = 0.3967
Water = 0.6033

Upper cap - zircaloy (diameter = 0.96774 cm)

Upper stem - zircaloy (diameter = 0.54356 cm)

BPRA Volume Fractions:

The burnable poison and other materials inside the guide tubes are represented explicitly through region 3 and into region 2. This includes most of the upper end cap. The BPRA upper structure (beyond the end cap) is homogenized with the other assembly components within region 2. The volume fractions of these materials (including non-BPRA materials) are given in Table 2-6. For OFA fuel assemblies the volume fractions are the same for both Pyrex and WABA. There are 24 locations (guide tubes) for rod insertion in the fuel assembly. The number of burnable poison rods varies from 4 to 20 among the BPRAs for cycles 1 through 5 of Catawba 1. A thimble plug (Figure 2-11) is used for any empty location where a burnable poison (BP) rod is not installed.

Table 2-6. Volume Fractions for OFA Fuel Assemblies with WABA or Pyrex BPRAs for Regions 2 - 3

	Volume Fractions BPRAs			
Region	SS	Inc	Zr	Water
2	0.1733	0.0242	0.0051	0.7974
3*	0.0030	0.0249	0.0	0.9721

* Region 3 volume fractions are the same as for non-control assemblies (Table 2-3).

Figure 2-9. Axial Dimensions for Pyrex BPRAs for OFA Fuel Assembly

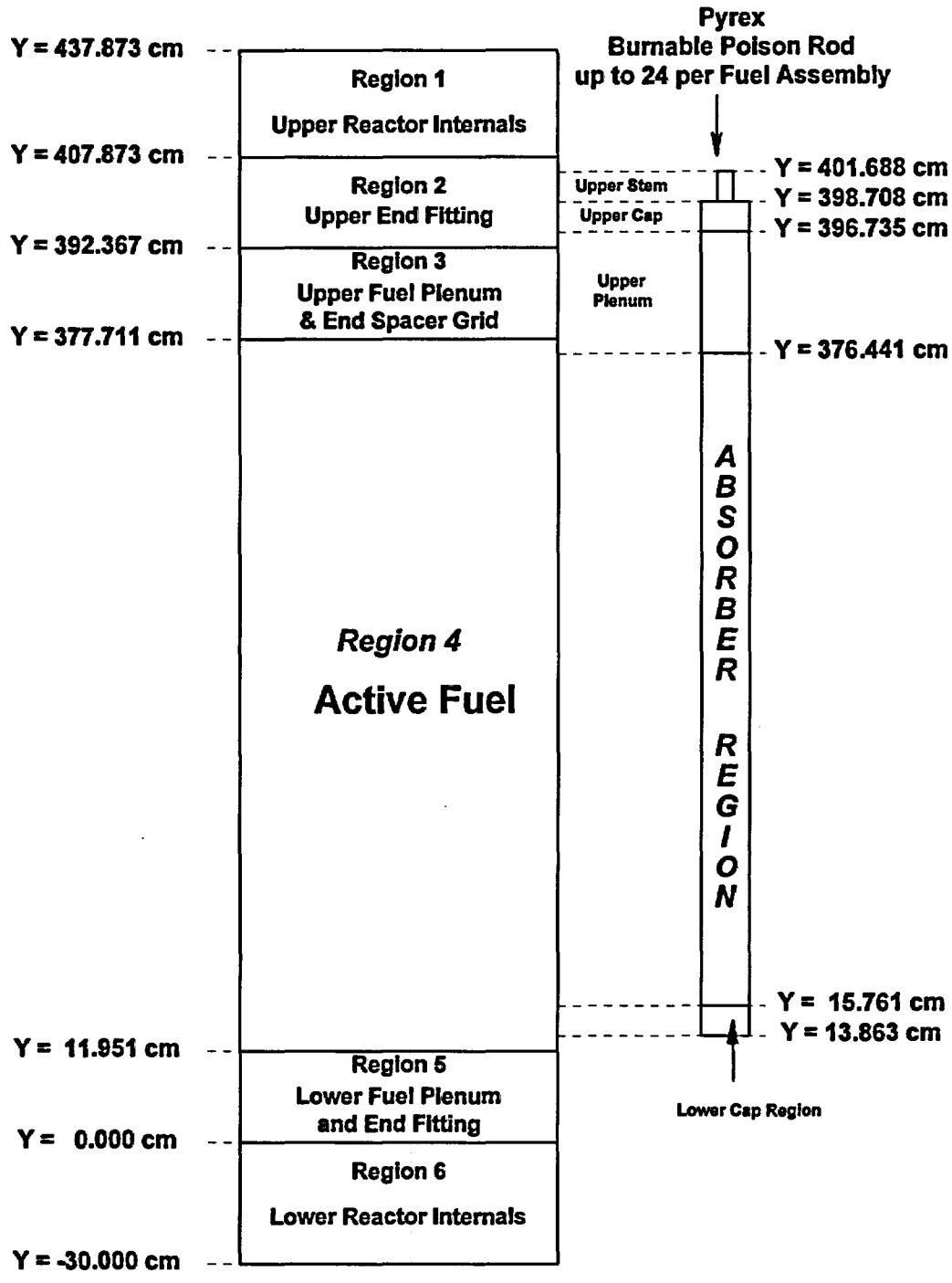


Figure 2-10. Axial Dimensions for WABA BPRAs for OFA Fuel Assembly

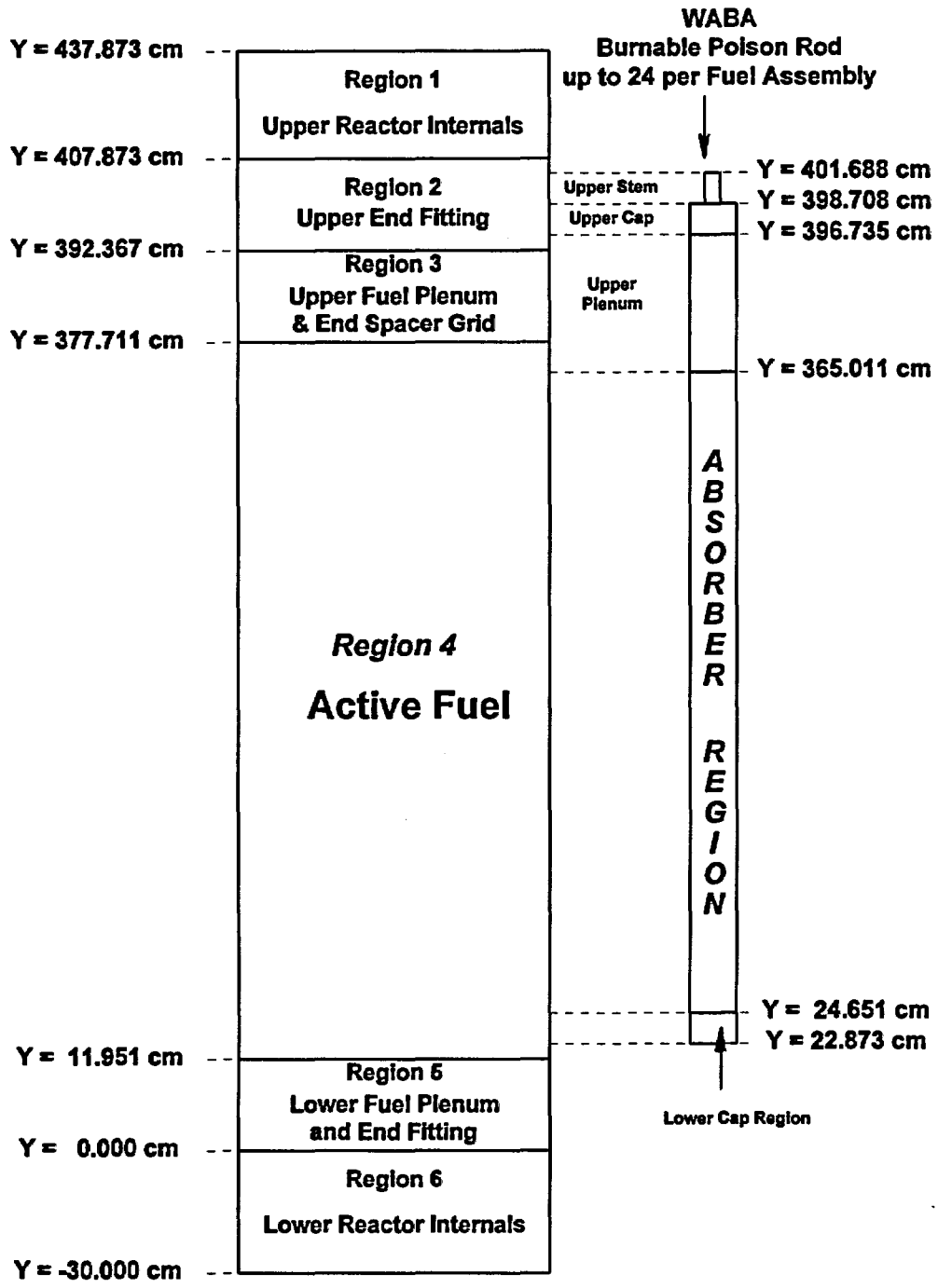
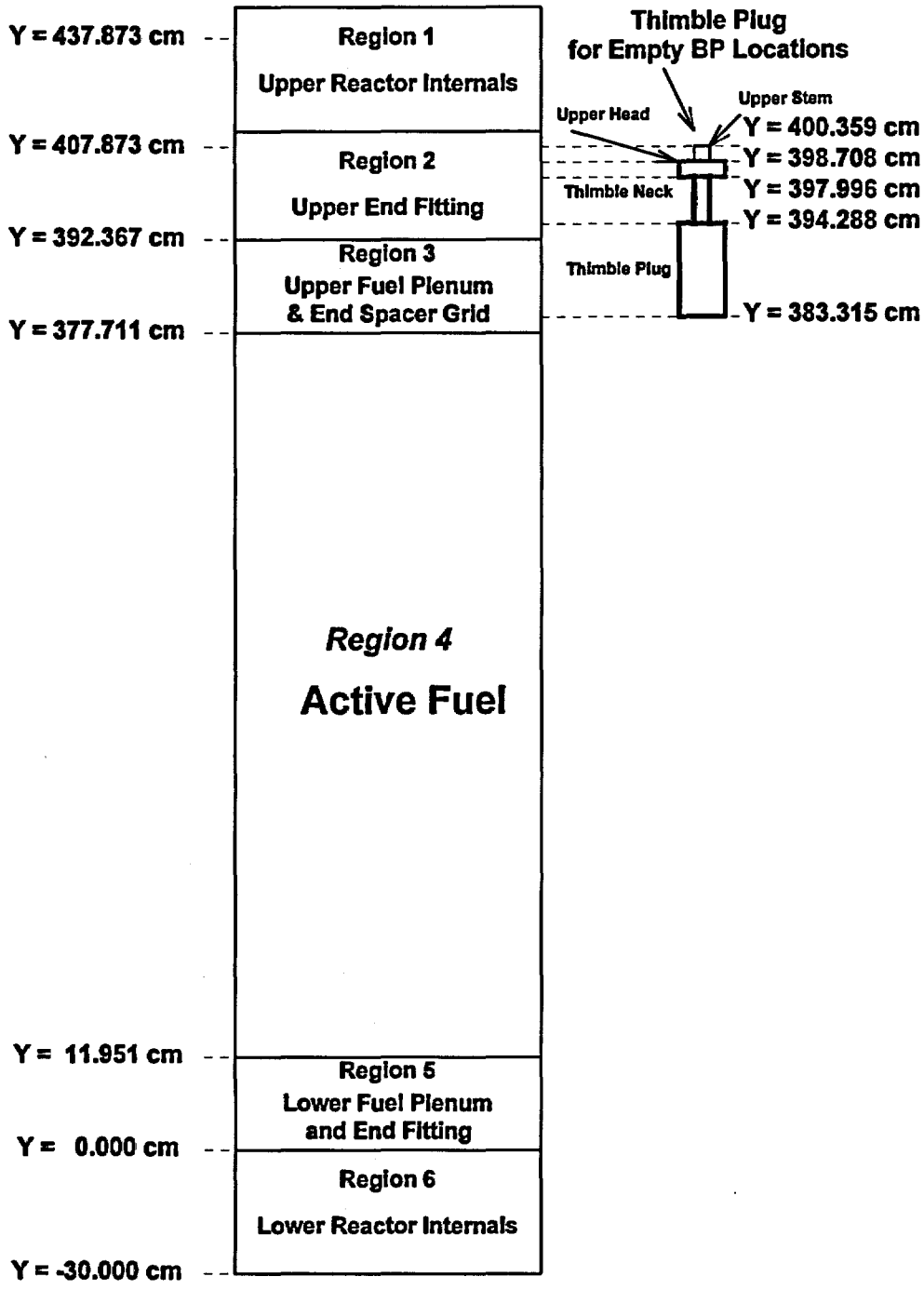


Figure 2-11. Axial Dimensions for Thimble Plug for OFA Fuel Assembly



Thimble Plug Materials/Dimensions:

Thimble plug - stainless steel (diameter = 1.08204 cm)

Thimble neck - stainless steel (diameter = 0.4826 cm)

Upper head - stainless steel (diameter = 0.96774 cm)

Upper stem - stainless steel (diameter = 0.54356 cm)

3.0 FUEL CYCLE DESIGN INFORMATION

This section provides fuel assembly design data for cycles 1 through 5 of the Catawba Unit 1 reactor. Material and geometry data for the fuel assembly components along with cycle length data are presented in Section 3.1. The fuel assembly locations for each cycle, fuel enrichments and number of burnable absorber rods for each assembly, and control rod bank locations are presented in Section 3.2.

3.1 Fuel Batch Data

Material and geometry data for each fresh fuel batch present in cycles 1-5 are given in Table 3-1. This includes the cycle in which the fuel was first loaded, the fuel assembly type, the enrichment and kilograms of uranium in each fuel assembly (by batch), the diameter of the fuel pellets, the BPRA type, and the type of fuel assembly grid material. The radial dimensions of the fuel clad, instrument tube, and guide tube are also presented. In addition, material and radial dimensions for RCCAs and BPRAs are provided. This data should be used in modeling each fuel assembly type for burnup calculations and the reactor criticality calculations for the statepoints defined in Table 3-2.

The length of each fuel cycle, expressed as effective-full-power-days (EFPD), is provided in Table 3-2. The time during each cycle where statepoint criticality data was measured is also presented.

Table 3-1. Fuel Assembly/Pin/Cycle Description for Cycles 1-5

Cycle	Fresh Fuel Batch	Assembly Type	wt% U235	kgU/ Assembly	FP Pellet OD (cm)	FP Clad OD (cm)	FP Clad ID (cm)	FA Grid Material	BPRA Type
1	1	OFA	1.610	423.782	0.784352	0.9144	0.8001	zircaloy	None
	2	OFA	2.400	423.782	0.784352	0.9144	0.8001	zircaloy	Pyrex
	3	OFA	3.100	423.782	0.784352	0.9144	0.8001	zircaloy	Pyrex
2	4A	OFA	3.195	425.368	0.784352	0.9144	0.8001	zircaloy	Pyrex
	4B	OFA	3.406	425.368	0.784352	0.9144	0.8001	zircaloy	None
3	5	OFA	3.397	423.523	0.784352	0.9144	0.8001	zircaloy	WABA
4	6	OFA	3.279	424.898	0.784352	0.9144	0.8001	zircaloy	WABA
5	7	OFA	3.411	426.407	0.784352	0.9144	0.8001	zircaloy	WABA

FP - Fuel Pin; FA - Fuel Assembly; BPRA - Burnable Poison Rod Assembly
OD - outer diameter; ID - inner diameter

Description	Assembly Type	Material	OD (cm)	ID (cm)
Instrument Tube	OFA	zircaloy	1.20396	1.12268
Guide Tube (Upper Region)	OFA	zircaloy	1.20396	1.12268
(Lower Region)	OFA	zircaloy	1.08966	1.00838

RCCAs	Upper Region	Lower Region
Pellet Material	B_4C	Ag-In-Cd
Fraction of Pellet Materials	-	Ag(80%), In(15.0%), Cd(5.0%)
Pellet Density	1.7715 g/cc	10.1587 g/cc
Pellet OD	0.74676 cm	0.76454 cm
Clad Material	SS304	SS304
Clad OD	0.96774 cm	0.96774 cm
Clad ID	0.77216 cm	0.77216 cm
Absorber Length	259.08 cm	101.60 cm

BPRAs (Annular)	Pyrex	WABA
Material	B_2O_3-SiO_2	B_4C-Al_2O_3
Boron Loading	12.5 wt% B_2O_3	14.0 wt% B_4C
	0.00624 g/cm (B-10)	0.006165 g/cm (B-10)
Absorber OD	0.85344 cm	0.8077 cm
Absorber ID	0.48260 cm	0.7061 cm
Clad Material	SS304	zircaloy
Outer Clad OD	0.96774 cm	0.96774 cm
Outer Clad ID	0.87376 cm	0.83570 cm
Inner Clad OD	0.46101 cm	0.67820 cm
Inner Clad ID	0.42799 cm	0.57150 cm

Table 3-2. Cycle Length and Time During Cycle Statepoint Data Measured for Cycles 1-5

Cycle	End-of-Cycle EFPD	Statepoint Number*	Time of Measurement EFPD
1	327.2	SP52	0.0
2	272.7	-	-
3	279.7	-	-
4	314.1	-	-
5	290.89	SP53	0.0
		SP54	274.53

* The unique statepoint numbers SP52, SP53, and SP54 are assigned to Catawba Unit 1 data.

3.2 Fuel Assembly Data

The fuel assembly loadings for each cycle are presented in Figures 3-1 through 3-5. A one-eighth core representation is used, where the fuel assembly at the center of the core is in location H8. Included in these figures are the location of the fuel assemblies in the current cycle, the location in a previous cycle (if applicable), the cycle that the fuel was first inserted, and the fuel batch number for each fuel assembly. The enrichment of U-235 (by batch), the locations of BPRAs, and number of burnable poison (BP) rods in each, and the location of the various control rod banks are also presented. The fuel assemblies with BPRAs may contain different number of BP rods (i.e., 4 to 20 BP rods). The location of these BP rods in a fuel assembly along with the orientation of the assembly in the reactor core are presented in Figure 3-6.

Each fuel assembly is given a unique alphanumeric designation which is then used in tracking the fuel assembly through its entire period of operation. This includes both the time that each fuel assembly was in the reactor during reactor operation (i.e., producing power) and the time spent in a non-power producing mode (e.g., in the reactor during shutdown or in the spent fuel pool).

