NAC INTERNATIONAL

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December 19, 2013

U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2738

Attn: Document Control Desk

Subject: Submission of a Request to Amend the U.S. Nuclear Regulatory Commission Certificate of Compliance No. 1031 for the NAC International MAGNASTOR® Cask System

Docket No. 72-1031

References:
1. U.S. Nuclear Regulatory Commission (NRC) Certificate of Compliance (CoC) No. 1031 for the NAC International MAGNASTOR Cask System, Amendment No. 3, July 25, 2013
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10. Removed callouts in figures within Appendix B of the CoC that show the TSC alignment tick mark as this has no impact on the safe loading of the system
11. Revised the cask surface dose rate shown in LCO 3.3.1 from 95 mrem/hour gamma to 120 mrem/hour gamma

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If you have any comments or questions, please contact me on my direct line at 678-328-1274.

Sincerely,

Anthony L. Patko
Director, Licensing
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e. Information that discloses patentable subject matter for which it may be desirable to obtain patent protection.

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Executed at Norcross, Georgia, this 19th day of December, 2013.

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Vice President, Engineering
NAC International

Subscribed and sworn before me this 19th day of December, 2013.

Jeannie Klinetob
Notary Public

JEANNIE KLINETOB
MY COMMISSION EXPIRES
NOTARY
PUBLIC
SEPTEMBER 25, 2015
GWINNETT COUNTY, GA

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MY COMMISSION EXPIRES
NOTARY
PUBLIC
SEPTEMBER 25, 2015
GWINNETT COUNTY, GA

Enclosure 1

Proposed Changes

for

MAGNASTOR® Technical Specifications, Amendment 5

(Docket No 72-1031)

NAC International

December 2013

APPENDIX A

TECHNICAL SPECIFICATIONS AND DESIGN FEATURES FOR THE MAGNASTOR SYSTEM

AMENDMENT 5

PROPOSED

3.3 MAGNASTOR SYSTEM Radiation Protection

3.3.1 CONCRETE CASK Maximum Surface Dose Rate

LCO 3.3.1 The maximum surface dose rates for the CONCRETE CASK, Reference Figure A3-1, shall not exceed the following limits:

a. PWR and BWR – 120 mrem/hour gamma and 5 mrem/hour neutron on the vertical concrete surfaces; and

b. PWR and BWR – 450 mrem/hour (neutron + gamma) on the top.

APPLICABILITY: Prior to start of STORAGE OPERATIONS

ACTIONS

----------NOTE----------

Separate Condition entry is allowed for each MAGNASTOR® SYSTEM.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. CONCRETE CASK maximum surface dose rate limits not met	A.1 Administratively verify correct fuel loading AND A.2 Perform analysis to verify compliance with the ISFSI radiation protection requirements of 10 CFR 20 and 10 CFR 72	24 hours 7 days
B. Required Action and associated Completion Time not met	B.1 Perform (and document) an engineering assessment and take appropriate corrective action to ensure the dose limits of 10 CFR 20 and 10 CFR 72 are not exceeded	60 days

(continued)

PROPOSED

APPENDIX B

APPROVED CONTENTS
FOR THE MAGNASTOR SYSTEM

AMENDMENT 5

PROPOSED

Appendix B
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PROPOSED

1.0 FUEL SPECIFICATIONS AND LOADING CONDITIONS

The MAGNASTOR SYSTEM is designed to safely store up to 37 undamaged PWR fuel assemblies in the 37 PWR Basket Assembly or up to 87 undamaged BWR fuel assemblies in the 87 BWR Basket Assembly. The system is also designed to store up to 4 damaged fuel cans (DFCs) in the DF Basket Assembly. The DF Basket Assembly has a capacity of up to 37 undamaged PWR fuel assemblies including 4 DFC locations. DFCs may be placed in up to 4 of the DFC locations. Each DFC may contain an undamaged PWR fuel assembly, a damaged PWR fuel assembly, or PWR FUEL DEBRIS equivalent to one PWR fuel assembly. FUEL DEBRIS is included in the definition of DAMAGED FUEL (Appendix A, Section 1.1). PWR UNDAMAGED FUEL assemblies may be placed directly in the DFC locations of a DF Basket Assembly without the use of a DFC.

The system requires few operating controls. The principal controls and limits for MAGNASTOR are satisfied by the selection of fuel for storage that meets the Approved Contents presented in this section and in the tables for MAGNASTOR design basis spent fuels.

If any Fuel Specification or Loading Condition of this section is violated, the following actions shall be completed:

- The affected fuel assemblies shall be placed in a safe condition.
- Within 24 hours, notify the NRC Operations Center.
- Within 60 days, submit a special report that describes the cause of the violation and actions taken to restore or demonstrate compliance and prevent reoccurrence.

PROPOSED

2.0 FUEL TO BE STORED IN THE MAGNASTOR SYSTEM

UNDAMAGED PWR FUEL ASSEMBLIES, DAMAGED PWR FUEL ASSEMBLIES, PWR FUEL DEBRIS (DAMAGED FUEL), UNDAMAGED BWR FUEL ASSEMBLIES and NONFUEL HARDWARE meeting the limits specified in Tables B2-1 through B2-33 may be stored in the MAGNASTOR SYSTEM.

PROPOSED

Table B2-1 TSC with PWR Fuel Limits

I. TSC with PWR Fuel Basket

A. Allowable Contents

1. Uranium PWR UNDAMAGED FUEL ASSEMBLIES listed in Tables B2-2 and B2-3 and meeting the following specifications:

a. Cladding Type:	Zirconium-based alloy.
b. Enrichment, Post-irradiation Cooling Time and Average Assembly Burnup:	Generic maximum enrichment limits are shown in Table B2-2. The physical characteristics of the different PWR SNF ASSEMBLIES are defined in Table B2-3. The fuel type specific maximum enrichments as a function of neutron absorber sheet areal density at various minimum soluble boron levels are defined in Table B2-4. For variable enrichment SNF assemblies, maximum enrichments represent peak rod enrichments. Combined minimum enrichment, maximum SNF assembly average burnup and minimum cool time limits are shown in Tables B2-15 through B2-22 and B2-25 through B2-33. For SNF assembly average burnup levels below those shown in Tables B2-15 through B2-22 and B2-25 through B2-33, an SNF assembly minimum cool time is specified generically in Table B2-13 and specifically for WE14x14 in Table B2-25, provided that the minimum initial SNF assembly average enrichment limits are applied.
c. Decay Heat Per SNF Assembly	
1) Preferential Loading:	≤ 1,200 watts[a]
2) Uniform Loading:	≤ 959 watts
d. Nominal Fresh Fuel Assembly Length (in.):	≤ 178.3
e. Nominal Fresh Fuel Assembly Width (in.):	≤ 8.54
f. Weight Per Storage Location (lbs.):	≤ 1,765, including SNF Assembly, NONFUEL HARDWARE and fuel spacers
g. Total Canister Contents Weight (lbs.):	≤ 62,160, including SNF Assemblies, NONFUEL HARDWARE and fuel spacers

B. Quantity per TSC: Up to 37 PWR UNDAMAGED SNF ASSEMBLIES as shown in Figure B2-1.

(continued)

[a] 1,800 Watts for the four-zone preferential loading with WE 14x14 (ng14b) fuel

PROPOSED

Table B2-1 TSC with PWR Fuel Limits (continued)

C. PWR UNDAMAGED SNF ASSEMBLIES may contain NONFUEL HARDWARE. SNF assembly lattices possessing less than the nominal number of undamaged fuel rods specified in Table B2-3 must contain solid filler rods that displace a volume equal to, or greater than, that of the fuel rod that the filler rod replaces. SNF assemblies may have stainless steel rods inserted to displace guide tube "dashpot" water. NONFUEL HARDWARE cool times shall be in accordance with Tables B2-5, B2-6, and B2-7. Alternatively, the ^{60}Co curie limits in Tables B2-6 and B2-7 may be used to establish site-specific NONFUEL HARDWARE constraints.

D. Spacers may be used in a TSC to axially position SNF assemblies to facilitate handling and operations.

E. Unenriched fuel assemblies and unirradiated (i.e., not inserted in-core) fuel assemblies are not authorized for loading. Low enriched, unenriched, and/or annular fuel pellet axial end blankets are permitted, provided that the nominal length of the blanket is not greater than six (6) inches.

F. SNF may be loaded uniformly at a maximum heat load of 959 watts/assembly (Figure B2-1). Alternatively, a preferential loading pattern may be applied as described in Table B2-8 and Figure B2-2.

G. RCCs are restricted to fuel storage locations No. 11, 12, 13, 18, 19, 20, 25, 26 and 27 (Figure B2-1). Minimum RCC cool times are:

Minimum Cool Time (years)	Maximum Exposure (GWd/MTU)
10[a]	180
14	270
20	360

H. One Neutron Source, or Neutron Source Assembly (NSA) is permitted to be loaded in a TSC in fuel storage locations No. 11, 12, 13, 18, 19, 20, 25, 26, or 27 (Figure B2-1). Neutron source assemblies may contain source rods attached to hardware similar in configuration to guide tube plug devices (thimble plugs) and burnable absorbers, in addition to containing burnable poison rodlets and/or thimble plug rodlets. For NSAs containing absorber rodlets, the BPAA cool time and burnup/exposure or hardware ^{60}Co curie limit listed in Table B2-6 are applied to the neutron sources. NSAs having only thimble plug rodlets require the thimble plug restriction in Table B2-7 to be applied. Combination NSAs, containing both thimble plug and burnable absorber rodlets must apply the more limiting of the two minimum cool time/curie limit.

I. Fuel assemblies may contain any number of unirradiated (i.e., not inserted in-core) nonfuel solid filler fuel replacement rods. Activated stainless steel rods are limited to 5 per assembly at a maximum burnup/exposure of 32.5 GWd/MTU.

J. Fuel assemblies may contain an HFRA at a maximum burnup/exposure of 4.0 GWd/MTU and a minimum cool time of 16 years.

(continued)

[a] 2.5 years for the WE 14x14 CEA

PROPOSED

Table B2-1 TSC with PWR Fuel Limits (continued)

II. TSC with DF Basket Assembly

A. Allowable Contents

1. Uranium PWR UNDAMAGED SNF ASSEMBLIES and DAMAGED FUEL (PWR DAMAGED SNF ASSEMBLIES or PWR FUEL DEBRIS) listed in Tables B2-2 and B2-3 and meeting the following specifications:

a. Cladding Type:	Zirconium-based alloy.
b. Enrichment, Post-irradiation Cooling Time and Average Assembly Burnup:	Generic maximum enrichment limits are shown in Table B2-2. The physical characteristics of the different PWR SNF ASSEMBLIES are defined in Table B2-3. The fuel type specific maximum enrichments as a function of neutron absorber sheet areal density at various minimum soluble boron levels are defined in Table B2-4. For variable enrichment SNF assemblies, maximum SNF enrichments represent peak rod enrichments. Combined minimum enrichment, maximum SNF assembly average burnup and minimum cool time limits are shown in Tables B2-15 through B2-22 and B2-25 through B2-33. For SNF assembly average burnup levels below those shown in Tables B2-15 through B2-22 and B2-25 and B2-33, an SNF assembly minimum cool time is specified generically in Table B2-13 and specifically for WE14x14 in Table B2-25, provided that the minimum initial SNF assembly average enrichment limits are applied.
c. Decay Heat Per SNF Assembly	
1). Preferential Loading:	≤ 1,200 watts[a]
2). Uniform Loading:	≤ 959 watts
d. Nominal Fresh SNF Assy:	≤ 178.3
e. Nominal Fresh SNF Assembly Width (in.):	≤ 8.54
f. Weight Per Storage location (lbs.)	≤ 1,765, including SNF Assembly, NONFUEL HARDWARE, DFC and fuel spacer
g. Total Canister Contents Weight (lbs.)	≤ 61,184, including SNF Assemblies, NONFUEL HARDWARE, DFCs and fuel spacers

(continued)

[a] 1,800 Watts for the four-zone preferential loading with WE 14x14 (ng14b) fuel

PROPOSED

Table B2-1 TSC with PWR Fuel Limits (continued)

B. Quantity per TSC: Up to a total of 37 PWR UNDAMAGED SNF ASSEMBLIES including up to four (4) DFCs containing PWR UNDAMAGED SNF ASSEMBLIES, PWR DAMAGED SNF ASSEMBLIES, and/or PWR FUEL DEBRIS loaded in the DFC locations No. 4, 8, 30 and 34, as shown on Figure B2-3, for the DF Basket Assembly.

C. The contents of a DFC must be less than, or equivalent to, one PWR UNDAMAGED SNF ASSEMBLY. PWR SNF ASSEMBLIES loaded in a DFC shall not contain NONFUEL HARDWARE with the exception of instrument tube tie components, guide tube anchors or similar devices, and steel inserts.

D. PWR UNDAMAGED SNF ASSEMBLIES not loaded in a DFC may contain NONFUEL HARDWARE consistent with Table B2-5. SNF assembly lattices not containing the nominal number of fuel rods specified in Table B2-3 must contain solid filler rods that displace a volume equal to, or greater than, that of the fuel rod that the filler rod replaces. SNF assemblies may have stainless steel rods inserted to displace guide tube "dashpot" water. NONFUEL HARDWARE cool times shall be in accordance with Tables B2-5, B2-6, and B2-7. Alternatively, the ^{60}Co curie limits in Tables B2-6 and B2-7 may be used to establish site-specific NONFUEL HARDWARE constraints. Alternatively, the ^{60}Co curie limits in Tables B2-6 and B2-7 may be used to establish site-specific NONFUEL HARDWARE constraints.

E. Spacers may be used in a TSC to axially position PWR UNDAMAGED SNF ASSEMBLIES, and DFCs to facilitate handling and operation.

F. Unenriched fuel assemblies and unirradiated (i.e., not inserted in-core) fuel assemblies are not authorized for loading. Low enriched, unenriched, and/or annular fuel pellet axial end blankets are permitted, provided that the nominal length of the end blanket is not greater than six (6) inches.

G. RCCs are restricted to fuel storage locations No. 11, 12, 13, 18, 19, 20, 25, 26 and 27 (Figure B2-1). Minimum RCC cool times are:

Minimum Cool Time (years)	Maximum Exposure (GWd/MTU)
10[a]	180
14	270
20	360

(continued)

[a] 2.5 years for the WE 14x14 CEA

PROPOSED

Table B2-1 TSC with PWR Fuel Limits (continued)

H. One Neutron Source, or Neutron Source Assembly (NSA) is permitted to be loaded in a TSC in fuel storage locations No. 11, 12, 13, 18, 19, 20, 25, 26 or 27 (Figure B2-1). Neutron source assemblies may contain source rods attached to hardware similar in configuration to guide tube plug devices (thimble plugs) and burnable absorbers, in addition to containing burnable poison rodlets and/or thimble plug rodlets. For NSAs containing absorber rodlets, the BPAA cool time and burnup/exposure or hardware ^{60}Co curie limit listed in Table B2-6 are applied to the neutron sources. NSAs having only thimble plug rodlets require the thimble plug restriction in Table B2-7 to be applied. Combination NSAs, containing both thimble plug and burnable absorber rodlets must apply the more limiting of the two minimum cool time/curie limit.

I. Fuel assemblies may contain any number of unirradiated (i.e., not inserted in-core) nonfuel solid filler fuel replacement rods. Activated stainless steel rods are limited to 5 per assembly at a maximum burnup/exposure of 32.5 GWd/MTU.

J. Fuel assemblies may contain an HFRA at a maximum burnup/exposure of 4.0 GWd/MTU and a minimum cool time of 16 years.

PROPOSED

Table B2-2 PWR Fuel Assembly Characteristics

Characteristic	14×14	14×14	15×15	15×15	16×16	17×17
Max Initial Enrichment (wt % ^{235}U)	5.0	5.0	5.0	5.0	5.0	5.0
Min Initial Enrichment (wt % ^{235}U)	1.3	1.3	1.3	1.3	1.3	1.3
Number of Fuel Rods	176	179	204	208	236	264
Max Assembly Average Burnup (MWd/MTU)	60,000	60,000	60,000	60,000	60,000	60,000
Peak Average Rod Burnup (MWd/MTU)	62,500	62,500	62,500	62,500	62,500	62,500
Min Cool Time (years)	4	4[2]	4	4	4	4
Max Weight (lb) per Storage Location	See Note 1	See Note 1	See Note 1	See Note 1	See Note 1	See Note 1
Max Decay Heat (Watts) per Preferential Storage Location	1,200	1,200	1,200	1,200	1,200	1,200

- All reported enrichment values are nominal preirradiation fabrication values.
- Maximum initial enrichment is based on a minimum soluble boron concentration in the spent fuel pool water. Required soluble boron content is fuel type and enrichment specific. Minimum soluble boron content varies between 1,500 and 2,500 ppm. Maximum initial enrichment represents the peak fuel rod enrichment for variably-enriched fuel assemblies.

PROPOSED

Notes:

1. Maximum weight per storage location is as detailed in Table B2-1
2. Minimum cool time of 2.5 years for WE 14x14 PWR fuel

Table B2-3 Bounding PWR Fuel Assembly Loading Criteria

Assembly Type	No. of Fuel Rods	No. of Guide Tubes[1]	Geometry[2]					
			Max Pitch (inch)	Min Clad OD (inch)	Min Clad Thick. (inch)	Max Pellet OD (inch)	Max Active Length (inch)	Max Load (MTU)
BW15H1	208	17	0.568	0.43	0.0265	0.3686	144.0	0.4858
BW15H2	208	17	0.568	0.43	0.025	0.3735	144.0	0.4988
BW15H3	208	17	0.568	0.428	0.023	0.3742	144.0	0.5006
BW15H4	208	17	0.568	0.414	0.022	0.3622	144.0	0.4690
BW17H1	264	25	0.502	0.377	0.022	0.3252	144.0	0.4799
CE14H1	176	5	0.58	0.44	0.026	0.3805	137.0	0.4167
CE16H1	236	5	0.5063	0.382	0.025	0.325	150.0	0.4463
WE14H1	179	17	0.556	0.40	0.0162	0.3674	145.2	0.4188
WE15H1	204	21	0.563	0.422	0.0242	0.3669	144.0	0.4720
WE15H2	204	21	0.563	0.417	0.0265	0.357	144.0	0.4469
WE17H1	264	25	0.496	0.372	0.0205	0.3232	144.0	0.4740
WE17H2	264	25	0.496	0.36	0.0225	0.3088	144.0	0.4327

[1] Combined number of guide and instrument tubes.
[2] Assembly characteristics represent cold, unirradiated, nominal configurations.

PROPOSED

Note: Amendment No. 2 removed the enrichment/soluble boron limits from this table, along with the note pertaining to them. This information is now presented in Table B2-4.

Table B2-4 Bounding PWR Fuel Assembly Loading Criteria – Enrichment/Soluble Boron Limits

TSC with Undamaged PWR Fuel Basket Assembly Max. Initial Enrichment (wt % ^{235}U)

	Absorber[a] 0.036 ^{10}B g/cm^2					Absorber[a] 0.030 ^{10}B g/cm^2					Absorber[a] 0.027 ^{10}B g/cm^2				
Soluble Boron	1500 (ppm)	1750 (ppm)	2000 (ppm)	2250 (ppm)	2500 (ppm)	1500 (ppm)	1750 (ppm)	2000 (ppm)	2250 (ppm)	2500 (ppm)	1500 (ppm)	1750 (ppm)	2000 (ppm)	2250 (ppm)	2500 (ppm)
BW15H1	3.7%	4.1%	4.4%	4.7%	5.0%	3.6%	4.0%	4.2%	4.5%	4.8%	3.6%	3.9%	4.2%	4.5%	4.8%
BW15H2	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	3.9%	4.2%	4.5%	4.8%	3.6%	3.8%	4.1%	4.4%	4.7%
BW15H3	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	3.9%	4.2%	4.4%	4.7%	3.5%	3.8%	4.1%	4.4%	4.7%
BW15H4	3.8%	4.2%	4.5%	4.8%	5.0%	3.7%	4.1%	4.4%	4.7%	5.0%	3.7%	4.0%	4.3%	4.6%	5.0%
BW17H1	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	3.9%	4.2%	4.5%	4.8%	3.6%	3.9%	4.1%	4.5%	4.7%
CE14H1	4.5%	4.8%	5.0%	5.0%	5.0%	4.3%	4.7%	5.0%	5.0%	5.0%	4.3%	4.6%	5.0%	5.0%	5.0%
CE16H1	4.4%	4.8%	5.0%	5.0%	5.0%	4.3%	4.6%	5.0%	5.0%	5.0%	4.2%	4.6%	4.9%	5.0%	5.0%
WE14H1	4.7%	5.0%	5.0%	5.0%	5.0%	4.6%	5.0%	5.0%	5.0%	5.0%	4.5%	5.0%	5.0%	5.0%	5.0%
WE15H1	3.8%	4.2%	4.5%	4.8%	5.0%	3.7%	4.1%	4.4%	4.7%	5.0%	3.7%	4.0%	4.3%	4.6%	4.9%
WE15H2	4.0%	4.4%	4.7%	5.0%	5.0%	3.9%	4.2%	4.6%	4.9%	5.0%	3.8%	4.2%	4.5%	4.8%	5.0%
WE17H1	3.7%	4.1%	4.4%	4.7%	5.0%	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	3.9%	4.2%	4.5%	4.9%
WE17H2	4.0%	4.3%	4.7%	5.0%	5.0%	3.9%	4.3%	4.6%	4.9%	5.0%	3.8%	4.2%	4.5%	4.9%	5.0%

TSC with Damaged PWR Fuel Basket Assembly Max. Initial Enrichment (wt % ^{235}U)

BW15H1	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	3.9%	4.2%	4.5%	4.7%	3.6%	3.8%	4.1%	4.4%	4.7%
BW15H2	3.6%	3.9%	4.2%	4.5%	4.8%	3.6%	3.8%	4.1%	4.4%	4.7%	3.5%	3.8%	4.1%	4.3%	4.6%
BW15H3	3.6%	3.9%	4.2%	4.5%	4.8%	3.5%	3.8%	4.1%	4.4%	4.6%	3.5%	3.8%	4.0%	4.3%	4.6%
BW15H4	3.8%	4.1%	4.4%	4.7%	5.0%	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	3.9%	4.2%	4.5%	4.8%
BW17H1	3.6%	3.9%	4.2%	4.5%	4.8%	3.6%	3.9%	4.1%	4.4%	4.7%	3.5%	3.8%	4.1%	4.4%	4.6%
CE14H1	4.4%	4.8%	5.0%	5.0%	5.0%	4.3%	4.7%	5.0%	5.0%	5.0%	4.3%	4.6%	4.9%	5.0%	5.0%
CE16H1	4.4%	4.7%	5.0%	5.0%	5.0%	4.2%	4.6%	5.0%	5.0%	5.0%	4.2%	4.5%	4.9%	5.0%	5.0%
WE14H1	4.6%	5.0%	5.0%	5.0%	5.0%	4.5%	5.0%	5.0%	5.0%	5.0%	4.5%	4.9%	5.0%	5.0%	5.0%
WE15H1	3.8%	4.1%	4.4%	4.7%	5.0%	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	4.0%	4.3%	4.6%	4.8%
WE15H2	3.9%	4.3%	4.6%	4.9%	5.0%	3.8%	4.2%	4.5%	4.8%	5.0%	3.8%	4.1%	4.4%	4.7%	5.0%
WE17H1	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	3.9%	4.2%	4.5%	4.8%	3.6%	3.9%	4.2%	4.5%	4.8%
WE17H2	3.9%	4.3%	4.6%	5.0%	5.0%	3.9%	4.2%	4.5%	4.9%	5.0%	3.8%	4.1%	4.5%	4.8%	5.0%

- Specified soluble boron concentrations are independent of whether an assembly contains a nonfuel insert.

[a] Borated aluminum neutron absorber sheet effective areal ^{10}B density.

Table B2-5 Additional SNF Assembly Cool Time Required to Load NONFUEL HARDWARE

Core (Assembly)	Cool Time (years)		
	BPAA/HFRA	GTPD/NSA	RCC
CE 14×14	--	--	0.1
WE 14×14	0.5	0.1	0.2
WE 15×15	0.5	0.1	0.7
B&W 15×15	0.1	0.1	0.1
CE 16×16	--	--	0.1
WE 17×17	0.5	0.1	0.7
B&W 17×17	0.1	0.1	0.1

Note: Additional SNF assembly cooling time to be added to the minimum SNF assembly cool time based on SNF assembly initial enrichment and SNF assembly average burnup listed in Tables B2-15 through B2-22 and B2-25 through B2-33.

PROPOSED

Table B2-6 Allowed BPAA/NSA Burnup and Cool Time Combinations

Maximum Burnup (GWd/MTU)	Minimum Cool Time (yrs)				
	WE 14×14	WE 15×15	B&W 15×15	WE 17×17	B&W 17×17
10	0.5	0.5	0.5	0.5	0.5
15	0.5	0.5	0.5	0.5	0.5
20	0.5	1.0	2.0	2.0	0.5
25	1.0	2.5	3.5	3.5	1.0
30	2.5	4.0	5.0	5.0	2.5
32.5	3.0	4.5	6.0	6.0	3.0
35	3.5	5.0	6.0	6.0	3.5
37.5	4.0	6.0	7.0	7.0	4.0
40	4.5	6.0	7.0	7.0	4.5
45	5.0	7.0	8.0	8.0	6.0
50	6.0	8.0	9.0	9.0	7.0
55	7.0	8.0	10.0	9.0	7.0
60	7.0	9.0	10.0	10.0	8.0
65	8.0	10.0	12.0	12.0	8.0
70	8.0	10.0	12.0	12.0	9.0
Max ^{60}Co Activity (Ci)	718	733	19	637	26

Note: Specified minimum cool times for BPRAs are independent of the required minimum cool times for the fuel assembly containing the BPRA.

Table B2-7 Allowed GTPD/NSA Burnup and Cool Time Combinations

Maximum Burnup (GWd/MTU)	Minimum Cool Time (yrs)				
	WE 14×14	WE 15×15	B&W 15×15	WE 17×17	B&W 17×17
45	2.0	3.5	7.0	5.0	6.0
90	6.0	7.0	10.0	9.0	10.0
135	7.0	9.0	12.0	10.0	12.0
180	8.0	9.0	14.0	12.0	12.0
^{60}Co Activity (Ci)	63.5	64.1	56.9	64.0	63.6

Note: Specified minimum cool times for thimble plugs are independent of the required minimum cool times for the fuel assembly containing the thimble plug.