Starting with the letter A for cycle 1, each subsequent cycle is assigned a unique letter designation (B for cycle 2, C for cycle 3, to E for cycle 5). In addition, each one-eighth core location is assigned a unique number. As noted in Table 2-2, the Catawba Unit 1 reactor contains 193 fuel assemblies. Assuming eighth core symmetry reduces this number to 31 fuel assemblies represented. Thus, the assemblies are numbered 1 through 31. Starting at the center of the core, location H8 is number 1. Numbers 2 through 8 are assigned to locations G8 through A8. Proceeding from left to right (then down), number 9 is assigned to location G9, number 15 to location A9, number 16 to location F10, number 22 to location E11, etc., to number 31 being

assigned to location B13.

Using this nomenclature, the assemblies in cycle 1 are labeled A1 (for H8) through A31 (for B13). For subsequent cycles, a complete set of labels is not required since a combination of burned and fresh fuel is used. From Figure 3-8 it is seen that the first fresh fuel assembly encountered in cycle 2 is in location A8. Thus, the cycle 2 labeling for new fuel starts with assembly B8. Figures 3-7 through 3-11 were constructed by applying this nomenclature to the fuel assembly location data given in Figures 3-1 through 3-5. Note that the nomenclature accommodates the shuffling of symmetric components of fuel assemblies to two separate locations in the one-eighth core representation. This is seen in Figure 3-7 where assembly A21 from core location A10 (representing 8 fuel assemblies in the core) in cycle 1 was shuffled for cycle 2 to core locations E8 and C8 (each representing 4 fuel assemblies in the core). The assembly represented at location C8 was then given the identification A21a.

Figure 3-1. Cycle 1 One-Eighth Core Loading for Catawba Unit 1

	H	G	F	E	D	C	B	A
8	F(1) 1	F(1) 2	F(1) 1	F(1) 2	F(1) 1	F(1) 2	F(1) 1	F(1) 3
9		F(1) 1	F(1) 2	F(1) 1	F(1) 2	F(1) 1	F(1) 3	F(1) 3
10			F(1) 1	F(1) 2	F(1) 1	F(1) 2	F(1) 1	F(1) 3
11				F(1) 1	F(1) 2	F(1) 1	F(1) 3	F(1) 3
12					F(1) 2	F(1) 2	F(1) 3	
13						F(1) 3	F(1) 3	

CR	= Previous FA position Column/Row (C/R) - 1/8th Core
F	= Cycle FA was Fresh (F)
B	= Fuel Batch (B)

Cycle	Batch	Wt% U-235
1	1	1.610
	2	2.400
	3	3.100

BPRA Loading	
Fuel Assembly Location	Number BP Rods/ Assembly
A8, A10	6
E8, F9, D9, E10	12
C13	15
G8, C8, C10, D11, B11, C12	16
B9	20

Control Rod Bank	Core Location
CA	F8
CB	B10
CC	B8, F10
CD	H8, D12

Figure 3-2. Cycle 2 One-Eighth Core Loading for Catawba Unit 1

	H	G	F	E	D	C	B	A
8	B10 F(1) 1	A8 F(1) 3	B9 F(1) 3	A10 F(1) 3	G8 F(1) 2	A10 F(1) 3	C13 F(1) 3	 F(2) 4B
9		B9 F(1) 3	A9 F(1) 3	C12 F(1) 2	A11 F(1) 3	D11 F(1) 2	B12 F(1) 3	 F(2) 4A
10			C8 F(1) 2	 F(2) 4A	D9 F(1) 2	 F(2) 4A	B11 F(1) 3	 F(2) 4B
11				D12 F(1) 2	 F(2) 4A	C10 F(1) 2	 F(2) 4A	E10 F(1) 2
12					E8 F(1) 2	B13 F(1) 3	 F(2) 4A	
13						 F(2) 4B	F9 F(1) 2	

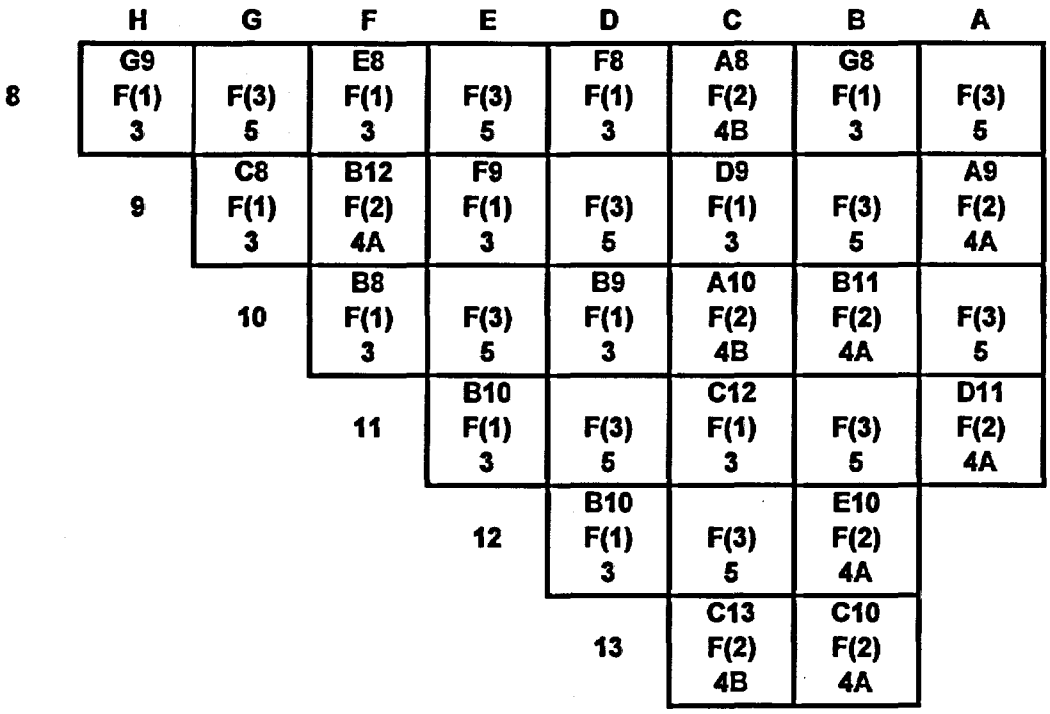
CR	= Previous FA position Column/Row (C/R) - 1/8th Core
F	= Cycle FA was Fresh (F)
B	= Fuel Batch (B)

Cycle	Batch	Wt% U-235
2	1	1.610
	2	2.400
	3	3.100
	4A	3.195
	4B	3.406

BPRA Loading	
Fuel Assembly Location	Number BP Rods/ Assembly
B11	4
E10, C10	8
D11	12

Control Rod Bank	Core Location
CA	F8
CB	B10
CC	B8, F10
CD	H8, D12

Figure 3-3. Cycle 3 One-Eighth Core Loading for Catawba Unit 1



CR	= Previous FA position Column/Row (C/R) - 1/8th Core
F	= Cycle FA was Fresh (F)
B	= Fuel Batch (B)

Cycle	Batch	Wt% U-235
3	3	3.100
	4A	3.195
	4B	3.406
	5	3.397

BPRA Loading	
Fuel Assembly Location	Number BP Rods/ Assembly
B11, C12	4
G8, E8, D9, B9, E10, D11	8

Control Rod Bank	Core Location
CA	F8
CB	B10
CC	B8, F10
CD	H8, D12

Figure 3-4. Cycle 4 One-Eighth Core Loading for Catawba Unit 1

	H	G	F	E	D	C	B	A
8	G9 * F(1) 3	F(4) 6	G8 F(3) 5	D9 F(3) 5	E8 F(3) 5	C8 F(2) 4B	A8 F(3) 5	F(4) 6
9	C13 F(2) 4B	D11 F(3) 5	F9 F(2) 4A	F(4) 6	A9 F(2) 4A	F(4) 6	A10 F(3) 5	
10	E10 F(3) 5	F(4) 6	C10 F(2) 4B	F(4) 6	B9 F(3) 5	F(4) 6		
11	B10 F(2) 4A	B11 F(3) 5	B13 F(2) 4A	F(4) 6	A11 F(2) 4A			
12	D9 F(3) 5	F(4) 6	C12 F(3) 5					
13	E10 F(3) 5	B12 F(2) 4A						

* = Cycle 2 Location

CR	= Previous FA position Column/Row (C/R) - 1/8th Core
F	= Cycle FA was Fresh (F)
B	= Fuel Batch (B)

Cycle	Batch	Wt% U-235
4	3	3.100
	4A	3.195
	4B	3.406
	5	3.397
	6	3.279

BPRA Loading	
Fuel Assembly Location	Number BP Rods/ Assembly
C12	4
G8, D9, B9, E10, C10	8

Control Rod Bank	Core Location
CA	F8
CB	B10
CC	B8, F10
CD	H8, D12

Figure 3-5. Cycle 5 One-Eighth Core Loading for Catawba Unit 1

	H	G	F	E	D	C	B	A
8	G9 * F(1) 3	F(5) 7	D9 F(4) 6	F(5) 7	B8 F(3) 5	A8 F(4) 6	G8 F(4) 6	F(5) 7
9	B10 ** F(2) 4A	B11 F(4) 6	B13 F(2) 4A	F(5) 7	A9 F(3) 5	F(5) 7	C10 F(4) 6	
10	C13 F(3) 5	F(5) 7	A11 F(2) 4A	A10 F(4) 6	E10 F(4) 6	F(5) 7		
11	B10 F(3) 5	F(5) 7	B12 F(3) 5	F(5) 7	D11 F(3) 5			
12	B10 F(3) 5	F(5) 7	C12 F(4) 6					
13	D9 F(4) 6	B9 F(4) 6						

* = Cycle 2 Location
** = Cycle 3 Location

CR	= Previous FA position Column/Row (C/R) - 1/8th Core
F	= Cycle FA was Fresh (F)
B	= Fuel Batch (B)

Cycle	Batch	Wt% U-235
5	3	3.100
	4A	3.195
	5	3.397
	6	3.297
	7	3.411

BPRA Loading	
Fuel Assembly Location	Number BP Rods/ Assembly
C12	4
G8, E8, B9, E10, D11	8
D9	12

Control Rod Bank	Core Location
CA	F8
CB	B10
CC	B8, F10
CD	H8, D12

Figure 3-6. Burnable Poison Rod Locations within a Fuel Assembly

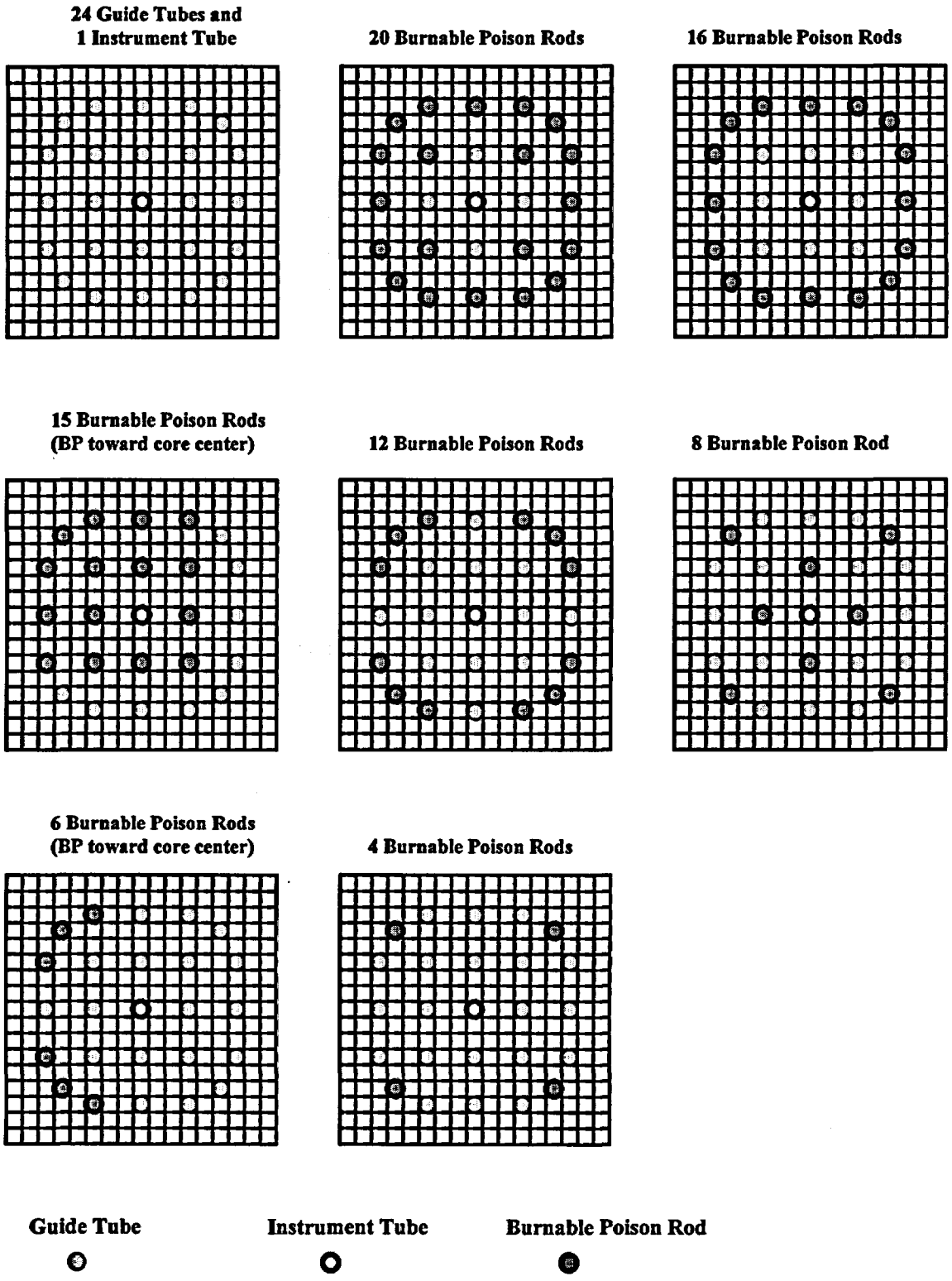
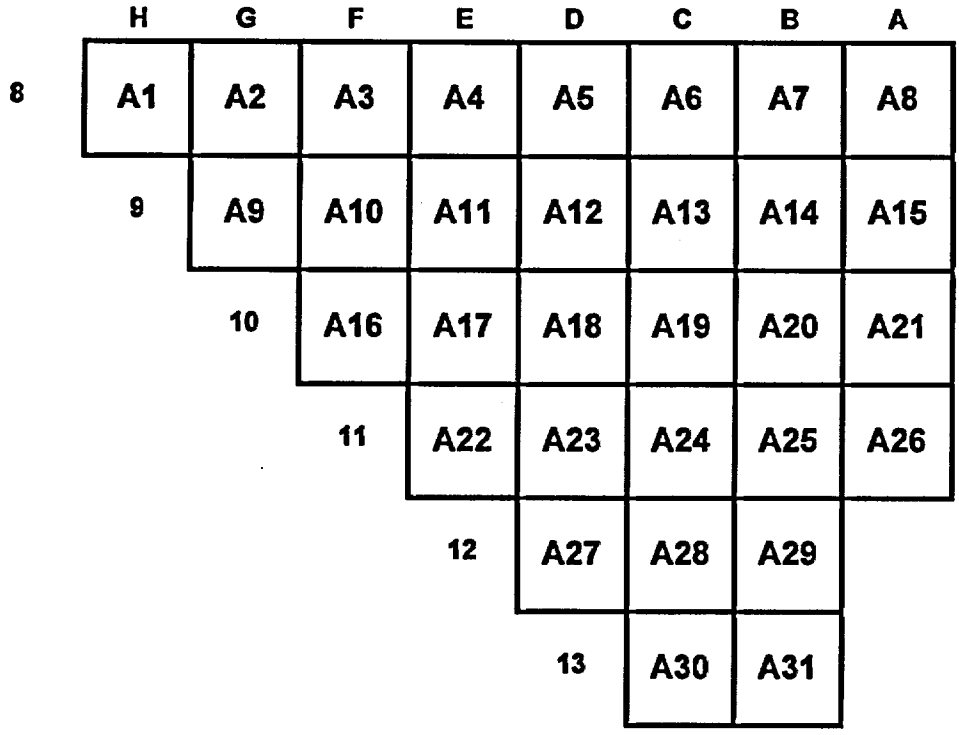
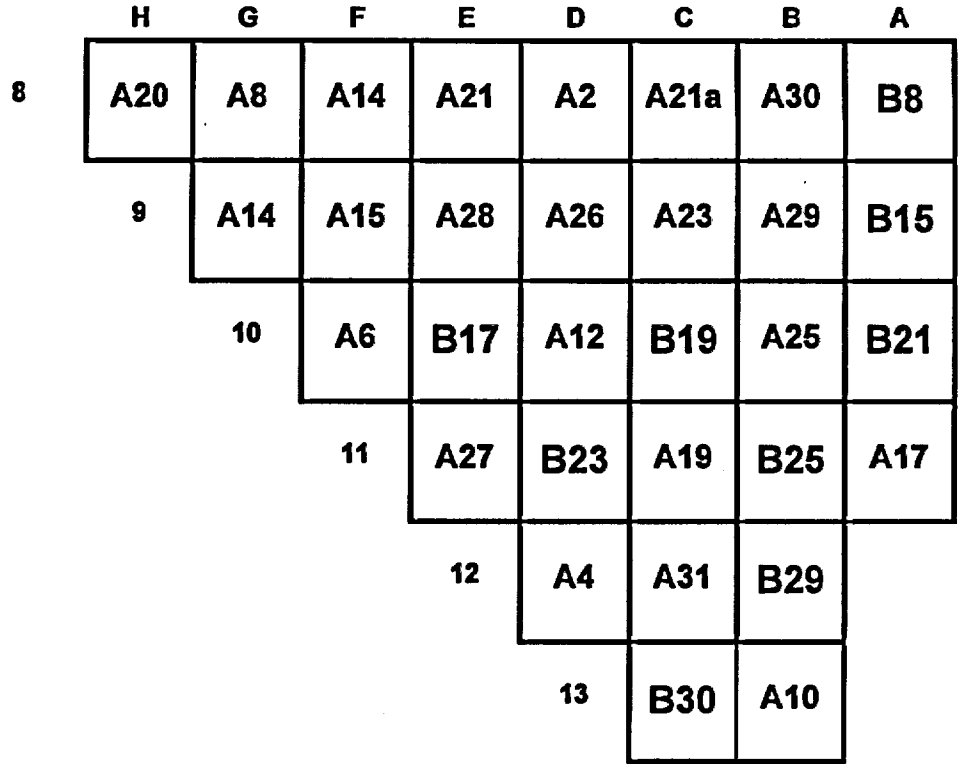