PROPOSED

Table B2-8 PWR Fuel Preferential Loading Pattern Definitions

Three-Zone

Zone Description (see Figure B2-2)	Designator	Maximum Heat Load (W/assy)	# Assemblies
Inner Zone	A	922	9
Middle Zone	B	1,200	12
Outer Zone	C	800	16

Four-Zone

Zone Description (see Figure B2-2)	Designator	Maximum Heat Load (W/assy)	# Assemblies
Inner Zone	A	513	9
Middle Zone	B1	1,300	8
	B2	1,800	4
Outer Zone	C	830	16

PROPOSED

Figure B2-1 Schematic of 37-Assembly PWR Basket

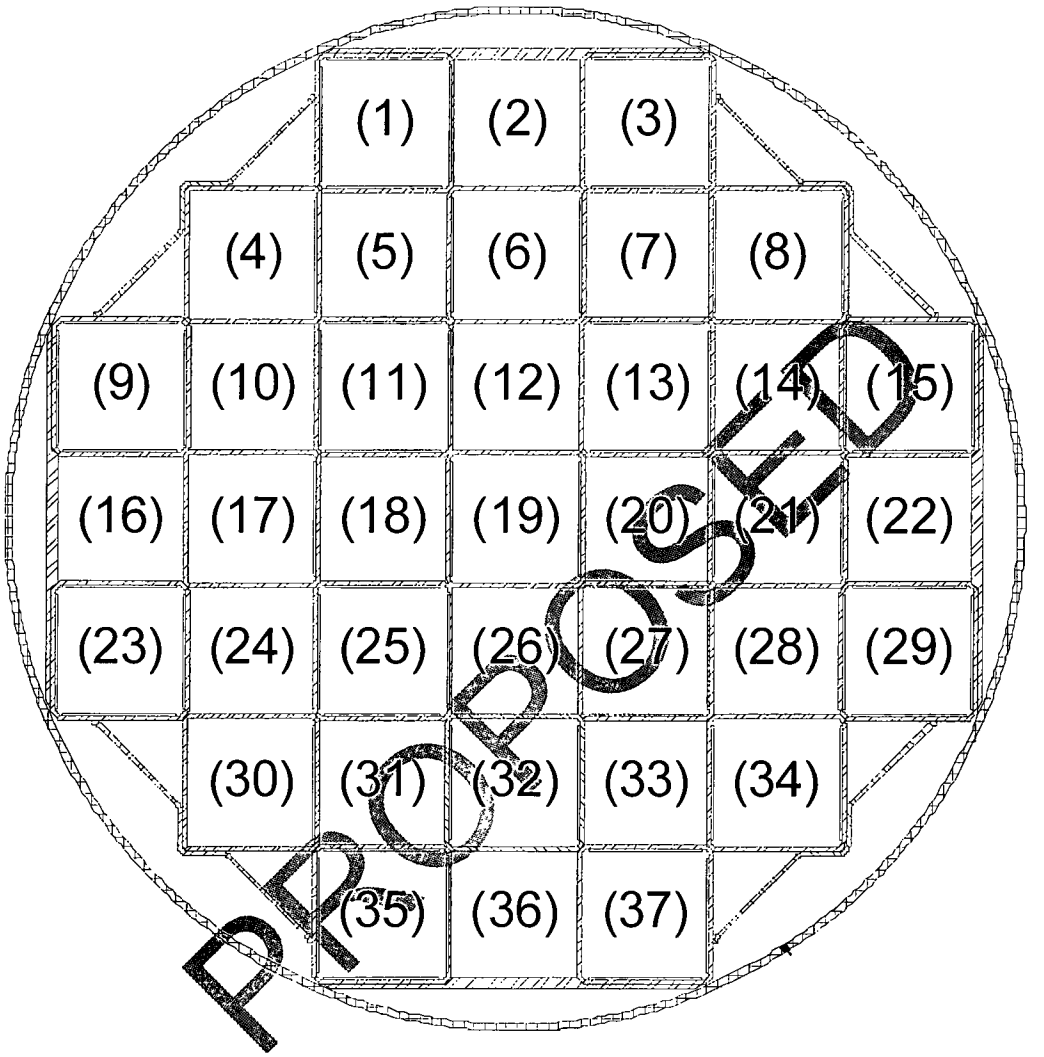
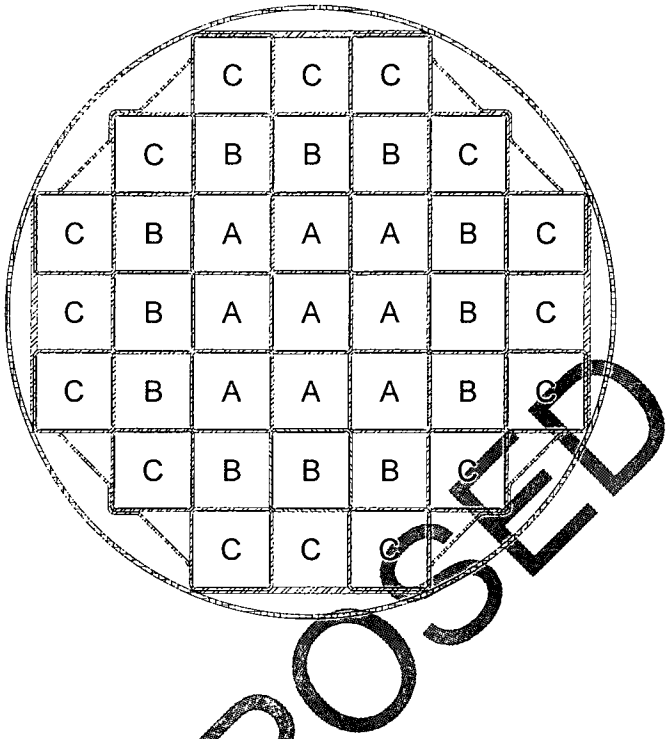
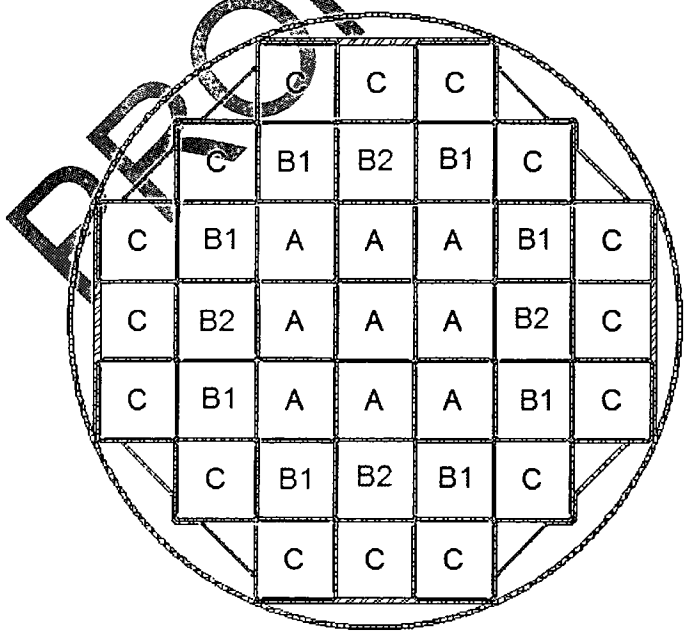


Figure B2-2 Schematic of 37-Assembly PWR Basket Preferential Loading Patterns

Three-Zone



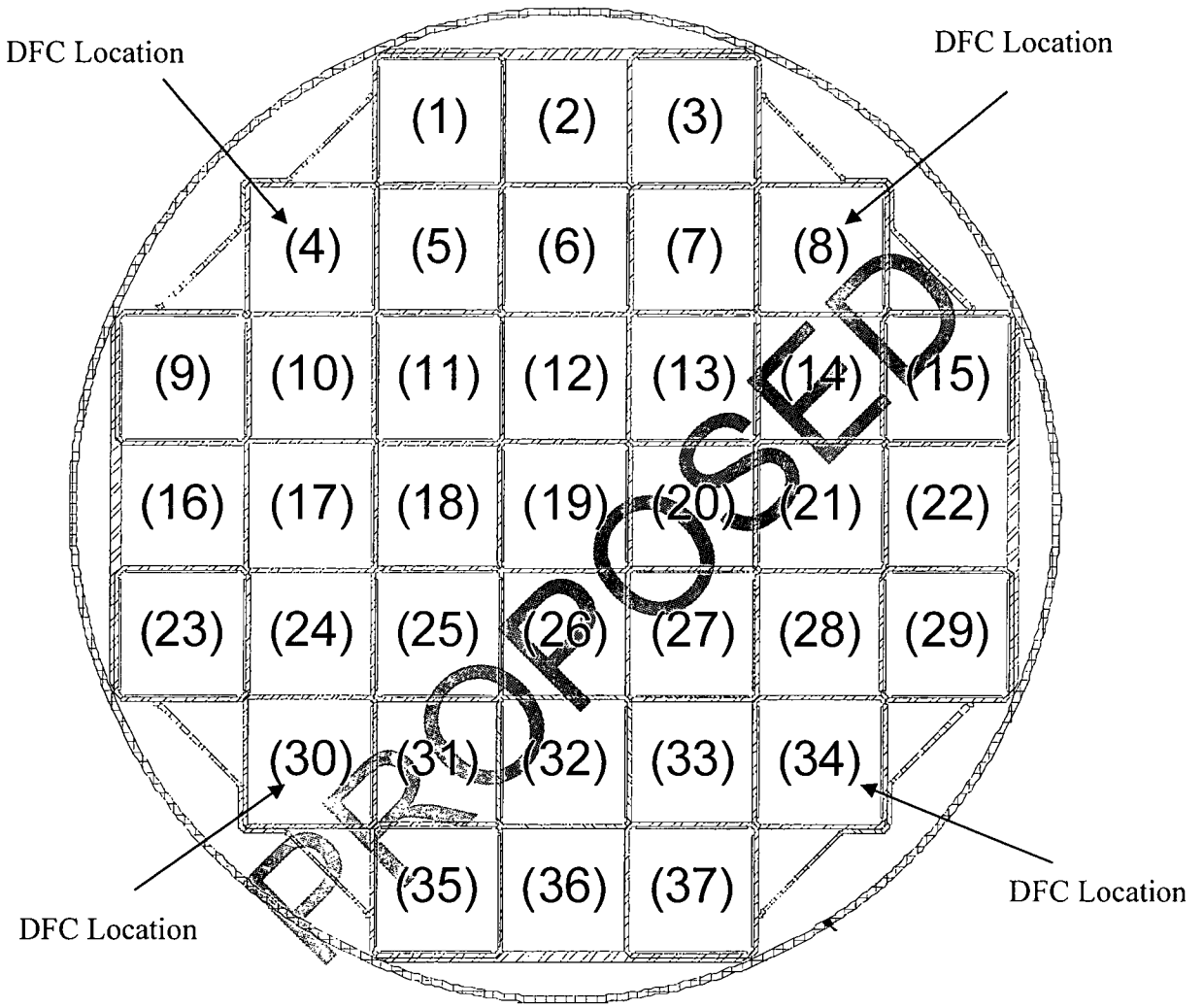
Four-Zone



PROPOSED

Refer to Table B2-8 for Maximum Heat Loads

Figure B2-3 Schematic of DF Basket Assembly Configuration for PWR SNF with DFCs



DFC designated locations may contain a loaded DFC or a PWR UNDAMAGED SNF ASSEMBLY.

Table B2-9 TSC with BWR Fuel Limits

I. BWR FUEL

A. Allowable Contents

1. Uranium BWR UNDAMAGED FUEL assemblies listed in Tables B2-10 and B2-11 and meeting the following specifications:

a. Cladding Type:	Zirconium-based alloy.
b. Enrichment: Post-irradiation Cooling Time and Assembly Average Burnup	Generic maximum INITIAL PEAK PLANAR-AVERAGE ENRICHMENTS are shown in Table B2-10. The physical characteristics of the different BWR SNF ASSEMBLIES are defined in Table B2-11. Fuel type specific enrichment limits for the 87-assembly and 82-assembly BWR fuel basket configurations are defined in Table B2-12 as a function of neutron absorber areal density. Combined minimum enrichment, maximum SNF assembly average burnup and minimum cool time limits are shown in Table B2-23 and Table B2-24. For SNF assembly average burnup levels below those shown in Table B2-23 and Table B2-24, an SNF assembly minimum cool time is specified in Table B2-14, provided that the minimum initial SNF assembly average enrichment limits are applied.
c. Decay Heat per SNF Assembly:	≤ 379 watts
d. Nominal Fresh Fuel Design SNF Assembly Length (in.):	≤ 176.2
e. Nominal Fresh Fuel Design SNF Assembly Width (in.):	≤ 5.52
f. SNF Assembly Weight (lb):	≤ 704, including channels

B. Quantity per TSC: Up to 87 BWR UNDAMAGED SNF ASSEMBLIES. With the exception of the designated nonfuel locations in the 82-assembly basket configuration, fuel storage locations not containing a fuel assembly shall have an empty fuel cell insert installed. Prior to use of the 82-assembly configurations, the cell fuel storage locations shown in Figures B2-4 and B2-5 must be physically blocked to prevent fuel assembly loading.

(continued)

PROPOSED

Table B2-9 TSC with BWR Fuel Limits (continued)

C. BWR fuel assemblies may be unchanneled, or channeled with zirconium-based alloy channels.

D. BWR fuel assemblies with stainless steel channels are not authorized.

E. SNF Assembly lattices possessing less than the nominal number of undamaged fuel rods (see Table B2-11) must contain solid filler rods that displace a volume equal to, or greater than, that of the fuel rod that the filler rod replaces.

F. Spacers may be used in a TSC to axially position BWR SNF assemblies to facilitate handling.

G. Unirradiated (i.e., not inserted in-core) fuel assemblies are not authorized for loading. Unenriched axial blankets are permitted, provided that the nominal length of the blanket is not greater than six (6) inches.

H. Allowable SNF assembly locations for the standard and alternate 82-assembly fuel basket configurations are shown in Figure B2-5.

PROPOSED

Table B2-10 BWR SNF Assembly Characteristics

Characteristic	Fuel Class			
	7×7	8×8	9×9	10×10
Max Initial Enrichment (wt % ^{235}U)	4.5	4.5	4.5	4.5
Number of Fuel Rods	48/49	59/60/61/ 62/63/64	72/74[a]/76/ 79/80	91[a]/92[a]/ 96[a]/100
Max Assembly Average Burnup (MWd/MTU)	60,000	60,000	60,000	60,000
Peak Average Rod Burnup (MWd/MTU)	62,500	62,500	62,500	62,500
Min Cool Time (years)	4	4	4	4
Min Average Enrichment (wt % ^{235}U)	0.7	0.7	0.7	0.7
Max Weight (lb) per Storage Location	704	704	704	704
Max Decay Heat (Watts) per Storage Location	379	379	379	379

- Each BWR fuel assembly may include a zirconium-based alloy channel.
- Assembly weight includes the weight of the channel.
- Maximum initial enrichment is the peak planar-average enrichment.
- Water rods may occupy more than one fuel lattice location. Fuel assembly to contain nominal number of water rods for the specific assembly design.
- All enrichment values are nominal preirradiation fabrication values.
- Spacers may be used to axially position fuel assemblies to facilitate handling.

PROPOSED

[a] Assemblies may contain partial-length fuel rods.

Table B2-11 BWR SNF Assembly Loading Criteria

			Geometry [3,4]					
Assembly Type	Number of Fuel Rods	Number of Partial Length Rods [1]	Max Pitch (inch)	Min Clad OD (inch)	Min Clad Thick. (inch)	Max Pellet OD (inch)	Max Active Length (inch)	Max Loading (MTU)
B7_48A	48	N/A	0.7380	0.5700	0.03600	0.4900	144.0	0.1981
B7_49A	49	N/A	0.7380	0.5630	0.03200	0.4880	146.0	0.2034
B7_49B	49	N/A	0.7380	0.5630	0.03200	0.4910	150.0	0.2115
B8_59A	59	N/A	0.6400	0.4930	0.03400	0.4160	150.0	0.1828
B8_60A	60	N/A	0.6417	0.4840	0.03150	0.4110	150.0	0.1815
B8_60B	60	N/A	0.6400	0.4830	0.03000	0.4140	150.0	0.1841
B8_61B	61	N/A	0.6400	0.4830	0.03000	0.4140	150.0	0.1872
B8_62A	62	N/A	0.6417	0.4830	0.02900	0.4160	150.0	0.1921
B8_63A	63	N/A	0.6420	0.4840	0.02725	0.4195	150.0	0.1985
B8_64A	64	N/A	0.6420	0.4840	0.02725	0.4195	150.0	0.2017
B8_64B[5]	64	N/A	0.6090	0.4576	0.02900	0.3913	150.0	0.1755
B9_72A	72	N/A	0.5720	0.4330	0.02600	0.3740	150.0	0.1803
B9_74A	74[2]	8	0.5720	0.4240	0.02390	0.3760	150.0	0.1873
B9_76A	76	N/A	0.5720	0.4170	0.02090	0.3750	150.0	0.1914
B9_79A	79	N/A	0.5720	0.4240	0.02390	0.3760	150.0	0.2000
B9_80A	80	N/A	0.5720	0.4230	0.02950	0.3565	150.0	0.1821
B10_91A	91[2]	8	0.5100	0.3957	0.02385	0.3420	150.0	0.1906
B10_92A	92[2]	14	0.5100	0.4040	0.02600	0.3455	150.0	0.1966
B10_96A[5]	96[2]	12	0.4880	0.3780	0.02430	0.3224	150.0	0.1787
B10_100A[5]	100	N/A	0.4880	0.3780	0.02430	0.3224	150.0	0.1861

1 Location of the partial length rods is illustrated in Figure B2-6.
2 Assemblies may contain partial-length fuel rods.
3 Assembly characteristics represent cold, unirradiated, nominal configurations.
4 Maximum channel thickness allowed is 120 mils (nominal).
5 Composed of four subchannel clusters.

Note: Amendment No. 2 removed the enrichment/soluble boron limits from this table. This information is now presented in Table B2-12.

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Table B2-12 BWR SNF Assembly Loading Criteria – Enrichment Limits for 87-Assembly and 82-Assembly Configurations

	Max. Initial Enrichment[a] (wt % ^{235}U)					
	Absorber[b] 0.027 ^{10}B g/cm^2		Absorber 0.0225 ^{10}B g/cm^2		Absorber 0.02 ^{10}B g/cm^2	
	87-Assy Basket	82-Assy Basket	87-Assy Basket	82-Assy Basket	87-Assy Basket	82-Assy Basket
B7_48A	4.0%	4.5%	3.7%	4.5%	3.6%	4.4%
B7_49A	3.8%	4.5%	3.6%	4.4%	3.5%	4.3%
B7_49B	3.8%	4.5%	3.6%	4.4%	3.5%	4.2%
B8_59A	3.9%	4.5%	3.7%	4.5%	3.6%	4.3%
B8_60A	3.8%	4.5%	3.7%	4.4%	3.5%	4.2%
B8_60B	3.8%	4.5%	3.6%	4.3%	3.5%	4.2%
B8_61B	3.8%	4.5%	3.6%	4.3%	3.5%	4.2%
B8_62A	3.8%	4.5%	3.6%	4.3%	3.5%	4.1%
B8_63A	3.8%	4.5%	3.6%	4.3%	3.4%	4.2%
B8_64A	3.8%	4.5%	3.6%	4.3%	3.5%	4.2%
B8_64B	3.6%	4.3%	3.4%	4.1%	3.3%	4.0%
B9_72A	3.8%	4.5%	3.6%	4.3%	3.4%	4.1%
B9_74A	3.7%[c]	4.3%	3.4%	4.1%	3.4%	4.0%
B9_76A	3.5%	4.2%	3.4%	4.0%	3.3%	3.9%
B9_79A	3.7%	4.4%	3.4%	4.2%	3.3%	4.0%
B9_80A	3.8%	4.5%	3.6%	4.3%	3.5%	4.2%
B10_91A	3.7%	4.5%[d]	3.6%	4.3%	3.5%	4.1%
B10_92A	3.8%	4.5%[d]	3.6%	4.3%	3.5%	4.1%
B10_96A	3.7%	4.3%	3.5%	4.1%	3.4%	4.0%
B10_100A	3.6%	4.4%	3.5%	4.1%	3.4%	4.0%

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[a] Maximum planar average.

[b] Borated aluminum neutron absorber sheet effective areal ^{10}B density.

[c] 3.85% in the 86-assembly basket configuration

[d] 4.55% in the alternate 82-assembly basket configuration

Figure B2-4 Schematic of 87-Assembly BWR Basket

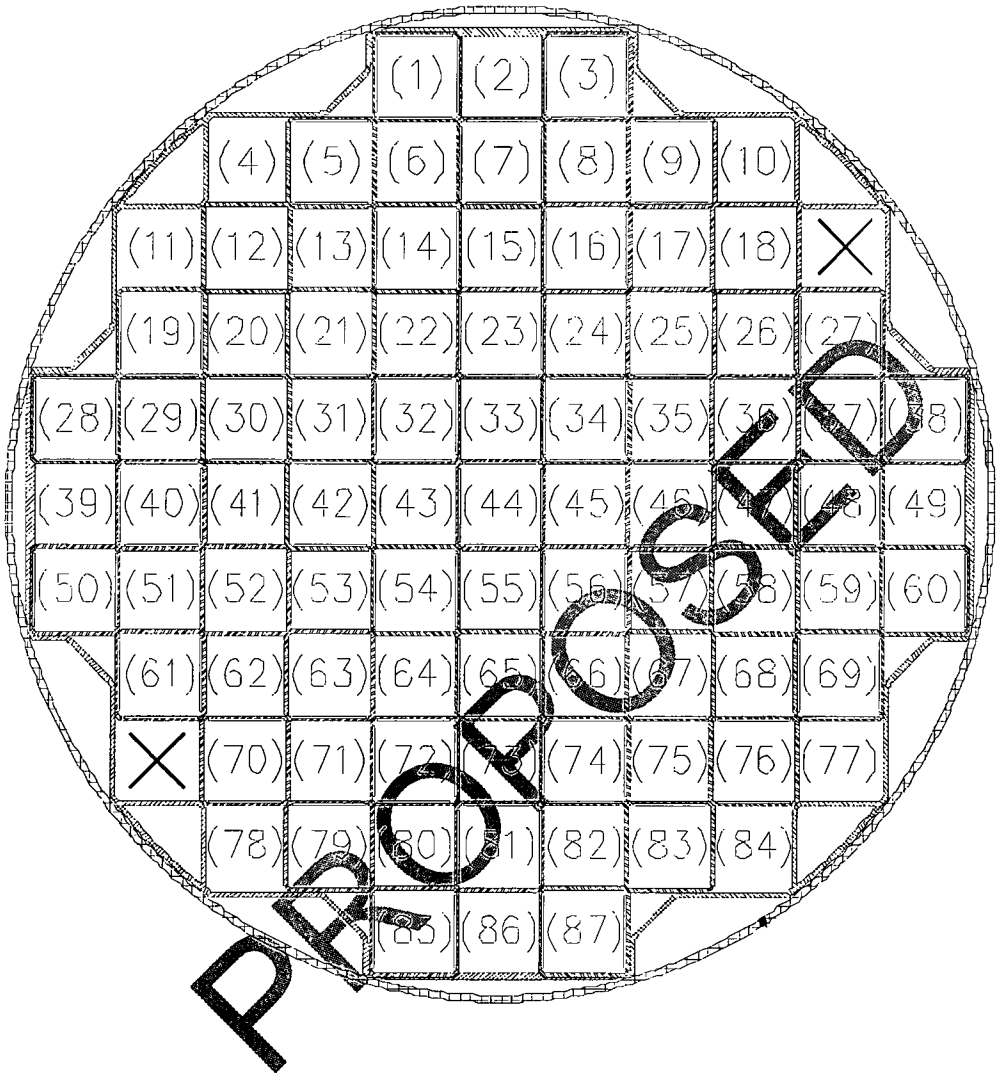
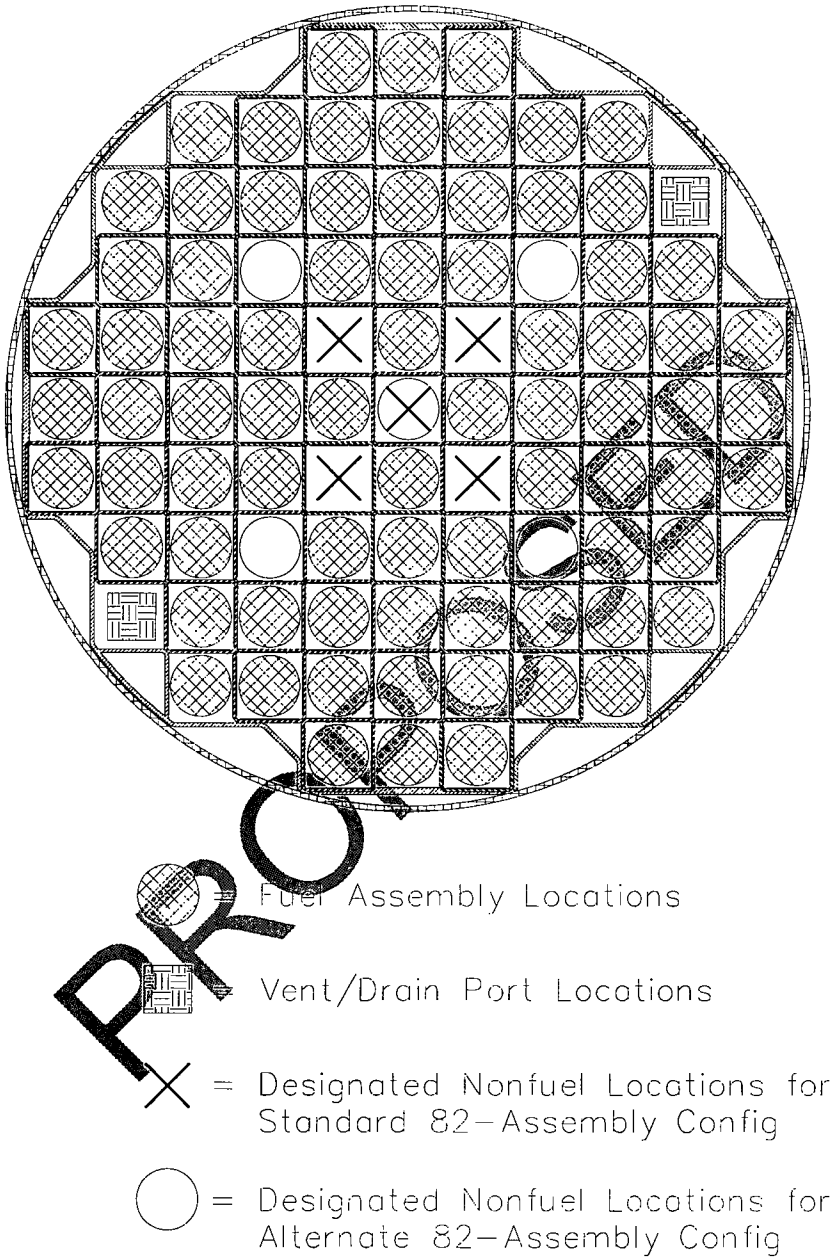
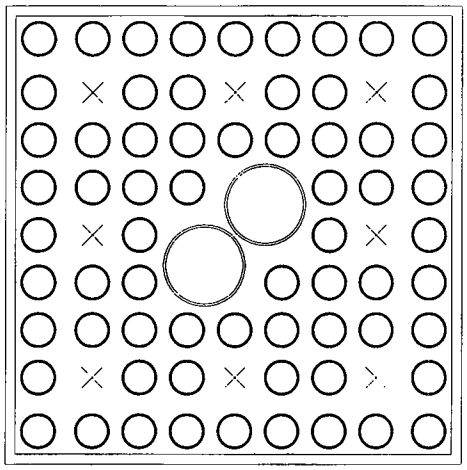


Figure B2-5 Schematic of 82-Assembly BWR Basket



PROOF

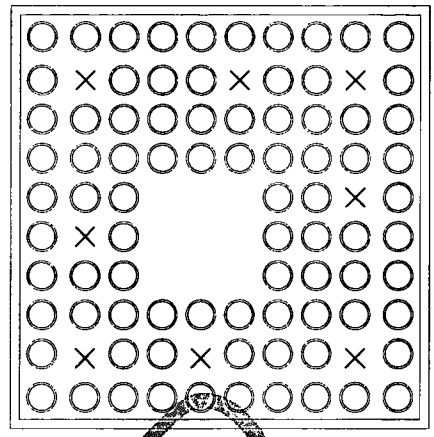
Figure B2-6 BWR Partial Length Fuel Rod Location Sketches



○ = Fuel Rod Location

× = Par ial Rod Location

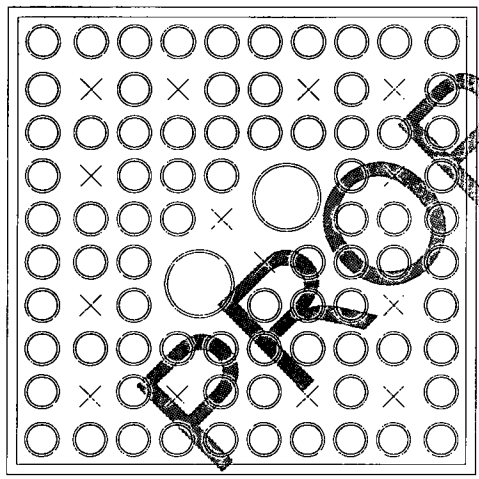
B9_74A 8 Partial Length Rods



○ = Fuel Rod Location

× = Partial Rod Location

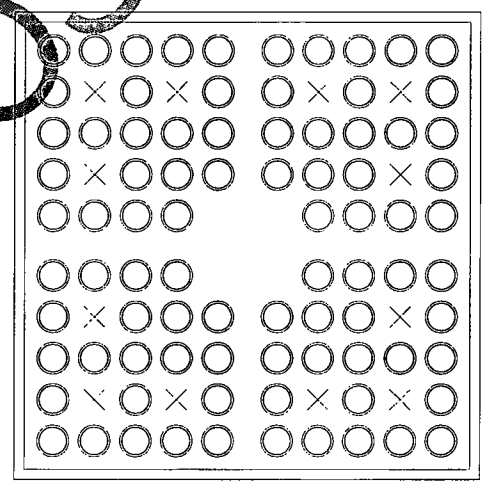
B10_91A 8 Partial Length Rods



○ = Fuel Rod Location

× = Partial Rod Location

B10_92A 14 Partial Length Rods



○ = Fuel Rod Location

× = Partial Rod Location

B10_96A 12 Partial Length Rods

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Table B2-13 PWR Loading Table – Low SNF Assembly Average Burnup Enrichment Limits