Figure 3-7. Cycle 1 Fuel Assembly Identification & Locations for Catawba 1



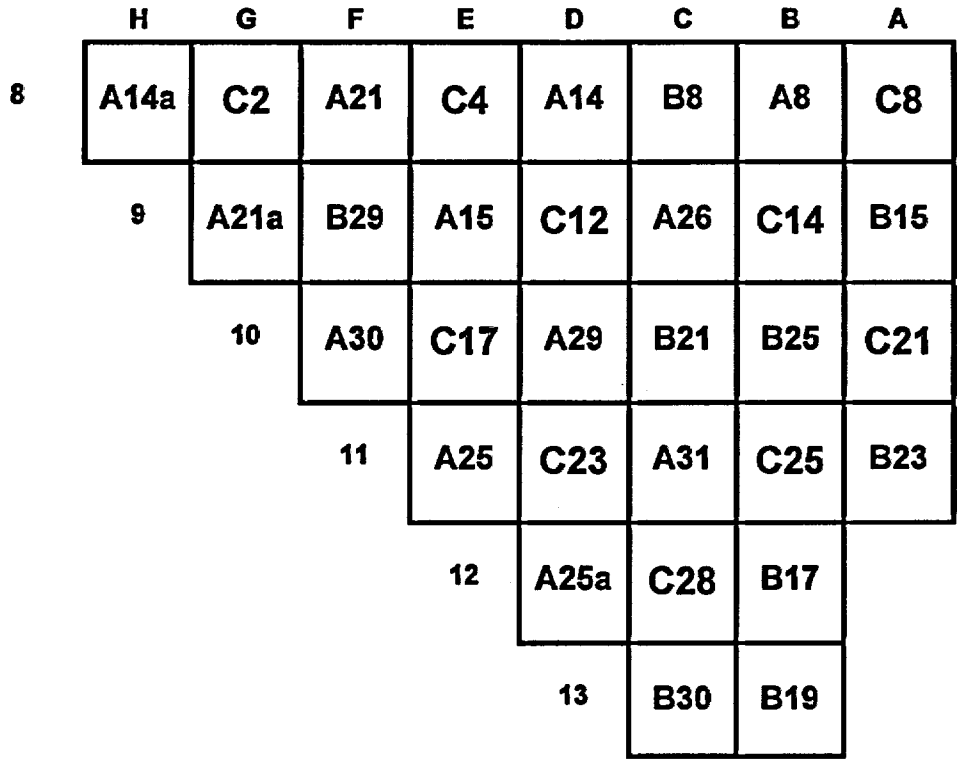
A Cycle 1
B Cycle 2
C Cycle 3
D Cycle 4
E Cycle 5

Figure 3-8. Cycle 2 Fuel Assembly Identification & Locations for Catawba 1



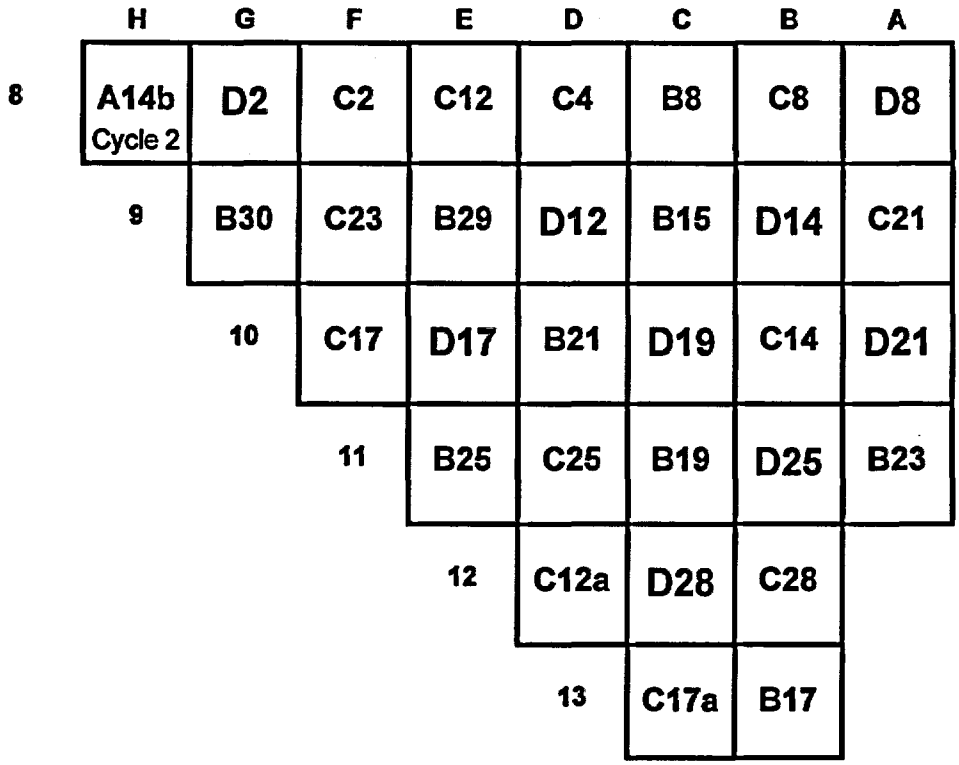
A Cycle 1
B Cycle 2
C Cycle 3
D Cycle 4
E Cycle 5

Figure 3-9. Cycle 3 Fuel Assembly Identification & Locations for Catawba 1



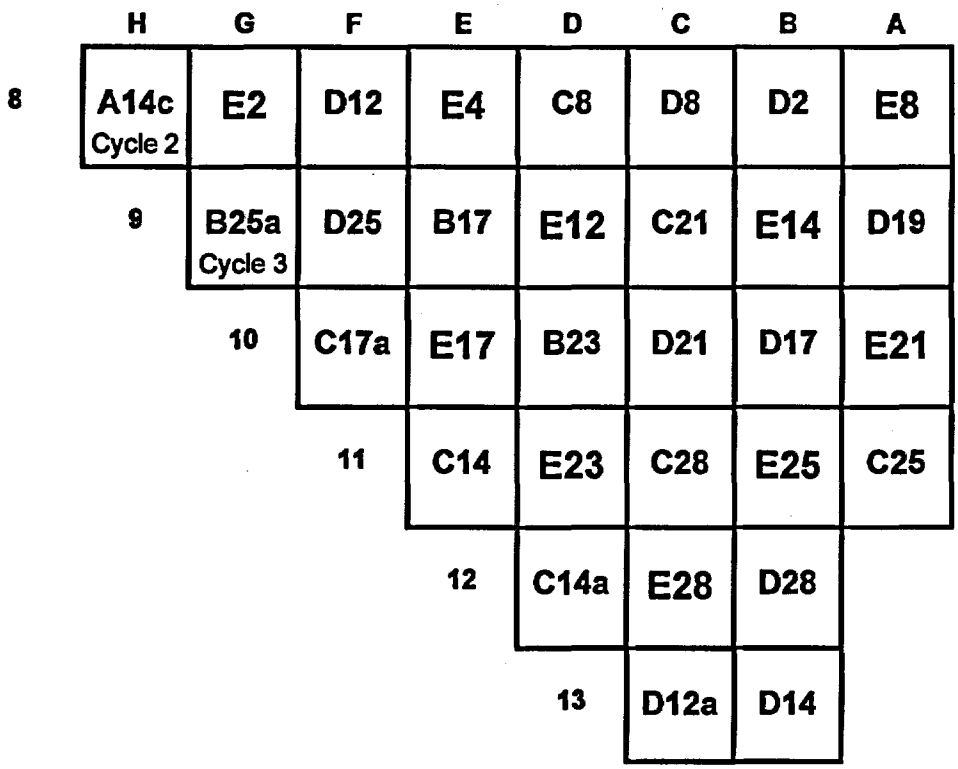
A Cycle 1
B Cycle 2
C Cycle 3
D Cycle 4
E Cycle 5

Figure 3-10. Cycle 4 Fuel Assembly Identification & Locations for Catawba 1



A Cycle 1
B Cycle 2
C Cycle 3
D Cycle 4
E Cycle 5

Figure 3-11. Cycle 5 Fuel Assembly Identification & Locations for Catawba 1



A Cycle 1
B Cycle 2
C Cycle 3
D Cycle 4
E Cycle 5

To aid in the burnup calculations, and thus the generation of isotopic data for the statepoint calculations, the information provided in Figures 3-1 through 3-11 was reduced to two tables. Table 3-3 traces each fuel assembly (and subsequent split by shuffling symmetric components to more than one location, if applicable) by assembly identification and cycle from the time the assembly was first inserted in the reactor through cycle 5. Those assemblies which split for a subsequent cycle (i.e., with an "a" or "b" designator) carry a hyphen (-) designator in the cycle column to indicate those cycles where the assemblies are present prior to the split. This will aid the burnup calculation process by indicating where redundant data generation is not required. Note that only those fuel assemblies which contribute to the statepoint calculations in cycle 5 are included in this table. These are the fuel assemblies that require burnup calculations. The location of each assembly in each cycle is indicated by the coordinates given in the figures (e.g., H8, B13).

Table 3-4 is a repeat of portions of Table 3-3 where control rod bank insertion and burnable absorber (BA) loadings are given for those assemblies that contained control rods or burnable absorber rods during cycle operation. Control rod insertion and burnable absorber rods must be modeled in the burnup calculations for those assemblies and axial locations where either type of rod are present. (More data concerning control rod insertion time by axial node is given in Section 4.) The rod bank indicator CD is given for those assemblies and cycles where rod bank CD was inserted. (This is the only bank inserted during normal cycle operation.) The burnable absorber loadings are given as the number of burnable absorber (or burnable poison) rods present in the fuel assembly. For those cycles where the rod bank or the burnable absorber rods are not present, the assembly presence in the core is indicated with an "X".

Table 3-3. Fuel Assembly Locations by Cycle for Burnup Calculations

Assembly Number / Batch	Assembly Location in Cycle 1	2	3	4	5	Comments
A14c / 3	B9	G9			H8	Cycle 1
						Cycle 2
B17 / 4A		E10	B12	B13	E9	
B23 / 4A		D11	A11	A11	D10	
B25a / 4A		B11	B10		G9	
						Cycle 3
C8 / 5			A8	B8	D8	
C14 / 5			B9	B10	E11	
C14a / 5			-	-	D12	
C17a / 5			E10	C13	F10	
C21 / 5			A10	A9	C9	
C25 / 5			B11	D11	A11	
C28 / 5			C12	B12	C11	
						Cycle 4
D2 / 6				G8	B8	
D8 / 6				A8	C8	
D12 / 6				D9	F8	
D12a / 6				-	C13	
D14 / 6				B9	B13	
D17 / 6				E10	B10	
D19 / 6				C10	A9	
D21 / 6				A10	C10	
D25 / 6				B11	F9	
D28 / 6				C12	B12	
						Cycle 5
E2 / 7					G8	
E4 / 7					E8	
E8 / 7					A8	
E12 / 7					D9	
E14 / 7					B9	
E17 / 7					E10	
E21 / 7					A10	
E23 / 7					D11	
E25 / 7					B11	
E28 / 7					C12	

Table 3-4. Control Rod and BA Loading by Cycle for Burnup Calculations

Assembly Number / Batch	Number of BA Rods or Rod Bank ID / Assembly Location In Cycle					Comments
	1	2	3	4	5	
A14c / 3	20/B9	X			CD/H8	Cycle 1
						Cycle 2
B17 / 4A		8/E10	X	X	X	
B23 / 4A		12/D11	X	X	X	BA=>Pyrex
B25a / 4A		4/B11	X		X	for Cycles 1 & 2
						Cycle 3
C14 / 5			8/B9	X	X	
C14a / 5			8/B9	-	CD/D12	BA=>WABA
C17a / 5			8/E10	X	X	
C25 / 5			4/B11	X	X	
C28 / 5			4/C12	X	X	
						Cycle 4
D2 / 6				8/G8	X	
D12 / 6				8/D9	X	BA=>WABA
D12a / 6				8/D9	X	
D14 / 6				8/B9	X	
D17 / 6				8/E10	X	
D19 / 6				8/C10	X	
D28 / 6				4/C12	X	
						Cycle 5
E2 / 7					8/G8	
E4 / 7					8/E8	BA=>WABA
E12 / 7					12/D9	
E14 / 7					8/B9	
E17 / 7					8/E10	
E23 / 7					8/D11	
E28 / 7					4/C12	

4.0 CORE OPERATIONS AND STATEPOINT INFORMATION

This section provides core operations data for the burnup calculations required to generate isotopic concentrations for the statepoint evaluations. The measured critical conditions for the statepoints evaluated are also contained in this section.

4.1 Core Follow Data

The use of commercial reactor criticality data for model validation requires detailed knowledge of how the reactor was operated for the lifetime of every fuel assembly contributing to the criticality database. This is necessary in order to adequately model the conditions for burnup calculations at each axial location of each fuel assembly represented in the reactor core for each statepoint evaluation. Thus, core follow calculations based on core operation data are used to provide local conditions as a function of time to be used for all burnup calculations performed in support of the statepoint evaluations. In addition, measured global data such as rod insertions and boron letdown data are also provided.

The core follow calculations provide three-dimensional thermal-hydraulic (TH) feedback and burnup data. These data are presented at axial node locations. The nodal spacings for the axial nodes are presented in Table 4-1, where node 1 represents the top axial node in the reactor core. Tables 4-2 through 4-32 provide axial burnup profiles for each assembly at each datapoint or statepoint along with axial fuel temperature and moderator specific volume distributions used in the burnup calculations between datapoints or statepoints. The statepoint evaluations for Catawba 1 were performed at beginning-of-life (0 EFPD of cycle 1), beginning-of-cycle for cycle 5 (0 EFPD), and 274.5 EFPD of cycle 5. Some of the fuel assemblies present in cycle 5 for the statepoint evaluations were initially inserted in the core in cycles 1, 2, 3, and 4. The modeling of fuel assembly operating history for assemblies which were first inserted prior to cycle 5 requires burnup, fuel temperature, and moderator specific volume data for the cycles since the fuel was first inserted into the core. These data are provided at datapoints for the cycles prior to cycle 5 and at statepoints for cycle 5. The data is also given by axial node location.

Control rod insertion time (by axial node) for each assembly with a control rod inserted during core operation is provided in Tables 4-33 and 4-34. This data was also obtained from the core follow calculations based on core operation data. In addition, boron letdown data for cycles 1 through 5 are provided in Table 4-35. The data provided in Table 4-35 are coefficients from a linear regression fit of core operation data for each cycle.

Table 4-1. Axial Node Spacings for Catawba 1 Burnup Calculations

Axial Node	Node Spacings (cm)
1	12.70
2	10.16
3	22.86
4	22.86
5	22.86
6	22.86
7	22.86
8	22.86
9	22.86
10	22.86
11	22.86
12	22.86
13	22.86
14	22.86
15	22.86
16	22.86
17	10.16
18	12.70

Table 4-2. Burnup and TH Feedback Parameters by Axial Node for Assembly A14c

Axial	Burnup	SP52 to DP1		Burnup	DP1 to DP2		Burnup	DP2 to DP3	
Node	DP1	T-Fuel	Spec.Vol	DP2	T-Fuel	Spec.Vol	DP3	T-Fuel	Spec.Vol
1	2.058	774.1	0.0244	5.069	911.4	0.0248	8.823	990.7	0.0246
2	3.255	859.5	0.0243	7.760	1023.3	0.0248	13.098	1087.9	0.0245
3	4.929	976.5	0.0243	11.200	1123.6	0.0246	17.815	1152.2	0.0243
4	6.784	1094.9	0.0241	14.390	1177.9	0.0244	21.435	1145.7	0.0241
5	8.124	1170.5	0.0239	16.137	1178.3	0.0241	22.923	1105.1	0.0238
6	9.053	1216.1	0.0237	17.014	1154.2	0.0239	23.422	1067.7	0.0236
7	9.681	1240.5	0.0235	17.430	1125.9	0.0236	23.524	1039.7	0.0234
8	10.095	1250.6	0.0233	17.629	1102.2	0.0234	23.498	1019.6	0.0232
9	10.362	1251.8	0.0231	17.746	1085.9	0.0232	23.456	1004.8	0.0230
10	10.515	1248.2	0.0228	17.846	1077.8	0.0230	23.442	993.4	0.0228
11	10.560	1241.6	0.0226	17.946	1078.3	0.0228	23.465	984.8	0.0227
12	10.468	1231.4	0.0224	18.015	1088.0	0.0226	23.509	979.8	0.0225
13	10.164	1213.1	0.0222	17.951	1106.4	0.0224	23.501	981.1	0.0223
14	9.512	1177.7	0.0221	17.512	1129.1	0.0222	23.224	991.5	0.0222
15	8.303	1111.9	0.0219	16.194	1138.8	0.0221	22.116	1011.8	0.0220
16	6.280	995.5	0.0218	13.109	1090.7	0.0219	18.883	1019.2	0.0219
17	4.228	860.6	0.0217	9.281	994.9	0.0218	14.158	973.5	0.0218
18	2.579	746.6	0.0217	5.830	865.2	0.0217	9.222	879.8	0.0217

Axial	Burnup	DP3 to SP53		Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	12.875	918.8	0.0244	14.487	744.6	0.0242	16.659	773.4	0.0242
2	18.546	980.9	0.0243	20.961	784.4	0.0241	24.177	827.6	0.0242
3	24.281	1011.7	0.0242	28.789	907.2	0.0240	34.135	945.5	0.0240
4	28.204	1015.0	0.0239	33.722	970.7	0.0239	39.906	980.4	0.0238
5	29.547	998.5	0.0237	35.378	990.7	0.0237	41.669	978.6	0.0237
6	29.884	984.4	0.0235	35.836	995.7	0.0235	42.098	970.6	0.0235
7	29.902	976.3	0.0234	35.898	995.0	0.0233	42.121	962.8	0.0233
8	29.854	972.0	0.0232	35.851	991.1	0.0231	42.049	956.6	0.0231
9	29.821	969.3	0.0230	35.787	985.1	0.0229	41.979	951.8	0.0229
10	29.823	966.6	0.0228	35.731	977.3	0.0227	41.936	948.3	0.0228
11	29.863	963.4	0.0227	35.690	967.9	0.0226	41.924	946.0	0.0226
12	29.937	960.8	0.0225	35.657	956.8	0.0224	41.938	945.0	0.0225
13	30.008	960.8	0.0224	35.592	943.6	0.0222	41.934	945.3	0.0223
14	29.906	967.0	0.0222	35.312	927.3	0.0221	41.723	946.3	0.0222
15	29.059	981.0	0.0220	34.205	904.7	0.0220	40.637	945.0	0.0220
16	25.823	986.2	0.0219	30.454	870.8	0.0218	36.610	925.1	0.0219
17	20.281	958.3	0.0218	24.129	827.3	0.0218	29.506	882.4	0.0218
18	13.708	886.6	0.0217	16.472	775.6	0.0217	20.507	822.3	0.0217

Datapoint or Statepoint	EFPD / Cycle
SP52	0.0 / Cy1
DP1	180.0 / Cy1
DP2	0.0 / Cy2
DP3	126.0 / Cy2
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup - GWd/MTU
T-Fuel - °F
Spec. Vol. - ft^3 / lbm

Table 4-3. Burnup and TH Feedback Parameters by Axial Node for Assembly B17

Axial	Burnup	DP2 to DP3		Burnup	DP3 to DP4		Burnup	DP4 to DP5	
Node	DP3	T-Fuel	Spec.Vol	DP4	T-Fuel	Spec.Vol	DP5	T-Fuel	Spec.Vol
1	3.447	1016.1	0.0252	7.647	992.6	0.0254	9.655	749.9	0.0233
2	5.073	1171.7	0.0251	10.940	1088.8	0.0253	13.871	799.0	0.0233
3	6.665	1311.0	0.0249	14.047	1164.0	0.0251	17.881	839.8	0.0232
4	7.559	1380.5	0.0246	15.716	1199.9	0.0248	20.247	866.9	0.0231
5	7.634	1379.3	0.0243	15.906	1201.6	0.0245	20.782	879.6	0.0230
6	7.456	1358.0	0.0240	15.710	1198.1	0.0243	20.771	885.5	0.0229
7	7.258	1336.2	0.0238	15.519	1196.6	0.0240	20.680	887.4	0.0228
8	7.106	1319.0	0.0235	15.417	1197.2	0.0237	20.627	886.7	0.0226
9	7.002	1306.5	0.0233	15.390	1198.7	0.0235	20.612	884.6	0.0225
10	6.936	1297.5	0.0231	15.410	1199.9	0.0232	20.618	881.6	0.0224
11	6.904	1291.5	0.0228	15.466	1200.5	0.0230	20.636	878.0	0.0223
12	6.910	1288.9	0.0226	15.575	1201.1	0.0228	20.676	873.2	0.0222
13	6.963	1290.1	0.0224	15.762	1203.1	0.0226	20.751	866.0	0.0221
14	7.034	1292.6	0.0222	16.002	1207.3	0.0223	20.809	854.7	0.0220
15	6.961	1281.4	0.0221	16.006	1208.5	0.0221	20.499	836.8	0.0219
16	6.226	1209.8	0.0219	14.677	1174.4	0.0219	18.554	806.7	0.0218
17	4.800	1074.0	0.0218	11.669	1089.9	0.0218	14.707	766.0	0.0217
18	3.136	906.2	0.0217	7.851	962.1	0.0217	9.914	713.2	0.0217

Axial	Burnup	DP5 to DP6		Burnup	DP6 to DP7		Burnup	DP7 to SP53	
Node	DP6	T-Fuel	Spec.Vol	DP7	T-Fuel	Spec.Vol	SP53	T-Fuel	Spec.Vol
1	11.543	778.2	0.0234	12.410	644.3	0.0224	13.796	674.4	0.0225
2	16.487	824.3	0.0234	17.752	664.7	0.0224	19.666	695.2	0.0225
3	21.115	851.9	0.0233	22.753	680.2	0.0223	25.085	709.1	0.0225
4	23.838	866.4	0.0232	25.769	693.0	0.0223	28.332	714.3	0.0224
5	24.474	867.7	0.0230	26.552	698.5	0.0223	29.171	713.0	0.0223
6	24.483	865.1	0.0229	26.631	700.2	0.0222	29.248	710.3	0.0223
7	24.393	861.9	0.0228	26.566	699.9	0.0222	29.169	707.7	0.0222
8	24.339	858.8	0.0227	26.513	698.6	0.0221	29.102	705.4	0.0222
9	24.329	856.3	0.0226	26.490	696.8	0.0221	29.073	703.6	0.0221
10	24.350	854.5	0.0225	26.489	695.0	0.0220	29.074	702.2	0.0221
11	24.393	853.5	0.0223	26.505	693.1	0.0220	29.100	701.3	0.0220
12	24.468	853.2	0.0222	26.544	690.9	0.0219	29.158	700.8	0.0220
13	24.582	853.2	0.0221	26.605	687.7	0.0219	29.245	700.6	0.0219
14	24.668	852.6	0.0220	26.610	682.5	0.0218	29.272	700.4	0.0219
15	24.329	848.6	0.0219	26.135	674.1	0.0218	28.782	699.3	0.0218
16	22.118	832.0	0.0218	23.677	660.1	0.0217	26.157	693.1	0.0218
17	17.682	802.9	0.0218	18.918	644.5	0.0217	21.012	678.3	0.0217
18	12.035	750.7	0.0217	12.887	624.8	0.0217	14.398	656.5	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP2	0.0 / Cy2
DP3	126.0 / Cy2
DP4	0.0 / Cy3
DP5	159.0 / Cy3
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5

Burnup - GWd/MTU
T-Fuel - °F
Spec. Vol. - ft^3 / lbm

Table 4-3. Burnup and TH Feedback Parameters by Axial Node for Assembly B17 (Cont'd)

Axial	Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	DP8	T-Fuel	Spec.Vol	DP7	T-Fuel	Spec.Vol
1	16.693	839.9	0.0242	20.475	867.4	0.0242
2	23.619	887.5	0.0241	28.548	915.9	0.0242
3	29.931	933.7	0.0240	35.713	957.2	0.0240
4	33.792	965.8	0.0238	39.988	978.1	0.0238
5	34.911	982.0	0.0236	41.175	976.6	0.0236
6	35.128	987.9	0.0234	41.372	969.7	0.0235
7	35.113	988.4	0.0233	41.326	962.7	0.0233
8	35.062	985.5	0.0231	41.255	956.7	0.0231
9	35.017	980.4	0.0229	41.205	952.0	0.0229
10	34.975	973.6	0.0227	41.177	948.5	0.0228
11	34.934	965.3	0.0226	41.169	946.4	0.0226
12	34.898	955.1	0.0224	41.182	945.5	0.0225
13	34.855	942.5	0.0222	41.201	945.7	0.0223
14	34.697	925.8	0.0221	41.102	946.3	0.0222
15	33.920	901.7	0.0220	40.320	943.3	0.0220
16	30.746	864.7	0.0218	36.836	921.3	0.0219
17	24.811	820.7	0.0218	30.115	876.4	0.0218
18	17.134	769.7	0.0217	21.126	816.6	0.0217

Table 4-4. Burnup and TH Feedback Parameters by Axial Node for Assembly B23

Axial	Burnup	DP2 to DP3		Burnup	DP3 to DP4		Burnup	DP4 to DP5	
Node	DP3	T-Fuel	Spec.Vol	DP4	T-Fuel	Spec.Vol	DP5	T-Fuel	Spec.Vol
1	2.728	952.2	0.0249	6.261	946.7	0.0253	7.750	705.4	0.0229
2	4.122	1102.2	0.0248	9.207	1049.6	0.0252	11.408	743.8	0.0228
3	5.692	1240.3	0.0247	12.463	1138.7	0.0251	15.339	775.4	0.0228
4	6.742	1317.3	0.0244	14.591	1192.1	0.0248	17.969	794.1	0.0227
5	6.977	1326.0	0.0241	15.088	1201.6	0.0245	18.716	802.4	0.0226
6	6.919	1312.9	0.0239	15.064	1199.8	0.0242	18.828	806.2	0.0226
7	6.806	1296.9	0.0236	14.976	1198.4	0.0240	18.814	807.2	0.0225
8	6.711	1283.8	0.0234	14.939	1198.8	0.0237	18.813	806.4	0.0224
9	6.648	1274.1	0.0232	14.957	1200.1	0.0235	18.840	804.5	0.0223
10	6.612	1267.2	0.0230	15.012	1201.4	0.0232	18.885	802.1	0.0222
11	6.599	1262.5	0.0228	15.096	1202.4	0.0230	18.942	799.2	0.0221
12	6.610	1260.2	0.0226	15.218	1203.7	0.0228	19.014	795.4	0.0221
13	6.644	1259.8	0.0224	15.392	1206.6	0.0225	19.104	790.0	0.0220
14	6.661	1257.5	0.0222	15.568	1211.3	0.0223	19.142	781.4	0.0219
15	6.500	1238.5	0.0220	15.442	1211.0	0.0221	18.770	767.8	0.0218
16	5.704	1160.7	0.0219	13.956	1171.2	0.0219	16.798	743.9	0.0218
17	4.331	1028.8	0.0218	10.935	1083.5	0.0218	13.128	711.1	0.0217
18	2.814	871.2	0.0217	7.297	951.2	0.0217	8.761	671.0	0.0217

Datapoint or Statepoint	EFPD / Cycle			Burnup	- GWd/MTU
DP2	0.0 / Cy2			T-Fuel	- °F
DP3	126.0 / Cy2			Spec. Vol.	- ft^3 / lbm
DP4	0.0 / Cy3				
DP5	159.0 / Cy3	DP8	130.0 / Cy5		
SP54	274.5 / Cy5	SP53	0.0 / Cy5		

Table 4-4. Burnup and TH Feedback Parameters by Axial Node for Assembly B23 (Cont'd)

Axial	Burnup	DP5 to DP6		Burnup	DP6 to DP7		Burnup	DP7 to SP53	
Node	DP6	T-Fuel	Spec.Vol	DP7	T-Fuel	Spec.Vol	SP53	T-Fuel	Spec.Vol
1	9.164	729.1	0.0229	10.337	675.8	0.0227	12.133	708.4	0.0228
2	13.395	767.1	0.0229	15.127	706.6	0.0227	17.627	738.6	0.0227
3	17.792	789.6	0.0228	20.050	729.2	0.0226	23.099	753.9	0.0227
4	20.671	795.7	0.0228	23.327	744.7	0.0226	26.650	760.0	0.0226
5	21.478	794.7	0.0227	24.329	752.3	0.0225	27.702	757.9	0.0225
6	21.597	792.1	0.0226	24.544	755.0	0.0224	27.907	754.4	0.0225
7	21.578	789.3	0.0225	24.565	754.9	0.0223	27.909	751.1	0.0224
8	21.572	786.6	0.0224	24.567	753.5	0.0223	27.898	748.3	0.0223
9	21.600	784.3	0.0223	24.585	751.5	0.0222	27.913	746.2	0.0223
10	21.653	782.7	0.0222	24.618	749.5	0.0221	27.955	744.7	0.0222
11	21.725	781.6	0.0222	24.661	747.5	0.0221	28.018	743.8	0.0221
12	21.822	781.1	0.0221	24.716	744.9	0.0220	28.106	743.5	0.0220
13	21.940	780.9	0.0220	24.771	741.0	0.0219	28.202	743.8	0.0220
14	21.998	780.3	0.0219	24.722	734.3	0.0219	28.193	744.3	0.0219
15	21.598	777.3	0.0219	24.132	722.4	0.0218	27.593	743.5	0.0218
16	19.408	765.8	0.0218	21.572	702.1	0.0218	24.801	735.0	0.0218
17	15.275	742.0	0.0217	16.950	678.3	0.0217	19.644	715.9	0.0217
18	10.265	699.8	0.0217	11.389	647.1	0.0217	13.299	684.1	0.0217

Axial	Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	15.040	849.0	0.0243	18.857	879.8	0.0243
2	21.630	900.4	0.0242	26.642	928.3	0.0242
3	28.049	947.4	0.0241	33.954	967.0	0.0241
4	32.264	981.1	0.0239	38.606	988.8	0.0239
5	33.626	996.4	0.0237	40.040	987.1	0.0237
6	33.987	1003.2	0.0235	40.378	979.8	0.0235
7	34.064	1004.3	0.0233	40.422	972.4	0.0233
8	34.080	1002.0	0.0231	40.416	966.1	0.0231
9	34.089	997.4	0.0230	40.421	961.3	0.0230
10	34.098	991.2	0.0228	40.446	957.9	0.0228
11	34.104	983.4	0.0226	40.487	955.8	0.0226
12	34.107	973.8	0.0224	40.544	955.1	0.0225
13	34.081	961.6	0.0223	40.590	955.7	0.0223
14	33.891	945.2	0.0221	40.473	957.0	0.0222
15	32.998	921.8	0.0220	39.593	955.0	0.0220
16	29.632	885.0	0.0218	35.923	933.6	0.0219
17	23.631	836.5	0.0218	29.111	890.1	0.0218
18	16.152	782.6	0.0217	20.260	828.5	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP5	159.0 / Cy3
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-5. Burnup and TH Feedback Parameters by Axial Node for Assembly B25a

Axial	Burnup	DP2 to DP3		Burnup	DP3 to DP4		Burnup	DP4 to DP5	
Node	DP3	T-Fuel	Spec.Vol	DP4	T-Fuel	Spec.Vol	DP5	T-Fuel	Spec.Vol
1	2.497	909.1	0.0247	5.789	918.8	0.0247	9.119	872.3	0.0246
2	3.780	1044.2	0.0246	8.489	1015.8	0.0246	13.290	948.9	0.0245
3	5.142	1170.2	0.0244	11.191	1087.1	0.0245	17.415	1013.4	0.0244
4	6.099	1249.1	0.0242	12.934	1120.2	0.0243	20.213	1054.0	0.0242
5	6.398	1267.2	0.0240	13.429	1124.0	0.0240	21.224	1070.3	0.0240
6	6.431	1263.2	0.0238	13.501	1121.5	0.0238	21.587	1077.1	0.0237
7	6.393	1254.4	0.0235	13.495	1119.7	0.0236	21.756	1079.0	0.0235
8	6.356	1246.7	0.0233	13.515	1119.5	0.0234	21.878	1078.1	0.0233
9	6.339	1241.4	0.0231	13.572	1120.0	0.0232	21.987	1075.6	0.0231
10	6.340	1238.2	0.0229	13.655	1120.5	0.0230	22.081	1072.3	0.0229
11	6.357	1236.7	0.0227	13.759	1120.8	0.0228	22.158	1068.2	0.0227
12	6.389	1236.6	0.0225	13.889	1121.5	0.0226	22.215	1062.9	0.0225
13	6.428	1237.0	0.0224	14.048	1123.5	0.0224	22.234	1054.7	0.0223
14	6.424	1233.3	0.0222	14.177	1127.2	0.0222	22.118	1041.5	0.0222
15	6.218	1210.7	0.0220	13.991	1127.4	0.0221	21.480	1018.8	0.0220
16	5.386	1129.9	0.0219	12.562	1097.5	0.0219	19.088	973.7	0.0219
17	4.043	999.6	0.0218	9.809	1023.4	0.0218	14.943	906.9	0.0218
18	2.591	847.2	0.0217	6.505	903.6	0.0217	9.988	819.4	0.0217

Axial	Burnup	DP5 to SP53		Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	12.101	893.6	0.0245	14.943	843.6	0.0243	18.624	870.4	0.0242
2	17.349	958.8	0.0244	21.313	898.7	0.0242	26.192	919.9	0.0242
3	22.363	997.7	0.0242	27.339	950.9	0.0241	33.158	960.7	0.0240
4	25.625	1017.7	0.0240	31.291	987.7	0.0239	37.565	982.7	0.0238
5	26.738	1017.1	0.0238	32.676	1000.4	0.0237	39.000	979.0	0.0236
6	27.107	1011.5	0.0236	33.152	1003.1	0.0235	39.426	970.0	0.0234
7	27.269	1005.8	0.0234	33.344	1000.9	0.0233	39.560	961.3	0.0233
8	27.391	1001.1	0.0232	33.452	995.7	0.0231	39.627	953.9	0.0231
9	27.513	997.7	0.0231	33.530	988.5	0.0229	39.683	948.2	0.0229
10	27.637	995.6	0.0229	33.586	979.9	0.0227	39.738	943.9	0.0228
11	27.763	995.0	0.0227	33.622	969.9	0.0226	39.792	940.9	0.0226
12	27.887	995.9	0.0225	33.634	958.5	0.0224	39.841	939.3	0.0225
13	27.990	998.1	0.0224	33.597	945.1	0.0222	39.859	939.2	0.0223
14	27.957	1000.6	0.0222	33.383	928.8	0.0221	39.708	939.9	0.0222
15	27.333	999.6	0.0220	32.493	907.5	0.0220	38.836	938.3	0.0220
16	24.609	977.7	0.0219	29.245	874.0	0.0218	35.318	919.1	0.0219
17	19.607	933.5	0.0218	23.441	827.9	0.0218	28.741	878.9	0.0218
18	13.342	857.2	0.0217	16.084	775.2	0.0217	20.054	820.2	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP2	0.0 / Cy2
DP3	126.0 / Cy2
DP4	0.0 / Cy3
DP5	159.0 / Cy3
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup - GWd/MTU
T-Fuel - °F
Spec. Vol. - ft^3 / lbm

Table 4-6. Burnup and TH Feedback Parameters by Axial Node for Assembly C8

Axial	Burnup	DP4 to DP5		Burnup	DP5 to DP6		Burnup	DP6 to DP7	
Node	DP5	T-Fuel	Spec.Vol	DP6	T-Fuel	Spec.Vol	DP7	T-Fuel	Spec.Vol
1	2.313	816.7	0.0238	4.486	849.3	0.0239	7.662	891.0	0.0249
2	3.482	912.6	0.0238	6.580	933.5	0.0238	11.203	982.9	0.0248
3	4.694	1003.8	0.0237	8.623	997.0	0.0237	14.706	1060.5	0.0247
4	5.628	1065.5	0.0236	10.033	1024.9	0.0236	17.243	1116.5	0.0244
5	6.085	1090.0	0.0234	10.611	1025.7	0.0234	18.364	1139.6	0.0242
6	6.332	1099.1	0.0233	10.877	1020.2	0.0232	18.897	1146.9	0.0239
7	6.478	1102.0	0.0231	11.023	1014.8	0.0231	19.172	1147.3	0.0237
8	6.567	1102.4	0.0229	11.117	1010.9	0.0229	19.324	1145.1	0.0235
9	6.617	1101.7	0.0228	11.186	1008.5	0.0228	19.409	1142.6	0.0232
10	6.637	1100.5	0.0226	11.238	1007.7	0.0227	19.455	1140.8	0.0230
11	6.626	1099.0	0.0225	11.278	1008.6	0.0225	19.468	1139.6	0.0228
12	6.580	1096.6	0.0223	11.298	1011.1	0.0224	19.432	1138.0	0.0226
13	6.479	1091.5	0.0222	11.276	1015.3	0.0222	19.302	1133.8	0.0224
14	6.280	1080.4	0.0221	11.150	1019.8	0.0221	18.961	1122.5	0.0222
15	5.875	1053.9	0.0219	10.726	1019.9	0.0220	18.084	1095.6	0.0220
16	4.972	987.9	0.0218	9.424	994.0	0.0218	15.761	1034.1	0.0219
17	3.724	890.2	0.0217	7.304	926.0	0.0218	12.208	949.1	0.0218
18	2.398	777.4	0.0217	4.831	823.6	0.0217	8.106	842.0	0.0217