Max. Assembly Avg. Burnup (MWd/MTU)	Min. Assembly Avg. Initial Enrichment (wt% ^{235}U)	Minimum Cool Time (yrs)			
Heat Load per Assy	--	959 W	800 W	922 W	1,200 W
10,000	1.3	4.0	4.0	4.0	4.0
15,000	1.5	4.0	4.0	4.0	4.0
20,000	1.7	4.0	4.0	4.0	4.0
25,000	1.9	4.0	4.3	4.0	4.0
30,000	2.1	4.4	5.2	4.5	4.0

Table B2-14 BWR Loading Table – Low SNF Assembly Average Burnup Enrichment Limits

Max. Assembly Avg. Burnup (MWd/MTU)	Min. Assembly Avg. Initial Enrichment (wt% ^{235}U)	Minimum Cool Time (yrs)
5,000	0.7	4.0
10,000	1.3	4.0
15,000	1.5	4.0
20,000	1.7	4.0
25,000	1.9	4.0
30,000	2.1	4.3

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Table B2-15 Loading Table for PWR Fuel – 959 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	30 < Assembly Average Burnup ≤ 32.5 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	4.1	4.1	4.6	4.7	4.4	4.7	4.7
2.3 ≤ E < 2.5	4.0	4.1	4.5	4.7	4.4	4.6	4.6
2.5 ≤ E < 2.7	4.0	4.0	4.5	4.6	4.3	4.6	4.6
2.7 ≤ E < 2.9	4.0	4.0	4.5	4.5	4.3	4.5	4.5
2.9 ≤ E < 3.1	4.0	4.0	4.4	4.5	4.2	4.5	4.5
3.1 ≤ E < 3.3	4.0	4.0	4.4	4.5	4.2	4.5	4.5
3.3 ≤ E < 3.5	4.0	4.0	4.3	4.4	4.2	4.4	4.4
3.5 ≤ E < 3.7	4.0	4.0	4.3	4.4	4.1	4.4	4.4
3.7 ≤ E < 3.9	4.0	4.0	4.3	4.4	4.1	4.4	4.4
3.9 ≤ E < 4.1	4.0	4.0	4.2	4.3	4.0	4.3	4.3
4.1 ≤ E < 4.3	4.0	4.0	4.2	4.3	4.0	4.3	4.3
4.3 ≤ E < 4.5	4.0	4.0	4.2	4.3	4.0	4.3	4.3
4.5 ≤ E < 4.7	4.0	4.0	4.1	4.2	4.0	4.2	4.2
4.7 ≤ E < 4.9	4.0	4.0	4.1	4.2	4.0	4.2	4.2
E ≥ 4.9	4.0	4.0	4.1	4.2	4.0	4.2	4.2
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**32.5 < Assembly Average Burnup ≤ 35 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**CE 16×16**	**WE 17×17**	**B&W 17×17**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	4.3	4.4	5.0	5.1	4.7	5.0	5.0
2.5 ≤ E < 2.7	4.3	4.4	4.9	5.0	4.7	5.0	5.0
2.7 ≤ E < 2.9	4.2	4.3	4.8	5.0	4.6	4.9	4.9
2.9 ≤ E < 3.1	4.2	4.3	4.8	4.9	4.6	4.9	4.9
3.1 ≤ E < 3.3	4.1	4.2	4.7	4.9	4.5	4.8	4.8
3.3 ≤ E < 3.5	4.1	4.2	4.7	4.8	4.5	4.8	4.8
3.5 ≤ E < 3.7	4.1	4.1	4.6	4.8	4.4	4.7	4.7
3.7 ≤ E < 3.9	4.0	4.1	4.6	4.7	4.4	4.7	4.7
3.9 ≤ E < 4.1	4.0	4.1	4.6	4.7	4.4	4.7	4.7
4.1 ≤ E < 4.3	4.0	4.0	4.5	4.7	4.3	4.6	4.6
4.3 ≤ E < 4.5	4.0	4.0	4.5	4.6	4.3	4.6	4.6
4.5 ≤ E < 4.7	4.0	4.0	4.5	4.6	4.3	4.6	4.6
4.7 ≤ E < 4.9	4.0	4.0	4.4	4.6	4.3	4.5	4.5
E ≥ 4.9	4.0	4.0	4.4	4.5	4.2	4.5	4.5

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Table B2-15 Loading Table for PWR Fuel – 959 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	35 < Assembly Average Burnup ≤ 37.5 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	4.7	4.8	5.5	5.7	5.2	5.6	5.6
2.5 ≤ E < 2.7	4.6	4.7	5.4	5.6	5.1	5.5	5.5
2.7 ≤ E < 2.9	4.6	4.7	5.3	5.5	5.0	5.4	5.4
2.9 ≤ E < 3.1	4.5	4.6	5.3	5.4	5.0	5.4	5.4
3.1 ≤ E < 3.3	4.5	4.5	5.2	5.4	4.9	5.3	5.3
3.3 ≤ E < 3.5	4.4	4.5	5.1	5.3	4.9	5.2	5.2
3.5 ≤ E < 3.7	4.4	4.5	5.0	5.2	4.8	5.2	5.2
3.7 ≤ E < 3.9	4.3	4.4	5.0	5.2	4.8	5.1	5.1
3.9 ≤ E < 4.1	4.3	4.4	5.0	5.1	4.7	5.1	5.1
4.1 ≤ E < 4.3	4.3	4.4	4.9	5.1	4.7	5.0	5.0
4.3 ≤ E < 4.5	4.2	4.3	4.9	5.0	4.7	5.0	5.0
4.5 ≤ E < 4.7	4.2	4.3	4.9	5.0	4.6	5.0	5.0
4.7 ≤ E < 4.9	4.2	4.3	4.8	5.0	4.6	4.9	4.9
E ≥ 4.9	4.1	4.2	4.8	4.9	4.5	4.9	4.9

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	37.5 < Assembly Average Burnup ≤ 40 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	5.0	5.2	5.9	6.1	5.6	6.0	6.0
2.7 ≤ E < 2.9	5.0	5.1	5.9	6.0	5.5	5.9	5.9
2.9 ≤ E < 3.1	4.9	5.0	5.8	6.0	5.5	5.9	5.9
3.1 ≤ E < 3.3	4.9	4.9	5.7	5.9	5.4	5.8	5.8
3.3 ≤ E < 3.5	4.8	4.9	5.7	5.8	5.3	5.7	5.7
3.5 ≤ E < 3.7	4.7	4.8	5.6	5.8	5.2	5.7	5.7
3.7 ≤ E < 3.9	4.7	4.8	5.5	5.7	5.2	5.6	5.6
3.9 ≤ E < 4.1	4.6	4.8	5.5	5.7	5.1	5.6	5.6
4.1 ≤ E < 4.3	4.6	4.7	5.4	5.6	5.1	5.5	5.5
4.3 ≤ E < 4.5	4.5	4.7	5.4	5.6	5.0	5.5	5.5
4.5 ≤ E < 4.7	4.5	4.6	5.3	5.5	5.0	5.4	5.4
4.7 ≤ E < 4.9	4.5	4.6	5.3	5.5	5.0	5.4	5.4
E ≥ 4.9	4.5	4.5	5.2	5.4	4.9	5.4	5.4

PROPOSED

Table B2-15 Loading Table for PWR Fuel – 959 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	40 < Assembly Average Burnup ≤ 41 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	5.3	5.4	6.2	6.4	5.8	6.3	6.3
2.7 ≤ E < 2.9	5.2	5.3	6.1	6.3	5.7	6.2	6.2
2.9 ≤ E < 3.1	5.1	5.2	6.0	6.2	5.7	6.1	6.1
3.1 ≤ E < 3.3	5.0	5.1	5.9	6.1	5.6	6.0	6.0
3.3 ≤ E < 3.5	4.9	5.1	5.9	6.0	5.5	5.9	5.9
3.5 ≤ E < 3.7	4.9	5.0	5.8	6.0	5.5	5.9	5.9
3.7 ≤ E < 3.9	4.8	4.9	5.7	5.9	5.4	5.8	5.8
3.9 ≤ E < 4.1	4.8	4.9	5.7	5.9	5.3	5.8	5.8
4.1 ≤ E < 4.3	4.7	4.9	5.6	5.8	5.3	5.7	5.7
4.3 ≤ E < 4.5	4.7	4.8	5.6	5.8	5.2	5.7	5.7
4.5 ≤ E < 4.7	4.7	4.8	5.5	5.7	5.2	5.6	5.6
4.7 ≤ E < 4.9	4.6	4.7	5.5	5.7	5.1	5.6	5.6
E ≥ 4.9	4.6	4.7	5.5	5.6	5.1	5.6	5.6

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	41 < Assembly Average Burnup ≤ 42 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	5.5	5.6	6.5	6.7	6.0	6.6	6.6
2.7 ≤ E < 2.9	5.4	5.5	6.4	6.6	5.9	6.5	6.5
2.9 ≤ E < 3.1	5.3	5.4	6.3	6.5	5.9	6.4	6.4
3.1 ≤ E < 3.3	5.2	5.3	6.2	6.4	5.8	6.3	6.3
3.3 ≤ E < 3.5	5.1	5.3	6.1	6.3	5.7	6.2	6.2
3.5 ≤ E < 3.7	5.0	5.2	6.0	6.2	5.7	6.1	6.1
3.7 ≤ E < 3.9	5.0	5.1	5.9	6.2	5.6	6.0	6.0
3.9 ≤ E < 4.1	4.9	5.1	5.9	6.1	5.5	6.0	6.0
4.1 ≤ E < 4.3	4.9	5.0	5.8	6.0	5.5	5.9	5.9
4.3 ≤ E < 4.5	4.9	5.0	5.8	6.0	5.4	5.9	5.9
4.5 ≤ E < 4.7	4.8	4.9	5.7	5.9	5.4	5.8	5.8
4.7 ≤ E < 4.9	4.8	4.9	5.7	5.9	5.3	5.8	5.8
E ≥ 4.9	4.7	4.9	5.7	5.9	5.3	5.8	5.8

PROPOSED

Table B2-15 Loading Table for PWR Fuel – 959 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	42 < Assembly Average Burnup ≤ 43 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	5.7	5.8	6.8	7.0	6.3	6.9	6.9
2.7 ≤ E < 2.9	5.6	5.7	6.7	6.9	6.2	6.8	6.8
2.9 ≤ E < 3.1	5.5	5.6	6.6	6.8	6.0	6.7	6.7
3.1 ≤ E < 3.3	5.4	5.6	6.5	6.7	6.0	6.6	6.6
3.3 ≤ E < 3.5	5.3	5.5	6.4	6.6	5.9	6.5	6.5
3.5 ≤ E < 3.7	5.3	5.4	6.3	6.5	5.9	6.4	6.4
3.7 ≤ E < 3.9	5.2	5.3	6.2	6.5	5.8	6.3	6.3
3.9 ≤ E < 4.1	5.1	5.3	6.1	6.4	5.7	6.2	6.2
4.1 ≤ E < 4.3	5.0	5.2	6.0	6.3	5.7	6.2	6.1
4.3 ≤ E < 4.5	5.0	5.2	6.0	6.2	5.6	6.1	6.1
4.5 ≤ E < 4.7	5.0	5.1	5.9	6.2	5.6	6.0	6.0
4.7 ≤ E < 4.9	4.9	5.0	5.9	6.1	5.5	6.0	6.0
E ≥ 4.9	4.9	5.0	5.8	6.0	5.5	6.0	5.9

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	43 < Assembly Average Burnup ≤ 44 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	5.9	6.0	7.1	7.4	6.6	7.2	7.2
2.7 ≤ E < 2.9	5.8	5.9	7.0	7.3	6.5	7.0	7.0
2.9 ≤ E < 3.1	5.7	5.8	6.9	7.1	6.4	6.9	6.9
3.1 ≤ E < 3.3	5.6	5.8	6.8	7.0	6.2	6.8	6.8
3.3 ≤ E < 3.5	5.5	5.7	6.7	6.9	6.1	6.8	6.7
3.5 ≤ E < 3.7	5.5	5.6	6.6	6.8	6.0	6.7	6.7
3.7 ≤ E < 3.9	5.4	5.6	6.5	6.8	6.0	6.6	6.6
3.9 ≤ E < 4.1	5.3	5.5	6.4	6.7	5.9	6.5	6.5
4.1 ≤ E < 4.3	5.3	5.4	6.3	6.6	5.9	6.4	6.4
4.3 ≤ E < 4.5	5.2	5.4	6.2	6.5	5.8	6.4	6.4
4.5 ≤ E < 4.7	5.1	5.3	6.2	6.5	5.8	6.3	6.3
4.7 ≤ E < 4.9	5.1	5.3	6.1	6.4	5.7	6.2	6.2
E ≥ 4.9	5.0	5.2	6.0	6.3	5.7	6.2	6.2

PROPOSED

Table B2-15 Loading Table for PWR Fuel – 959 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	44 < Assembly Average Burnup ≤ 45 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	6.0	6.2	7.3	7.7	6.7	7.4	7.4
2.9 ≤ E < 3.1	5.9	6.0	7.2	7.6	6.6	7.3	7.3
3.1 ≤ E < 3.3	5.8	6.0	7.0	7.4	6.5	7.2	7.1
3.3 ≤ E < 3.5	5.7	5.9	6.9	7.3	6.4	7.0	7.0
3.5 ≤ E < 3.7	5.7	5.8	6.8	7.2	6.3	6.9	6.9
3.7 ≤ E < 3.9	5.6	5.8	6.8	7.0	6.2	6.9	6.9
3.9 ≤ E < 4.1	5.5	5.7	6.7	7.0	6.2	6.8	6.8
4.1 ≤ E < 4.3	5.5	5.6	6.6	6.9	6.1	6.7	6.7
4.3 ≤ E < 4.5	5.4	5.6	6.5	6.8	6.0	6.7	6.6
4.5 ≤ E < 4.7	5.3	5.5	6.5	6.7	6.0	6.6	6.6
4.7 ≤ E < 4.9	5.3	5.5	6.4	6.7	5.9	6.5	6.5
E ≥ 4.9	5.2	5.4	6.3	6.6	5.9	6.5	6.5

PROPOSED

Note: **For fuel assembly average burnup greater than 45 GWd/MTU, cool time tables have been revised to account for a 5% margin in heat load.**

Table B2-16 Loading Table for PWR Fuel – 911 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	45 < Assembly Average Burnup ≤ 46 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	6.7	6.9	8.5	9.0	7.7	8.6	8.6
2.9 ≤ E < 3.1	6.6	6.8	8.3	8.8	7.5	8.4	8.4
3.1 ≤ E < 3.3	6.5	6.7	8.1	8.6	7.4	8.2	8.2
3.3 ≤ E < 3.5	6.4	6.6	8.0	8.5	7.3	8.1	8.1
3.5 ≤ E < 3.7	6.3	6.5	7.8	8.3	7.1	8.0	7.9
3.7 ≤ E < 3.9	6.2	6.4	7.7	8.2	7.0	7.8	7.8
3.9 ≤ E < 4.1	6.1	6.3	7.6	8.0	6.9	7.7	7.7
4.1 ≤ E < 4.3	6.0	6.2	7.5	7.9	6.9	7.7	7.6
4.3 ≤ E < 4.5	6.0	6.2	7.4	7.8	6.8	7.6	7.6
4.5 ≤ E < 4.7	5.9	6.1	7.3	7.8	6.7	7.5	7.5
4.7 ≤ E < 4.9	5.9	6.0	7.2	7.7	6.7	7.4	7.4
E ≥ 4.9	5.8	6.0	7.2	7.6	6.6	7.3	7.3

PROPOSED

Table B2-16 Loading Table for PWR Fuel – 911 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	46 < Assembly Average Burnup ≤ 47 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	7.0	7.3	9.0	9.6	8.0	9.1	9.1
2.9 ≤ E < 3.1	6.9	7.1	8.8	9.4	7.9	8.9	8.9
3.1 ≤ E < 3.3	6.8	7.0	8.6	9.2	7.8	8.7	8.7
3.3 ≤ E < 3.5	6.7	6.9	8.4	9.0	7.6	8.6	8.6
3.5 ≤ E < 3.7	6.6	6.8	8.3	8.8	7.5	8.4	8.4
3.7 ≤ E < 3.9	6.5	6.7	8.1	8.7	7.4	8.3	8.3
3.9 ≤ E < 4.1	6.4	6.6	8.0	8.5	7.3	8.1	8.1
4.1 ≤ E < 4.3	6.3	6.5	7.9	8.4	7.2	8.0	8.0
4.3 ≤ E < 4.5	6.2	6.5	7.8	8.3	7.1	7.9	7.9
4.5 ≤ E < 4.7	6.1	6.4	7.7	8.2	7.0	7.9	7.8
4.7 ≤ E < 4.9	6.0	6.3	7.6	8.1	6.9	7.8	7.8
E ≥ 4.9	6.0	6.2	7.6	8.0	6.9	7.7	7.7
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**47 < Assembly Average Burnup ≤ 48 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**CE 16×16**	**WE 17×17**	**B&W 17×17**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	7.4	7.7	9.6	10.3	8.6	9.7	9.7
2.9 ≤ E < 3.1	7.2	7.6	9.4	10.0	8.4	9.5	9.5
3.1 ≤ E < 3.3	7.1	7.4	9.1	9.8	8.2	9.3	9.3
3.3 ≤ E < 3.5	7.0	7.2	8.9	9.6	8.0	9.1	9.0
3.5 ≤ E < 3.7	6.9	7.1	8.8	9.4	7.9	8.9	8.9
3.7 ≤ E < 3.9	6.7	7.0	8.6	9.2	7.8	8.8	8.7
3.9 ≤ E < 4.1	6.7	6.9	8.5	9.0	7.6	8.6	8.6
4.1 ≤ E < 4.3	6.6	6.8	8.4	8.9	7.6	8.5	8.5
4.3 ≤ E < 4.5	6.5	6.7	8.2	8.8	7.4	8.4	8.4
4.5 ≤ E < 4.7	6.4	6.7	8.1	8.7	7.4	8.3	8.3
4.7 ≤ E < 4.9	6.3	6.6	8.0	8.6	7.3	8.2	8.2
E ≥ 4.9	6.2	6.5	7.9	8.5	7.2	8.1	8.1

PROPOSED

Table B2-16 Loading Table for PWR Fuel – 911 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	48 < Assembly Average Burnup ≤ 49 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	7.8	8.1	10.2	11.1	9.0	10.4	10.4
2.9 ≤ E < 3.1	7.6	7.9	10.0	10.8	8.8	10.1	10.1
3.1 ≤ E < 3.3	7.5	7.8	9.7	10.5	8.6	9.9	9.8
3.3 ≤ E < 3.5	7.3	7.6	9.5	10.2	8.5	9.7	9.6
3.5 ≤ E < 3.7	7.2	7.5	9.3	10.0	8.3	9.5	9.4
3.7 ≤ E < 3.9	7.0	7.4	9.1	9.8	8.2	9.3	9.3
3.9 ≤ E < 4.1	6.9	7.2	9.0	9.6	8.0	9.1	9.1
4.1 ≤ E < 4.3	6.8	7.1	8.8	9.5	7.9	9.0	9.0
4.3 ≤ E < 4.5	6.8	7.0	8.7	9.3	7.8	8.9	8.9
4.5 ≤ E < 4.7	6.7	6.9	8.6	9.2	7.7	8.8	8.7
4.7 ≤ E < 4.9	6.6	6.9	8.5	9.1	7.6	8.7	8.6
E ≥ 4.9	6.5	6.8	8.4	9.0	7.6	8.6	8.5

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	49 < Assembly Average Burnup ≤ 50 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	8.0	8.3	10.7	11.6	9.4	10.9	10.9
3.1 ≤ E < 3.3	7.8	8.1	10.4	11.3	9.1	10.6	10.6
3.3 ≤ E < 3.5	7.7	7.9	10.1	11.0	9.0	10.3	10.3
3.5 ≤ E < 3.7	7.5	7.8	9.9	10.8	8.8	10.0	10.0
3.7 ≤ E < 3.9	7.4	7.6	9.7	10.5	8.6	9.9	9.9
3.9 ≤ E < 4.1	7.3	7.5	9.5	10.3	8.5	9.7	9.7
4.1 ≤ E < 4.3	7.1	7.4	9.4	10.1	8.3	9.6	9.5
4.3 ≤ E < 4.5	7.0	7.3	9.2	9.9	8.2	9.4	9.4
4.5 ≤ E < 4.7	6.9	7.2	9.1	9.8	8.1	9.3	9.2
4.7 ≤ E < 4.9	6.9	7.1	9.0	9.6	8.0	9.1	9.1
E ≥ 4.9	6.8	7.0	8.9	9.5	7.9	9.0	9.0

PROPOSED

Table B2-16 Loading Table for PWR Fuel – 911 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	50 < Assembly Average Burnup ≤ 51 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	8.3	8.7	11.5	12.3	10.0	11.6	11.6
3.1 ≤ E < 3.3	8.0	8.5	11.2	12.0	9.8	11.3	11.3
3.3 ≤ E < 3.5	7.9	8.3	10.9	11.7	9.5	11.1	11.1
3.5 ≤ E < 3.7	7.8	8.1	10.6	11.5	9.3	10.8	10.8
3.7 ≤ E < 3.9	7.6	8.0	10.4	11.3	9.1	10.6	10.6
3.9 ≤ E < 4.1	7.5	7.9	10.1	11.1	9.0	10.4	10.4
4.1 ≤ E < 4.3	7.4	7.8	10.0	10.9	8.8	10.2	10.1
4.3 ≤ E < 4.5	7.3	7.6	9.8	10.6	8.7	10.0	10.0
4.5 ≤ E < 4.7	7.1	7.5	9.7	10.5	8.6	9.8	9.8
4.7 ≤ E < 4.9	7.0	7.4	9.5	10.3	8.5	9.7	9.7
E ≥ 4.9	7.0	7.3	9.4	10.1	8.3	9.6	9.6
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**51 < Assembly Average Burnup ≤ 52 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	8.8	9.3	12.2	13.0	10.7	12.4	12.4
3.1 ≤ E < 3.3	8.5	9.0	11.9	12.6	10.4	12.1	12.0
3.3 ≤ E < 3.5	8.3	8.8	11.6	12.3	10.1	11.8	11.8
3.5 ≤ E < 3.7	8.1	8.6	11.4	11.9	9.9	11.6	11.5
3.7 ≤ E < 3.9	8.0	8.5	11.1	11.7	9.7	11.3	11.3
3.9 ≤ E < 4.1	7.9	8.3	10.9	11.5	9.5	11.1	11.1
4.1 ≤ E < 4.3	7.7	8.1	10.7	11.3	9.3	10.9	10.9
4.3 ≤ E < 4.5	7.6	8.0	10.5	11.1	9.2	10.7	10.7
4.5 ≤ E < 4.7	7.5	7.9	10.3	11.0	9.0	10.5	10.5
4.7 ≤ E < 4.9	7.4	7.8	10.1	10.8	8.9	10.3	10.3
E ≥ 4.9	7.3	7.7	10.0	10.6	8.8	10.2	10.2

PROPOSED

Table B2-16 Loading Table for PWR Fuel – 911 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	52 < Assembly Average Burnup ≤ 53 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	9.3	9.8	12.8	13.8	11.4	13.3	13.3
3.1 ≤ E < 3.3	9.0	9.6	12.4	13.5	11.2	13.0	13.0
3.3 ≤ E < 3.5	8.8	9.3	12.1	13.2	10.9	12.6	12.6
3.5 ≤ E < 3.7	8.6	9.1	11.8	12.8	10.6	12.3	12.3
3.7 ≤ E < 3.9	8.4	9.0	11.5	12.6	10.3	12.0	12.0
3.9 ≤ E < 4.1	8.2	8.8	11.3	12.3	10.1	11.8	11.8
4.1 ≤ E < 4.3	8.1	8.6	11.1	12.0	9.9	11.6	11.6
4.3 ≤ E < 4.5	8.0	8.5	10.9	11.8	9.7	11.4	11.4
4.5 ≤ E < 4.7	7.9	8.3	10.7	11.7	9.6	11.2	11.2
4.7 ≤ E < 4.9	7.8	8.2	10.6	11.5	9.4	11.1	11.0
E ≥ 4.9	7.7	8.1	10.4	11.3	9.3	10.9	10.9
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**53 < Assembly Average Burnup ≤ 54 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**CE 16×16**	**WE 17×17**	**B&W 17×17**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	9.8	10.5	13.6	14.9	12.2	14.2	14.2
3.1 ≤ E < 3.3	9.6	10.2	13.3	14.4	11.8	13.8	13.8
3.3 ≤ E < 3.5	9.3	9.9	12.9	14.0	11.6	13.5	13.5
3.5 ≤ E < 3.7	9.1	9.7	12.6	13.7	11.3	13.2	13.2
3.7 ≤ E < 3.9	8.9	9.5	12.3	13.4	11.0	12.9	12.9
3.9 ≤ E < 4.1	8.7	9.3	12.0	13.2	10.8	12.6	12.6
4.1 ≤ E < 4.3	8.6	9.1	11.8	12.9	10.6	12.4	12.4
4.3 ≤ E < 4.5	8.4	8.9	11.6	12.6	10.4	12.1	12.1
4.5 ≤ E < 4.7	8.3	8.8	11.4	12.4	10.1	11.9	11.9
4.7 ≤ E < 4.9	8.1	8.7	11.3	12.2	10.0	11.8	11.7
E ≥ 4.9	8.0	8.8	11.1	12.0	9.9	11.6	11.6

PROPOSED

Table B2-16 Loading Table for PWR Fuel – 911 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	54 < Assembly Average Burnup ≤ 55 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	10.1	10.9	14.1	15.4	12.7	14.8	14.8
3.3 ≤ E < 3.5	9.9	10.6	13.8	15.0	12.3	14.4	14.4
3.5 ≤ E < 3.7	9.6	10.3	13.5	14.7	12.0	14.0	14.0
3.7 ≤ E < 3.9	9.4	10.1	13.1	14.3	11.8	13.8	13.8
3.9 ≤ E < 4.1	9.2	9.8	12.9	14.0	11.5	13.5	13.5
4.1 ≤ E < 4.3	9.0	9.7	12.6	13.8	11.3	13.3	13.2
4.3 ≤ E < 4.5	8.9	9.5	12.3	13.5	11.1	13.0	13.0
4.5 ≤ E < 4.7	8.7	9.3	12.1	13.3	10.9	12.8	12.7
4.7 ≤ E < 4.9	8.6	9.1	11.9	13.1	10.7	12.6	12.5
E ≥ 4.9	8.5	9.0	11.7	12.9	10.5	12.3	12.3

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	55 < Assembly Average Burnup ≤ 56 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	10.9	11.6	15.1	16.5	13.1	15.8	15.8
3.3 ≤ E < 3.5	10.5	11.3	14.7	16.0	12.8	15.4	15.4
3.5 ≤ E < 3.7	10.2	11.0	14.3	15.7	12.4	15.1	15.0
3.7 ≤ E < 3.9	9.9	10.8	14.0	15.3	12.1	14.7	14.7
3.9 ≤ E < 4.1	9.7	10.5	13.7	15.0	11.9	14.4	14.4
4.1 ≤ E < 4.3	9.5	10.2	13.4	14.7	11.7	14.1	14.1
4.3 ≤ E < 4.5	9.3	10.0	13.2	14.5	11.4	13.8	13.8
4.5 ≤ E < 4.7	9.2	9.9	12.9	14.2	11.2	13.6	13.6
4.7 ≤ E < 4.9	9.0	9.7	12.7	13.9	11.1	13.4	13.4
E ≥ 4.9	8.9	9.5	12.5	13.8	10.9	13.2	13.2