Axial	Burnup	DP7 to SP53		Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	12.130	926.2	0.0248	15.246	868.4	0.0245	19.293	894.8	0.0245
2	17.286	997.1	0.0247	21.565	925.0	0.0244	26.866	947.7	0.0244
3	22.158	1043.7	0.0245	27.453	977.6	0.0243	33.712	990.7	0.0242
4	25.413	1062.2	0.0243	31.398	1013.6	0.0241	38.109	1013.2	0.0240
5	26.667	1059.8	0.0241	32.942	1027.0	0.0239	39.701	1010.3	0.0238
6	27.177	1051.5	0.0238	33.582	1031.2	0.0236	40.295	1001.5	0.0236
7	27.417	1043.8	0.0236	33.879	1030.5	0.0234	40.539	992.9	0.0234
8	27.561	1038.4	0.0234	34.036	1026.9	0.0232	40.665	985.9	0.0232
9	27.674	1035.2	0.0232	34.132	1021.3	0.0230	40.751	980.6	0.0230
10	27.781	1033.9	0.0230	34.197	1014.3	0.0228	40.829	976.8	0.0229
11	27.888	1034.5	0.0228	34.239	1005.7	0.0226	40.904	974.5	0.0227
12	27.986	1037.4	0.0226	34.244	995.4	0.0225	40.966	973.8	0.0225
13	28.030	1042.7	0.0224	34.164	983.0	0.0223	40.963	974.7	0.0224
14	27.879	1050.1	0.0223	33.837	967.0	0.0221	40.725	976.7	0.0222
15	27.087	1054.2	0.0221	32.762	944.0	0.0220	39.681	975.8	0.0220
16	24.272	1036.2	0.0219	29.355	905.0	0.0219	35.966	953.9	0.0219
17	19.364	986.1	0.0218	23.553	852.5	0.0218	29.303	907.2	0.0218
18	13.224	896.4	0.0217	16.221	794.4	0.0217	20.533	840.7	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP4	0.0 / Cy3
DP5	159.0 / Cy3
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup - GWd/MTU
T-Fuel - °F
Spec. Vol. - ft^3 / lbm

Table 4-7. Burnup and TH Feedback Parameters by Axial Node for Assembly C14

Axial	Burnup	DP4 to DP5		Burnup	DP5 to DP6		Burnup	DP6 to DP7	
Node	DP5	T-Fuel	Spec.Vol	DP6	T-Fuel	Spec.Vol	DP7	T-Fuel	Spec.Vol
1	3.600	943.2	0.0250	6.855	969.6	0.0250	9.773	852.0	0.0246
2	5.025	1054.9	0.0249	9.392	1056.5	0.0249	13.672	932.7	0.0245
3	6.647	1163.9	0.0248	12.117	1126.1	0.0248	17.759	1004.1	0.0244
4	7.911	1238.5	0.0245	14.023	1158.4	0.0245	20.725	1052.6	0.0242
5	8.529	1267.7	0.0243	14.808	1161.2	0.0243	22.020	1071.3	0.0240
6	8.875	1279.7	0.0240	15.187	1155.5	0.0240	22.643	1076.0	0.0237
7	9.089	1284.3	0.0238	15.412	1149.4	0.0238	22.978	1074.7	0.0235
8	9.227	1285.7	0.0235	15.569	1144.9	0.0235	23.176	1071.2	0.0233
9	9.310	1285.6	0.0233	15.688	1142.4	0.0233	23.299	1067.6	0.0231
10	9.350	1284.9	0.0231	15.784	1142.0	0.0231	23.376	1064.6	0.0229
11	9.347	1283.7	0.0228	15.859	1143.7	0.0229	23.414	1062.3	0.0227
12	9.293	1281.0	0.0226	15.907	1147.6	0.0227	23.398	1059.6	0.0225
13	9.165	1275.1	0.0224	15.900	1153.8	0.0225	23.279	1054.6	0.0223
14	8.911	1261.8	0.0222	15.762	1160.6	0.0223	22.929	1043.6	0.0222
15	8.391	1231.0	0.0220	15.248	1161.3	0.0221	21.984	1019.5	0.0220
16	7.194	1152.5	0.0219	13.549	1127.4	0.0219	19.342	966.9	0.0219
17	5.522	1033.8	0.0218	10.724	1053.5	0.0218	15.209	892.6	0.0218
18	3.823	899.3	0.0217	7.565	943.7	0.0217	10.557	800.0	0.0217

Axial	Burnup	DP7 to SP53		Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	13.930	892.5	0.0245	16.781	838.0	0.0244	20.550	869.8	0.0244
2	19.375	958.5	0.0245	23.353	892.0	0.0243	28.358	925.7	0.0243
3	24.752	1001.7	0.0243	29.766	948.2	0.0242	35.758	974.9	0.0242
4	28.398	1023.9	0.0241	34.156	988.9	0.0240	40.656	1000.6	0.0239
5	29.818	1020.7	0.0239	35.891	1007.8	0.0238	42.461	998.0	0.0237
6	30.415	1011.8	0.0237	36.620	1013.2	0.0236	43.144	989.0	0.0235
7	30.711	1003.8	0.0235	36.965	1012.5	0.0234	43.432	980.0	0.0234
8	30.894	998.0	0.0233	37.152	1008.6	0.0232	43.580	972.6	0.0232
9	31.034	994.4	0.0231	37.268	1002.7	0.0230	43.681	967.0	0.0230
10	31.160	992.7	0.0229	37.347	995.5	0.0228	43.767	963.0	0.0228
11	31.280	992.7	0.0227	37.397	986.8	0.0226	43.847	960.6	0.0227
12	31.380	994.8	0.0226	37.406	976.7	0.0224	43.907	959.7	0.0225
13	31.414	999.4	0.0224	37.317	964.3	0.0223	43.892	960.5	0.0223
14	31.233	1005.8	0.0222	36.962	948.2	0.0221	43.620	962.4	0.0222
15	30.356	1009.3	0.0220	35.801	924.1	0.0220	42.484	961.1	0.0220
16	27.246	989.7	0.0219	32.114	881.7	0.0218	38.494	939.7	0.0219
17	21.857	938.1	0.0218	25.870	833.0	0.0218	31.424	889.1	0.0218
18	15.301	859.8	0.0217	18.167	775.6	0.0217	22.323	821.9	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP4	0.0 / Cy3
DP5	159.0 / Cy3
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup - GWd/MTU
T-Fuel - °F
Spec. Vol. - ft^3 / lbm

Table 4-8. Burnup and TH Feedback Parameters by Axial Node for Assembly C14a

Axial	Burnup	DP4 to DP5		Burnup	DP5 to DP6		Burnup	DP6 to DP7	
Node	DP5	T-Fuel	Spec.Vol	DP6	T-Fuel	Spec.Vol	DP7	T-Fuel	Spec.Vol
1	3.600	943.2	0.0250	6.855	969.6	0.0250	9.773	852.0	0.0246
2	5.025	1054.9	0.0249	9.392	1056.5	0.0249	13.672	932.7	0.0245
3	6.647	1163.9	0.0248	12.117	1126.1	0.0248	17.759	1004.1	0.0244
4	7.911	1238.5	0.0245	14.023	1158.4	0.0245	20.725	1052.6	0.0242
5	8.529	1267.7	0.0243	14.808	1161.2	0.0243	22.02	1071.3	0.0240
6	8.875	1279.7	0.0240	15.187	1155.5	0.0240	22.643	1076.0	0.0237
7	9.089	1284.3	0.0238	15.412	1149.4	0.0238	22.978	1074.7	0.0235
8	9.227	1285.7	0.0235	15.569	1144.9	0.0235	23.176	1071.2	0.0233
9	9.310	1285.6	0.0233	15.688	1142.4	0.0233	23.299	1067.6	0.0231
10	9.350	1284.9	0.0231	15.784	1142.0	0.0231	23.376	1064.6	0.0229
11	9.347	1283.7	0.0228	15.859	1143.7	0.0229	23.414	1062.3	0.0227
12	9.293	1281.0	0.0226	15.907	1147.6	0.0227	23.398	1059.6	0.0225
13	9.165	1275.1	0.0224	15.900	1153.8	0.0225	23.279	1054.6	0.0223
14	8.911	1261.8	0.0222	15.762	1160.6	0.0223	22.929	1043.6	0.0222
15	8.391	1231.0	0.0220	15.248	1161.3	0.0221	21.984	1019.5	0.0220
16	7.194	1152.5	0.0219	13.549	1127.4	0.0219	19.342	966.9	0.0219
17	5.522	1033.8	0.0218	10.724	1053.5	0.0218	15.209	892.6	0.0218
18	3.823	899.3	0.0217	7.565	943.7	0.0217	10.557	800.0	0.0217

Axial	Burnup	DP7 to SP53		Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	13.928	892.5	0.0245	15.428	733.7	0.0242	17.509	764.8	0.0242
2	19.373	958.5	0.0245	21.665	773.8	0.0242	24.791	820.8	0.0241
3	24.749	1001.7	0.0243	29.124	896.1	0.0241	34.398	941.2	0.0240
4	28.395	1023.9	0.0241	33.865	966.2	0.0239	40.025	979.3	0.0238
5	29.814	1020.7	0.0239	35.664	990.6	0.0237	41.944	977.9	0.0236
6	30.411	1011.8	0.0237	36.413	997.6	0.0235	42.653	969.0	0.0234
7	30.707	1003.8	0.0235	36.767	997.6	0.0233	42.952	960.1	0.0233
8	30.889	998.0	0.0233	36.963	994.4	0.0231	43.109	952.9	0.0231
9	31.029	994.4	0.0231	37.089	989.4	0.0229	43.221	947.5	0.0229
10	31.155	992.7	0.0229	37.180	983.2	0.0228	43.320	943.6	0.0228
11	31.274	992.7	0.0227	37.245	975.7	0.0226	43.415	941.3	0.0226
12	31.374	994.8	0.0226	37.268	966.8	0.0224	43.492	940.6	0.0225
13	31.408	999.4	0.0224	37.194	955.6	0.0223	43.494	941.7	0.0223
14	31.227	1005.8	0.0222	36.848	940.4	0.0221	43.235	943.8	0.0222
15	30.350	1009.3	0.0220	35.684	916.2	0.0220	42.098	942.9	0.0220
16	27.241	989.7	0.0219	31.974	872.3	0.0218	38.085	921.7	0.0219
17	21.853	938.1	0.0218	25.713	822.8	0.0218	31.006	872.8	0.0218
18	15.298	859.8	0.0217	18.030	765.9	0.0217	21.970	809.1	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP4	0.0 / Cy3
DP5	159.0 / Cy3
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup - GWd/MTU
T-Fuel - °F
Spec. Vol. - ft^3 / lbm

Table 4-9. Burnup and TH Feedback Parameters by Axial Node for Assembly C17a

Axial	Burnup	DP4 to DP5		Burnup	DP5 to DP6		Burnup	DP6 to DP7	
Node	DP5	T-Fuel	Spec.Vol	DP6	T-Fuel	Spec.Vol	DP7	T-Fuel	Spec.Vol
1	4.176	995.7	0.0253	7.859	1014.5	0.0254	9.702	750.8	0.0235
2	5.738	1111.7	0.0252	10.619	1100.8	0.0253	13.386	807.8	0.0235
3	7.443	1223.7	0.0250	13.486	1170.2	0.0251	17.241	861.9	0.0234
4	8.661	1293.6	0.0247	15.342	1205.5	0.0248	19.913	898.9	0.0233
5	9.158	1315.6	0.0244	15.974	1205.0	0.0245	20.937	912.8	0.0231
6	9.382	1320.4	0.0242	16.202	1197.0	0.0242	21.344	916.4	0.0230
7	9.499	1319.6	0.0239	16.311	1189.7	0.0240	21.525	915.2	0.0229
8	9.561	1317.0	0.0236	16.383	1184.8	0.0237	21.613	912.2	0.0227
9	9.580	1313.7	0.0234	16.435	1182.3	0.0235	21.654	909.0	0.0226
10	9.563	1310.1	0.0231	16.472	1182.1	0.0232	21.663	906.1	0.0225
11	9.508	1305.9	0.0229	16.496	1184.0	0.0230	21.646	903.5	0.0224
12	9.416	1300.8	0.0227	16.507	1188.2	0.0228	21.597	900.6	0.0222
13	9.280	1293.9	0.0225	16.498	1194.8	0.0226	21.492	895.6	0.0221
14	9.069	1282.3	0.0223	16.424	1202.8	0.0223	21.251	886.0	0.0220
15	8.663	1257.6	0.0221	16.068	1205.8	0.0221	20.581	867.3	0.0219
16	7.621	1188.0	0.0219	14.575	1174.0	0.0219	18.445	830.7	0.0218
17	6.004	1072.5	0.0218	11.785	1096.7	0.0218	14.782	780.7	0.0217
18	4.231	935.7	0.0217	8.437	982.2	0.0217	10.443	718.9	0.0217

Axial	Burnup	DP7 to SP53		Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	12.482	796.3	0.0236	15.476	854.7	0.0243	19.365	881.7	0.0243
2	17.292	850.6	0.0236	21.448	913.5	0.0243	26.583	935.8	0.0242
3	22.163	885.4	0.0235	27.295	963.2	0.0241	33.336	975.5	0.0241
4	25.444	903.4	0.0234	31.205	995.1	0.0239	37.640	993.7	0.0239
5	26.621	901.5	0.0232	32.636	1006.7	0.0237	39.099	989.3	0.0237
6	27.030	895.0	0.0231	33.156	1009.5	0.0235	39.564	980.1	0.0235
7	27.186	888.9	0.0229	33.352	1007.9	0.0233	39.706	971.5	0.0233
8	27.259	884.2	0.0228	33.425	1003.6	0.0231	39.744	964.4	0.0231
9	27.305	881.1	0.0227	33.441	997.5	0.0229	39.747	959.1	0.0230
10	27.341	879.4	0.0226	33.425	990.0	0.0228	39.739	955.2	0.0228
11	27.373	879.0	0.0224	33.384	981.1	0.0226	39.727	952.8	0.0226
12	27.396	880.0	0.0223	33.310	970.8	0.0224	39.703	951.9	0.0225
13	27.385	882.3	0.0222	33.172	958.4	0.0223	39.635	952.6	0.0223
14	27.240	885.4	0.0221	32.853	942.9	0.0221	39.393	954.1	0.0222
15	26.583	885.6	0.0219	31.923	921.3	0.0220	38.486	952.8	0.0220
16	24.070	869.5	0.0218	28.858	884.7	0.0218	35.132	932.4	0.0219
17	19.483	835.2	0.0218	23.421	835.1	0.0218	28.874	888.9	0.0218
18	13.782	775.3	0.0217	16.571	776.4	0.0217	20.622	822.9	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP4	0.0 / Cy3
DP5	159.0 / Cy3
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-10. Burnup and TH Feedback Parameters by Axial Node for Assembly C21

Axial	Burnup	DP4 to DP5		Burnup	DP5 to DP6		Burnup	DP6 to DP7	
Node	DP5	T-Fuel	Spec.Vol	DP6	T-Fuel	Spec.Vol	DP7	T-Fuel	Spec.Vol
1	2.230	809.0	0.0238	4.313	839.7	0.0238	6.341	778.2	0.0236
2	3.378	903.4	0.0238	6.365	922.8	0.0238	9.390	845.0	0.0236
3	4.586	994.6	0.0237	8.393	985.9	0.0237	12.441	904.8	0.0235
4	5.531	1056.9	0.0235	9.813	1013.8	0.0235	14.665	946.0	0.0234
5	5.994	1081.7	0.0234	10.400	1014.6	0.0234	15.636	962.9	0.0233
6	6.243	1091.0	0.0232	10.669	1009.3	0.0232	16.086	967.8	0.0231
7	6.389	1093.9	0.0231	10.814	1003.8	0.0230	16.312	967.6	0.0230
8	6.476	1094.1	0.0229	10.905	999.7	0.0229	16.434	965.5	0.0228
9	6.524	1093.4	0.0228	10.970	997.2	0.0228	16.503	963.3	0.0227
10	6.542	1092.2	0.0226	11.019	996.4	0.0226	16.542	961.4	0.0225
11	6.531	1090.8	0.0225	11.056	997.2	0.0225	16.556	960.0	0.0224
12	6.486	1088.3	0.0223	11.074	999.7	0.0224	16.533	958.2	0.0223
13	6.387	1083.4	0.0222	11.051	1003.7	0.0222	16.432	954.4	0.0222
14	6.189	1072.2	0.0220	10.921	1008.2	0.0221	16.146	945.5	0.0220
15	5.783	1045.6	0.0219	10.493	1007.8	0.0220	15.385	924.8	0.0219
16	4.875	979.4	0.0218	9.189	981.5	0.0218	13.338	879.2	0.0218
17	3.632	882.1	0.0217	7.089	914.5	0.0218	10.232	815.1	0.0217
18	2.327	771.0	0.0217	4.668	814.1	0.0217	6.727	739.5	0.0217

Axial	Burnup	DP7 to SP53		Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	9.320	819.9	0.0237	12.415	882.8	0.0247	16.438	909.3	0.0245
2	13.560	877.6	0.0237	17.874	951.9	0.0246	23.204	961.8	0.0245
3	17.643	918.0	0.0236	23.057	1004.9	0.0244	29.401	1005.8	0.0243
4	20.431	932.3	0.0234	26.598	1042.8	0.0242	33.416	1022.5	0.0241
5	21.513	928.8	0.0233	28.007	1057.2	0.0240	34.877	1018.3	0.0239
6	21.946	921.5	0.0231	28.596	1062.2	0.0238	35.421	1009.2	0.0237
7	22.142	915.0	0.0230	28.869	1062.4	0.0235	35.646	1000.6	0.0235
8	22.252	910.4	0.0229	29.012	1059.8	0.0233	35.763	993.7	0.0233
9	22.335	907.6	0.0227	29.098	1055.4	0.0231	35.846	988.6	0.0231
10	22.412	906.2	0.0226	29.152	1049.4	0.0229	35.921	985.2	0.0229
11	22.488	906.3	0.0225	29.182	1042.0	0.0227	35.993	983.2	0.0227
12	22.555	908.0	0.0223	29.173	1032.8	0.0225	36.051	983.0	0.0225
13	22.570	911.7	0.0222	29.077	1021.3	0.0223	36.047	984.6	0.0224
14	22.408	917.0	0.0221	28.744	1006.1	0.0222	35.820	987.7	0.0222
15	21.672	920.3	0.0220	27.712	984.0	0.0220	34.838	988.5	0.0220
16	19.190	905.9	0.0218	24.578	943.1	0.0219	31.391	971.3	0.0219
17	15.038	863.8	0.0218	19.418	888.8	0.0218	25.302	926.0	0.0218
18	10.079	793.6	0.0217	13.150	814.8	0.0217	17.496	859.6	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP4	0.0 / Cy3
DP5	159.0 / Cy3
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup - GWd/MTU
T-Fuel - °F
Spec. Vol. - ft^3 / lbm