PROPOSED

Table B2-16 Loading Table for PWR Fuel – 911 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	56 < Assembly Average Burnup ≤ 57 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	11.5	12.3	16.0	17.4	14.0	16.8	16.8
3.3 ≤ E < 3.5	11.2	12.0	15.6	17.1	13.6	16.4	16.4
3.5 ≤ E < 3.7	10.9	11.7	15.3	16.7	13.3	16.0	16.0
3.7 ≤ E < 3.9	10.6	11.4	14.9	16.3	13.0	15.7	15.6
3.9 ≤ E < 4.1	10.3	11.2	14.6	16.0	12.6	15.4	15.3
4.1 ≤ E < 4.3	10.1	10.9	14.2	15.7	12.4	15.1	15.1
4.3 ≤ E < 4.5	9.9	10.7	14.0	15.4	12.1	14.8	14.8
4.5 ≤ E < 4.7	9.7	10.5	13.8	15.2	11.9	14.5	14.5
4.7 ≤ E < 4.9	9.5	10.3	13.6	14.9	11.7	14.2	14.2
E ≥ 4.9	9.4	10.1	13.4	14.7	11.5	14.0	14.0
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**57 < Assembly Average Burnup ≤ 58 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**CE 16×16**	**WE 17×17**	**B&W 17×17**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	12.2	13.2	17.0	18.5	14.9	17.8	17.7
3.3 ≤ E < 3.5	11.9	12.8	16.7	18.1	14.5	17.4	17.4
3.5 ≤ E < 3.7	11.6	12.4	16.2	17.7	14.1	17.0	17.0
3.7 ≤ E < 3.9	11.3	12.1	15.9	17.3	13.8	16.7	16.6
3.9 ≤ E < 4.1	11.0	11.9	15.6	17.0	13.5	16.3	16.3
4.1 ≤ E < 4.3	10.7	11.6	15.3	16.7	13.2	16.0	16.0
4.3 ≤ E < 4.5	10.5	11.4	15.0	16.4	12.9	15.7	15.7
4.5 ≤ E < 4.7	10.3	11.2	14.7	16.1	12.7	15.5	15.4
4.7 ≤ E < 4.9	10.0	10.9	14.4	15.8	12.4	15.2	15.2
E ≥ 4.9	9.9	10.8	14.2	15.6	12.2	15.0	14.9

PROPOSED

Table B2-16 Loading Table for PWR Fuel – 911 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	58 < Assembly Average Burnup ≤ 59 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	13.0	14.0	18.0	19.5	15.8	18.8	18.8
3.3 ≤ E < 3.5	12.6	13.6	17.6	19.1	15.4	18.4	18.4
3.5 ≤ E < 3.7	12.2	13.3	17.2	18.7	15.0	18.0	18.0
3.7 ≤ E < 3.9	11.9	12.9	16.9	18.3	14.6	17.7	17.7
3.9 ≤ E < 4.1	11.6	12.6	16.5	18.0	14.3	17.4	17.3
4.1 ≤ E < 4.3	11.4	12.3	16.2	17.7	14.0	17.0	17.0
4.3 ≤ E < 4.5	11.1	12.0	15.9	17.4	13.7	16.7	16.7
4.5 ≤ E < 4.7	10.9	11.8	15.6	17.1	13.5	16.4	16.4
4.7 ≤ E < 4.9	10.7	11.6	15.4	16.8	13.2	16.1	16.1
E ≥ 4.9	10.5	11.4	15.1	16.6	13.0	15.9	15.9

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	59 < Assembly Average Burnup ≤ 60 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	-	-	-	-	-	-	-
3.3 ≤ E < 3.5	13.4	14.4	18.6	20.1	16.3	19.0	19.0
3.5 ≤ E < 3.7	13.0	14.1	18.2	19.7	15.9	18.6	18.5
3.7 ≤ E < 3.9	12.7	13.7	17.8	19.4	15.5	18.2	18.1
3.9 ≤ E < 4.1	12.3	13.4	17.5	19.0	15.2	17.9	17.8
4.1 ≤ E < 4.3	12.0	13.1	17.1	18.7	14.9	17.5	17.5
4.3 ≤ E < 4.5	11.8	12.8	16.8	18.4	14.6	17.2	17.2
4.5 ≤ E < 4.7	11.6	12.6	16.5	18.0	14.3	16.9	16.9
4.7 ≤ E < 4.9	11.3	12.3	16.2	17.8	14.0	16.6	16.6
E ≥ 4.9	11.2	12.1	16.0	17.6	13.8	16.4	16.3

PROPOSED

Table B2-17 Loading Table for PWR Fuel – 1,200 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	30 < Assembly Average Burnup ≤ 32.5 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	4.0	4.0	4.0	4.0	4.0	4.0	4.0
2.3 ≤ E < 2.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0
2.5 ≤ E < 2.7	4.0	4.0	4.0	4.0	4.0	4.0	4.0
2.7 ≤ E < 2.9	4.0	4.0	4.0	4.0	4.0	4.0	4.0
2.9 ≤ E < 3.1	4.0	4.0	4.0	4.0	4.0	4.0	4.0
3.1 ≤ E < 3.3	4.0	4.0	4.0	4.0	4.0	4.0	4.0
3.3 ≤ E < 3.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0
3.5 ≤ E < 3.7	4.0	4.0	4.0	4.0	4.0	4.0	4.0
3.7 ≤ E < 3.9	4.0	4.0	4.0	4.0	4.0	4.0	4.0
3.9 ≤ E < 4.1	4.0	4.0	4.0	4.0	4.0	4.0	4.0
4.1 ≤ E < 4.3	4.0	4.0	4.0	4.0	4.0	4.0	4.0
4.3 ≤ E < 4.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0
4.5 ≤ E < 4.7	4.0	4.0	4.0	4.0	4.0	4.0	4.0
4.7 ≤ E < 4.9	4.0	4.0	4.0	4.0	4.0	4.0	4.0
E ≥ 4.9	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**32.5 < Assembly Average Burnup ≤ 35 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**CE 16×16**	**WE 17×17**	**B&W 17×17**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	4.0	4.0	4.0	4.1	4.0	4.1	4.1
2.5 ≤ E < 2.7	4.0	4.0	4.0	4.1	4.0	4.0	4.0
2.7 ≤ E < 2.9	4.0	4.0	4.0	4.0	4.0	4.0	4.0
2.9 ≤ E < 3.1	4.0	4.0	4.0	4.0	4.0	4.0	4.0
3.1 ≤ E < 3.3	4.0	4.0	4.0	4.0	4.0	4.0	4.0
3.3 ≤ E < 3.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0
3.5 ≤ E < 3.7	4.0	4.0	4.0	4.0	4.0	4.0	4.0
3.7 ≤ E < 3.9	4.0	4.0	4.0	4.0	4.0	4.0	4.0
3.9 ≤ E < 4.1	4.0	4.0	4.0	4.0	4.0	4.0	4.0
4.1 ≤ E < 4.3	4.0	4.0	4.0	4.0	4.0	4.0	4.0
4.3 ≤ E < 4.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0
4.5 ≤ E < 4.7	4.0	4.0	4.0	4.0	4.0	4.0	4.0
4.7 ≤ E < 4.9	4.0	4.0	4.0	4.0	4.0	4.0	4.0
E ≥ 4.9	4.0	4.0	4.0	4.0	4.0	4.0	4.0

PROPOSED

Table B2-17 Loading Table for PWR Fuel – 1,200 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	35 < Assembly Average Burnup ≤ 37.5 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	4.0	4.0	4.3	4.4	4.2	4.4	4.4
2.5 ≤ E < 2.7	4.0	4.0	4.3	4.4	4.1	4.4	4.4
2.7 ≤ E < 2.9	4.0	4.0	4.2	4.3	4.1	4.3	4.3
2.9 ≤ E < 3.1	4.0	4.0	4.2	4.3	4.0	4.3	4.3
3.1 ≤ E < 3.3	4.0	4.0	4.1	4.2	4.0	4.2	4.2
3.3 ≤ E < 3.5	4.0	4.0	4.1	4.2	4.0	4.2	4.2
3.5 ≤ E < 3.7	4.0	4.0	4.0	4.2	4.0	4.2	4.2
3.7 ≤ E < 3.9	4.0	4.0	4.0	4.1	4.0	4.1	4.1
3.9 ≤ E < 4.1	4.0	4.0	4.0	4.1	4.0	4.1	4.1
4.1 ≤ E < 4.3	4.0	4.0	4.0	4.0	4.0	4.0	4.0
4.3 ≤ E < 4.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0
4.5 ≤ E < 4.7	4.0	4.0	4.0	4.0	4.0	4.0	4.0
4.7 ≤ E < 4.9	4.0	4.0	4.0	4.0	4.0	4.0	4.0
E ≥ 4.9	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	37.5 < Assembly Average Burnup ≤ 40 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	4.0	4.1	4.6	4.8	4.4	4.7	4.7
2.7 ≤ E < 2.9	4.0	4.0	4.6	4.7	4.4	4.7	4.7
2.9 ≤ E < 3.1	4.0	4.0	4.5	4.6	4.3	4.6	4.6
3.1 ≤ E < 3.3	4.0	4.0	4.5	4.6	4.3	4.5	4.5
3.3 ≤ E < 3.5	4.0	4.0	4.4	4.5	4.2	4.5	4.5
3.5 ≤ E < 3.7	4.0	4.0	4.4	4.5	4.2	4.5	4.4
3.7 ≤ E < 3.9	4.0	4.0	4.3	4.4	4.1	4.4	4.4
3.9 ≤ E < 4.1	4.0	4.0	4.3	4.4	4.1	4.4	4.4
4.1 ≤ E < 4.3	4.0	4.0	4.2	4.3	4.1	4.3	4.3
4.3 ≤ E < 4.5	4.0	4.0	4.2	4.3	4.0	4.3	4.3
4.5 ≤ E < 4.7	4.0	4.0	4.2	4.3	4.0	4.3	4.3
4.7 ≤ E < 4.9	4.0	4.0	4.1	4.3	4.0	4.3	4.3
E ≥ 4.9	4.0	4.0	4.1	4.2	4.0	4.2	4.2

PROPOSED

Table B2-17 Loading Table for PWR Fuel – 1,200 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	40 < Assembly Average Burnup ≤ 41 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	4.2	4.2	4.8	4.9	4.5	4.9	4.9
2.7 ≤ E < 2.9	4.1	4.2	4.7	4.8	4.5	4.8	4.8
2.9 ≤ E < 3.1	4.0	4.1	4.7	4.8	4.4	4.8	4.7
3.1 ≤ E < 3.3	4.0	4.1	4.6	4.7	4.4	4.7	4.7
3.3 ≤ E < 3.5	4.0	4.0	4.5	4.7	4.4	4.6	4.6
3.5 ≤ E < 3.7	4.0	4.0	4.5	4.6	4.3	4.6	4.6
3.7 ≤ E < 3.9	4.0	4.0	4.4	4.5	4.2	4.5	4.5
3.9 ≤ E < 4.1	4.0	4.0	4.4	4.5	4.2	4.5	4.5
4.1 ≤ E < 4.3	4.0	4.0	4.4	4.5	4.2	4.5	4.5
4.3 ≤ E < 4.5	4.0	4.0	4.3	4.4	4.1	4.4	4.4
4.5 ≤ E < 4.7	4.0	4.0	4.3	4.4	4.1	4.4	4.4
4.7 ≤ E < 4.9	4.0	4.0	4.3	4.4	4.1	4.4	4.4
E ≥ 4.9	4.0	4.0	4.2	4.3	4.0	4.4	4.3

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	41 < Assembly Average Burnup ≤ 42 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	4.3	4.4	4.9	5.1	4.7	5.0	5.0
2.7 ≤ E < 2.9	4.2	4.3	4.9	5.0	4.6	5.0	5.0
2.9 ≤ E < 3.1	4.2	4.2	4.8	4.9	4.6	4.9	4.9
3.1 ≤ E < 3.3	4.1	4.2	4.7	4.9	4.5	4.8	4.8
3.3 ≤ E < 3.5	4.0	4.1	4.7	4.8	4.5	4.8	4.8
3.5 ≤ E < 3.7	4.0	4.1	4.6	4.8	4.4	4.7	4.7
3.7 ≤ E < 3.9	4.0	4.1	4.6	4.7	4.4	4.7	4.7
3.9 ≤ E < 4.1	4.0	4.0	4.5	4.6	4.3	4.6	4.6
4.1 ≤ E < 4.3	4.0	4.0	4.5	4.6	4.3	4.6	4.6
4.3 ≤ E < 4.5	4.0	4.0	4.4	4.6	4.3	4.5	4.5
4.5 ≤ E < 4.7	4.0	4.0	4.4	4.5	4.2	4.5	4.5
4.7 ≤ E < 4.9	4.0	4.0	4.4	4.5	4.2	4.5	4.5
E ≥ 4.9	4.0	4.0	4.3	4.5	4.2	4.5	4.5

PROPOSED

Table B2-17 Loading Table for PWR Fuel – 1,200 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	42 < Assembly Average Burnup ≤ 43 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	4.4	4.5	5.1	5.3	4.9	5.2	5.2
2.7 ≤ E < 2.9	4.4	4.4	5.0	5.2	4.8	5.1	5.1
2.9 ≤ E < 3.1	4.3	4.4	5.0	5.1	4.7	5.0	5.0
3.1 ≤ E < 3.3	4.2	4.3	4.9	5.0	4.7	5.0	5.0
3.3 ≤ E < 3.5	4.2	4.3	4.8	5.0	4.6	4.9	4.9
3.5 ≤ E < 3.7	4.1	4.2	4.8	4.9	4.5	4.9	4.9
3.7 ≤ E < 3.9	4.1	4.2	4.7	4.9	4.5	4.8	4.8
3.9 ≤ E < 4.1	4.0	4.1	4.7	4.8	4.4	4.8	4.8
4.1 ≤ E < 4.3	4.0	4.1	4.6	4.8	4.4	4.7	4.7
4.3 ≤ E < 4.5	4.0	4.0	4.6	4.7	4.4	4.7	4.7
4.5 ≤ E < 4.7	4.0	4.0	4.5	4.7	4.3	4.7	4.6
4.7 ≤ E < 4.9	4.0	4.0	4.5	4.6	4.3	4.6	4.6
E ≥ 4.9	4.0	4.0	4.4	4.6	4.3	4.6	4.5

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	43 < Assembly Average Burnup ≤ 44 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	4.5	4.6	5.3	5.5	5.0	5.4	5.4
2.7 ≤ E < 2.9	4.5	4.6	5.2	5.4	4.9	5.3	5.3
2.9 ≤ E < 3.1	4.4	4.5	5.1	5.3	4.9	5.2	5.2
3.1 ≤ E < 3.3	4.4	4.4	5.0	5.2	4.8	5.2	5.2
3.3 ≤ E < 3.5	4.3	4.4	5.0	5.1	4.7	5.1	5.1
3.5 ≤ E < 3.7	4.2	4.3	4.9	5.1	4.7	5.0	5.0
3.7 ≤ E < 3.9	4.2	4.3	4.9	5.0	4.6	5.0	5.0
3.9 ≤ E < 4.1	4.1	4.3	4.8	5.0	4.6	4.9	4.9
4.1 ≤ E < 4.3	4.1	4.2	4.8	4.9	4.5	4.9	4.9
4.3 ≤ E < 4.5	4.1	4.2	4.7	4.9	4.5	4.8	4.8
4.5 ≤ E < 4.7	4.0	4.2	4.7	4.8	4.5	4.8	4.8
4.7 ≤ E < 4.9	4.0	4.1	4.6	4.8	4.4	4.8	4.7
E ≥ 4.9	4.0	4.1	4.6	4.8	4.4	4.7	4.7

PROPOSED

Table B2-17 Loading Table for PWR Fuel – 1,200 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	44 < Assembly Average Burnup ≤ 45 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	4.6	4.7	5.4	5.6	5.1	5.5	5.5
2.9 ≤ E < 3.1	4.5	4.6	5.3	5.5	5.0	5.4	5.4
3.1 ≤ E < 3.3	4.5	4.6	5.2	5.4	4.9	5.4	5.4
3.3 ≤ E < 3.5	4.4	4.5	5.2	5.4	4.9	5.3	5.3
3.5 ≤ E < 3.7	4.4	4.5	5.1	5.3	4.8	5.2	5.2
3.7 ≤ E < 3.9	4.3	4.4	5.0	5.2	4.8	5.1	5.1
3.9 ≤ E < 4.1	4.3	4.4	5.0	5.1	4.7	5.1	5.1
4.1 ≤ E < 4.3	4.2	4.3	4.9	5.1	4.7	5.0	5.0
4.3 ≤ E < 4.5	4.2	4.3	4.9	5.0	4.6	5.0	5.0
4.5 ≤ E < 4.7	4.1	4.2	4.8	5.0	4.6	4.9	4.9
4.7 ≤ E < 4.9	4.1	4.2	4.8	4.9	4.5	4.9	4.9
E ≥ 4.9	4.0	4.2	4.7	4.9	4.5	4.9	4.8

PROPOSED

Note: **For fuel assembly average burnup greater than 45 GWd/MTU, cool time tables have been revised to account for a 5% margin in heat load.**

Table B2-18 Loading Table for PWR Fuel – 1,140 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	45 < Assembly Average Burnup ≤ 46 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	5.0	5.2	6.0	6.2	5.6	6.0	6.0
2.9 ≤ E < 3.1	5.0	5.1	5.9	6.0	5.5	6.0	6.0
3.1 ≤ E < 3.3	4.9	5.0	5.8	6.0	5.5	5.9	5.9
3.3 ≤ E < 3.5	4.8	4.9	5.7	5.9	5.4	5.8	5.8
3.5 ≤ E < 3.7	4.8	4.9	5.6	5.8	5.3	5.7	5.7
3.7 ≤ E < 3.9	4.7	4.8	5.6	5.8	5.2	5.7	5.7
3.9 ≤ E < 4.1	4.6	4.8	5.5	5.7	5.1	5.6	5.6
4.1 ≤ E < 4.3	4.6	4.7	5.4	5.6	5.1	5.5	5.6
4.3 ≤ E < 4.5	4.5	4.6	5.4	5.6	5.0	5.5	5.5
4.5 ≤ E < 4.7	4.5	4.6	5.3	5.5	5.0	5.4	5.4
4.7 ≤ E < 4.9	4.4	4.6	5.3	5.5	4.9	5.4	5.4
E ≥ 4.9	4.4	4.5	5.2	5.4	4.9	5.4	5.3

PROPOSED

Table B2-18 Loading Table for PWR Fuel – 1,140 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	46 < Assembly Average Burnup ≤ 47 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	5.2	5.4	6.2	6.5	5.8	6.3	6.3
2.9 ≤ E < 3.1	5.1	5.3	6.1	6.4	5.7	6.2	6.2
3.1 ≤ E < 3.3	5.0	5.2	6.0	6.2	5.6	6.1	6.1
3.3 ≤ E < 3.5	5.0	5.1	5.9	6.1	5.6	6.0	6.0
3.5 ≤ E < 3.7	4.9	5.0	5.8	6.0	5.5	5.9	5.9
3.7 ≤ E < 3.9	4.8	5.0	5.8	6.0	5.4	5.9	5.9
3.9 ≤ E < 4.1	4.8	4.9	5.7	5.9	5.3	5.8	5.8
4.1 ≤ E < 4.3	4.7	4.8	5.6	5.8	5.3	5.8	5.7
4.3 ≤ E < 4.5	4.7	4.8	5.6	5.8	5.2	5.7	5.7
4.5 ≤ E < 4.7	4.6	4.7	5.5	5.7	5.2	5.6	5.6
4.7 ≤ E < 4.9	4.6	4.7	5.5	5.7	5.1	5.6	5.6
E ≥ 4.9	4.5	4.7	5.4	5.6	5.0	5.5	5.5

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	47 < Assembly Average Burnup ≤ 48 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	5.4	5.6	6.5	6.8	6.0	6.6	6.6
2.9 ≤ E < 3.1	5.3	5.5	6.4	6.6	5.9	6.5	6.5
3.1 ≤ E < 3.3	5.2	5.4	6.2	6.5	5.8	6.4	6.4
3.3 ≤ E < 3.5	5.1	5.3	6.1	6.4	5.8	6.2	6.2
3.5 ≤ E < 3.7	5.0	5.2	6.0	6.3	5.7	6.2	6.1
3.7 ≤ E < 3.9	5.0	5.1	5.9	6.2	5.6	6.0	6.0
3.9 ≤ E < 4.1	4.9	5.0	5.9	6.1	5.5	6.0	6.0
4.1 ≤ E < 4.3	4.9	5.0	5.8	6.0	5.5	5.9	5.9
4.3 ≤ E < 4.5	4.8	4.9	5.8	6.0	5.4	5.9	5.9
4.5 ≤ E < 4.7	4.8	4.9	5.7	5.9	5.3	5.8	5.8
4.7 ≤ E < 4.9	4.7	4.9	5.7	5.8	5.3	5.8	5.8
E ≥ 4.9	4.7	4.8	5.6	5.8	5.2	5.7	5.7

PROPOSED

Table B2-18 Loading Table for PWR Fuel – 1,140 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	48 < Assembly Average Burnup ≤ 49 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	5.6	5.8	6.8	7.0	6.3	6.9	6.9
2.9 ≤ E < 3.1	5.5	5.7	6.7	6.9	6.1	6.8	6.7
3.1 ≤ E < 3.3	5.4	5.6	6.5	6.8	6.0	6.6	6.6
3.3 ≤ E < 3.5	5.3	5.5	6.4	6.7	5.9	6.5	6.5
3.5 ≤ E < 3.7	5.2	5.4	6.3	6.6	5.9	6.4	6.4
3.7 ≤ E < 3.9	5.2	5.3	6.2	6.5	5.8	6.3	6.3
3.9 ≤ E < 4.1	5.1	5.2	6.1	6.4	5.7	6.2	6.2
4.1 ≤ E < 4.3	5.0	5.2	6.0	6.3	5.7	6.1	6.1
4.3 ≤ E < 4.5	5.0	5.1	5.9	6.2	5.6	6.0	6.0
4.5 ≤ E < 4.7	4.9	5.0	5.9	6.1	5.5	6.0	6.0
4.7 ≤ E < 4.9	4.8	5.0	5.8	6.0	5.5	5.9	5.9
E ≥ 4.9	4.8	4.9	5.8	6.0	5.4	5.9	5.9

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	49 < Assembly Average Burnup ≤ 50 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	5.7	5.8	6.9	7.3	6.4	7.0	7.0
3.1 ≤ E < 3.3	5.6	5.7	6.8	7.1	6.3	6.9	6.9
3.3 ≤ E < 3.5	5.5	5.6	6.7	7.0	6.2	6.8	6.8
3.5 ≤ E < 3.7	5.4	5.5	6.6	6.9	6.0	6.7	6.7
3.7 ≤ E < 3.9	5.4	5.5	6.5	6.8	6.0	6.6	6.6
3.9 ≤ E < 4.1	5.3	5.4	6.4	6.7	5.9	6.5	6.5
4.1 ≤ E < 4.3	5.2	5.3	6.3	6.6	5.8	6.4	6.4
4.3 ≤ E < 4.5	5.1	5.2	6.2	6.5	5.8	6.3	6.3
4.5 ≤ E < 4.7	5.0	5.2	6.1	6.4	5.7	6.2	6.2
4.7 ≤ E < 4.9	5.0	5.1	6.0	6.3	5.7	6.2	6.2
E ≥ 4.9	4.9	5.0	6.0	6.2	5.6	6.1	6.1

PROPOSED

Table B2-18 Loading Table for PWR Fuel – 1,140 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	50 < Assembly Average Burnup ≤ 51 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	5.8	6.0	7.3	7.6	6.7	7.4	7.4
3.1 ≤ E < 3.3	5.8	5.9	7.1	7.5	6.6	7.2	7.2
3.3 ≤ E < 3.5	5.7	5.8	7.0	7.3	6.4	7.1	7.0
3.5 ≤ E < 3.7	5.6	5.7	6.8	7.2	6.3	6.9	6.9
3.7 ≤ E < 3.9	5.5	5.7	6.7	7.0	6.2	6.9	6.8
3.9 ≤ E < 4.1	5.4	5.6	6.6	6.9	6.1	6.8	6.8
4.1 ≤ E < 4.3	5.3	5.5	6.5	6.8	6.0	6.7	6.7
4.3 ≤ E < 4.5	5.2	5.4	6.4	6.8	6.0	6.6	6.6
4.5 ≤ E < 4.7	5.2	5.4	6.4	6.7	5.9	6.5	6.5
4.7 ≤ E < 4.9	5.1	5.3	6.3	6.6	5.8	6.4	6.4
E ≥ 4.9	5.0	5.2	6.2	6.5	5.8	6.4	6.3
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**51 < Assembly Average Burnup ≤ 52 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	6.0	6.3	7.6	7.9	6.9	7.7	7.7
3.1 ≤ E < 3.3	5.9	6.1	7.5	7.7	6.8	7.6	7.6
3.3 ≤ E < 3.5	5.8	6.0	7.3	7.6	6.7	7.4	7.4
3.5 ≤ E < 3.7	5.8	5.9	7.1	7.4	6.6	7.3	7.3
3.7 ≤ E < 3.9	5.7	5.9	7.0	7.3	6.5	7.1	7.1
3.9 ≤ E < 4.1	5.6	5.8	6.9	7.1	6.4	7.0	7.0
4.1 ≤ E < 4.3	5.5	5.7	6.8	7.0	6.3	6.9	6.9
4.3 ≤ E < 4.5	5.4	5.6	6.7	6.9	6.2	6.8	6.8
4.5 ≤ E < 4.7	5.4	5.6	6.6	6.8	6.1	6.8	6.8
4.7 ≤ E < 4.9	5.3	5.5	6.5	6.8	6.0	6.7	6.7
E ≥ 4.9	5.2	5.4	6.5	6.7	6.0	6.6	6.6

PROPOSED

Table B2-18 Loading Table for PWR Fuel – 1,140 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	52 < Assembly Average Burnup ≤ 53 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	6.3	6.5	7.9	8.3	7.3	8.1	8.1
3.1 ≤ E < 3.3	6.2	6.4	7.7	8.1	7.1	7.9	7.9
3.3 ≤ E < 3.5	6.0	6.3	7.5	7.9	7.0	7.8	7.8
3.5 ≤ E < 3.7	5.9	6.1	7.4	7.8	6.9	7.6	7.6
3.7 ≤ E < 3.9	5.8	6.1	7.2	7.6	6.7	7.5	7.5
3.9 ≤ E < 4.1	5.8	6.0	7.1	7.5	6.6	7.4	7.3
4.1 ≤ E < 4.3	5.7	5.9	7.0	7.4	6.5	7.2	7.2
4.3 ≤ E < 4.5	5.6	5.8	6.9	7.2	6.4	7.1	7.1
4.5 ≤ E < 4.7	5.5	5.7	6.8	7.1	6.4	7.0	7.0
4.7 ≤ E < 4.9	5.5	5.7	6.7	7.0	6.3	6.9	6.9
E ≥ 4.9	5.4	5.6	6.6	6.9	6.2	6.9	6.9

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	53 < Assembly Average Burnup ≤ 54 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	6.6	6.8	8.3	8.8	7.6	8.6	8.6
3.1 ≤ E < 3.3	6.4	6.7	8.0	8.6	7.5	8.3	8.3
3.3 ≤ E < 3.5	6.3	6.5	7.9	8.3	7.3	8.2	8.1
3.5 ≤ E < 3.7	6.1	6.4	7.7	8.1	7.1	8.0	8.0
3.7 ≤ E < 3.9	6.0	6.3	7.6	8.0	7.0	7.9	7.8
3.9 ≤ E < 4.1	5.9	6.2	7.4	7.8	6.9	7.7	7.7
4.1 ≤ E < 4.3	5.9	6.1	7.3	7.7	6.8	7.6	7.6
4.3 ≤ E < 4.5	5.8	6.0	7.2	7.6	6.7	7.5	7.5
4.5 ≤ E < 4.7	5.7	5.9	7.0	7.5	6.6	7.4	7.3
4.7 ≤ E < 4.9	5.7	5.9	7.0	7.4	6.5	7.2	7.2
E ≥ 4.9	5.6	5.9	6.9	7.3	6.4	7.1	7.1