Table 4-11. Burnup and TH Feedback Parameters by Axial Node for Assembly C25

Axial	Burnup	DP4 to DP5		Burnup	DP5 to DP6		Burnup	DP6 to DP7	
Node	DP5	T-Fuel	Spec.Vol	DP6	T-Fuel	Spec.Vol	DP7	T-Fuel	Spec.Vol
1	3.104	898.6	0.0246	5.935	928.1	0.0246	8.960	872.0	0.0247
2	4.521	1012.3	0.0246	8.439	1019.3	0.0245	12.872	957.6	0.0246
3	6.068	1120.0	0.0244	11.013	1087.3	0.0244	16.957	1038.9	0.0245
4	7.271	1191.6	0.0242	12.813	1115.4	0.0242	19.908	1089.8	0.0243
5	7.850	1218.8	0.0240	13.546	1115.7	0.0239	21.143	1104.9	0.0240
6	8.159	1228.6	0.0238	13.880	1109.2	0.0237	21.690	1106.5	0.0238
7	8.341	1231.7	0.0236	14.065	1102.7	0.0235	21.952	1102.7	0.0236
8	8.451	1231.9	0.0233	14.185	1097.9	0.0233	22.080	1097.1	0.0234
9	8.513	1231.0	0.0231	14.273	1095.1	0.0231	22.137	1091.6	0.0231
10	8.537	1229.7	0.0229	14.342	1094.2	0.0229	22.151	1086.9	0.0229
11	8.525	1228.0	0.0227	14.395	1095.4	0.0228	22.130	1082.9	0.0227
12	8.469	1225.2	0.0225	14.425	1098.6	0.0226	22.062	1078.8	0.0225
13	8.349	1219.6	0.0223	14.409	1103.8	0.0224	21.905	1072.6	0.0224
14	8.115	1207.5	0.0222	14.274	1109.8	0.0222	21.548	1061.6	0.0222
15	7.634	1178.6	0.0220	13.794	1110.4	0.0220	20.673	1040.0	0.0220
16	6.525	1104.5	0.0219	12.230	1082.3	0.0219	18.268	993.5	0.0219
17	4.959	990.7	0.0218	9.610	1012.2	0.0218	14.402	922.5	0.0218
18	3.307	855.8	0.0217	6.571	901.4	0.0217	9.835	829.2	0.0217

Axial	Burnup	DP7 to SP53		Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	13.139	903.4	0.0246	14.180	667.7	0.0226	15.650	691.4	0.0226
2	18.596	972.5	0.0245	20.103	691.7	0.0226	22.130	714.7	0.0226
3	24.091	1021.9	0.0244	26.012	711.8	0.0225	28.451	729.9	0.0226
4	27.808	1044.4	0.0242	30.016	724.2	0.0225	32.644	734.3	0.0225
5	29.176	1038.4	0.0239	31.506	728.7	0.0224	34.147	732.4	0.0224
6	29.682	1027.7	0.0237	32.063	729.8	0.0223	34.674	728.3	0.0224
7	29.886	1018.5	0.0235	32.284	729.0	0.0223	34.864	724.3	0.0223
8	29.981	1011.7	0.0233	32.380	727.3	0.0222	34.939	721.1	0.0222
9	30.037	1007.3	0.0231	32.428	725.0	0.0222	34.976	718.5	0.0222
10	30.084	1004.8	0.0229	32.457	722.3	0.0221	35.004	716.6	0.0221
11	30.127	1004.2	0.0228	32.477	719.3	0.0220	35.032	715.2	0.0221
12	30.158	1005.5	0.0226	32.475	715.7	0.0220	35.047	714.5	0.0220
13	30.137	1009.3	0.0224	32.407	711.4	0.0219	35.005	714.3	0.0219
14	29.941	1015.3	0.0222	32.137	705.4	0.0219	34.761	714.3	0.0219
15	29.159	1019.7	0.0221	31.222	696.0	0.0218	33.838	712.7	0.0218
16	26.387	1004.5	0.0219	28.177	680.1	0.0218	30.623	703.1	0.0218
17	21.356	959.7	0.0218	22.769	659.2	0.0217	24.824	687.1	0.0217
18	14.885	881.9	0.0217	15.856	636.3	0.0217	17.334	661.9	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP4	0.0 / Cy3
DP5	159.0 / Cy3
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup - GWd/MTU
T-Fuel - °F
Spec. Vol. - ft^3 / lbm

Table 4-12. Burnup and TH Feedback Parameters by Axial Node for Assembly C28

Axial	Burnup	DP4 to DP5		Burnup	DP5 to DP6		Burnup	DP6 to DP7	
Node	DP5	T-Fuel	Spec.Vol	DP6	T-Fuel	Spec.Vol	DP7	T-Fuel	Spec.Vol
1	3.128	911.2	0.0249	5.976	943.6	0.0249	7.700	742.4	0.0233
2	4.643	1035.7	0.0249	8.647	1043.4	0.0248	11.219	794.6	0.0232
3	6.471	1159.0	0.0247	11.715	1122.3	0.0247	15.135	840.5	0.0232
4	7.884	1239.7	0.0245	13.884	1155.3	0.0244	17.969	870.2	0.0231
5	8.508	1267.5	0.0242	14.698	1155.7	0.0242	19.101	881.1	0.0230
6	8.817	1276.5	0.0240	15.035	1148.4	0.0240	19.583	883.4	0.0228
7	8.991	1278.6	0.0237	15.211	1141.4	0.0237	19.816	881.8	0.0227
8	9.093	1278.0	0.0235	15.326	1136.4	0.0235	19.942	878.7	0.0226
9	9.149	1276.5	0.0233	15.411	1133.7	0.0233	20.014	875.5	0.0225
10	9.165	1274.7	0.0230	15.479	1133.1	0.0231	20.054	872.6	0.0224
11	9.146	1272.6	0.0228	15.532	1134.6	0.0229	20.068	870.0	0.0223
12	9.083	1269.5	0.0226	15.566	1138.2	0.0227	20.046	867.1	0.0222
13	8.960	1263.9	0.0224	15.561	1144.1	0.0225	19.955	862.5	0.0221
14	8.731	1252.0	0.0222	15.451	1151.0	0.0223	19.698	854.0	0.0220
15	8.259	1224.0	0.0220	15.001	1152.5	0.0221	18.973	837.6	0.0219
16	7.128	1149.2	0.0219	13.412	1122.5	0.0219	16.811	804.5	0.0218
17	5.472	1031.2	0.0218	10.637	1050.8	0.0218	13.254	757.7	0.0217
18	3.677	888.0	0.0217	7.326	936.3	0.0217	9.067	703.1	0.0217

Axial	Burnup	DP7 to SP53		Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	10.293	784.9	0.0234	12.979	840.1	0.0244	16.556	875.1	0.0243
2	14.851	835.1	0.0233	18.682	904.7	0.0243	23.510	926.0	0.0242
3	19.633	864.2	0.0233	24.557	955.8	0.0242	30.393	969.9	0.0241
4	22.934	871.3	0.0231	28.657	999.6	0.0240	35.003	988.8	0.0239
5	24.163	867.7	0.0230	30.240	1017.4	0.0238	36.657	986.1	0.0237
6	24.630	861.1	0.0229	30.871	1023.3	0.0236	37.247	977.4	0.0235
7	24.832	855.2	0.0228	31.149	1023.7	0.0234	37.477	968.9	0.0233
8	24.938	850.8	0.0227	31.287	1021.3	0.0232	37.587	962.3	0.0231
9	25.010	847.7	0.0226	31.363	1017.2	0.0230	37.658	957.3	0.0230
10	25.070	845.9	0.0224	31.404	1011.8	0.0228	37.718	954.0	0.0228
11	25.123	845.2	0.0223	31.418	1005.2	0.0226	37.774	952.3	0.0226
12	25.162	845.8	0.0222	31.393	997.1	0.0225	37.814	952.1	0.0225
13	25.152	847.7	0.0221	31.282	986.7	0.0223	37.793	953.8	0.0223
14	24.980	850.5	0.0220	30.947	972.3	0.0221	37.558	956.5	0.0222
15	24.268	851.0	0.0219	29.935	949.4	0.0220	36.582	956.1	0.0220
16	21.767	838.6	0.0218	26.776	905.9	0.0218	33.103	935.1	0.0219
17	17.375	809.8	0.0218	21.408	850.0	0.0218	26.846	892.4	0.0218
18	11.975	753.0	0.0217	14.782	784.7	0.0217	18.780	828.5	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP4	0.0 / Cy3
DP5	159.0 / Cy3
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup - GWd/MTU
T-Fuel - °F
Spec. Vol. - ft^3 / lbm

Table 4-13. Burnup and TH Feedback Parameters by Axial Node for Assembly D2

Axial	Burnup	DP6 to DP7		Burnup	DP7 to SP53		Burnup	SP53 to DP8	
Node	DP7	T-Fuel	Spec.Vol	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol
1	3.551	967.4	0.0252	8.152	979.8	0.0252	10.899	858.6	0.0245
2	5.013	1093.7	0.0251	11.230	1066.6	0.0251	15.186	937.2	0.0245
3	6.796	1229.3	0.0250	14.722	1142.9	0.0249	19.794	995.6	0.0243
4	8.146	1317.1	0.0247	17.059	1176.7	0.0246	22.930	1032.0	0.0241
5	8.683	1342.1	0.0244	17.796	1172.6	0.0244	24.035	1048.5	0.0239
6	8.885	1345.1	0.0241	17.987	1162.9	0.0241	24.411	1056.4	0.0237
7	8.946	1340.7	0.0239	18.019	1155.1	0.0239	24.541	1058.5	0.0235
8	8.940	1334.7	0.0236	18.013	1150.4	0.0236	24.586	1057.6	0.0233
9	8.896	1329.4	0.0233	18.006	1148.2	0.0234	24.599	1054.7	0.0231
10	8.830	1325.7	0.0231	18.012	1148.3	0.0232	24.599	1050.2	0.0229
11	8.745	1323.4	0.0229	18.033	1150.3	0.0229	24.589	1044.1	0.0227
12	8.635	1321.1	0.0227	18.064	1154.5	0.0227	24.560	1036.2	0.0225
13	8.481	1316.1	0.0224	18.089	1161.2	0.0225	24.481	1025.3	0.0223
14	8.238	1303.5	0.0222	18.034	1169.9	0.0223	24.246	1009.1	0.0221
15	7.780	1271.2	0.0220	17.643	1174.6	0.0221	23.508	982.9	0.0220
16	6.728	1186.4	0.0219	15.979	1147.4	0.0219	21.087	937.5	0.0218
17	5.217	1059.1	0.0218	12.889	1072.5	0.0218	16.913	875.1	0.0218
18	3.634	916.8	0.0217	9.191	964.6	0.0217	11.919	789.6	0.0217

Axial	Burnup	DP8 to SP54	
Node	SP54	T-Fuel	Spec.Vol
1	14.522	886.9	0.0244
2	20.130	948.1	0.0243
3	25.778	989.5	0.0242
4	29.435	1007.5	0.0240
5	30.632	1004.0	0.0238
6	30.989	996.1	0.0236
7	31.090	988.6	0.0234
8	31.122	982.8	0.0232
9	31.144	978.5	0.0230
10	31.175	975.7	0.0228
11	31.216	974.4	0.0227
12	31.261	974.6	0.0225
13	31.276	976.4	0.0223
14	31.135	979.2	0.0222
15	30.400	978.8	0.0220
16	27.560	958.0	0.0219
17	22.366	906.1	0.0218
18	15.825	837.0	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-14. Burnup and TH Feedback Parameters by Axial Node for Assembly D8

Axial	Burnup	DP6 to DP7		Burnup	DP7 to SP53		Burnup	SP53 to DP8	
Node	DP7	T-Fuel	Spec.Vol	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol
1	2.131	815.7	0.0240	5.254	860.7	0.0240	8.439	923.4	0.0250
2	3.258	917.0	0.0239	7.732	946.2	0.0240	12.255	1012.2	0.0249
3	4.472	1019.6	0.0238	10.175	1009.4	0.0238	15.945	1083.4	0.0247
4	5.452	1095.4	0.0237	11.862	1035.8	0.0237	18.493	1130.2	0.0245
5	5.929	1127.0	0.0235	12.504	1035.9	0.0235	19.514	1147.7	0.0242
6	6.160	1138.2	0.0234	12.742	1029.4	0.0233	19.938	1154.0	0.0240
7	6.272	1141.1	0.0232	12.837	1023.3	0.0232	20.130	1155.0	0.0237
8	6.325	1140.9	0.0230	12.891	1019.1	0.0230	20.232	1153.0	0.0235
9	6.347	1140.4	0.0228	12.941	1016.8	0.0229	20.296	1148.8	0.0232
10	6.351	1140.6	0.0227	13.000	1016.3	0.0227	20.340	1142.9	0.0230
11	6.339	1141.4	0.0225	13.070	1017.5	0.0226	20.367	1135.1	0.0228
12	6.305	1141.7	0.0224	13.149	1020.6	0.0224	20.370	1125.3	0.0226
13	6.226	1138.9	0.0222	13.211	1026.0	0.0223	20.314	1112.8	0.0224
14	6.048	1127.3	0.0221	13.175	1032.8	0.0221	20.091	1096.0	0.0222
15	5.644	1095.2	0.0219	12.782	1035.2	0.0220	19.362	1070.8	0.0220
16	4.720	1013.7	0.0218	11.290	1010.1	0.0219	17.111	1022.1	0.0219
17	3.480	901.3	0.0217	8.759	944.2	0.0218	13.406	950.7	0.0218
18	2.209	779.3	0.0217	5.788	839.8	0.0217	8.968	852.2	0.0217

Axial	Burnup	DP8 to SP54	
Node	SP54	T-Fuel	Spec.Vol
1	12.574	942.5	0.0248
2	17.823	1012.4	0.0247
3	22.669	1057.0	0.0245
4	25.776	1073.0	0.0243
5	26.879	1068.5	0.0241
6	27.269	1058.9	0.0238
7	27.421	1050.1	0.0236
8	27.504	1043.2	0.0234
9	27.572	1038.1	0.0232
10	27.644	1034.6	0.0230
11	27.724	1032.8	0.0228
12	27.803	1032.7	0.0226
13	27.849	1034.6	0.0224
14	27.739	1038.2	0.0222
15	27.049	1039.6	0.0221
16	24.410	1022.6	0.0219
17	19.616	976.0	0.0218
18	13.457	892.6	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-15. Burnup and TH Feedback Parameters by Axial Node for Assembly D12

Axial	Burnup	DP6 to DP7		Burnup	DP7 to SP53		Burnup	SP53 to DP8	
Node	DP7	T-Fuel	Spec.Vol	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol
1	3.653	973.1	0.0252	8.608	999.9	0.0252	11.697	886.4	0.0247
2	5.076	1093.6	0.0251	11.677	1083.1	0.0252	16.070	970.3	0.0247
3	6.678	1214.9	0.0249	14.861	1151.3	0.0250	20.444	1033.7	0.0245
4	7.908	1299.8	0.0247	16.956	1182.9	0.0247	23.357	1072.1	0.0243
5	8.471	1331.2	0.0244	17.692	1180.5	0.0244	24.435	1087.1	0.0241
6	8.730	1340.0	0.0241	17.943	1171.4	0.0241	24.834	1092.5	0.0238
7	8.839	1339.7	0.0239	18.026	1163.5	0.0239	24.980	1092.1	0.0236
8	8.870	1336.4	0.0236	18.056	1158.2	0.0236	25.025	1088.4	0.0233
9	8.857	1332.9	0.0233	18.078	1155.6	0.0234	25.027	1082.6	0.0231
10	8.817	1330.5	0.0231	18.109	1155.2	0.0232	25.009	1074.9	0.0229
11	8.754	1329.1	0.0229	18.153	1156.9	0.0230	24.978	1065.5	0.0227
12	8.661	1327.2	0.0227	18.204	1161.0	0.0227	24.925	1054.2	0.0225
13	8.514	1321.9	0.0224	18.239	1167.9	0.0225	24.821	1040.5	0.0223
14	8.259	1307.3	0.0222	18.175	1176.7	0.0223	24.562	1023.0	0.0222
15	7.766	1271.0	0.0220	17.735	1181.2	0.0221	23.805	998.1	0.0220
16	6.669	1181.5	0.0219	15.991	1152.7	0.0219	21.379	958.5	0.0219
17	5.145	1052.6	0.0218	12.855	1076.4	0.0218	17.193	899.5	0.0218
18	3.576	910.8	0.0217	9.153	967.0	0.0217	12.140	811.4	0.0217

Axial	Burnup	DP8 to SP54	
Node	SP54	T-Fuel	Spec.Vol
1	15.678	912.4	0.0246
2	21.441	974.2	0.0246
3	26.913	1023.0	0.0244
4	30.365	1041.8	0.0242
5	31.522	1036.5	0.0239
6	31.886	1026.9	0.0237
7	31.988	1018.0	0.0235
8	32.008	1011.1	0.0233
9	32.008	1006.0	0.0231
10	32.010	1002.5	0.0229
11	32.020	1000.4	0.0227
12	32.031	1000.0	0.0226
13	32.010	1001.2	0.0224
14	31.841	1003.8	0.0222
15	31.105	1004.2	0.0221
16	28.311	986.2	0.0219
17	23.118	934.1	0.0218
18	16.438	862.1	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-16. Burnup and TH Feedback Parameters by Axial Node for Assembly D12a

Axial	Burnup	DP6 to DP7		Burnup	DP7 to SP53		Burnup	SP53 to DP8	
Node	DP7	T-Fuel	Spec.Vol	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol
1	3.653	973.1	0.0252	8.607	999.9	0.0252	10.340	753.9	0.0235
2	5.076	1093.6	0.0251	11.676	1083.1	0.0252	14.258	810.6	0.0235
3	6.678	1214.9	0.0249	14.861	1151.3	0.0250	18.321	861.5	0.0234
4	7.908	1299.8	0.0247	16.956	1182.9	0.0247	21.101	897.1	0.0233
5	8.471	1331.2	0.0244	17.694	1180.5	0.0244	22.144	911.4	0.0232
6	8.730	1340.0	0.0241	17.945	1171.4	0.0241	22.527	916.1	0.0230
7	8.839	1339.7	0.0239	18.028	1163.5	0.0239	22.665	916.2	0.0229
8	8.870	1336.4	0.0236	18.059	1158.2	0.0236	22.714	914.0	0.0228
9	8.857	1332.9	0.0233	18.081	1155.6	0.0234	22.731	910.5	0.0226
10	8.817	1330.5	0.0231	18.112	1155.2	0.0232	22.741	905.9	0.0225
11	8.754	1329.1	0.0229	18.156	1156.9	0.0230	22.749	900.3	0.0224
12	8.661	1327.2	0.0227	18.208	1161.0	0.0227	22.745	893.6	0.0222
13	8.514	1321.9	0.0224	18.243	1167.9	0.0225	22.696	884.9	0.0221
14	8.259	1307.3	0.0222	18.178	1176.7	0.0223	22.494	873.1	0.0220
15	7.766	1271.0	0.0220	17.738	1181.2	0.0221	21.802	855.0	0.0219
16	6.669	1181.5	0.0219	15.993	1152.7	0.0219	19.517	823.3	0.0218
17	5.145	1052.6	0.0218	12.856	1076.4	0.0218	15.615	778.6	0.0217
18	3.576	910.8	0.0217	9.154	967.0	0.0217	11.014	718.5	0.0217

Axial	Burnup	DP8 to SP54	
Node	SP54	T-Fuel	Spec.Vol
1	12.796	795.4	0.0236
2	17.719	849.0	0.0235
3	22.671	883.6	0.0235
4	25.957	901.7	0.0233
5	27.098	898.9	0.0232
6	27.461	891.5	0.0230
7	27.564	884.5	0.0229
8	27.589	879.0	0.0228
9	27.601	875.0	0.0227
10	27.621	872.1	0.0225
11	27.656	870.3	0.0224
12	27.696	869.7	0.0223
13	27.707	870.4	0.0222
14	27.566	872.0	0.0221
15	26.866	871.2	0.0219
16	24.251	855.4	0.0218
17	19.568	821.9	0.0218
18	13.817	765.5	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-17. Burnup and TH Feedback Parameters by Axial Node for Assembly D14

Axial	Burnup	DP6 to DP7		Burnup	DP7 to SP53		Burnup	SP53 to DP8	
Node	DP7	T-Fuel	Spec.Vol	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol
1	3.179	927.6	0.0250	7.696	971.8	0.0251	8.611	665.7	0.0225
2	4.497	1043.7	0.0249	10.598	1058.3	0.0250	11.962	696.1	0.0225
3	6.045	1164.3	0.0248	13.733	1126.8	0.0248	15.524	721.9	0.0225
4	7.312	1255.1	0.0246	15.935	1162.4	0.0246	18.038	737.9	0.0224
5	7.936	1293.2	0.0243	16.788	1163.0	0.0243	19.025	743.5	0.0224
6	8.248	1307.4	0.0240	17.123	1155.5	0.0241	19.413	744.6	0.0223
7	8.405	1311.2	0.0238	17.273	1148.3	0.0238	19.579	743.6	0.0223
8	8.481	1311.3	0.0235	17.365	1143.6	0.0236	19.669	741.4	0.0222
9	8.514	1311.0	0.0233	17.448	1141.4	0.0234	19.739	738.6	0.0221
10	8.521	1311.5	0.0231	17.539	1141.3	0.0231	19.809	735.3	0.0221
11	8.504	1312.8	0.0228	17.644	1143.4	0.0229	19.885	731.5	0.0220
12	8.456	1313.5	0.0226	17.756	1147.9	0.0227	19.960	727.1	0.0220
13	8.348	1310.2	0.0224	17.847	1155.3	0.0225	19.999	721.9	0.0219
14	8.114	1296.2	0.0222	17.815	1164.6	0.0223	19.892	715.3	0.0218
15	7.599	1257.2	0.0220	17.342	1168.8	0.0221	19.292	706.2	0.0218
16	6.425	1160.4	0.0219	15.457	1137.5	0.0219	17.147	690.6	0.0218
17	4.858	1027.1	0.0218	12.229	1060.7	0.0218	13.550	668.3	0.0217
18	3.324	885.9	0.0217	8.597	950.6	0.0217	9.483	638.8	0.0217

Axial	Burnup	DP8 to SP54	
Node	SP54	T-Fuel	Spec.Vol
1	9.957	694.9	0.0226
2	13.877	728.3	0.0226
3	17.904	748.2	0.0226
4	20.660	752.4	0.0225
5	21.681	748.9	0.0224
6	22.045	743.9	0.0224
7	22.180	739.4	0.0223
8	22.247	735.7	0.0222
9	22.304	732.8	0.0222
10	22.369	730.5	0.0221
11	22.448	728.7	0.0221
12	22.535	727.5	0.0220
13	22.593	727.0	0.0219
14	22.506	726.9	0.0219
15	21.890	725.9	0.0218
16	19.563	719.4	0.0218
17	15.549	702.1	0.0217
18	10.880	668.1	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-18. Burnup and TH Feedback Parameters by Axial Node for Assembly D17

Axial	Burnup	DP6 to DP7		Burnup	DP7 to SP53		Burnup	SP53 to DP8	
Node	DP7	T-Fuel	Spec.Vol	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol
1	3.687	977.3	0.0252	8.622	999.0	0.0252	11.152	834.2	0.0243
2	5.129	1099.1	0.0251	11.710	1082.2	0.0251	15.386	909.5	0.0243
3	6.757	1222.2	0.0250	14.922	1150.7	0.0250	19.681	968.5	0.0241
4	8.001	1306.9	0.0247	17.031	1181.7	0.0247	22.577	1006.4	0.0240
5	8.556	1336.5	0.0244	17.757	1178.6	0.0244	23.660	1022.3	0.0238
6	8.799	1343.4	0.0241	17.988	1169.0	0.0241	24.063	1029.2	0.0236
7	8.894	1341.6	0.0239	18.052	1160.9	0.0239	24.215	1030.8	0.0234
8	8.911	1337.2	0.0236	18.067	1155.6	0.0236	24.273	1029.5	0.0232
9	8.886	1333.0	0.0233	18.075	1153.0	0.0234	24.296	1026.3	0.0230
10	8.835	1330.0	0.0231	18.094	1152.6	0.0232	24.306	1021.8	0.0228
11	8.764	1328.2	0.0229	18.127	1154.3	0.0230	24.308	1015.9	0.0226
12	8.664	1326.1	0.0227	18.170	1158.4	0.0227	24.293	1008.3	0.0224
13	8.513	1320.9	0.0224	18.200	1165.2	0.0225	24.225	998.0	0.0223
14	8.261	1306.9	0.0222	18.137	1174.0	0.0223	23.993	982.9	0.0221
15	7.777	1271.8	0.0220	17.711	1178.6	0.0221	23.241	958.5	0.0220
16	6.690	1183.5	0.0219	15.987	1150.5	0.0219	20.800	916.1	0.0218
17	5.166	1054.7	0.0218	12.860	1074.7	0.0218	16.639	856.6	0.0218
18	3.592	912.6	0.0217	9.158	965.8	0.0217	11.707	775.0	0.0217

Axial	Burnup	DP8 to SP54	
Node	SP54	T-Fuel	Spec.Vol
1	14.526	865.9	0.0242
2	20.020	925.3	0.0241
3	25.327	966.5	0.0240
4	28.734	984.6	0.0238
5	29.901	980.7	0.0236
6	30.278	972.4	0.0234
7	30.395	964.7	0.0233
8	30.435	958.6	0.0231
9	30.462	954.3	0.0229
10	30.497	951.4	0.0228
11	30.545	949.9	0.0226
12	30.598	949.9	0.0225
13	30.617	951.5	0.0223
14	30.476	954.3	0.0222
15	29.733	954.4	0.0220
16	26.903	935.5	0.0219
17	21.772	888.3	0.0218
18	15.370	821.5	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-19. Burnup and TH Feedback Parameters by Axial Node for Assembly D19

Axial	Burnup	DP6 to DP7		Burnup	DP7 to SP53		Burnup	SP53 to DP8	
Node	DP7	T-Fuel	Spec.Vol	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol
1	3.401	951.5	0.0252	8.159	990.8	0.0252	9.826	746.4	0.0233
2	4.773	1071.1	0.0251	11.160	1076.6	0.0252	13.616	799.1	0.0233
3	6.373	1194.1	0.0249	14.379	1146.1	0.0250	17.587	842.0	0.0232
4	7.673	1285.4	0.0247	16.623	1181.7	0.0247	20.380	868.1	0.0231
5	8.307	1322.4	0.0244	17.487	1181.0	0.0244	21.486	877.7	0.0230
6	8.619	1335.2	0.0241	17.819	1172.5	0.0242	21.928	880.4	0.0229
7	8.769	1337.7	0.0239	17.959	1164.8	0.0239	22.118	880.2	0.0228
8	8.833	1336.6	0.0236	18.034	1159.7	0.0237	22.212	878.3	0.0226
9	8.849	1335.0	0.0234	18.095	1157.1	0.0234	22.273	875.2	0.0225
10	8.836	1334.2	0.0231	18.162	1156.9	0.0232	22.324	871.2	0.0224
11	8.798	1334.3	0.0229	18.239	1158.7	0.0230	22.371	866.2	0.0223
12	8.726	1333.6	0.0227	18.321	1163.0	0.0227	22.405	860.1	0.0222
13	8.593	1329.0	0.0224	18.381	1170.2	0.0225	22.388	852.2	0.0221
14	8.339	1314.0	0.0222	18.323	1179.3	0.0223	22.202	841.0	0.0220
15	7.818	1275.1	0.0220	17.852	1183.9	0.0221	21.487	823.7	0.0219
16	6.660	1180.2	0.0219	16.008	1154.1	0.0219	19.131	793.6	0.0218
17	5.091	1047.3	0.0218	12.783	1076.2	0.0218	15.199	752.1	0.0217
18	3.517	904.5	0.0217	9.057	965.5	0.0217	10.669	698.1	0.0217

Axial	Burnup	DP8 to SP54	
Node	SP54	T-Fuel	Spec.Vol
1	12.117	776.3	0.0234
2	16.825	825.1	0.0233
3	21.547	853.1	0.0232
4	24.730	864.9	0.0231
5	25.903	862.1	0.0230
6	26.325	855.9	0.0229
7	26.484	850.0	0.0228
8	26.559	845.3	0.0226
9	26.617	841.7	0.0225
10	26.679	839.1	0.0224
11	26.752	837.5	0.0223
12	26.826	836.9	0.0222
13	26.861	837.4	0.0221
14	26.724	838.4	0.0220
15	25.986	836.9	0.0219
16	23.299	821.1	0.0218
17	18.640	790.5	0.0217
18	13.080	738.5	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-20. Burnup and TH Feedback Parameters by Axial Node for Assembly D21

Axial	Burnup	DP6 to DP7		Burnup	DP7 to SP53		Burnup	SP53 to DP8	
Node	DP7	T-Fuel	Spec.Vol	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol
1	1.848	783.2	0.0236	4.613	831.0	0.0237	7.630	911.5	0.0249
2	2.829	872.2	0.0236	6.806	911.4	0.0237	11.130	1002.9	0.0248
3	3.879	963.9	0.0235	8.955	971.7	0.0236	14.528	1077.5	0.0247
4	4.720	1030.0	0.0234	10.424	996.8	0.0234	16.890	1127.5	0.0244
5	5.128	1057.8	0.0232	10.978	995.9	0.0233	17.847	1148.3	0.0242
6	5.324	1067.8	0.0231	11.177	989.7	0.0231	18.245	1156.2	0.0239
7	5.414	1070.0	0.0229	11.249	983.8	0.0230	18.421	1158.1	0.0237
8	5.450	1069.3	0.0228	11.282	979.7	0.0228	18.507	1156.7	0.0234
9	5.458	1068.1	0.0227	11.310	977.4	0.0227	18.553	1153.1	0.0232
10	5.450	1067.3	0.0225	11.344	976.8	0.0226	18.577	1147.8	0.0230
11	5.428	1066.9	0.0224	11.388	977.7	0.0225	18.584	1140.8	0.0228
12	5.386	1065.9	0.0223	11.437	980.4	0.0223	18.565	1131.7	0.0226
13	5.304	1061.8	0.0221	11.469	985.1	0.0222	18.487	1119.9	0.0224
14	5.137	1049.8	0.0220	11.415	990.8	0.0221	18.249	1103.3	0.0222
15	4.782	1019.5	0.0219	11.054	992.3	0.0220	17.546	1077.1	0.0220
16	3.995	948.8	0.0218	9.750	968.9	0.0218	15.467	1025.7	0.0219
17	2.947	850.4	0.0217	7.555	905.4	0.0218	12.087	951.3	0.0218
18	1.873	746.8	0.0217	4.987	807.9	0.0217	8.066	848.9	0.0217

Axial	Burnup	DP8 to SP54	
Node	SP54	T-Fuel	Spec.Vol
1	11.595	936.3	0.0247
2	16.508	1008.0	0.0246
3	21.069	1054.3	0.0245
4	24.014	1070.6	0.0242
5	25.067	1064.6	0.0240
6	25.439	1054.8	0.0238
7	25.578	1046.0	0.0236
8	25.646	1039.1	0.0234
9	25.698	1034.2	0.0232
10	25.754	1031.0	0.0230
11	25.816	1029.4	0.0228
12	25.877	1029.6	0.0226
13	25.903	1031.9	0.0224
14	25.779	1035.9	0.0222
15	25.113	1038.0	0.0221
16	22.636	1022.7	0.0219
17	18.156	976.3	0.0218
18	12.426	890.3	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-21. Burnup and TH Feedback Parameters by Axial Node for Assembly D25

Axial	Burnup	DP6 to DP7		Burnup	DP7 to SP53		Burnup	SP53 to DP8	
Node	DP7	T-Fuel	Spec.Vol	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol
1	2.560	866.3	0.0245	6.290	914.8	0.0245	9.389	903.1	0.0246
2	3.883	985.4	0.0245	9.164	1008.1	0.0244	13.536	982.9	0.0246
3	5.310	1102.8	0.0243	11.990	1072.2	0.0243	17.514	1047.8	0.0244
4	6.462	1186.1	0.0241	13.940	1098.0	0.0241	20.226	1085.2	0.0242
5	7.033	1220.4	0.0239	14.704	1096.4	0.0239	21.299	1097.2	0.0240
6	7.316	1232.6	0.0237	15.003	1088.4	0.0237	21.730	1099.7	0.0237
7	7.455	1235.4	0.0235	15.129	1081.2	0.0235	21.909	1097.8	0.0235
8	7.517	1234.9	0.0233	15.198	1076.4	0.0233	21.984	1093.2	0.0233
9	7.539	1234.0	0.0231	15.254	1073.9	0.0231	22.014	1086.7	0.0231
10	7.536	1233.8	0.0229	15.314	1073.3	0.0229	22.021	1078.5	0.0229
11	7.512	1234.4	0.0227	15.384	1074.5	0.0227	22.012	1068.7	0.0227
12	7.458	1234.2	0.0225	15.458	1077.9	0.0226	21.979	1057.1	0.0225
13	7.349	1230.4	0.0223	15.507	1083.7	0.0224	21.889	1043.4	0.0223
14	7.127	1216.9	0.0221	15.447	1091.3	0.0222	21.639	1026.9	0.0222
15	6.660	1180.9	0.0220	15.010	1094.8	0.0220	20.901	1004.9	0.0220
16	5.617	1093.5	0.0218	13.372	1070.4	0.0219	18.623	966.0	0.0219
17	4.193	968.1	0.0218	10.510	1004.5	0.0218	14.753	906.0	0.0218
18	2.689	825.7	0.0217	7.032	892.0	0.0217	9.971	822.1	0.0217

Axial	Burnup	DP8 to SP54	
Node	SP54	T-Fuel	Spec.Vol
1	13.400	925.6	0.0246
2	18.908	989.5	0.0245
3	23.954	1029.0	0.0243
4	27.161	1044.8	0.0241
5	28.288	1038.3	0.0239
6	28.672	1028.0	0.0237
7	28.800	1018.7	0.0235
8	28.844	1011.4	0.0233
9	28.865	1005.9	0.0231
10	28.886	1002.0	0.0229
11	28.912	999.6	0.0227
12	28.936	998.8	0.0225
13	28.923	999.7	0.0224
14	28.759	1002.1	0.0222
15	28.048	1002.9	0.0220
16	25.430	986.1	0.0219
17	20.585	943.9	0.0218
18	14.221	870.9	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-22. Burnup and TH Feedback Parameters by Axial Node for Assembly D28

Axial	Burnup	DP6 to DP7		Burnup	DP7 to SP53		Burnup	SP53 to DP8	
Node	DP7	T-Fuel	Spec.Vol	SP53	T-Fuel	Spec.Vol	DP8	T-Fuel	Spec.Vol
1	2.517	870.1	0.0247	6.178	919.6	0.0247	7.792	748.9	0.0233
2	3.800	988.9	0.0247	8.985	1016.3	0.0247	11.378	801.2	0.0233
3	5.420	1123.9	0.0245	12.248	1094.4	0.0245	15.397	846.6	0.0232
4	6.797	1219.9	0.0243	14.679	1128.2	0.0243	18.386	874.4	0.0231
5	7.454	1256.4	0.0241	15.625	1127.5	0.0241	19.577	884.6	0.0230
6	7.763	1268.6	0.0239	15.975	1119.2	0.0238	20.036	887.5	0.0229
7	7.908	1270.9	0.0236	16.115	1111.7	0.0236	20.221	887.0	0.0227
8	7.971	1269.9	0.0234	16.186	1106.7	0.0234	20.308	884.7	0.0226
9	7.990	1268.5	0.0232	16.243	1104.1	0.0232	20.361	881.3	0.0225
10	7.982	1268.1	0.0230	16.305	1103.6	0.0230	20.404	877.1	0.0224
11	7.952	1268.5	0.0228	16.378	1105.1	0.0228	20.445	871.9	0.0223
12	7.891	1268.4	0.0226	16.455	1108.9	0.0226	20.473	865.8	0.0222
13	7.774	1264.5	0.0224	16.508	1115.1	0.0224	20.452	858.0	0.0221
14	7.542	1250.8	0.0222	16.451	1123.0	0.0222	20.274	847.5	0.0220
15	7.060	1214.4	0.0220	16.006	1126.5	0.0221	19.604	831.3	0.0219
16	5.980	1124.7	0.0219	14.301	1099.5	0.0219	17.409	801.1	0.0218
17	4.505	997.3	0.0218	11.308	1030.8	0.0218	13.723	757.6	0.0217
18	2.982	854.2	0.0217	7.759	920.3	0.0217	9.374	704.0	0.0217

Axial	Burnup	DP8 to SP54	
Node	SP54	T-Fuel	Spec.Vol
1	10.053	784.2	0.0233
2	14.554	835.0	0.0233
3	19.326	863.5	0.0232
4	22.701	869.0	0.0231
5	23.951	864.6	0.0230
6	24.381	857.4	0.0229
7	24.530	850.9	0.0227
8	24.593	845.8	0.0226
9	24.639	842.0	0.0225
10	24.690	839.3	0.0224
11	24.753	837.5	0.0223
12	24.819	836.8	0.0222
13	24.850	837.3	0.0221
14	24.726	838.6	0.0220
15	24.048	838.0	0.0219
16	21.554	824.9	0.0218
17	17.161	797.5	0.0217
18	11.795	743.5	0.0217

Datapoint or Statepoint	EFPD / Cycle
DP6	0.0 / Cy4
DP7	147.1 / Cy4
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-23. Burnup and TH Feedback Parameters by Axial Node for Assembly E2