PROPOSED

Table B2-18 Loading Table for PWR Fuel – 1,140 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	54 < Assembly Average Burnup ≤ 55 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	6.7	6.9	8.5	9.0	7.8	8.8	8.8
3.3 ≤ E < 3.5	6.6	6.8	8.3	8.8	7.6	8.6	8.6
3.5 ≤ E < 3.7	6.4	6.7	8.1	8.6	7.5	8.4	8.4
3.7 ≤ E < 3.9	6.3	6.6	7.9	8.4	7.3	8.2	8.2
3.9 ≤ E < 4.1	6.2	6.5	7.8	8.2	7.2	8.0	8.0
4.1 ≤ E < 4.3	6.1	6.3	7.6	8.1	7.0	7.9	7.9
4.3 ≤ E < 4.5	6.0	6.2	7.5	7.9	7.0	7.8	7.8
4.5 ≤ E < 4.7	5.9	6.1	7.4	7.8	6.9	7.7	7.7
4.7 ≤ E < 4.9	5.9	6.0	7.3	7.7	6.8	7.6	7.6
E ≥ 4.9	5.8	6.0	7.2	7.6	6.7	7.5	7.5

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	55 < Assembly Average Burnup ≤ 56 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	6.9	7.3	8.9	9.6	8.0	9.3	9.3
3.3 ≤ E < 3.5	6.8	7.1	8.7	9.3	7.8	9.0	9.0
3.5 ≤ E < 3.7	6.7	6.9	8.5	9.1	7.7	8.8	8.9
3.7 ≤ E < 3.9	6.6	6.8	8.3	8.9	7.5	8.7	8.7
3.9 ≤ E < 4.1	6.4	6.7	8.1	8.7	7.4	8.5	8.5
4.1 ≤ E < 4.3	6.3	6.6	8.0	8.5	7.2	8.3	8.3
4.3 ≤ E < 4.5	6.2	6.5	7.9	8.4	7.1	8.2	8.1
4.5 ≤ E < 4.7	6.1	6.4	7.7	8.2	7.0	8.0	8.0
4.7 ≤ E < 4.9	6.0	6.3	7.6	8.1	6.9	7.9	7.9
E ≥ 4.9	6.0	6.2	7.5	8.0	6.8	7.8	7.8

PROPOSED

Table B2-18 Loading Table for PWR Fuel – 1,140 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	56 < Assembly Average Burnup ≤ 57 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	7.3	7.6	9.4	10.1	8.4	9.8	9.8
3.3 ≤ E < 3.5	7.1	7.4	9.2	9.9	8.2	9.6	9.6
3.5 ≤ E < 3.7	6.9	7.3	9.0	9.6	8.0	9.4	9.3
3.7 ≤ E < 3.9	6.8	7.1	8.8	9.4	7.9	9.1	9.1
3.9 ≤ E < 4.1	6.7	7.0	8.6	9.2	7.7	8.9	8.9
4.1 ≤ E < 4.3	6.6	6.9	8.4	9.0	7.6	8.8	8.8
4.3 ≤ E < 4.5	6.5	6.8	8.2	8.8	7.5	8.6	8.6
4.5 ≤ E < 4.7	6.4	6.7	8.1	8.7	7.3	8.5	8.4
4.7 ≤ E < 4.9	6.3	6.6	8.0	8.5	7.2	8.3	8.3
E ≥ 4.9	6.2	6.5	7.8	8.4	7.1	8.2	8.2

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	57 < Assembly Average Burnup ≤ 58 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	7.6	8.0	10.0	10.8	8.9	10.5	10.4
3.3 ≤ E < 3.5	7.4	7.8	9.7	10.5	8.7	10.2	10.1
3.5 ≤ E < 3.7	7.2	7.6	9.5	10.2	8.4	9.9	9.9
3.7 ≤ E < 3.9	7.1	7.5	9.3	9.9	8.2	9.7	9.6
3.9 ≤ E < 4.1	6.9	7.3	9.0	9.7	8.1	9.5	9.4
4.1 ≤ E < 4.3	6.8	7.1	8.8	9.5	7.9	9.2	9.2
4.3 ≤ E < 4.5	6.7	7.0	8.7	9.3	7.8	9.0	9.0
4.5 ≤ E < 4.7	6.6	6.9	8.5	9.1	7.7	8.9	8.9
4.7 ≤ E < 4.9	6.5	6.8	8.4	8.9	7.5	8.7	8.7
E ≥ 4.9	6.4	6.7	8.2	8.8	7.4	8.6	8.6

PROPOSED

Table B2-18 Loading Table for PWR Fuel – 1,140 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	58 < Assembly Average Burnup ≤ 59 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	7.9	8.4	10.7	11.5	9.4	11.1	11.1
3.3 ≤ E < 3.5	7.8	8.2	10.3	11.2	9.1	10.8	10.8
3.5 ≤ E < 3.7	7.6	8.0	10.0	10.9	8.9	10.5	10.5
3.7 ≤ E < 3.9	7.4	7.8	9.8	10.6	8.7	10.2	10.2
3.9 ≤ E < 4.1	7.2	7.6	9.5	10.3	8.5	10.0	9.9
4.1 ≤ E < 4.3	7.1	7.5	9.3	10.0	8.3	9.8	9.7
4.3 ≤ E < 4.5	7.0	7.3	9.1	9.8	8.1	9.6	9.5
4.5 ≤ E < 4.7	6.9	7.2	8.9	9.6	8.0	9.4	9.4
4.7 ≤ E < 4.9	6.8	7.1	8.8	9.5	7.9	9.2	9.2
E ≥ 4.9	6.7	7.0	8.7	9.3	7.8	9.0	9.0

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	59 < Assembly Average Burnup ≤ 60 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	-	-	-	-	-	-	-
3.3 ≤ E < 3.5	8.1	8.6	11.0	11.8	9.6	11.2	11.2
3.5 ≤ E < 3.7	7.9	8.4	10.7	11.5	9.4	10.9	10.8
3.7 ≤ E < 3.9	7.7	8.2	10.3	11.2	9.1	10.6	10.5
3.9 ≤ E < 4.1	7.6	8.0	10.1	11.0	8.9	10.3	10.3
4.1 ≤ E < 4.3	7.4	7.8	9.8	10.7	8.7	10.0	10.0
4.3 ≤ E < 4.5	7.3	7.7	9.6	10.4	8.5	9.8	9.8
4.5 ≤ E < 4.7	7.1	7.6	9.4	10.2	8.4	9.7	9.6
4.7 ≤ E < 4.9	7.0	7.4	9.2	10.0	8.2	9.5	9.4
E ≥ 4.9	6.9	7.3	9.1	9.8	8.1	9.3	9.3

PROPOSED

Table B2-19 Loading Table for PWR Fuel – 922 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	30 < Assembly Average Burnup ≤ 32.5 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	4.2	4.3	4.8	4.9	4.6	4.9	4.9
2.3 ≤ E < 2.5	4.2	4.2	4.7	4.8	4.5	4.8	4.8
2.5 ≤ E < 2.7	4.1	4.2	4.7	4.8	4.5	4.8	4.8
2.7 ≤ E < 2.9	4.1	4.1	4.6	4.7	4.4	4.7	4.7
2.9 ≤ E < 3.1	4.0	4.1	4.6	4.7	4.4	4.7	4.7
3.1 ≤ E < 3.3	4.0	4.0	4.5	4.6	4.3	4.6	4.6
3.3 ≤ E < 3.5	4.0	4.0	4.5	4.6	4.3	4.6	4.6
3.5 ≤ E < 3.7	4.0	4.0	4.5	4.5	4.3	4.5	4.5
3.7 ≤ E < 3.9	4.0	4.0	4.4	4.5	4.2	4.5	4.5
3.9 ≤ E < 4.1	4.0	4.0	4.4	4.5	4.2	4.5	4.5
4.1 ≤ E < 4.3	4.0	4.0	4.4	4.5	4.2	4.4	4.4
4.3 ≤ E < 4.5	4.0	4.0	4.3	4.4	4.2	4.4	4.4
4.5 ≤ E < 4.7	4.0	4.0	4.3	4.4	4.1	4.4	4.4
4.7 ≤ E < 4.9	4.0	4.0	4.3	4.4	4.1	4.4	4.4
E ≥ 4.9	4.0	4.0	4.3	4.4	4.1	4.4	4.4
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**32.5 < Assembly Average Burnup ≤ 35 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**CE 16×16**	**WE 17×17**	**B&W 17×17**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	4.5	4.6	5.2	5.3	4.9	5.3	5.3
2.5 ≤ E < 2.7	4.4	4.5	5.1	5.3	4.9	5.2	5.2
2.7 ≤ E < 2.9	4.4	4.5	5.0	5.2	4.8	5.1	5.1
2.9 ≤ E < 3.1	4.4	4.4	5.0	5.1	4.8	5.1	5.1
3.1 ≤ E < 3.3	4.3	4.4	4.9	5.0	4.7	5.0	5.0
3.3 ≤ E < 3.5	4.3	4.3	4.9	5.0	4.7	5.0	5.0
3.5 ≤ E < 3.7	4.2	4.3	4.8	5.0	4.6	4.9	4.9
3.7 ≤ E < 3.9	4.2	4.3	4.8	4.9	4.6	4.9	4.9
3.9 ≤ E < 4.1	4.1	4.2	4.8	4.9	4.5	4.9	4.9
4.1 ≤ E < 4.3	4.1	4.2	4.7	4.9	4.5	4.8	4.8
4.3 ≤ E < 4.5	4.1	4.2	4.7	4.8	4.5	4.8	4.8
4.5 ≤ E < 4.7	4.0	4.1	4.7	4.8	4.5	4.8	4.8
4.7 ≤ E < 4.9	4.0	4.1	4.6	4.8	4.4	4.7	4.7
E ≥ 4.9	4.0	4.1	4.6	4.7	4.4	4.7	4.7

PROPOSED

Table B2-19 Loading Table for PWR Fuel – 922 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	35 < Assembly Average Burnup ≤ 37.5 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	4.9	5.0	5.7	5.9	5.4	5.8	5.8
2.5 ≤ E < 2.7	4.8	4.9	5.7	5.8	5.3	5.7	5.7
2.7 ≤ E < 2.9	4.8	4.9	5.6	5.8	5.3	5.7	5.7
2.9 ≤ E < 3.1	4.7	4.8	5.5	5.7	5.2	5.6	5.6
3.1 ≤ E < 3.3	4.6	4.7	5.4	5.6	5.1	5.5	5.5
3.3 ≤ E < 3.5	4.6	4.7	5.4	5.6	5.0	5.5	5.5
3.5 ≤ E < 3.7	4.5	4.6	5.3	5.5	5.0	5.4	5.4
3.7 ≤ E < 3.9	4.5	4.6	5.3	5.4	5.0	5.4	5.4
3.9 ≤ E < 4.1	4.5	4.6	5.2	5.4	4.9	5.3	5.3
4.1 ≤ E < 4.3	4.4	4.5	5.2	5.4	4.9	5.3	5.3
4.3 ≤ E < 4.5	4.4	4.5	5.1	5.3	4.9	5.2	5.2
4.5 ≤ E < 4.7	4.4	4.5	5.1	5.3	4.8	5.2	5.2
4.7 ≤ E < 4.9	4.3	4.4	5.0	5.2	4.8	5.2	5.2
E ≥ 4.9	4.3	4.4	5.0	5.2	4.8	5.1	5.1
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**37.5 < Assembly Average Burnup ≤ 40 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**CE 16×16**	**WE 17×17**	**B&W 17×17**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	5.3	5.4	6.2	6.5	5.9	6.3	6.3
2.7 ≤ E < 2.9	5.2	5.3	6.1	6.4	5.8	6.2	6.2
2.9 ≤ E < 3.1	5.1	5.3	6.0	6.3	5.7	6.1	6.1
3.1 ≤ E < 3.3	5.0	5.2	6.0	6.2	5.6	6.0	6.0
3.3 ≤ E < 3.5	5.0	5.1	5.9	6.1	5.6	6.0	6.0
3.5 ≤ E < 3.7	4.9	5.0	5.9	6.0	5.5	5.9	5.9
3.7 ≤ E < 3.9	4.9	5.0	5.8	6.0	5.5	5.9	5.9
3.9 ≤ E < 4.1	4.8	5.0	5.7	5.9	5.4	5.8	5.8
4.1 ≤ E < 4.3	4.8	4.9	5.7	5.9	5.4	5.8	5.8
4.3 ≤ E < 4.5	4.8	4.9	5.7	5.8	5.3	5.8	5.7
4.5 ≤ E < 4.7	4.7	4.8	5.6	5.8	5.3	5.7	5.7
4.7 ≤ E < 4.9	4.7	4.8	5.6	5.8	5.2	5.7	5.7
E ≥ 4.9	4.6	4.8	5.5	5.7	5.2	5.6	5.6

PROPOSED

Table B2-19 Loading Table for PWR Fuel – 922 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	40 < Assembly Average Burnup ≤ 41 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	5.5	5.6	6.6	6.8	6.0	6.6	6.6
2.7 ≤ E < 2.9	5.4	5.6	6.4	6.7	6.0	6.5	6.5
2.9 ≤ E < 3.1	5.3	5.5	6.3	6.6	5.9	6.4	6.4
3.1 ≤ E < 3.3	5.3	5.4	6.2	6.5	5.8	6.3	6.3
3.3 ≤ E < 3.5	5.2	5.3	6.1	6.4	5.8	6.3	6.2
3.5 ≤ E < 3.7	5.1	5.3	6.1	6.3	5.7	6.2	6.2
3.7 ≤ E < 3.9	5.0	5.2	6.0	6.2	5.7	6.1	6.1
3.9 ≤ E < 4.1	5.0	5.1	5.9	6.2	5.6	6.0	6.0
4.1 ≤ E < 4.3	5.0	5.1	5.9	6.1	5.6	6.0	6.0
4.3 ≤ E < 4.5	4.9	5.0	5.9	6.0	5.5	5.9	5.9
4.5 ≤ E < 4.7	4.9	5.0	5.8	6.0	5.5	5.9	5.9
4.7 ≤ E < 4.9	4.8	5.0	5.8	6.0	5.4	5.9	5.9
E ≥ 4.9	4.8	4.9	5.7	5.9	5.4	5.8	5.8

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	41 < Assembly Average Burnup ≤ 42 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	5.7	5.9	6.9	7.1	6.4	6.9	6.9
2.7 ≤ E < 2.9	5.6	5.8	6.7	7.0	6.2	6.8	6.8
2.9 ≤ E < 3.1	5.6	5.7	6.6	6.9	6.1	6.7	6.7
3.1 ≤ E < 3.3	5.5	5.6	6.5	6.8	6.0	6.6	6.6
3.3 ≤ E < 3.5	5.4	5.5	6.4	6.7	6.0	6.6	6.5
3.5 ≤ E < 3.7	5.3	5.5	6.4	6.6	5.9	6.5	6.5
3.7 ≤ E < 3.9	5.3	5.4	6.3	6.6	5.9	6.4	6.4
3.9 ≤ E < 4.1	5.2	5.4	6.2	6.5	5.8	6.3	6.3
4.1 ≤ E < 4.3	5.1	5.3	6.1	6.4	5.8	6.3	6.2
4.3 ≤ E < 4.5	5.1	5.2	6.0	6.3	5.7	6.2	6.2
4.5 ≤ E < 4.7	5.0	5.2	6.0	6.3	5.7	6.1	6.1
4.7 ≤ E < 4.9	5.0	5.1	6.0	6.2	5.6	6.1	6.1
E ≥ 4.9	4.9	5.1	5.9	6.2	5.6	6.0	6.0

PROPOSED

Table B2-19 Loading Table for PWR Fuel – 922 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	42 < Assembly Average Burnup ≤ 43 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	5.9	6.1	7.2	7.5	6.7	7.3	7.3
2.7 ≤ E < 2.9	5.8	6.0	7.0	7.4	6.5	7.1	7.1
2.9 ≤ E < 3.1	5.8	5.9	6.9	7.3	6.4	7.0	7.0
3.1 ≤ E < 3.3	5.7	5.8	6.8	7.1	6.3	6.9	6.9
3.3 ≤ E < 3.5	5.6	5.8	6.7	7.0	6.2	6.8	6.8
3.5 ≤ E < 3.7	5.5	5.7	6.7	6.9	6.1	6.8	6.7
3.7 ≤ E < 3.9	5.5	5.6	6.6	6.8	6.1	6.7	6.7
3.9 ≤ E < 4.1	5.4	5.6	6.5	6.8	6.0	6.6	6.6
4.1 ≤ E < 4.3	5.3	5.5	6.4	6.7	6.0	6.5	6.5
4.3 ≤ E < 4.5	5.3	5.5	6.4	6.6	5.9	6.5	6.5
4.5 ≤ E < 4.7	5.2	5.4	6.3	6.6	5.9	6.4	6.4
4.7 ≤ E < 4.9	5.2	5.3	6.2	6.5	5.8	6.4	6.4
E ≥ 4.9	5.1	5.3	6.2	6.5	5.8	6.3	6.3

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	43 < Assembly Average Burnup ≤ 44 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	6.2	6.4	7.6	8.0	6.9	7.7	7.7
2.7 ≤ E < 2.9	6.0	6.2	7.4	7.8	6.8	7.5	7.5
2.9 ≤ E < 3.1	6.0	6.1	7.3	7.7	6.7	7.4	7.4
3.1 ≤ E < 3.3	5.9	6.0	7.2	7.5	6.6	7.3	7.3
3.3 ≤ E < 3.5	5.8	6.0	7.0	7.4	6.5	7.1	7.1
3.5 ≤ E < 3.7	5.8	5.9	6.9	7.3	6.4	7.0	7.0
3.7 ≤ E < 3.9	5.7	5.8	6.9	7.2	6.3	7.0	7.0
3.9 ≤ E < 4.1	5.6	5.8	6.8	7.1	6.3	6.9	6.9
4.1 ≤ E < 4.3	5.5	5.7	6.7	7.0	6.2	6.8	6.8
4.3 ≤ E < 4.5	5.5	5.7	6.7	6.9	6.1	6.8	6.8
4.5 ≤ E < 4.7	5.4	5.6	6.6	6.9	6.0	6.7	6.7
4.7 ≤ E < 4.9	5.4	5.6	6.5	6.8	6.0	6.6	6.6
E ≥ 4.9	5.3	5.5	6.5	6.8	6.0	6.6	6.6

PROPOSED

Table B2-19 Loading Table for PWR Fuel – 922 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	44 < Assembly Average Burnup ≤ 45 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	6.3	6.6	7.8	8.3	7.1	7.9	7.9
2.9 ≤ E < 3.1	6.2	6.4	7.7	8.1	7.0	7.8	7.8
3.1 ≤ E < 3.3	6.1	6.3	7.6	7.9	6.9	7.7	7.7
3.3 ≤ E < 3.5	6.0	6.2	7.4	7.8	6.8	7.5	7.5
3.5 ≤ E < 3.7	5.9	6.1	7.3	7.7	6.7	7.4	7.4
3.7 ≤ E < 3.9	5.9	6.0	7.2	7.6	6.6	7.3	7.3
3.9 ≤ E < 4.1	5.8	6.0	7.1	7.5	6.6	7.2	7.2
4.1 ≤ E < 4.3	5.7	5.9	7.0	7.4	6.5	7.1	7.1
4.3 ≤ E < 4.5	5.7	5.9	6.9	7.3	6.4	7.0	7.0
4.5 ≤ E < 4.7	5.6	5.8	6.9	7.2	6.3	7.0	7.0
4.7 ≤ E < 4.9	5.6	5.8	6.8	7.1	6.3	6.9	6.9
E ≥ 4.9	5.5	5.7	6.7	7.0	6.2	6.9	6.9

PROPOSED

Note: **For fuel assembly average burnup greater than 45 GWd/MTU, cool time tables have been revised to account for a 5% margin in heat load.**

Table B2-20 Loading Table for PWR Fuel – 876 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	45 < Assembly Average Burnup ≤ 46 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	7.1	7.4	9.2	9.8	8.2	9.3	9.3
2.9 ≤ E < 3.1	7.0	7.3	9.0	9.6	8.0	9.1	9.0
3.1 ≤ E < 3.3	6.9	7.1	8.8	9.4	7.9	8.9	8.9
3.3 ≤ E < 3.5	6.8	7.0	8.6	9.1	7.8	8.7	8.7
3.5 ≤ E < 3.7	6.7	6.9	8.5	9.0	7.6	8.6	8.6
3.7 ≤ E < 3.9	6.6	6.8	8.3	8.9	7.5	8.5	8.4
3.9 ≤ E < 4.1	6.5	6.7	8.2	8.7	7.4	8.3	8.3
4.1 ≤ E < 4.3	6.4	6.6	8.1	8.6	7.3	8.2	8.2
4.3 ≤ E < 4.5	6.3	6.6	8.0	8.5	7.2	8.1	8.1
4.5 ≤ E < 4.7	6.2	6.5	7.9	8.4	7.2	8.0	8.0
4.7 ≤ E < 4.9	6.2	6.4	7.8	8.3	7.1	8.0	7.9
E ≥ 4.9	6.1	6.4	7.7	8.2	7.0	7.9	7.9

PROPOSED

Table B2-20 Loading Table for PWR Fuel – 876 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	46 < Assembly Average Burnup ≤ 47 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	7.5	7.8	9.8	10.5	8.7	9.9	9.9
2.9 ≤ E < 3.1	7.4	7.7	9.6	10.3	8.5	9.7	9.7
3.1 ≤ E < 3.3	7.2	7.5	9.3	10.0	8.3	9.5	9.5
3.3 ≤ E < 3.5	7.1	7.4	9.1	9.8	8.1	9.3	9.3
3.5 ≤ E < 3.7	7.0	7.2	9.0	9.6	8.0	9.1	9.1
3.7 ≤ E < 3.9	6.9	7.1	8.8	9.4	7.9	9.0	8.9
3.9 ≤ E < 4.1	6.8	7.0	8.7	9.3	7.8	8.8	8.8
4.1 ≤ E < 4.3	6.7	6.9	8.6	9.1	7.7	8.7	8.7
4.3 ≤ E < 4.5	6.6	6.9	8.4	9.0	7.6	8.6	8.6
4.5 ≤ E < 4.7	6.5	6.8	8.3	8.9	7.5	8.5	8.5
4.7 ≤ E < 4.9	6.5	6.7	8.2	8.8	7.5	8.4	8.4
E ≥ 4.9	6.4	6.7	8.1	8.7	7.4	8.3	8.3

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	47 < Assembly Average Burnup ≤ 48 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	7.9	8.3	10.5	11.3	9.2	10.7	10.6
2.9 ≤ E < 3.1	7.7	8.1	10.2	11.1	9.0	10.4	10.3
3.1 ≤ E < 3.3	7.6	7.9	10.0	10.8	8.8	10.1	10.1
3.3 ≤ E < 3.5	7.4	7.8	9.7	10.5	8.7	9.9	9.9
3.5 ≤ E < 3.7	7.3	7.6	9.6	10.3	8.5	9.7	9.7
3.7 ≤ E < 3.9	7.2	7.5	9.4	10.1	8.4	9.5	9.5
3.9 ≤ E < 4.1	7.0	7.4	9.2	9.9	8.2	9.4	9.4
4.1 ≤ E < 4.3	7.0	7.3	9.0	9.7	8.1	9.2	9.2
4.3 ≤ E < 4.5	6.9	7.2	8.9	9.6	8.0	9.1	9.1
4.5 ≤ E < 4.7	6.8	7.1	8.8	9.5	7.9	9.0	9.0
4.7 ≤ E < 4.9	6.7	7.0	8.7	9.4	7.8	8.9	8.9
E ≥ 4.9	6.7	6.9	8.6	9.2	7.7	8.8	8.8

PROPOSED

Table B2-20 Loading Table for PWR Fuel – 876 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	48 < Assembly Average Burnup ≤ 49 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	8.4	8.8	11.3	12.1	9.9	11.4	11.4
2.9 ≤ E < 3.1	8.2	8.6	11.0	11.8	9.6	11.1	11.1
3.1 ≤ E < 3.3	8.0	8.4	10.7	11.6	9.4	10.9	10.8
3.3 ≤ E < 3.5	7.8	8.2	10.4	11.3	9.2	10.6	10.6
3.5 ≤ E < 3.7	7.7	8.0	10.2	11.1	9.0	10.4	10.4
3.7 ≤ E < 3.9	7.6	7.9	10.0	10.8	8.8	10.2	10.1
3.9 ≤ E < 4.1	7.4	7.8	9.8	10.6	8.7	10.0	9.9
4.1 ≤ E < 4.3	7.3	7.7	9.7	10.4	8.6	9.8	9.8
4.3 ≤ E < 4.5	7.2	7.6	9.5	10.3	8.4	9.7	9.7
4.5 ≤ E < 4.7	7.1	7.5	9.4	10.1	8.3	9.6	9.5
4.7 ≤ E < 4.9	7.0	7.4	9.2	10.0	8.2	9.4	9.4
E ≥ 4.9	6.9	7.3	9.1	9.8	8.1	9.3	9.3

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	49 < Assembly Average Burnup ≤ 50 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	8.7	8.9	11.8	12.7	10.2	11.9	11.9
3.1 ≤ E < 3.3	8.4	8.7	11.5	12.4	10.0	11.7	11.6
3.3 ≤ E < 3.5	8.2	8.5	11.2	12.1	9.8	11.4	11.4
3.5 ≤ E < 3.7	8.1	8.4	11.0	11.8	9.6	11.2	11.1
3.7 ≤ E < 3.9	7.9	8.2	10.7	11.6	9.4	10.9	10.9
3.9 ≤ E < 4.1	7.8	8.0	10.5	11.4	9.2	10.7	10.7
4.1 ≤ E < 4.3	7.7	7.9	10.3	11.2	9.0	10.5	10.5
4.3 ≤ E < 4.5	7.6	7.8	10.1	11.0	8.9	10.4	10.3
4.5 ≤ E < 4.7	7.5	7.7	9.9	10.9	8.8	10.2	10.1
4.7 ≤ E < 4.9	7.4	7.6	9.8	10.7	8.7	10.0	10.0
E ≥ 4.9	7.3	7.6	9.7	10.5	8.6	9.9	9.9

PROPOSED

Table B2-20 Loading Table for PWR Fuel – 876 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	50 < Assembly Average Burnup ≤ 51 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	8.9	9.5	12.6	13.7	11.0	12.8	12.8
3.1 ≤ E < 3.3	8.7	9.3	12.2	13.3	10.7	12.5	12.4
3.3 ≤ E < 3.5	8.5	9.0	11.9	13.0	10.5	12.1	12.1
3.5 ≤ E < 3.7	8.4	8.8	11.7	12.7	10.2	11.9	11.9
3.7 ≤ E < 3.9	8.2	8.7	11.5	12.4	10.0	11.7	11.6
3.9 ≤ E < 4.1	8.0	8.5	11.2	12.2	9.8	11.5	11.4
4.1 ≤ E < 4.3	7.9	8.4	11.0	11.9	9.6	11.3	11.2
4.3 ≤ E < 4.5	7.8	8.2	10.9	11.8	9.5	11.1	11.0
4.5 ≤ E < 4.7	7.7	8.1	10.7	11.6	9.3	10.9	10.9
4.7 ≤ E < 4.9	7.6	8.0	10.5	11.4	9.2	10.8	10.7
E ≥ 4.9	7.5	7.9	10.4	11.3	9.1	10.6	10.6

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	51 < Assembly Average Burnup ≤ 52 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	9.5	10.1	13.5	14.3	11.7	13.7	13.7
3.1 ≤ E < 3.3	9.2	9.8	13.2	13.9	11.5	13.4	13.4
3.3 ≤ E < 3.5	9.0	9.6	12.8	13.6	11.2	13.1	13.0
3.5 ≤ E < 3.7	8.8	9.4	12.5	13.3	10.9	12.8	12.7
3.7 ≤ E < 3.9	8.7	9.2	12.2	13.0	10.7	12.5	12.4
3.9 ≤ E < 4.1	8.5	9.0	12.0	12.8	10.4	12.2	12.2
4.1 ≤ E < 4.3	8.3	8.9	11.8	12.5	10.2	12.0	11.9
4.3 ≤ E < 4.5	8.2	8.7	11.6	12.3	10.0	11.8	11.8
4.5 ≤ E < 4.7	8.1	8.6	11.4	12.1	9.9	11.6	11.6
4.7 ≤ E < 4.9	8.0	8.5	11.2	11.9	9.8	11.5	11.5
E ≥ 4.9	7.9	8.3	11.1	11.8	9.6	11.3	11.3