Axial	Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	3.122	966.7	0.0254	7.194	994.9	0.0254
2	4.396	1090.9	0.0253	9.922	1088.9	0.0253
3	5.989	1231.2	0.0251	13.121	1172.6	0.0251
4	7.215	1335.3	0.0249	15.314	1214.7	0.0248
5	7.731	1375.5	0.0246	16.058	1214.9	0.0245
6	7.959	1389.7	0.0243	16.304	1206.1	0.0242
7	8.062	1392.8	0.0240	16.393	1197.3	0.0240
8	8.101	1390.5	0.0237	16.433	1190.7	0.0237
9	8.098	1385.6	0.0234	16.457	1186.6	0.0235
10	8.062	1378.6	0.0232	16.474	1184.7	0.0232
11	7.994	1369.7	0.0229	16.487	1184.9	0.0230
12	7.893	1357.7	0.0227	16.492	1187.4	0.0228
13	7.748	1341.9	0.0225	16.477	1192.2	0.0225
14	7.527	1319.3	0.0222	16.383	1198.1	0.0223
15	7.126	1280.3	0.0220	15.983	1198.7	0.0221
16	6.195	1193.1	0.0219	14.436	1165.0	0.0219
17	4.831	1066.0	0.0218	11.628	1088.1	0.0218
18	3.384	923.9	0.0217	8.301	973.9	0.0217

Table 4-24. Burnup and TH Feedback Parameters by Axial Node for Assembly E4

Axial	Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	3.415	997.2	0.0254	7.862	1019.8	0.0254
2	4.692	1119.0	0.0253	10.603	1108.5	0.0254
3	6.113	1243.6	0.0251	13.460	1180.1	0.0252
4	7.177	1331.9	0.0249	15.345	1218.1	0.0249
5	7.659	1368.0	0.0245	16.027	1219.0	0.0246
6	7.895	1382.4	0.0242	16.287	1211.0	0.0243
7	8.016	1387.0	0.0240	16.402	1202.7	0.0240
8	8.074	1386.2	0.0237	16.468	1196.5	0.0237
9	8.089	1382.4	0.0234	16.516	1192.5	0.0235
10	8.071	1376.5	0.0232	16.557	1190.7	0.0232
11	8.020	1368.6	0.0229	16.592	1191.1	0.0230
12	7.933	1357.7	0.0227	16.618	1193.8	0.0228
13	7.796	1342.7	0.0225	16.616	1198.7	0.0225
14	7.574	1320.2	0.0222	16.520	1204.6	0.0223
15	7.159	1280.2	0.0220	16.094	1204.6	0.0221
16	6.211	1192.1	0.0219	14.509	1169.6	0.0219
17	4.845	1065.4	0.0218	11.683	1091.4	0.0218
18	3.399	924.2	0.0217	8.348	976.7	0.0217

Datapoint or Statepoint	EFPD / Cycle
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-25. Burnup and TH Feedback Parameters by Axial Node for Assembly E8

Axial	Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	1.891	816.7	0.0239	4.485	851.9	0.0239
2	2.861	916.5	0.0238	6.587	938.2	0.0238
3	3.878	1015.3	0.0237	8.632	1003.2	0.0237
4	4.660	1086.3	0.0236	10.004	1031.5	0.0236
5	5.022	1116.4	0.0234	10.507	1031.4	0.0234
6	5.196	1128.0	0.0233	10.689	1024.6	0.0232
7	5.286	1131.8	0.0231	10.764	1017.7	0.0231
8	5.333	1132.1	0.0229	10.807	1012.5	0.0229
9	5.354	1130.4	0.0228	10.843	1009.0	0.0228
10	5.356	1127.3	0.0226	10.878	1007.2	0.0226
11	5.338	1122.9	0.0225	10.912	1007.1	0.0225
12	5.296	1116.6	0.0223	10.942	1008.6	0.0224
13	5.215	1107.1	0.0222	10.948	1011.7	0.0222
14	5.058	1090.3	0.0220	10.866	1015.8	0.0221
15	4.727	1056.4	0.0219	10.493	1015.3	0.0220
16	3.979	982.1	0.0218	9.235	987.9	0.0218
17	2.960	879.4	0.0217	7.151	919.4	0.0218
18	1.895	767.3	0.0217	4.722	817.6	0.0217

Table 4-26. Burnup and TH Feedback Parameters by Axial Node for Assembly E12

Axial	Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	3.405	994.5	0.0253	7.862	1020.4	0.0254
2	4.559	1105.2	0.0252	10.395	1105.4	0.0253
3	5.923	1225.1	0.0250	13.192	1178.9	0.0252
4	6.967	1312.0	0.0247	15.077	1217.3	0.0249
5	7.446	1348.0	0.0245	15.765	1219.0	0.0245
6	7.684	1362.8	0.0242	16.030	1211.4	0.0243
7	7.809	1367.8	0.0239	16.151	1203.2	0.0240
8	7.872	1367.8	0.0236	16.224	1197.0	0.0237
9	7.895	1364.7	0.0234	16.280	1193.1	0.0235
10	7.885	1359.4	0.0231	16.331	1191.4	0.0232
11	7.844	1351.9	0.0229	16.377	1191.8	0.0230
12	7.768	1341.8	0.0227	16.416	1194.5	0.0228
13	7.642	1327.6	0.0224	16.427	1199.6	0.0225
14	7.430	1305.9	0.0222	16.344	1205.7	0.0223
15	7.023	1266.7	0.0220	15.925	1205.6	0.0221
16	6.087	1179.8	0.0219	14.332	1168.8	0.0219
17	4.762	1057.2	0.0218	11.546	1090.0	0.0218
18	3.436	927.5	0.0217	8.421	979.0	0.0217

Datapoint or Statepoint	EFPD / Cycle
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-27. Burnup and TH Feedback Parameters by Axial Node for Assembly E14

Axial	Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	2.935	943.4	0.0250	6.835	973.9	0.0250
2	4.112	1060.8	0.0249	9.373	1063.3	0.0249
3	5.462	1181.4	0.0248	12.085	1135.5	0.0247
4	6.513	1270.1	0.0246	13.931	1167.4	0.0245
5	7.004	1307.6	0.0243	14.614	1168.7	0.0242
6	7.251	1323.2	0.0240	14.880	1161.2	0.0240
7	7.386	1329.2	0.0238	15.006	1153.3	0.0237
8	7.464	1330.5	0.0235	15.092	1147.3	0.0235
9	7.506	1329.2	0.0233	15.166	1143.5	0.0233
10	7.520	1326.1	0.0230	15.237	1141.7	0.0231
11	7.506	1321.2	0.0228	15.307	1141.9	0.0229
12	7.458	1313.8	0.0226	15.370	1144.4	0.0227
13	7.358	1302.2	0.0224	15.404	1149.2	0.0225
14	7.160	1282.0	0.0222	15.332	1155.0	0.0223
15	6.739	1241.9	0.0220	14.895	1154.7	0.0221
16	5.755	1150.5	0.0219	13.269	1121.5	0.0219
17	4.394	1023.7	0.0218	10.504	1047.0	0.0218
18	3.032	886.2	0.0217	7.405	936.8	0.0217

Table 4-28. Burnup and TH Feedback Parameters by Axial Node for Assembly E17

Axial	Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	3.341	988.4	0.0253	7.732	1017.1	0.0254
2	4.599	1109.1	0.0252	10.443	1106.1	0.0253
3	6.007	1232.9	0.0251	13.289	1178.6	0.0251
4	7.077	1322.0	0.0248	15.191	1216.3	0.0248
5	7.567	1359.0	0.0245	15.887	1217.2	0.0245
6	7.806	1373.9	0.0242	16.150	1209.0	0.0242
7	7.927	1378.5	0.0239	16.262	1200.5	0.0240
8	7.984	1377.9	0.0237	16.324	1194.1	0.0237
9	7.999	1374.2	0.0234	16.370	1189.9	0.0235
10	7.982	1368.4	0.0231	16.411	1188.1	0.0232
11	7.935	1360.5	0.0229	16.448	1188.4	0.0230
12	7.852	1349.9	0.0227	16.479	1191.0	0.0228
13	7.721	1335.2	0.0224	16.482	1196.0	0.0225
14	7.502	1312.9	0.0222	16.391	1202.0	0.0223
15	7.089	1273.0	0.0220	15.967	1202.0	0.0221
16	6.147	1185.5	0.0219	14.390	1166.9	0.0219
17	4.796	1060.2	0.0218	11.589	1089.5	0.0218
18	3.367	920.4	0.0217	8.286	975.0	0.0217

Datapoint or Statepoint	EFPD / Cycle
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-29. Burnup and TH Feedback Parameters by Axial Node for Assembly E21

Axial	Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	1.681	789.2	0.0236	4.015	826.2	0.0236
2	2.553	879.2	0.0235	5.920	907.4	0.0236
3	3.465	970.2	0.0235	7.767	969.4	0.0235
4	4.164	1034.2	0.0233	8.995	996.1	0.0233
5	4.484	1061.0	0.0232	9.434	995.7	0.0232
6	4.634	1071.4	0.0231	9.584	989.1	0.0231
7	4.707	1074.6	0.0229	9.638	982.5	0.0229
8	4.743	1074.4	0.0228	9.665	977.4	0.0228
9	4.756	1072.4	0.0226	9.686	974.0	0.0227
10	4.753	1069.1	0.0225	9.709	972.1	0.0225
11	4.733	1064.7	0.0224	9.732	971.8	0.0224
12	4.692	1058.6	0.0222	9.753	973.1	0.0223
13	4.618	1049.5	0.0221	9.754	976.1	0.0222
14	4.478	1034.0	0.0220	9.679	979.7	0.0221
15	4.185	1003.6	0.0219	9.348	978.8	0.0219
16	3.523	937.2	0.0218	8.227	952.0	0.0218
17	2.618	843.6	0.0217	6.362	888.0	0.0218
18	1.674	743.8	0.0217	4.192	792.5	0.0217

Table 4-30. Burnup and TH Feedback Parameters by Axial Node for Assembly E23

Axial	Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	2.984	951.3	0.0254	6.976	990.4	0.0254
2	4.214	1072.9	0.0253	9.645	1085.4	0.0253
3	5.777	1210.8	0.0251	12.813	1170.9	0.0251
4	7.030	1317.3	0.0249	15.062	1213.4	0.0248
5	7.600	1361.8	0.0246	15.884	1214.7	0.0245
6	7.872	1379.4	0.0243	16.185	1206.0	0.0242
7	8.011	1385.3	0.0240	16.314	1197.0	0.0240
8	8.082	1385.6	0.0237	16.389	1190.2	0.0237
9	8.113	1382.8	0.0234	16.450	1185.9	0.0235
10	8.113	1378.2	0.0232	16.509	1183.9	0.0232
11	8.084	1371.9	0.0229	16.568	1184.2	0.0230
12	8.020	1363.4	0.0227	16.623	1186.9	0.0228
13	7.905	1350.3	0.0225	16.652	1192.1	0.0225
14	7.694	1329.0	0.0222	16.582	1198.7	0.0223
15	7.267	1288.3	0.0221	16.155	1199.5	0.0221
16	6.274	1196.6	0.0219	14.522	1165.0	0.0219
17	4.863	1066.2	0.0218	11.645	1087.1	0.0218
18	3.397	923.3	0.0217	8.295	972.8	0.0217

Datapoint or Statepoint	EFPD / Cycle
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-31. Burnup and TH Feedback Parameters by Axial Node for Assembly E25

Axial	Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	2.413	883.1	0.0246	5.690	920.1	0.0245
2	3.632	1006.6	0.0246	8.283	1017.5	0.0244
3	4.920	1125.6	0.0244	10.805	1085.8	0.0243
4	5.912	1210.0	0.0242	12.484	1111.5	0.0241
5	6.373	1245.8	0.0240	13.097	1109.0	0.0238
6	6.598	1260.2	0.0238	13.320	1099.9	0.0236
7	6.715	1265.2	0.0235	13.415	1091.5	0.0234
8	6.780	1265.8	0.0233	13.474	1085.2	0.0232
9	6.813	1264.2	0.0231	13.525	1081.1	0.0231
10	6.822	1261.1	0.0229	13.578	1079.0	0.0229
11	6.809	1256.6	0.0227	13.632	1078.7	0.0227
12	6.767	1250.1	0.0225	13.683	1080.6	0.0225
13	6.679	1239.9	0.0223	13.712	1084.6	0.0224
14	6.503	1221.9	0.0222	13.650	1090.1	0.0222
15	6.121	1185.2	0.0220	13.266	1091.6	0.0220
16	5.216	1100.6	0.0218	11.825	1066.4	0.0219
17	3.924	977.3	0.0218	9.287	998.5	0.0218
18	2.531	834.1	0.0217	6.204	884.2	0.0217

Table 4-32. Burnup and TH Feedback Parameters by Axial Node for Assembly E28

Axial	Burnup	SP53 to DP8		Burnup	DP8 to SP54	
Node	DP8	T-Fuel	Spec.Vol	SP54	T-Fuel	Spec.Vol
1	2.431	888.6	0.0249	5.780	935.5	0.0249
2	3.630	1009.6	0.0249	8.379	1037.1	0.0248
3	5.126	1146.9	0.0247	11.385	1122.1	0.0246
4	6.344	1252.0	0.0245	13.537	1157.5	0.0244
5	6.900	1296.3	0.0242	14.322	1157.2	0.0241
6	7.161	1313.7	0.0240	14.603	1148.3	0.0239
7	7.293	1319.7	0.0237	14.719	1139.6	0.0237
8	7.364	1320.6	0.0235	14.789	1133.0	0.0234
9	7.399	1318.8	0.0233	14.849	1128.8	0.0232
10	7.408	1315.4	0.0230	14.910	1126.8	0.0230
11	7.392	1310.4	0.0228	14.973	1126.8	0.0228
12	7.345	1303.2	0.0226	15.033	1129.1	0.0226
13	7.250	1292.1	0.0224	15.071	1133.8	0.0224
14	7.060	1272.7	0.0222	15.009	1139.8	0.0223
15	6.649	1233.5	0.0220	14.595	1140.5	0.0221
16	5.681	1143.5	0.0219	13.027	1110.9	0.0219
17	4.314	1015.7	0.0218	10.296	1038.6	0.0218
18	2.877	870.0	0.0217	7.070	924.3	0.0217

Datapoint or Statepoint	EFPD / Cycle
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Burnup	- GWd/MTU
T-Fuel	- °F
Spec. Vol.	- ft^3 / lbm

Table 4-33. Rod Insertion Time by Axial Node for Assembly A14c

Axial Node	Time Rod Inserted (EFPD) SP53 to DP8	DP8 to SP54
1	130.0	144.5
2	126.9	123.2
3	6.1	8.3
4	0.0	0.0
5	0.0	0.0
6	0.0	0.0
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
10	0.0	0.0
11	0.0	0.0
12	0.0	0.0
13	0.0	0.0
14	0.0	0.0
15	0.0	0.0
16	0.0	0.0
17	0.0	0.0
18	0.0	0.0

Table 4-34. Rod Insertion Time by Axial Node for Assembly C14a

Axial Node	Time Rod Inserted (EFPD) SP53 to DP8	DP8 to SP54
1	130.0	144.5
2	126.9	123.1
3	6.1	8.3
4	0.0	0.0
5	0.0	0.0
6	0.0	0.0
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
10	0.0	0.0
11	0.0	0.0
12	0.0	0.0
13	0.0	0.0
14	0.0	0.0
15	0.0	0.0
16	0.0	0.0
17	0.0	0.0
18	0.0	0.0

Statepoint	EFPD / Cycle
SP53	0.0 / Cy5
DP8	130.0 / Cy5
SP54	274.5 / Cy5

Table 4-35. Critical Boron Data for Catawba 1 Burnup Calculations

$$ppmB = A + B \cdot EFPD$$

Cycle	A (ppmB)	B (ppmB/EFPD)
1	706.80	-1.91
2	973.71	-3.36
3	1037.07	-3.29
4	1176.47	-3.54
5	1056.37	-3.28

4.2 Statepoint Critical Condition Measurements

Measured critical conditions for 3 reactor startups (or statepoints) are provided in Table 4-36. The data includes the initial startup of the reactor or beginning-of-life (BOL), the beginning-of-cycle (BOC) of reload cycle 5, and one reactor restart during cycle 5 of Catawba Unit 1. The cycle and statepoint number, along with the EFPDs during the cycle for which the startup occurred, is provided. The elapsed time (in hours) since the reactor was shutdown (downtime) prior to the startup is also given for each statepoint. In addition, Table 4-36 provides the measured soluble boron concentration (ppmB), rod bank positions, and temperature of the moderator or coolant in the reactor (for each statepoint) when criticality was achieved.

Table 4-37 provides shutdown and startup dates for each cycle and statepoint. The cycle shutdown and startup dates can be used in determining the downtime for fuel assemblies that are out of the reactor for one or more cycles and are then reinserted in a later cycle.

Table 4-36. Statepoint Data for Catawba Unit 1 - Measured Critical Conditions

Cycle(SP)	EFPD	Downtime (hours)	ppmB	Rod Positions, cm above bottom of fuel* Bk CA	Bk CB	Bk CC	Bk CD	T(coolant) (F)
1(SP52)	0.0	0	969	WD	WD	WD	231	557
5(SP53)	0.0	2016	1453	WD	WD	WD	293	558.6
5(SP54)	274.5	71.7	543	WD	WD	WD	258	557

Bk = Rod Bank
WD = Rod Withdrawn

* Measured from the bottom of active fuel region to bottom of control rod absorber region (See Figure 2-8).

Table 4-37. Statepoint Data for Catawba Unit 1 - Shutdown and Startup Dates

Cycle(SP)	EFPD	Shutdown Date	Startup Date
1(SP52)	0.0	-	07 Jan 1985
2(-)*	0.0	08 Aug 1986	17 Nov 1986
3(-)*	0.0	03 Oct 1987	29 Dec 1987
4(-)*	0.0	24 Nov 1988	07 Feb 1989
5(SP53)*	0.0	28 Jan 1990	22 Apr 1990
5(SP54)	274.5	27 Feb 1991	02 Mar 1991
	290.9 (EOC)	20 Mar 1991	

EOC = end-of-cycle

* Shutdown date is for previous cycle.

5.0 CONCLUSIONS

The data reported herein is acceptable for quality affecting activities and for use in analyses affecting procurement, construction, or fabrication. The classification analysis for the repository (which includes the waste package) carries TBV-228 because of the preliminary status of the basis for the MGR design. This report conservatively assumes that the resolution of TBV-228 will find the waste package to be quality affecting; consequently, use of any of the data reported herein does not need to carry TBV-228.

6.0 REFERENCES

1. *Quality Assurance Program for Framatome Cogema Fuels*, Document Number: 56-1177617-04, FCF, August 5, 1996.

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3. QAP-2-0 Activity Evaluations, ID No. WP-06, *Develop Technical Documents*, CRWMS M&O, August 3, 1997.

4. *Quality Assurance Requirements and Description*, DOE/RW-0333P, REV 7, DOE OCRWM.

5. *Catawba 1 NEMO Depletion and Statepoints (HLW)*, Document Number: 32-1267226-00, FCF.