PROPOSED

Table B2-20 Loading Table for PWR Fuel – 876 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	52 < Assembly Average Burnup ≤ 53 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	10.1	10.9	14.0	15.3	12.6	14.7	14.7
3.1 ≤ E < 3.3	9.8	10.5	13.7	14.9	12.2	14.3	14.3
3.3 ≤ E < 3.5	9.6	10.2	13.4	14.6	11.9	14.0	13.9
3.5 ≤ E < 3.7	9.3	10.0	13.1	14.2	11.6	13.7	13.6
3.7 ≤ E < 3.9	9.1	9.9	12.8	13.9	11.4	13.4	13.3
3.9 ≤ E < 4.1	8.9	9.6	12.5	13.7	11.2	13.1	13.1
4.1 ≤ E < 4.3	8.8	9.4	12.2	13.4	11.0	12.9	12.8
4.3 ≤ E < 4.5	8.7	9.2	12.0	13.2	10.8	12.6	12.6
4.5 ≤ E < 4.7	8.5	9.0	11.8	13.0	10.6	12.4	12.4
4.7 ≤ E < 4.9	8.4	8.9	11.7	12.8	10.4	12.2	12.2
E ≥ 4.9	8.3	8.8	11.5	12.6	10.2	12.0	12.0
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**53 < Assembly Average Burnup ≤ 54 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**CE 16×16**	**WE 17×17**	**B&W 17×17**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	10.8	11.6	15.1	16.4	13.5	15.7	15.6
3.1 ≤ E < 3.3	10.5	11.3	14.6	15.9	13.1	15.3	15.3
3.3 ≤ E < 3.5	10.1	11.0	14.2	15.6	12.7	14.9	14.9
3.5 ≤ E < 3.7	9.9	10.7	13.9	15.2	12.4	14.6	14.6
3.7 ≤ E < 3.9	9.7	10.4	13.6	14.9	12.1	14.3	14.2
3.9 ≤ E < 4.1	9.5	10.2	13.4	14.6	11.9	14.0	14.0
4.1 ≤ E < 4.3	9.3	9.9	13.1	14.3	11.7	13.7	13.7
4.3 ≤ E < 4.5	9.1	9.8	12.9	14.0	11.5	13.5	13.5
4.5 ≤ E < 4.7	9.0	9.6	12.6	13.8	11.3	13.3	13.3
4.7 ≤ E < 4.9	8.8	9.5	12.4	13.6	11.1	13.1	13.1
E ≥ 4.9	8.7	9.6	12.2	13.4	10.9	12.9	12.9

PROPOSED

Table B2-20 Loading Table for PWR Fuel – 876 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	54 < Assembly Average Burnup ≤ 55 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	11.2	12.0	15.6	17.0	13.9	16.3	16.3
3.3 ≤ E < 3.5	10.9	11.7	15.2	16.6	13.6	15.9	15.9
3.5 ≤ E < 3.7	10.6	11.4	14.9	16.2	13.3	15.6	15.6
3.7 ≤ E < 3.9	10.3	11.2	14.5	15.9	13.0	15.3	15.3
3.9 ≤ E < 4.1	10.0	10.9	14.2	15.6	12.7	15.0	14.9
4.1 ≤ E < 4.3	9.9	10.7	13.9	15.3	12.4	14.7	14.6
4.3 ≤ E < 4.5	9.7	10.5	13.7	15.1	12.2	14.4	14.4
4.5 ≤ E < 4.7	9.5	10.2	13.5	14.8	12.0	14.1	14.1
4.7 ≤ E < 4.9	9.3	10.0	13.3	14.6	11.8	13.9	13.9
E ≥ 4.9	9.2	9.9	13.1	14.3	11.6	13.8	13.7
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**55 < Assembly Average Burnup ≤ 56 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**CE 16×16**	**WE 17×17**	**B&W 17×17**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	11.9	12.8	16.6	18.1	14.5	17.4	17.3
3.3 ≤ E < 3.5	11.5	12.5	16.2	17.6	14.1	17.0	16.9
3.5 ≤ E < 3.7	11.3	12.1	15.8	17.3	13.7	16.6	16.6
3.7 ≤ E < 3.9	11.0	11.8	15.5	17.0	13.4	16.3	16.2
3.9 ≤ E < 4.1	10.7	11.6	15.2	16.6	13.2	15.9	15.9
4.1 ≤ E < 4.3	10.5	11.3	14.9	16.3	12.9	15.7	15.6
4.3 ≤ E < 4.5	10.2	11.1	14.6	16.0	12.6	15.4	15.3
4.5 ≤ E < 4.7	10.0	10.9	14.3	15.8	12.4	15.2	15.1
4.7 ≤ E < 4.9	9.9	10.7	14.1	15.6	12.2	14.9	14.9
E ≥ 4.9	9.7	10.5	13.9	15.3	12.0	14.7	14.6

PROPOSED

Table B2-20 Loading Table for PWR Fuel – 876 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	56 < Assembly Average Burnup ≤ 57 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	12.6	13.6	17.6	19.1	15.5	18.4	18.4
3.3 ≤ E < 3.5	12.3	13.3	17.2	18.7	15.0	18.0	18.0
3.5 ≤ E < 3.7	11.9	13.0	16.8	18.4	14.6	17.7	17.6
3.7 ≤ E < 3.9	11.7	12.6	16.5	18.0	14.3	17.3	17.3
3.9 ≤ E < 4.1	11.4	12.3	16.1	17.7	14.0	17.0	17.0
4.1 ≤ E < 4.3	11.2	12.0	15.8	17.4	13.7	16.7	16.7
4.3 ≤ E < 4.5	10.9	11.8	15.5	17.1	13.5	16.4	16.4
4.5 ≤ E < 4.7	10.7	11.6	15.3	16.8	13.2	16.1	16.1
4.7 ≤ E < 4.9	10.5	11.4	15.1	16.6	13.0	15.8	15.8
E ≥ 4.9	10.3	11.2	14.8	16.3	12.8	15.7	15.6
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**57 < Assembly Average Burnup ≤ 58 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**CE 16×16**	**WE 17×17**	**B&W 17×17**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	13.5	14.5	18.7	20.1	16.4	19.5	19.4
3.3 ≤ E < 3.5	13.1	14.1	18.3	19.8	15.9	19.1	19.0
3.5 ≤ E < 3.7	12.7	13.8	17.9	19.4	15.6	18.7	18.7
3.7 ≤ E < 3.9	12.4	13.4	17.5	19.0	15.3	18.4	18.3
3.9 ≤ E < 4.1	12.1	13.1	17.2	18.7	14.9	18.0	18.0
4.1 ≤ E < 4.3	11.8	12.9	16.9	18.4	14.6	17.7	17.7
4.3 ≤ E < 4.5	11.6	12.6	16.5	18.1	14.3	17.4	17.4
4.5 ≤ E < 4.7	11.4	12.3	16.3	17.8	14.0	17.2	17.1
4.7 ≤ E < 4.9	11.1	12.1	16.0	17.5	13.8	16.9	16.8
E ≥ 4.9	11.0	11.9	15.8	17.3	13.6	16.7	16.6

PROPOSED

Table B2-20 Loading Table for PWR Fuel – 876 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	58 < Assembly Average Burnup ≤ 59 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	14.3	15.4	19.7	21.2	17.4	20.5	20.5
3.3 ≤ E < 3.5	13.9	15.0	19.3	20.8	16.9	20.1	20.1
3.5 ≤ E < 3.7	13.5	14.7	18.9	20.4	16.6	19.8	19.7
3.7 ≤ E < 3.9	13.2	14.3	18.5	20.1	16.1	19.4	19.4
3.9 ≤ E < 4.1	12.9	14.0	18.2	19.7	15.8	19.1	19.0
4.1 ≤ E < 4.3	12.6	13.7	17.8	19.4	15.5	18.8	18.7
4.3 ≤ E < 4.5	12.2	13.4	17.6	19.1	15.2	18.4	18.4
4.5 ≤ E < 4.7	12.0	13.1	17.3	18.9	14.9	18.2	18.1
4.7 ≤ E < 4.9	11.8	12.9	17.0	18.6	14.7	17.9	17.8
E ≥ 4.9	11.6	12.7	16.8	18.4	14.5	17.6	17.6
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**59 < Assembly Average Burnup ≤ 60 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**CE 16×16**	**WE 17×17**	**B&W 17×17**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	-	-	-	-	-	-	-
3.3 ≤ E < 3.5	14.7	15.9	20.2	21.9	17.9	20.7	20.6
3.5 ≤ E < 3.7	14.3	15.6	19.9	21.5	17.5	20.3	20.2
3.7 ≤ E < 3.9	13.9	15.2	19.5	21.1	17.1	19.9	19.9
3.9 ≤ E < 4.1	13.6	14.9	19.2	20.8	16.8	19.6	19.5
4.1 ≤ E < 4.3	13.3	14.5	18.8	20.5	16.4	19.3	19.2
4.3 ≤ E < 4.5	13.1	14.2	18.5	20.2	16.1	18.9	18.9
4.5 ≤ E < 4.7	12.8	13.9	18.2	19.9	15.8	18.7	18.6
4.7 ≤ E < 4.9	12.5	13.7	18.0	19.6	15.6	18.4	18.3
E ≥ 4.9	12.3	13.5	17.7	19.4	15.4	18.2	18.1

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Table B2-21 Loading Table for PWR Fuel – 800 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	30 < Assembly Average Burnup ≤ 32.5 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	4.8	4.9	5.6	5.7	5.2	5.6	5.6
2.3 ≤ E < 2.5	4.7	4.8	5.5	5.7	5.2	5.6	5.6
2.5 ≤ E < 2.7	4.7	4.8	5.4	5.6	5.1	5.5	5.5
2.7 ≤ E < 2.9	4.6	4.7	5.4	5.5	5.0	5.5	5.5
2.9 ≤ E < 3.1	4.6	4.7	5.3	5.5	5.0	5.4	5.4
3.1 ≤ E < 3.3	4.5	4.6	5.3	5.4	5.0	5.3	5.3
3.3 ≤ E < 3.5	4.5	4.6	5.2	5.4	4.9	5.3	5.3
3.5 ≤ E < 3.7	4.5	4.5	5.1	5.3	4.9	5.2	5.2
3.7 ≤ E < 3.9	4.4	4.5	5.1	5.3	4.8	5.2	5.2
3.9 ≤ E < 4.1	4.4	4.5	5.0	5.2	4.8	5.2	5.1
4.1 ≤ E < 4.3	4.4	4.4	5.0	5.2	4.8	5.1	5.1
4.3 ≤ E < 4.5	4.3	4.4	5.0	5.1	4.8	5.1	5.1
4.5 ≤ E < 4.7	4.3	4.4	5.0	5.1	4.7	5.0	5.0
4.7 ≤ E < 4.9	4.3	4.4	4.9	5.1	4.7	5.0	5.0
E ≥ 4.9	4.3	4.3	4.9	5.0	4.7	5.0	5.0
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**32.5 < Assembly Average Burnup ≤ 35 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	5.2	5.3	6.0	6.3	5.7	6.1	6.1
2.5 ≤ E < 2.7	5.1	5.2	6.0	6.2	5.7	6.0	6.0
2.7 ≤ E < 2.9	5.0	5.2	5.9	6.1	5.6	6.0	6.0
2.9 ≤ E < 3.1	5.0	5.1	5.9	6.0	5.5	5.9	5.9
3.1 ≤ E < 3.3	4.9	5.0	5.8	6.0	5.5	5.9	5.9
3.3 ≤ E < 3.5	4.9	5.0	5.8	5.9	5.4	5.8	5.8
3.5 ≤ E < 3.7	4.9	4.9	5.7	5.9	5.4	5.8	5.8
3.7 ≤ E < 3.9	4.8	4.9	5.7	5.8	5.3	5.8	5.8
3.9 ≤ E < 4.1	4.8	4.9	5.6	5.8	5.3	5.7	5.7
4.1 ≤ E < 4.3	4.7	4.8	5.6	5.8	5.2	5.7	5.7
4.3 ≤ E < 4.5	4.7	4.8	5.5	5.7	5.2	5.6	5.6
4.5 ≤ E < 4.7	4.7	4.8	5.5	5.7	5.2	5.6	5.6
4.7 ≤ E < 4.9	4.6	4.7	5.5	5.7	5.1	5.6	5.6
E ≥ 4.9	4.6	4.7	5.4	5.6	5.1	5.5	5.5

PROPOSED

Table B2-21 Loading Table for PWR Fuel – 800 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	35 < Assembly Average Burnup ≤ 37.5 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	5.8	5.9	6.9	7.1	6.4	6.9	6.9
2.5 ≤ E < 2.7	5.7	5.8	6.8	7.0	6.3	6.8	6.8
2.7 ≤ E < 2.9	5.6	5.7	6.7	6.9	6.2	6.7	6.7
2.9 ≤ E < 3.1	5.5	5.7	6.6	6.8	6.1	6.7	6.7
3.1 ≤ E < 3.3	5.5	5.6	6.5	6.8	6.0	6.6	6.6
3.3 ≤ E < 3.5	5.4	5.5	6.4	6.7	6.0	6.5	6.5
3.5 ≤ E < 3.7	5.3	5.5	6.3	6.6	5.9	6.5	6.4
3.7 ≤ E < 3.9	5.3	5.4	6.3	6.5	5.9	6.4	6.4
3.9 ≤ E < 4.1	5.2	5.4	6.2	6.5	5.8	6.3	6.3
4.1 ≤ E < 4.3	5.2	5.3	6.1	6.4	5.8	6.3	6.3
4.3 ≤ E < 4.5	5.1	5.3	6.1	6.4	5.7	6.2	6.2
4.5 ≤ E < 4.7	5.1	5.2	6.0	6.3	5.7	6.2	6.2
4.7 ≤ E < 4.9	5.0	5.2	6.0	6.3	5.7	6.1	6.1
E ≥ 4.9	5.0	5.1	6.0	6.2	5.6	6.1	6.1

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	37.5 < Assembly Average Burnup ≤ 40 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	6.3	6.5	7.7	8.1	7.0	7.8	7.8
2.7 ≤ E < 2.9	6.2	6.4	7.6	8.0	6.9	7.7	7.7
2.9 ≤ E < 3.1	6.1	6.3	7.5	7.8	6.9	7.6	7.6
3.1 ≤ E < 3.3	6.0	6.2	7.4	7.7	6.8	7.4	7.4
3.3 ≤ E < 3.5	5.9	6.1	7.2	7.6	6.7	7.3	7.3
3.5 ≤ E < 3.7	5.9	6.0	7.1	7.5	6.6	7.3	7.2
3.7 ≤ E < 3.9	5.8	6.0	7.1	7.4	6.5	7.2	7.1
3.9 ≤ E < 4.1	5.8	5.9	7.0	7.4	6.5	7.1	7.1
4.1 ≤ E < 4.3	5.7	5.9	6.9	7.3	6.4	7.0	7.0
4.3 ≤ E < 4.5	5.7	5.8	6.9	7.2	6.4	7.0	7.0
4.5 ≤ E < 4.7	5.6	5.8	6.8	7.1	6.3	6.9	6.9
4.7 ≤ E < 4.9	5.6	5.7	6.8	7.1	6.3	6.9	6.9
E ≥ 4.9	5.5	5.7	6.7	7.0	6.2	6.8	6.8

PROPOSED

Table B2-21 Loading Table for PWR Fuel – 800 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	40 < Assembly Average Burnup ≤ 41 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	6.6	6.8	8.2	8.7	7.4	8.3	8.3
2.7 ≤ E < 2.9	6.5	6.7	8.0	8.5	7.3	8.1	8.1
2.9 ≤ E < 3.1	6.4	6.6	7.9	8.3	7.2	8.0	8.0
3.1 ≤ E < 3.3	6.3	6.5	7.8	8.2	7.1	7.9	7.9
3.3 ≤ E < 3.5	6.2	6.4	7.7	8.0	7.0	7.8	7.8
3.5 ≤ E < 3.7	6.1	6.3	7.6	8.0	6.9	7.7	7.7
3.7 ≤ E < 3.9	6.0	6.2	7.5	7.9	6.8	7.6	7.6
3.9 ≤ E < 4.1	6.0	6.1	7.4	7.8	6.8	7.5	7.5
4.1 ≤ E < 4.3	5.9	6.1	7.3	7.7	6.7	7.4	7.4
4.3 ≤ E < 4.5	5.9	6.0	7.2	7.6	6.7	7.4	7.3
4.5 ≤ E < 4.7	5.8	6.0	7.1	7.6	6.6	7.3	7.3
4.7 ≤ E < 4.9	5.8	5.9	7.1	7.5	6.6	7.2	7.2
E ≥ 4.9	5.7	5.9	7.0	7.4	6.5	7.2	7.2
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**41 < Assembly Average Burnup ≤ 42 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**CE 16×16**	**WE 17×17**	**B&W 17×17**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	6.9	7.1	8.7	9.3	7.8	8.8	8.8
2.7 ≤ E < 2.9	6.8	7.0	8.6	9.0	7.7	8.6	8.6
2.9 ≤ E < 3.1	6.7	6.9	8.4	8.9	7.6	8.5	8.5
3.1 ≤ E < 3.3	6.6	6.8	8.2	8.7	7.5	8.3	8.3
3.3 ≤ E < 3.5	6.5	6.7	8.1	8.6	7.3	8.2	8.2
3.5 ≤ E < 3.7	6.4	6.6	8.0	8.5	7.2	8.1	8.1
3.7 ≤ E < 3.9	6.3	6.5	7.9	8.3	7.1	8.0	8.0
3.9 ≤ E < 4.1	6.2	6.5	7.8	8.2	7.1	7.9	7.9
4.1 ≤ E < 4.3	6.1	6.4	7.7	8.1	7.0	7.8	7.8
4.3 ≤ E < 4.5	6.1	6.3	7.6	8.0	6.9	7.8	7.7
4.5 ≤ E < 4.7	6.0	6.3	7.6	8.0	6.9	7.7	7.7
4.7 ≤ E < 4.9	6.0	6.2	7.5	7.9	6.8	7.6	7.6
E ≥ 4.9	5.9	6.1	7.4	7.8	6.8	7.6	7.6

PROPOSED

Table B2-21 Loading Table for PWR Fuel – 800 W/Assembly (continued)

Mimimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	42 < Assembly Average Burnup ≤ 43 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	7.3	7.5	9.3	9.9	8.3	9.4	9.4
2.7 ≤ E < 2.9	7.1	7.4	9.1	9.7	8.1	9.2	9.2
2.9 ≤ E < 3.1	7.0	7.2	8.9	9.5	8.0	9.0	9.0
3.1 ≤ E < 3.3	6.9	7.1	8.8	9.3	7.9	8.9	8.8
3.3 ≤ E < 3.5	6.8	7.0	8.6	9.2	7.8	8.7	8.7
3.5 ≤ E < 3.7	6.7	6.9	8.5	9.0	7.7	8.6	8.6
3.7 ≤ E < 3.9	6.6	6.8	8.4	8.9	7.6	8.5	8.5
3.9 ≤ E < 4.1	6.5	6.8	8.2	8.8	7.5	8.4	8.4
4.1 ≤ E < 4.3	6.5	6.7	8.1	8.7	7.4	8.3	8.3
4.3 ≤ E < 4.5	6.4	6.6	8.0	8.6	7.3	8.2	8.2
4.5 ≤ E < 4.7	6.3	6.6	8.0	8.5	7.2	8.1	8.1
4.7 ≤ E < 4.9	6.2	6.5	7.9	8.4	7.2	8.0	8.0
E ≥ 4.9	6.2	6.4	7.8	8.3	7.1	8.0	8.0
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**43 < Assembly Average Burnup ≤ 44 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**CE 16×16**	**WE 17×17**	**B&W 17×17**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	7.7	8.0	10.0	10.8	8.8	10.0	10.1
2.7 ≤ E < 2.9	7.5	7.8	9.7	10.5	8.7	9.9	9.8
2.9 ≤ E < 3.1	7.4	7.7	9.5	10.2	8.5	9.7	9.6
3.1 ≤ E < 3.3	7.2	7.5	9.3	10.0	8.3	9.5	9.4
3.3 ≤ E < 3.5	7.1	7.4	9.2	9.8	8.2	9.3	9.3
3.5 ≤ E < 3.7	7.1	7.3	9.0	9.7	8.0	9.1	9.1
3.7 ≤ E < 3.9	6.9	7.2	8.9	9.5	8.0	9.0	9.0
3.9 ≤ E < 4.1	6.8	7.1	8.8	9.4	7.9	8.9	8.9
4.1 ≤ E < 4.3	6.7	7.0	8.7	9.2	7.8	8.8	8.8
4.3 ≤ E < 4.5	6.7	6.9	8.5	9.1	7.7	8.7	8.7
4.5 ≤ E < 4.7	6.6	6.9	8.5	9.0	7.6	8.6	8.6
4.7 ≤ E < 4.9	6.6	6.8	8.4	8.9	7.6	8.5	8.5
E ≥ 4.9	6.5	6.8	8.3	8.9	7.5	8.5	8.4

PROPOSED

Table B2-21 Loading Table for PWR Fuel – 800 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	44 < Assembly Average Burnup ≤ 45 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	7.9	8.2	10.5	11.4	9.2	10.6	10.6
2.9 ≤ E < 3.1	7.8	8.1	10.2	11.1	9.0	10.4	10.4
3.1 ≤ E < 3.3	7.6	7.9	10.0	10.8	8.8	10.1	10.1
3.3 ≤ E < 3.5	7.5	7.8	9.8	10.6	8.7	9.9	9.9
3.5 ≤ E < 3.7	7.3	7.7	9.6	10.4	8.6	9.8	9.8
3.7 ≤ E < 3.9	7.2	7.6	9.5	10.2	8.4	9.6	9.6
3.9 ≤ E < 4.1	7.1	7.5	9.3	10.0	8.3	9.5	9.5
4.1 ≤ E < 4.3	7.0	7.4	9.2	9.9	8.2	9.4	9.3
4.3 ≤ E < 4.5	7.0	7.3	9.1	9.8	8.1	9.2	9.2
4.5 ≤ E < 4.7	6.9	7.2	9.0	9.7	8.0	9.1	9.1
4.7 ≤ E < 4.9	6.8	7.1	8.9	9.6	7.9	9.0	9.0
E ≥ 4.9	6.8	7.0	8.8	9.5	7.9	9.0	8.9

PROPOSED

Note: **For fuel assembly average burnup greater than 45 GWd/MTU, cool time tables have been revised to account for a 5% margin in heat load.**

Table B2-22 Loading Table for PWR Fuel – 760 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	45 < Assembly Average Burnup ≤ 46 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	9.2	9.8	12.8	13.9	11.2	13.0	13.0
2.9 ≤ E < 3.1	9.0	9.6	12.5	13.6	10.9	12.7	12.7
3.1 ≤ E < 3.3	8.9	9.4	12.1	13.3	10.6	12.4	12.4
3.3 ≤ E < 3.5	8.7	9.1	11.9	13.0	10.4	12.1	12.1
3.5 ≤ E < 3.7	8.6	9.0	11.8	12.8	10.2	11.9	11.9
3.7 ≤ E < 3.9	8.4	8.8	11.6	12.5	10.0	11.8	11.7
3.9 ≤ E < 4.1	8.3	8.7	11.4	12.3	9.9	11.6	11.5
4.1 ≤ E < 4.3	8.1	8.6	11.2	12.2	9.7	11.4	11.4
4.3 ≤ E < 4.5	8.0	8.5	11.1	12.0	9.6	11.3	11.3
4.5 ≤ E < 4.7	7.9	8.4	10.9	11.9	9.5	11.2	11.1
4.7 ≤ E < 4.9	7.9	8.3	10.8	11.7	9.4	11.0	11.0
E ≥ 4.9	7.8	8.2	10.7	11.6	9.3	10.9	10.9

PROPOSED

Table B2-22 Loading Table for PWR Fuel – 760 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	46 < Assembly Average Burnup ≤ 47 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	9.9	10.6	13.8	15.0	12.0	13.9	13.9
2.9 ≤ E < 3.1	9.7	10.3	13.5	14.7	11.7	13.7	13.7
3.1 ≤ E < 3.3	9.4	10.0	13.2	14.4	11.4	13.4	13.4
3.3 ≤ E < 3.5	9.2	9.8	12.9	14.0	11.2	13.1	13.1
3.5 ≤ E < 3.7	9.0	9.6	12.7	13.8	11.0	12.9	12.8
3.7 ≤ E < 3.9	8.9	9.4	12.4	13.6	10.8	12.6	12.6
3.9 ≤ E < 4.1	8.8	9.3	12.2	13.4	10.6	12.5	12.4
4.1 ≤ E < 4.3	8.6	9.1	12.0	13.2	10.4	12.2	12.2
4.3 ≤ E < 4.5	8.5	9.0	11.8	13.0	10.3	12.1	12.0
4.5 ≤ E < 4.7	8.4	8.9	11.7	12.8	10.1	11.9	11.9
4.7 ≤ E < 4.9	8.3	8.8	11.6	12.7	10.0	11.8	11.8
E ≥ 4.9	8.2	8.7	11.5	12.5	9.9	11.7	11.7
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**47 < Assembly Average Burnup ≤ 48 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**CE 16×16**	**WE 17×17**	**B&W 17×17**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	10.6	11.4	14.9	16.1	12.9	15.1	15.1
2.9 ≤ E < 3.1	10.4	11.1	14.5	15.8	12.5	14.7	14.7
3.1 ≤ E < 3.3	10.0	10.8	14.1	15.5	12.2	14.4	14.4
3.3 ≤ E < 3.5	9.9	10.5	13.9	15.2	12.0	14.1	14.0
3.5 ≤ E < 3.7	9.6	10.3	13.6	14.9	11.8	13.8	13.8
3.7 ≤ E < 3.9	9.5	10.1	13.4	14.6	11.6	13.6	13.6
3.9 ≤ E < 4.1	9.3	9.9	13.2	14.4	11.4	13.4	13.4
4.1 ≤ E < 4.3	9.1	9.8	13.0	14.1	11.2	13.2	13.2
4.3 ≤ E < 4.5	9.0	9.6	12.8	14.0	11.1	13.0	13.0
4.5 ≤ E < 4.7	8.9	9.5	12.6	13.8	10.9	12.9	12.8
4.7 ≤ E < 4.9	8.8	9.3	12.4	13.6	10.8	12.7	12.7
E ≥ 4.9	8.7	9.2	12.3	13.5	10.7	12.5	12.5

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Table B2-22 Loading Table for PWR Fuel – 760 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	48 < Assembly Average Burnup ≤ 49 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	11.4	12.2	16.0	17.3	13.9	16.2	16.2
2.9 ≤ E < 3.1	11.1	11.8	15.6	17.0	13.5	15.8	15.8
3.1 ≤ E < 3.3	10.8	11.6	15.3	16.6	13.2	15.5	15.5
3.3 ≤ E < 3.5	10.6	11.3	14.9	16.3	12.9	15.2	15.2
3.5 ≤ E < 3.7	10.3	11.1	14.7	16.0	12.7	14.9	14.9
3.7 ≤ E < 3.9	10.1	10.9	14.4	15.7	12.4	14.6	14.6
3.9 ≤ E < 4.1	9.9	10.7	14.1	15.5	12.1	14.4	14.4
4.1 ≤ E < 4.3	9.7	10.4	13.9	15.2	12.0	14.1	14.1
4.3 ≤ E < 4.5	9.6	10.2	13.7	15.0	11.8	13.9	13.9
4.5 ≤ E < 4.7	9.5	10.1	13.5	14.9	11.7	13.8	13.8
4.7 ≤ E < 4.9	9.3	9.9	13.4	14.6	11.5	13.6	13.6
E ≥ 4.9	9.2	9.8	13.2	14.5	11.4	13.5	13.5

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	49 < Assembly Average Burnup ≤ 50 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	11.9	12.4	16.8	18.2	14.5	17.0	17.0
3.1 ≤ E < 3.3	11.6	12.1	16.4	17.8	14.1	16.6	16.6
3.3 ≤ E < 3.5	11.3	11.8	16.0	17.5	13.8	16.3	16.2
3.5 ≤ E < 3.7	11.1	11.6	15.7	17.2	13.6	16.0	16.0
3.7 ≤ E < 3.9	10.8	11.4	15.5	16.9	13.3	15.7	15.7
3.9 ≤ E < 4.1	10.6	11.2	15.2	16.6	13.1	15.5	15.5
4.1 ≤ E < 4.3	10.4	11.0	14.9	16.3	12.9	15.3	15.2
4.3 ≤ E < 4.5	10.2	10.8	14.7	16.1	12.7	15.0	15.0
4.5 ≤ E < 4.7	10.1	10.6	14.5	15.9	12.5	14.9	14.8
4.7 ≤ E < 4.9	9.9	10.5	14.3	15.7	12.3	14.6	14.6
E ≥ 4.9	9.8	10.3	14.1	15.5	12.2	14.5	14.5

PROPOSED

Table B2-22 Loading Table for PWR Fuel – 760 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	50 < Assembly Average Burnup ≤ 51 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	12.4	13.4	17.8	19.3	15.6	18.1	18.1
3.1 ≤ E < 3.3	12.1	13.1	17.5	19.0	15.2	17.8	17.8
3.3 ≤ E < 3.5	11.8	12.7	17.2	18.7	14.9	17.4	17.4
3.5 ≤ E < 3.7	11.5	12.4	16.8	18.3	14.5	17.2	17.1
3.7 ≤ E < 3.9	11.3	12.1	16.5	18.0	14.3	16.9	16.8
3.9 ≤ E < 4.1	11.1	11.9	16.2	17.7	14.0	16.6	16.5
4.1 ≤ E < 4.3	10.9	11.7	16.0	17.5	13.8	16.3	16.3
4.3 ≤ E < 4.5	10.7	11.5	15.8	17.3	13.6	16.1	16.0
4.5 ≤ E < 4.7	10.5	11.4	15.5	17.1	13.4	15.8	15.9
4.7 ≤ E < 4.9	10.4	11.2	15.3	16.8	13.2	15.7	15.7
E ≥ 4.9	10.2	11.1	15.2	16.7	13.1	15.5	15.5
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**51 < Assembly Average Burnup ≤ 52 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	13.3	14.3	19.0	20.1	16.7	19.4	19.3
3.1 ≤ E < 3.3	12.9	14.0	18.6	19.7	16.3	19.0	18.9
3.3 ≤ E < 3.5	12.6	13.6	18.2	19.4	15.9	18.6	18.6
3.5 ≤ E < 3.7	12.3	13.3	17.9	19.1	15.6	18.3	18.3
3.7 ≤ E < 3.9	12.0	13.1	17.6	18.8	15.3	18.0	17.9
3.9 ≤ E < 4.1	11.8	12.8	17.4	18.5	15.0	17.7	17.7
4.1 ≤ E < 4.3	11.6	12.5	17.1	18.2	14.8	17.5	17.4
4.3 ≤ E < 4.5	11.4	12.3	16.8	18.0	14.5	17.3	17.2
4.5 ≤ E < 4.7	11.2	12.1	16.6	17.7	14.4	17.0	17.0
4.7 ≤ E < 4.9	11.1	11.9	16.4	17.5	14.1	16.8	16.8
E ≥ 4.9	10.9	11.8	16.2	17.4	13.9	16.6	16.5

PROPOSED

Table B2-22 Loading Table for PWR Fuel – 760 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	52 < Assembly Average Burnup ≤ 53 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	14.2	15.3	19.7	21.3	17.8	20.5	20.5
3.1 ≤ E < 3.3	13.8	15.0	19.3	20.9	17.4	20.1	20.1
3.3 ≤ E < 3.5	13.5	14.6	18.9	20.6	17.1	19.8	19.7
3.5 ≤ E < 3.7	13.1	14.3	18.6	20.3	16.7	19.5	19.4
3.7 ≤ E < 3.9	12.9	14.2	18.3	19.9	16.4	19.2	19.1
3.9 ≤ E < 4.1	12.6	13.7	18.0	19.6	16.0	18.9	18.8
4.1 ≤ E < 4.3	12.3	13.5	17.7	19.4	15.8	18.6	18.5
4.3 ≤ E < 4.5	12.1	13.2	17.5	19.1	15.6	18.4	18.3
4.5 ≤ E < 4.7	11.9	13.0	17.3	18.8	15.3	18.2	18.1
4.7 ≤ E < 4.9	11.8	12.8	17.0	18.7	15.2	17.9	17.8
E ≥ 4.9	11.6	12.6	16.9	18.5	14.9	17.7	17.7
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**53 < Assembly Average Burnup ≤ 54 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**CE 16×16**	**WE 17×17**	**B&W 17×17**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	15.2	16.4	20.9	22.5	18.9	21.7	21.6
3.1 ≤ E < 3.3	14.8	16.0	20.4	22.1	18.5	21.3	21.3
3.3 ≤ E < 3.5	14.4	15.6	20.0	21.8	18.1	21.0	20.9
3.5 ≤ E < 3.7	14.0	15.2	19.7	21.4	17.7	20.6	20.6
3.7 ≤ E < 3.9	13.7	14.9	19.4	21.1	17.4	20.3	20.3
3.9 ≤ E < 4.1	13.4	14.6	19.1	20.8	17.2	20.1	20.0
4.1 ≤ E < 4.3	13.2	14.4	18.9	20.5	16.9	19.8	19.7
4.3 ≤ E < 4.5	12.9	14.1	18.6	20.3	16.6	19.5	19.5
4.5 ≤ E < 4.7	12.7	13.9	18.3	20.1	16.4	19.3	19.2
4.7 ≤ E < 4.9	12.5	13.6	18.1	19.8	16.1	19.0	19.0
E ≥ 4.9	12.4	13.9	17.9	19.6	15.9	18.8	18.8

PROPOSED

Table B2-22 Loading Table for PWR Fuel – 760 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	54 < Assembly Average Burnup ≤ 55 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	15.7	17.1	21.6	23.2	19.6	22.5	22.4
3.3 ≤ E < 3.5	15.4	17.7	21.2	22.9	19.2	22.1	22.1
3.5 ≤ E < 3.7	15.0	16.3	20.9	22.6	18.9	21.8	21.8
3.7 ≤ E < 3.9	14.6	16.0	20.6	22.2	18.5	21.5	21.5
3.9 ≤ E < 4.1	14.4	15.7	20.2	21.9	18.3	21.2	21.2
4.1 ≤ E < 4.3	14.1	15.4	19.9	21.7	18.0	20.9	20.9
4.3 ≤ E < 4.5	13.8	15.1	19.7	21.4	17.7	20.7	20.6
4.5 ≤ E < 4.7	13.6	14.9	19.4	21.2	17.5	20.5	20.4
4.7 ≤ E < 4.9	13.4	14.6	19.2	21.0	17.2	20.2	20.1
E ≥ 4.9	13.2	14.4	19.0	20.7	17.0	19.9	19.9
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**55 < Assembly Average Burnup ≤ 56 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	16.8	18.1	22.7	24.4	20.2	23.6	23.6
3.3 ≤ E < 3.5	16.3	17.7	22.4	24.1	19.8	23.3	23.3
3.5 ≤ E < 3.7	15.9	17.3	21.9	23.7	19.5	23.0	22.9
3.7 ≤ E < 3.9	15.6	17.0	21.7	23.4	19.2	22.6	22.6
3.9 ≤ E < 4.1	15.3	16.7	21.4	23.1	18.8	22.4	22.3
4.1 ≤ E < 4.3	15.0	16.4	21.0	22.9	18.5	22.1	22.0
4.3 ≤ E < 4.5	14.8	16.1	20.8	22.6	18.3	21.8	21.8
4.5 ≤ E < 4.7	14.5	15.8	20.5	22.4	17.9	21.6	21.5
4.7 ≤ E < 4.9	14.3	15.6	20.3	22.2	17.8	21.3	21.3
E ≥ 4.9	14.0	15.4	20.0	21.9	17.6	21.1	21.1

PROPOSED

Table B2-22 Loading Table for PWR Fuel – 760 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	56 < Assembly Average Burnup ≤ 57 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	17.7	19.2	23.8	25.6	21.3	24.7	24.7
3.3 ≤ E < 3.5	17.3	18.8	23.4	25.2	20.9	24.4	24.4
3.5 ≤ E < 3.7	16.9	18.4	23.1	24.9	20.5	24.0	24.0
3.7 ≤ E < 3.9	16.6	18.1	22.7	24.6	20.2	23.7	23.7
3.9 ≤ E < 4.1	16.2	17.7	22.4	24.3	19.9	23.5	23.5
4.1 ≤ E < 4.3	15.9	17.4	22.2	24.0	19.6	23.2	23.2
4.3 ≤ E < 4.5	15.7	17.1	21.9	23.8	19.3	23.0	22.9
4.5 ≤ E < 4.7	15.4	16.8	21.6	23.5	19.1	22.7	22.6
4.7 ≤ E < 4.9	15.2	16.6	21.4	23.3	18.8	22.5	22.4
E ≥ 4.9	15.0	16.4	21.2	23.0	18.6	22.2	22.2
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**57 < Assembly Average Burnup ≤ 58 GWd/MTU Minimum Cooling Time (years)**						
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**CE 16×16**	**WE 17×17**	**B&W 17×17**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	18.8	20.2	24.9	26.7	22.3	25.8	25.8
3.3 ≤ E < 3.5	18.3	19.9	24.6	26.3	22.0	25.5	25.5
3.5 ≤ E < 3.7	17.9	19.5	24.2	26.0	21.6	25.2	25.2
3.7 ≤ E < 3.9	17.6	19.1	23.9	25.7	21.3	24.9	24.8
3.9 ≤ E < 4.1	17.3	18.8	23.6	25.4	20.9	24.6	24.6
4.1 ≤ E < 4.3	16.9	18.4	23.3	25.1	20.6	24.4	24.3
4.3 ≤ E < 4.5	16.6	18.1	23.0	24.9	20.4	24.1	24.0
4.5 ≤ E < 4.7	16.3	17.9	22.8	24.6	20.0	23.8	23.8
4.7 ≤ E < 4.9	16.1	17.6	22.5	24.4	19.9	23.6	23.6
E ≥ 4.9	15.8	17.4	22.3	24.2	19.7	23.4	23.3

PROPOSED

Table B2-22 Loading Table for PWR Fuel – 760 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	58 < Assembly Average Burnup ≤ 59 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	19.8	21.3	25.9	27.7	23.4	26.9	26.9
3.3 ≤ E < 3.5	19.3	20.9	25.6	27.4	23.0	26.7	26.6
3.5 ≤ E < 3.7	18.9	20.5	25.3	27.1	22.7	26.3	26.2
3.7 ≤ E < 3.9	18.6	20.2	24.9	26.8	22.3	26.0	25.9
3.9 ≤ E < 4.1	18.2	19.8	24.6	26.5	22.0	25.7	25.7
4.1 ≤ E < 4.3	17.9	19.5	24.3	26.2	21.7	25.5	25.4
4.3 ≤ E < 4.5	17.6	19.2	24.1	26.0	21.4	25.2	25.2
4.5 ≤ E < 4.7	17.3	18.9	23.9	25.8	21.2	25.0	24.9
4.7 ≤ E < 4.9	17.1	18.7	23.6	25.5	20.9	24.7	24.7
E ≥ 4.9	16.8	18.4	23.4	25.3	20.7	24.5	24.4

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	59 < Assembly Average Burnup ≤ 60 GWd/MTU Minimum Cooling Time (years)						
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	CE 16×16	WE 17×17	B&W 17×17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	-	-	-	-	-	-	-
3.3 ≤ E < 3.5	20.3	22.0	26.7	28.4	24.1	27.2	27.1
3.5 ≤ E < 3.7	20.0	21.5	26.4	28.1	23.7	26.8	26.7
3.7 ≤ E < 3.9	19.6	21.2	26.0	27.8	23.4	26.5	26.5
3.9 ≤ E < 4.1	19.3	20.8	25.7	27.6	23.1	26.2	26.2
4.1 ≤ E < 4.3	18.9	20.5	25.4	27.3	22.7	26.0	25.9
4.3 ≤ E < 4.5	18.6	20.2	25.2	27.1	22.5	25.7	25.6
4.5 ≤ E < 4.7	18.3	20.0	24.9	26.8	22.2	25.5	25.4
4.7 ≤ E < 4.9	18.0	19.7	24.7	26.6	22.0	25.2	25.2
E ≥ 4.9	17.7	19.5	24.4	26.4	21.7	25.0	24.9

PROPOSED

Table B2-23 Loading Table for BWR Fuel – 379 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	30 < Assembly Average Burnup ≤ 32.5 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	4.3	4.6	4.0	4.5	4.0	4.5	4.4
2.3 ≤ E < 2.5	4.2	4.6	4.0	4.5	4.0	4.4	4.4
2.5 ≤ E < 2.7	4.2	4.5	4.0	4.4	4.0	4.4	4.3
2.7 ≤ E < 2.9	4.1	4.5	4.0	4.4	4.0	4.3	4.3
2.9 ≤ E < 3.1	4.1	4.4	4.0	4.3	4.0	4.3	4.2
3.1 ≤ E < 3.3	4.0	4.4	4.0	4.3	4.0	4.2	4.2
3.3 ≤ E < 3.5	4.0	4.3	4.0	4.2	4.0	4.2	4.1
3.5 ≤ E < 3.7	4.0	4.3	4.0	4.2	4.0	4.2	4.1
3.7 ≤ E < 3.9	4.0	4.3	4.0	4.2	4.0	4.1	4.0
3.9 ≤ E < 4.1	4.0	4.2	4.0	4.1	4.0	4.1	4.0
4.1 ≤ E < 4.3	4.0	4.2	4.0	4.1	4.0	4.1	4.0
4.3 ≤ E < 4.5	4.0	4.2	4.0	4.1	4.0	4.0	4.0
4.5 ≤ E < 4.7	4.0	4.1	4.0	4.0	4.0	4.0	4.0
4.7 ≤ E < 4.9	4.0	4.1	4.0	4.0	4.0	4.0	4.0
E ≥ 4.9	4.0	4.1	4.0	4.0	4.0	4.0	4.0
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**32.5 < Assembly Average Burnup ≤ 35 GWd/MTU Minimum Cooling Time (years)**						
	BWR/2-3 7×7	**BWR/4-6 7×7**	**BWR/2-3 8×8**	**BWR/4-6 8×8**	**BWR/2-3 9×9**	**BWR/4-6 9×9**	**BWR/4-6 10×10**
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	4.7	5.0	4.3	4.9	4.0	4.9	4.8
2.5 ≤ E < 2.7	4.6	4.9	4.3	4.8	4.0	4.8	4.7
2.7 ≤ E < 2.9	4.5	4.9	4.2	4.8	4.0	4.7	4.6
2.9 ≤ E < 3.1	4.5	4.8	4.2	4.7	4.0	4.7	4.6
3.1 ≤ E < 3.3	4.4	4.8	4.1	4.7	4.0	4.6	4.5
3.3 ≤ E < 3.5	4.4	4.7	4.0	4.6	4.0	4.6	4.5
3.5 ≤ E < 3.7	4.3	4.7	4.0	4.6	4.0	4.5	4.5
3.7 ≤ E < 3.9	4.3	4.6	4.0	4.5	4.0	4.5	4.4
3.9 ≤ E < 4.1	4.2	4.6	4.0	4.5	4.0	4.5	4.4
4.1 ≤ E < 4.3	4.2	4.5	4.0	4.5	4.0	4.4	4.3
4.3 ≤ E < 4.5	4.2	4.5	4.0	4.4	4.0	4.4	4.3
4.5 ≤ E < 4.7	4.1	4.5	4.0	4.4	4.0	4.4	4.3
4.7 ≤ E < 4.9	4.1	4.5	4.0	4.4	4.0	4.3	4.2
E ≥ 4.9	4.1	4.4	4.0	4.3	4.0	4.3	4.2

PROPOSED

Table B2-23 Loading Table for BWR Fuel – 379 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	35 < Assembly Average Burnup ≤ 37.5 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	5.2	5.6	4.7	5.4	4.4	5.4	5.2
2.5 ≤ E < 2.7	5.1	5.5	4.7	5.3	4.3	5.3	5.2
2.7 ≤ E < 2.9	5.0	5.4	4.6	5.3	4.3	5.2	5.1
2.9 ≤ E < 3.1	4.9	5.4	4.5	5.2	4.2	5.1	5.0
3.1 ≤ E < 3.3	4.9	5.3	4.5	5.1	4.1	5.1	4.9
3.3 ≤ E < 3.5	4.8	5.2	4.4	5.0	4.1	5.0	4.9
3.5 ≤ E < 3.7	4.8	5.1	4.4	5.0	4.0	4.9	4.8
3.7 ≤ E < 3.9	4.7	5.1	4.3	4.9	4.0	4.9	4.8
3.9 ≤ E < 4.1	4.6	5.0	4.3	4.9	4.0	4.9	4.7
4.1 ≤ E < 4.3	4.6	5.0	4.3	4.9	4.0	4.8	4.7
4.3 ≤ E < 4.5	4.6	4.9	4.2	4.8	4.0	4.8	4.7
4.5 ≤ E < 4.7	4.5	4.9	4.2	4.8	4.0	4.7	4.6
4.7 ≤ E < 4.9	4.5	4.9	4.1	4.7	4.0	4.7	4.6
E ≥ 4.9	4.5	4.9	4.1	4.7	4.0	4.7	4.6
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**37.5 < Assembly Average Burnup ≤ 40 GWd/MTU Minimum Cooling Time (years)**						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	5.7	6.1	5.2	5.9	4.7	5.9	5.7
2.7 ≤ E < 2.9	5.6	6.0	5.1	5.8	4.6	5.8	5.7
2.9 ≤ E < 3.1	5.5	5.9	5.0	5.8	4.6	5.7	5.6
3.1 ≤ E < 3.3	5.5	5.9	4.9	5.7	4.5	5.6	5.5
3.3 ≤ E < 3.5	5.4	5.8	4.9	5.6	4.4	5.6	5.4
3.5 ≤ E < 3.7	5.3	5.7	4.8	5.6	4.4	5.5	5.4
3.7 ≤ E < 3.9	5.2	5.7	4.7	5.5	4.3	5.4	5.3
3.9 ≤ E < 4.1	5.2	5.6	4.7	5.4	4.3	5.4	5.2
4.1 ≤ E < 4.3	5.1	5.6	4.6	5.4	4.3	5.3	5.2
4.3 ≤ E < 4.5	5.0	5.5	4.6	5.3	4.2	5.3	5.1
4.5 ≤ E < 4.7	5.0	5.5	4.5	5.3	4.2	5.2	5.0
4.7 ≤ E < 4.9	5.0	5.4	4.5	5.2	4.1	5.2	5.0
E ≥ 4.9	4.9	5.4	4.5	5.2	4.1	5.1	5.0

PROPOSED

Table B2-23 Loading Table for BWR Fuel – 379 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	40 < Assembly Average Burnup ≤ 41 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	6.0	6.5	5.4	6.2	4.9	6.1	6.0
2.7 ≤ E < 2.9	5.9	6.4	5.3	6.1	4.8	6.0	5.9
2.9 ≤ E < 3.1	5.8	6.2	5.2	6.0	4.7	5.9	5.8
3.1 ≤ E < 3.3	5.7	6.1	5.1	5.9	4.7	5.9	5.7
3.3 ≤ E < 3.5	5.6	6.0	5.0	5.9	4.6	5.8	5.6
3.5 ≤ E < 3.7	5.5	6.0	5.0	5.8	4.5	5.7	5.6
3.7 ≤ E < 3.9	5.5	5.9	4.9	5.7	4.5	5.7	5.5
3.9 ≤ E < 4.1	5.4	5.9	4.9	5.7	4.4	5.6	5.5
4.1 ≤ E < 4.3	5.3	5.8	4.8	5.6	4.4	5.5	5.4
4.3 ≤ E < 4.5	5.3	5.8	4.8	5.6	4.4	5.5	5.3
4.5 ≤ E < 4.7	5.2	5.7	4.7	5.5	4.3	5.4	5.3
4.7 ≤ E < 4.9	5.2	5.7	4.7	5.5	4.3	5.4	5.2
E ≥ 4.9	5.1	5.6	4.6	5.4	4.2	5.4	5.2

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	41 < Assembly Average Burnup ≤ 42 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	6.3	6.8	5.6	6.5	5.1	6.4	6.2
2.7 ≤ E < 2.9	6.2	6.7	5.5	6.4	5.0	6.3	6.1
2.9 ≤ E < 3.1	6.0	6.6	5.5	6.3	4.9	6.2	6.0
3.1 ≤ E < 3.3	6.0	6.5	5.4	6.2	4.8	6.1	5.9
3.3 ≤ E < 3.5	5.9	6.4	5.3	6.1	4.8	6.0	5.9
3.5 ≤ E < 3.7	5.8	6.3	5.2	6.0	4.7	5.9	5.8
3.7 ≤ E < 3.9	5.7	6.2	5.1	5.9	4.6	5.9	5.7
3.9 ≤ E < 4.1	5.6	6.1	5.0	5.9	4.6	5.8	5.7
4.1 ≤ E < 4.3	5.6	6.0	5.0	5.8	4.5	5.8	5.6
4.3 ≤ E < 4.5	5.5	6.0	4.9	5.8	4.5	5.7	5.6
4.5 ≤ E < 4.7	5.5	5.9	4.9	5.7	4.5	5.7	5.5
4.7 ≤ E < 4.9	5.4	5.9	4.9	5.7	4.4	5.6	5.5
E ≥ 4.9	5.4	5.8	4.8	5.6	4.4	5.6	5.4

PROPOSED

Table B2-23 Loading Table for BWR Fuel – 379 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	42 < Assembly Average Burnup ≤ 43 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	6.6	7.1	5.9	6.8	5.3	6.8	6.6
2.7 ≤ E < 2.9	6.5	7.0	5.8	6.7	5.2	6.6	6.4
2.9 ≤ E < 3.1	6.4	6.9	5.7	6.6	5.1	6.5	6.3
3.1 ≤ E < 3.3	6.3	6.8	5.6	6.5	5.0	6.4	6.2
3.3 ≤ E < 3.5	6.1	6.7	5.5	6.4	4.9	6.3	6.1
3.5 ≤ E < 3.7	6.0	6.6	5.4	6.3	4.9	6.2	6.0
3.7 ≤ E < 3.9	6.0	6.5	5.4	6.2	4.8	6.1	5.9
3.9 ≤ E < 4.1	5.9	6.4	5.3	6.1	4.8	6.0	5.9
4.1 ≤ E < 4.3	5.8	6.3	5.2	6.0	4.7	6.0	5.8
4.3 ≤ E < 4.5	5.8	6.3	5.1	6.0	4.6	5.9	5.8
4.5 ≤ E < 4.7	5.7	6.2	5.1	6.0	4.6	5.9	5.7
4.7 ≤ E < 4.9	5.7	6.1	5.0	5.9	4.6	5.9	5.7
E ≥ 4.9	5.6	6.1	5.0	5.9	4.5	5.8	5.6
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**43 < Assembly Average Burnup ≤ 44 GWd/MTU Minimum Cooling Time (years)**						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	7.0	7.6	6.1	7.2	5.5	7.1	6.9
2.7 ≤ E < 2.9	6.8	7.4	6.0	7.0	5.4	6.9	6.7
2.9 ≤ E < 3.1	6.7	7.3	5.9	6.9	5.3	6.8	6.6
3.1 ≤ E < 3.3	6.6	7.1	5.8	6.8	5.2	6.7	6.5
3.3 ≤ E < 3.5	6.5	7.0	5.7	6.7	5.1	6.6	6.4
3.5 ≤ E < 3.7	6.4	6.9	5.7	6.6	5.0	6.5	6.3
3.7 ≤ E < 3.9	6.3	6.8	5.6	6.5	5.0	6.5	6.2
3.9 ≤ E < 4.1	6.2	6.7	5.5	6.4	4.9	6.4	6.1
4.1 ≤ E < 4.3	6.1	6.7	5.5	6.4	4.9	6.3	6.0
4.3 ≤ E < 4.5	6.0	6.6	5.4	6.3	4.8	6.2	6.0
4.5 ≤ E < 4.7	5.9	6.5	5.3	6.2	4.8	6.1	5.9
4.7 ≤ E < 4.9	5.9	6.5	5.3	6.2	4.7	6.1	5.9
E ≥ 4.9	5.8	6.4	5.2	6.1	4.7	6.0	5.9

PROPOSED

Table B2-23 Loading Table for BWR Fuel – 379 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	44 < Assembly Average Burnup ≤ 45 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	7.2	7.9	6.3	7.5	5.6	7.4	7.1
2.9 ≤ E < 3.1	7.0	7.7	6.2	7.3	5.5	7.2	6.9
3.1 ≤ E < 3.3	6.9	7.6	6.1	7.1	5.4	7.0	6.8
3.3 ≤ E < 3.5	6.8	7.4	6.0	7.0	5.4	6.9	6.7
3.5 ≤ E < 3.7	6.7	7.3	5.9	6.9	5.3	6.9	6.6
3.7 ≤ E < 3.9	6.6	7.2	5.8	6.8	5.2	6.8	6.5
3.9 ≤ E < 4.1	6.5	7.1	5.8	6.8	5.1	6.7	6.4
4.1 ≤ E < 4.3	6.4	7.0	5.7	6.7	5.0	6.6	6.3
4.3 ≤ E < 4.5	6.3	6.9	5.6	6.6	5.0	6.5	6.3
4.5 ≤ E < 4.7	6.3	6.8	5.6	6.5	4.9	6.4	6.2
4.7 ≤ E < 4.9	6.2	6.8	5.5	6.5	4.9	6.4	6.1
E ≥ 4.9	6.1	6.7	5.4	6.4	4.8	6.3	6.1

PROPOSED

Note: **For fuel assembly average burnup greater than 45 GWd/MTU, cool time tables have been revised to account for a 5% margin in heat load.**

Table B2-24 Loading Table for BWR Fuel – 360 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	45 < Assembly Average Burnup ≤ 46 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	8.5	9.3	7.3	8.8	6.3	8.6	8.2
2.9 ≤ E < 3.1	8.3	9.0	7.1	8.6	6.2	8.4	8.0
3.1 ≤ E < 3.3	8.1	8.9	7.0	8.4	6.0	8.2	7.9
3.3 ≤ E < 3.5	8.0	8.8	6.8	8.2	6.0	8.0	7.7
3.5 ≤ E < 3.7	7.9	8.6	6.7	8.0	5.9	7.9	7.6
3.7 ≤ E < 3.9	7.7	8.4	6.7	7.9	5.8	7.8	7.5
3.9 ≤ E < 4.1	7.6	8.3	6.6	7.8	5.8	7.7	7.4
4.1 ≤ E < 4.3	7.5	8.2	6.5	7.7	5.7	7.6	7.3
4.3 ≤ E < 4.5	7.4	8.1	6.4	7.6	5.6	7.5	7.2
4.5 ≤ E < 4.7	7.3	8.0	6.3	7.6	5.6	7.4	7.1
4.7 ≤ E < 4.9	7.2	7.9	6.2	7.5	5.5	7.4	7.0
E ≥ 4.9	7.1	7.8	6.1	7.4	5.4	7.3	7.0

PROPOSED

Table B2-24 Loading Table for BWR Fuel – 360 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	46 < Assembly Average Burnup ≤ 47 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	9.1	10.0	7.7	9.3	6.7	9.2	8.7
2.9 ≤ E < 3.1	8.9	9.8	7.5	9.1	6.5	8.9	8.5
3.1 ≤ E < 3.3	8.7	9.5	7.4	8.9	6.4	8.8	8.3
3.3 ≤ E < 3.5	8.5	9.3	7.2	8.7	6.2	8.6	8.2
3.5 ≤ E < 3.7	8.3	9.1	7.0	8.6	6.1	8.4	8.0
3.7 ≤ E < 3.9	8.2	9.0	7.0	8.4	6.0	8.3	7.9
3.9 ≤ E < 4.1	8.0	8.8	6.9	8.3	6.0	8.1	7.8
4.1 ≤ E < 4.3	7.9	8.7	6.8	8.2	5.9	8.0	7.7
4.3 ≤ E < 4.5	7.8	8.6	6.7	8.1	5.8	7.9	7.6
4.5 ≤ E < 4.7	7.7	8.5	6.6	8.0	5.8	7.9	7.5
4.7 ≤ E < 4.9	7.6	8.4	6.5	7.9	5.7	7.8	7.4
E ≥ 4.9	7.5	8.3	6.5	7.8	5.7	7.7	7.4

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	47 < Assembly Average Burnup ≤ 48 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	9.8	10.7	8.2	9.9	6.9	9.8	9.3
2.9 ≤ E < 3.1	9.6	10.5	8.0	9.7	6.8	9.5	9.1
3.1 ≤ E < 3.3	9.3	10.2	7.8	9.5	6.7	9.3	8.9
3.3 ≤ E < 3.5	9.1	9.9	7.7	9.3	6.6	9.2	8.7
3.5 ≤ E < 3.7	8.9	9.7	7.5	9.1	6.5	9.0	8.5
3.7 ≤ E < 3.9	8.7	9.6	7.4	8.9	6.3	8.8	8.4
3.9 ≤ E < 4.1	8.6	9.4	7.2	8.8	6.2	8.7	8.2
4.1 ≤ E < 4.3	8.4	9.3	7.1	8.7	6.1	8.6	8.1
4.3 ≤ E < 4.5	8.3	9.1	7.0	8.6	6.0	8.4	8.0
4.5 ≤ E < 4.7	8.1	9.0	6.9	8.5	6.0	8.3	7.9
4.7 ≤ E < 4.9	8.0	8.9	6.9	8.3	5.9	8.2	7.8
E ≥ 4.9	7.9	8.8	6.8	8.2	5.9	8.1	7.8

PROPOSED

Table B2-24 Loading Table for BWR Fuel – 360 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	48 < Assembly Average Burnup ≤ 49 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	10.5	11.6	8.7	10.8	7.3	10.6	9.9
2.9 ≤ E < 3.1	10.2	11.3	8.5	10.4	7.1	10.2	9.7
3.1 ≤ E < 3.3	10.0	11.0	8.3	10.1	7.0	9.9	9.4
3.3 ≤ E < 3.5	9.7	10.7	8.1	9.9	6.9	9.8	9.2
3.5 ≤ E < 3.7	9.5	10.5	7.9	9.7	6.8	9.6	9.0
3.7 ≤ E < 3.9	9.3	10.3	7.8	9.5	6.7	9.4	8.9
3.9 ≤ E < 4.1	9.1	10.1	7.7	9.4	6.5	9.2	8.7
4.1 ≤ E < 4.3	9.0	9.9	7.5	9.2	6.4	9.0	8.6
4.3 ≤ E < 4.5	8.8	9.7	7.4	9.1	6.3	8.9	8.5
4.5 ≤ E < 4.7	8.7	9.6	7.3	8.9	6.3	8.8	8.4
4.7 ≤ E < 4.9	8.6	9.5	7.2	8.9	6.2	8.7	8.3
E ≥ 4.9	8.5	9.3	7.1	8.8	6.1	8.6	8.2

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	49 < Assembly Average Burnup ≤ 50 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	11.0	12.0	9.0	11.2	7.6	11.0	10.3
3.1 ≤ E < 3.3	10.7	11.7	8.8	10.9	7.4	10.7	10.1
3.3 ≤ E < 3.5	10.4	11.5	8.6	10.7	7.2	10.4	9.8
3.5 ≤ E < 3.7	10.2	11.3	8.4	10.4	7.0	10.2	9.7
3.7 ≤ E < 3.9	10.0	11.0	8.2	10.2	7.0	10.0	9.5
3.9 ≤ E < 4.1	9.7	10.8	8.0	10.0	6.8	9.8	9.3
4.1 ≤ E < 4.3	9.6	10.6	7.9	9.8	6.7	9.7	9.1
4.3 ≤ E < 4.5	9.4	10.4	7.8	9.7	6.7	9.5	9.0
4.5 ≤ E < 4.7	9.3	10.2	7.7	9.5	6.6	9.4	8.9
4.7 ≤ E < 4.9	9.1	10.1	7.6	9.4	6.5	9.2	8.7
E ≥ 4.9	9.0	10.0	7.5	9.3	6.4	9.1	8.6

PROPOSED

Table B2-24 Loading Table for BWR Fuel – 360 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	50 < Assembly Average Burnup ≤ 51 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	11.8	12.9	9.6	12.0	8.0	11.8	11.1
3.1 ≤ E < 3.3	11.5	12.6	9.4	11.7	7.8	11.5	10.9
3.3 ≤ E < 3.5	11.2	12.3	9.1	11.5	7.6	11.2	10.6
3.5 ≤ E < 3.7	10.9	11.9	8.9	11.1	7.5	11.0	10.3
3.7 ≤ E < 3.9	10.7	11.8	8.7	10.9	7.3	10.7	10.0
3.9 ≤ E < 4.1	10.4	11.6	8.6	10.7	7.2	10.5	9.9
4.1 ≤ E < 4.3	10.3	11.3	8.4	10.5	7.0	10.3	9.7
4.3 ≤ E < 4.5	10.0	11.2	8.3	10.4	7.0	10.1	9.6
4.5 ≤ E < 4.7	9.9	11.0	8.1	10.1	6.8	9.9	9.4
4.7 ≤ E < 4.9	9.8	10.9	8.0	10.0	6.8	9.8	9.3
E ≥ 4.9	9.6	10.7	7.9	9.9	6.7	9.7	9.1

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	51 < Assembly Average Burnup ≤ 52 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	12.7	13.9	10.3	12.9	8.4	12.6	11.9
3.1 ≤ E < 3.3	12.3	13.4	10.0	12.5	8.2	12.3	11.6
3.3 ≤ E < 3.5	11.9	13.2	9.8	12.1	8.0	11.9	11.3
3.5 ≤ E < 3.7	11.7	12.9	9.5	11.9	7.9	11.7	11.0
3.7 ≤ E < 3.9	11.5	12.6	9.3	11.7	7.7	11.4	10.8
3.9 ≤ E < 4.1	11.2	12.4	9.1	11.5	7.6	11.3	10.5
4.1 ≤ E < 4.3	11.0	12.1	8.9	11.3	7.4	11.0	10.3
4.3 ≤ E < 4.5	10.8	11.8	8.8	11.1	7.3	10.9	10.2
4.5 ≤ E < 4.7	10.6	11.7	8.7	10.9	7.2	10.7	10.0
4.7 ≤ E < 4.9	10.5	11.6	8.5	10.7	7.1	10.5	9.9
E ≥ 4.9	10.2	11.4	8.4	10.6	7.0	10.4	9.8

PROPOSED

Table B2-24 Loading Table for BWR Fuel – 360 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	52 < Assembly Average Burnup ≤ 53 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	13.6	14.8	11.0	13.7	8.9	13.4	12.7
3.1 ≤ E < 3.3	13.2	14.5	10.7	13.3	8.7	13.1	12.4
3.3 ≤ E < 3.5	12.8	14.1	10.4	13.0	8.5	12.8	12.0
3.5 ≤ E < 3.7	12.6	13.8	10.1	12.7	8.3	12.5	11.8
3.7 ≤ E < 3.9	12.2	13.5	9.8	12.4	8.1	12.2	11.5
3.9 ≤ E < 4.1	11.9	13.2	9.7	12.2	7.9	12.0	11.3
4.1 ≤ E < 4.3	11.7	13.0	9.5	12.0	7.8	11.8	11.1
4.3 ≤ E < 4.5	11.6	12.7	9.3	11.8	7.7	11.5	10.9
4.5 ≤ E < 4.7	11.4	12.5	9.2	11.6	7.6	11.4	10.7
4.7 ≤ E < 4.9	11.2	12.4	9.0	11.5	7.5	11.3	10.5
E ≥ 4.9	11.0	12.1	8.9	11.3	7.4	11.1	10.4
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**53 < Assembly Average Burnup ≤ 54 GWd/MTU Minimum Cooling Time (years)**						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	14.5	15.8	11.8	14.6	9.5	14.4	13.6
3.1 ≤ E < 3.3	14.1	15.4	11.4	14.3	9.2	14.0	13.2
3.3 ≤ E < 3.5	13.8	15.1	11.1	13.9	8.9	13.6	12.8
3.5 ≤ E < 3.7	13.4	14.7	10.9	13.6	8.7	13.4	12.6
3.7 ≤ E < 3.9	13.1	14.4	10.6	13.3	8.6	13.1	12.2
3.9 ≤ E < 4.1	12.9	14.1	10.4	13.1	8.4	12.8	12.0
4.1 ≤ E < 4.3	12.6	13.9	10.1	12.8	8.2	12.5	11.8
4.3 ≤ E < 4.5	12.4	13.6	9.9	12.6	8.1	12.3	11.6
4.5 ≤ E < 4.7	12.1	13.4	9.7	12.3	7.9	12.1	11.4
4.7 ≤ E < 4.9	11.9	13.2	9.6	12.2	7.9	11.9	11.2
E ≥ 4.9	11.7	13.1	9.4	12.0	7.8	11.7	11.1

PROPOSED

Table B2-24 Loading Table for BWR Fuel – 360 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	54 < Assembly Average Burnup ≤ 55 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	15.0	16.4	12.1	15.2	9.8	14.9	14.1
3.3 ≤ E < 3.5	14.7	16.0	11.9	14.9	9.5	14.6	13.7
3.5 ≤ E < 3.7	14.3	15.7	11.5	14.5	9.3	14.2	13.4
3.7 ≤ E < 3.9	13.9	15.4	11.3	14.2	9.0	13.9	13.1
3.9 ≤ E < 4.1	13.6	15.1	11.1	13.9	8.9	13.6	12.8
4.1 ≤ E < 4.3	13.3	14.7	10.8	13.6	8.7	13.4	12.5
4.3 ≤ E < 4.5	13.1	14.5	10.5	13.4	8.5	13.1	12.3
4.5 ≤ E < 4.7	12.9	14.3	10.4	13.2	8.4	13.0	12.1
4.7 ≤ E < 4.9	12.8	14.1	10.2	13.0	8.3	12.8	11.9
E ≥ 4.9	12.5	13.9	10.0	12.8	8.1	12.5	11.7
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**55 < Assembly Average Burnup ≤ 56 GWd/MTU Minimum Cooling Time (years)**						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	15.8	17.5	13.1	16.2	10.4	15.9	15.0
3.3 ≤ E < 3.5	15.5	17.1	12.7	15.8	10.1	15.5	14.6
3.5 ≤ E < 3.7	15.1	16.7	12.3	15.5	9.9	15.2	14.3
3.7 ≤ E < 3.9	14.7	16.3	12.0	15.1	9.7	14.8	13.9
3.9 ≤ E < 4.1	14.4	16.0	11.8	14.9	9.4	14.6	13.6
4.1 ≤ E < 4.3	14.0	15.7	11.5	14.5	9.2	14.3	13.4
4.3 ≤ E < 4.5	13.8	15.4	11.3	14.3	9.0	14.0	13.1
4.5 ≤ E < 4.7	13.7	15.2	11.1	14.1	8.8	13.8	12.9
4.7 ≤ E < 4.9	13.4	15.0	10.9	13.9	8.7	13.7	12.8
E ≥ 4.9	13.3	14.8	10.7	13.7	8.6	13.4	12.5

PROPOSED

Table B2-24 Loading Table for BWR Fuel – 360 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	56 < Assembly Average Burnup ≤ 57 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	16.8	18.4	13.8	17.2	11.1	16.9	16.0
3.3 ≤ E < 3.5	16.5	18.1	13.5	16.8	10.9	16.4	15.5
3.5 ≤ E < 3.7	16.0	17.7	13.1	16.4	10.5	16.2	15.2
3.7 ≤ E < 3.9	15.7	17.3	12.9	16.1	10.2	15.7	14.8
3.9 ≤ E < 4.1	15.4	17.1	12.5	15.8	10.0	15.4	14.5
4.1 ≤ E < 4.3	15.1	16.8	12.2	15.4	9.8	15.2	14.3
4.3 ≤ E < 4.5	14.8	16.4	12.0	15.2	9.6	14.8	14.0
4.5 ≤ E < 4.7	14.6	16.2	11.8	15.0	9.4	14.7	13.8
4.7 ≤ E < 4.9	14.3	15.9	11.6	14.7	9.2	14.4	13.5
E ≥ 4.9	14.0	15.7	11.4	14.5	9.0	14.3	13.4
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**57 < Assembly Average Burnup ≤ 58 GWd/MTU Minimum Cooling Time (years)**						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	17.8	19.5	14.8	18.2	11.8	17.8	16.8
3.3 ≤ E < 3.5	17.3	19.1	14.4	17.7	11.5	17.5	16.5
3.5 ≤ E < 3.7	17.0	18.7	14.0	17.4	11.2	17.1	16.1
3.7 ≤ E < 3.9	16.6	18.3	13.6	17.0	10.9	16.8	15.7
3.9 ≤ E < 4.1	16.3	17.9	13.3	16.7	10.6	16.4	15.4
4.1 ≤ E < 4.3	15.9	17.7	13.1	16.3	10.3	16.1	15.1
4.3 ≤ E < 4.5	15.7	17.4	12.8	16.1	10.1	15.8	14.8
4.5 ≤ E < 4.7	15.5	17.1	12.5	15.9	9.9	15.5	14.6
4.7 ≤ E < 4.9	15.2	16.9	12.3	15.6	9.8	15.3	14.4
E ≥ 4.9	15.0	16.7	12.1	15.4	9.6	15.1	14.2

PROPOSED

Table B2-24 Loading Table for BWR Fuel – 360 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	58 < Assembly Average Burnup ≤ 59 GWd/MTU Minimum Cooling Time (years)						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	18.7	20.4	15.7	19.2	12.6	18.9	17.8
3.3 ≤ E < 3.5	18.4	20.0	15.2	18.8	12.2	18.4	17.4
3.5 ≤ E < 3.7	18.0	19.7	14.9	18.4	11.9	18.1	17.1
3.7 ≤ E < 3.9	17.6	19.3	14.5	18.1	11.6	17.7	16.7
3.9 ≤ E < 4.1	17.2	18.9	14.1	17.7	11.2	17.3	16.3
4.1 ≤ E < 4.3	16.9	18.7	13.8	17.4	11.0	17.1	16.1
4.3 ≤ E < 4.5	16.6	18.4	13.6	17.1	10.8	16.8	15.7
4.5 ≤ E < 4.7	16.4	18.0	13.3	16.9	10.6	16.5	15.5
4.7 ≤ E < 4.9	16.1	17.8	13.1	16.6	10.3	16.2	15.3
E ≥ 4.9	15.9	17.6	12.9	16.3	10.2	15.9	15.1
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**59 < Assembly Average Burnup ≤ 60 GWd/MTU Minimum Cooling Time (years)**						
	BWR/2-3 7×7	BWR/4-6 7×7	BWR/2-3 8×8	BWR/4-6 8×8	BWR/2-3 9×9	BWR/4-6 9×9	BWR/4-6 10×10
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-	-
2.9 ≤ E < 3.1	-	-	-	-	-	-	-
3.1 ≤ E < 3.3	-	-	-	-	-	-	-
3.3 ≤ E < 3.5	19.3	21.0	16.0	19.7	12.9	19.5	18.4
3.5 ≤ E < 3.7	18.9	20.7	15.6	19.3	12.7	19.1	17.9
3.7 ≤ E < 3.9	18.6	20.3	15.2	19.0	12.3	18.7	17.7
3.9 ≤ E < 4.1	18.2	19.9	14.9	18.7	11.9	18.3	17.3
4.1 ≤ E < 4.3	17.9	19.7	14.5	18.3	11.6	17.9	17.0
4.3 ≤ E < 4.5	17.6	19.4	14.2	18.1	11.4	17.7	16.6
4.5 ≤ E < 4.7	17.3	19.1	14.0	17.7	11.2	17.5	16.4
4.7 ≤ E < 4.9	17.1	18.8	13.8	17.6	11.0	17.2	16.1
E ≥ 4.9	16.9	18.6	13.6	17.3	10.8	16.9	15.9

PROPOSED

Table B2-25 Loading Table for PWR Fuel – 959 W/Assembly – WE 14x14 Fuel

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	B ≤10	10< B ≤15	15< B ≤20	20< B ≤25	25< B ≤30	30< B ≤32.5
1.3 ≤ E < 1.5	2.5	-	-	-	-	-
1.5 ≤ E < 1.7	2.5	2.5	-	-	-	-
1.7 ≤ E < 1.9	2.5	2.5	2.9	-	-	-
1.9 ≤ E < 2.1	2.5	2.5	2.9	3.4	-	-
2.1 ≤ E < 2.3	2.5	2.5	2.8	3.3	3.9	4.1
2.3 ≤ E < 2.5	2.5	2.5	2.8	3.3	3.8	4.1
2.5 ≤ E < 2.7	2.5	2.5	2.8	3.3	3.8	4.0
2.7 ≤ E < 2.9	2.5	2.5	2.8	3.2	3.7	4.0
2.9 ≤ E < 3.1	2.5	2.5	2.7	3.2	3.7	3.9
3.1 ≤ E < 3.3	2.5	2.5	2.7	3.2	3.7	3.9
3.3 ≤ E < 3.5	2.5	2.5	2.7	3.2	3.6	3.9
3.5 ≤ E < 3.7	2.5	2.5	2.7	3.1	3.6	3.8
3.7 ≤ E < 3.9	2.5	2.5	2.7	3.1	3.6	3.8
3.9 ≤ E < 4.1	2.5	2.5	2.6	3.1	3.6	3.8
4.1 ≤ E < 4.3	2.5	2.5	2.6	3.1	3.5	3.8
4.3 ≤ E < 4.5	2.5	2.5	2.6	3.0	3.5	3.7
4.5 ≤ E < 4.7	2.5	2.5	2.6	3.0	3.5	3.7
4.7 ≤ E < 4.9	2.5	2.5	2.6	3.0	3.5	3.7
E ≥ 4.9	2.5	2.5	2.6	3.0	3.5	3.7

PROPOSED

Table B2-25 Loading Table for PWR Fuel – 959 W/Assembly – WE 14x14 Fuel (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	32.5< B ≤35	35< B ≤37.5	37.5< B ≤40	40< B ≤41	41< B ≤42	42< B ≤43
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	4.4	4.8	-	-	-	-
2.5 ≤ E < 2.7	4.4	4.7	5.2	5.4	5.6	5.8
2.7 ≤ E < 2.9	4.3	4.7	5.1	5.3	5.5	5.7
2.9 ≤ E < 3.1	4.3	4.6	5.0	5.2	5.4	5.6
3.1 ≤ E < 3.3	4.2	4.5	4.9	5.1	5.3	5.6
3.3 ≤ E < 3.5	4.2	4.5	4.9	5.1	5.3	5.5
3.5 ≤ E < 3.7	4.1	4.5	4.8	5.0	5.2	5.4
3.7 ≤ E < 3.9	4.1	4.4	4.8	4.9	5.1	5.3
3.9 ≤ E < 4.1	4.1	4.4	4.8	4.9	5.1	5.3
4.1 ≤ E < 4.3	4.0	4.4	4.7	4.9	5.0	5.2
4.3 ≤ E < 4.5	4.0	4.3	4.7	4.8	5.0	5.2
4.5 ≤ E < 4.7	4.0	4.3	4.6	4.8	4.9	5.1
4.7 ≤ E < 4.9	4.0	4.3	4.6	4.7	4.9	5.0
E ≥ 4.9	3.9	4.2	4.5	4.7	4.9	5.0

PROPOSED

Table B2-26 Loading Table for PWR Fuel – 513 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	B ≤10	10< B ≤15	15< B ≤20	20< B ≤25	25< B ≤30	30< B ≤32.5
1.3 ≤ E < 1.5	2.9	-	-	-	-	-
1.5 ≤ E < 1.7	2.9	3.8	-	-	-	-
1.7 ≤ E < 1.9	2.9	3.7	4.5	-	-	-
1.9 ≤ E < 2.1	2.9	3.7	4.5	5.7	-	-
2.1 ≤ E < 2.3	2.8	3.7	4.5	5.7	7.5	8.9
2.3 ≤ E < 2.5	2.8	3.6	4.4	5.6	7.4	8.8
2.5 ≤ E < 2.7	2.8	3.6	4.4	5.6	7.3	8.6
2.7 ≤ E < 2.9	2.8	3.6	4.4	5.5	7.2	8.5
2.9 ≤ E < 3.1	2.8	3.5	4.4	5.5	7.1	8.5
3.1 ≤ E < 3.3	2.8	3.5	4.3	5.5	7.1	8.4
3.3 ≤ E < 3.5	2.8	3.5	4.3	5.4	7.0	8.3
3.5 ≤ E < 3.7	2.7	3.5	4.3	5.4	7.0	8.2
3.7 ≤ E < 3.9	2.7	3.5	4.3	5.4	7.0	8.1
3.9 ≤ E < 4.1	2.7	3.5	4.3	5.3	6.9	8.1
4.1 ≤ E < 4.3	2.7	3.5	4.2	5.3	6.9	8.0
4.3 ≤ E < 4.5	2.7	3.5	4.2	5.3	6.8	8.0
4.5 ≤ E < 4.7	2.7	3.5	4.2	5.2	6.8	7.9
4.7 ≤ E < 4.9	2.7	3.4	4.2	5.2	6.8	7.9
E ≥ 4.9	2.7	3.4	4.2	5.2	6.8	7.9

PROPOSED

Table B2-26 Loading Table for PWR Fuel – 513 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	32.5< B ≤35	35< B ≤37.5	37.5< B ≤40	40< B ≤41	41< B ≤42	42< B ≤43
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	10.9	13.7	-	-	-	-
2.5 ≤ E < 2.7	10.7	13.5	16.9	18.2	19.7	21.2
2.7 ≤ E < 2.9	10.5	13.3	16.5	18.0	19.4	20.8
2.9 ≤ E < 3.1	10.4	13.1	16.3	17.7	19.2	20.6
3.1 ≤ E < 3.3	10.2	12.8	16.0	17.5	18.9	20.4
3.3 ≤ E < 3.5	10.1	12.7	15.9	17.2	18.7	20.1
3.5 ≤ E < 3.7	10.0	12.5	15.6	17.0	18.4	19.9
3.7 ≤ E < 3.9	9.9	12.4	15.5	16.8	18.2	19.6
3.9 ≤ E < 4.1	9.8	12.3	15.3	16.7	18.0	19.5
4.1 ≤ E < 4.3	9.8	12.1	15.2	16.5	17.9	19.3
4.3 ≤ E < 4.5	9.7	12.0	15.1	16.3	17.7	19.2
4.5 ≤ E < 4.7	9.7	11.9	15.0	16.2	17.6	19.0
4.7 ≤ E < 4.9	9.6	11.9	14.9	16.1	17.5	18.8
E ≥ 4.9	9.5	11.8	14.8	16.0	17.3	18.7

PROPOSED

Table B2-26 Loading Table for PWR Fuel – 513 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU	
	43< B ≤44	44< B ≤45
1.3 ≤ E < 1.5	-	-
1.5 ≤ E < 1.7	-	-
1.7 ≤ E < 1.9	-	-
1.9 ≤ E < 2.1	-	-
2.1 ≤ E < 2.3	-	-
2.3 ≤ E < 2.5	-	-
2.5 ≤ E < 2.7	22.7	-
2.7 ≤ E < 2.9	22.3	23.8
2.9 ≤ E < 3.1	22.1	23.5
3.1 ≤ E < 3.3	21.8	23.2
3.3 ≤ E < 3.5	21.6	22.9
3.5 ≤ E < 3.7	21.3	22.7
3.7 ≤ E < 3.9	21.1	22.5
3.9 ≤ E < 4.1	20.9	22.3
4.1 ≤ E < 4.3	20.8	22.1
4.3 ≤ E < 4.5	20.6	21.9
4.5 ≤ E < 4.7	20.4	21.8
4.7 ≤ E < 4.9	20.3	21.6
E ≥ 4.9	20.1	21.5

PROPOSED

Table B2-27 Loading Table for PWR Fuel – 1300 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	B ≤10	10< B ≤15	15< B ≤20	20< B ≤25	25< B ≤30	30< B ≤32.5
1.3 ≤ E < 1.5	2.5	-	-	-	-	-
1.5 ≤ E < 1.7	2.5	2.5	-	-	-	-
1.7 ≤ E < 1.9	2.5	2.5	2.5	-	-	-
1.9 ≤ E < 2.1	2.5	2.5	2.5	2.7	-	-
2.1 ≤ E < 2.3	2.5	2.5	2.5	2.6	3.0	3.2
2.3 ≤ E < 2.5	2.5	2.5	2.5	2.6	3.0	3.2
2.5 ≤ E < 2.7	2.5	2.5	2.5	2.6	3.0	3.1
2.7 ≤ E < 2.9	2.5	2.5	2.5	2.6	2.9	3.1
2.9 ≤ E < 3.1	2.5	2.5	2.5	2.5	2.9	3.0
3.1 ≤ E < 3.3	2.5	2.5	2.5	2.5	2.9	3.0
3.3 ≤ E < 3.5	2.5	2.5	2.5	2.5	2.9	3.0
3.5 ≤ E < 3.7	2.5	2.5	2.5	2.5	2.8	3.0
3.7 ≤ E < 3.9	2.5	2.5	2.5	2.5	2.8	3.0
3.9 ≤ E < 4.1	2.5	2.5	2.5	2.5	2.8	2.9
4.1 ≤ E < 4.3	2.5	2.5	2.5	2.5	2.8	2.9
4.3 ≤ E < 4.5	2.5	2.5	2.5	2.5	2.8	2.9
4.5 ≤ E < 4.7	2.5	2.5	2.5	2.5	2.7	2.9
4.7 ≤ E < 4.9	2.5	2.5	2.5	2.5	2.7	2.9
E ≥ 4.9	2.5	2.5	2.5	2.5	2.7	2.8

PROPOSED

Table B2-27 Loading Table for PWR Fuel – 1300 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	32.5< B ≤35	35< B ≤37.5	37.5< B ≤40	40< B ≤41	41< B ≤42	42< B ≤43
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	3.4	3.6	-	-	-	-
2.5 ≤ E < 2.7	3.3	3.6	3.8	3.9	4.0	4.1
2.7 ≤ E < 2.9	3.3	3.5	3.8	3.9	4.0	4.1
2.9 ≤ E < 3.1	3.3	3.5	3.7	3.8	3.9	4.0
3.1 ≤ E < 3.3	3.2	3.4	3.7	3.8	3.9	4.0
3.3 ≤ E < 3.5	3.2	3.4	3.6	3.7	3.8	3.9
3.5 ≤ E < 3.7	3.2	3.4	3.6	3.7	3.8	3.9
3.7 ≤ E < 3.9	3.1	3.4	3.6	3.6	3.8	3.9
3.9 ≤ E < 4.1	3.1	3.3	3.5	3.6	3.7	3.8
4.1 ≤ E < 4.3	3.1	3.3	3.5	3.6	3.7	3.8
4.3 ≤ E < 4.5	3.0	3.3	3.5	3.6	3.6	3.8
4.5 ≤ E < 4.7	3.0	3.2	3.4	3.5	3.6	3.7
4.7 ≤ E < 4.9	3.0	3.2	3.4	3.5	3.6	3.7
E ≥ 4.9	3.0	3.2	3.4	3.5	3.5	3.7

PROPOSED

Table B2-27 Loading Table for PWR Fuel – 1300 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU	
	43< B ≤44	44< B ≤45
1.3 ≤ E < 1.5	-	-
1.5 ≤ E < 1.7	-	-
1.7 ≤ E < 1.9	-	-
1.9 ≤ E < 2.1	-	-
2.1 ≤ E < 2.3	-	-
2.3 ≤ E < 2.5	-	-
2.5 ≤ E < 2.7	4.3	-
2.7 ≤ E < 2.9	4.2	4.3
2.9 ≤ E < 3.1	4.2	4.3
3.1 ≤ E < 3.3	4.1	4.2
3.3 ≤ E < 3.5	4.0	4.2
3.5 ≤ E < 3.7	4.0	4.1
3.7 ≤ E < 3.9	4.0	4.0
3.9 ≤ E < 4.1	3.9	4.0
4.1 ≤ E < 4.3	3.9	4.0
4.3 ≤ E < 4.5	3.8	3.9
4.5 ≤ E < 4.7	3.9	3.9
4.7 ≤ E < 4.9	3.8	3.9
E ≥ 4.9	3.8	3.8

PROPOSED

Table B2-28 Loading Table for PWR Fuel – 1800 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	B ≤10	10< B ≤15	15< B ≤20	20< B ≤25	25< B ≤30	30< B ≤32.5
1.3 ≤ E < 1.5	2.5	-	-	-	-	-
1.5 ≤ E < 1.7	2.5	2.5	-	-	-	-
1.7 ≤ E < 1.9	2.5	2.5	2.5	-	-	-
1.9 ≤ E < 2.1	2.5	2.5	2.5	2.5	-	-
2.1 ≤ E < 2.3	2.5	2.5	2.5	2.5	2.5	2.5
2.3 ≤ E < 2.5	2.5	2.5	2.5	2.5	2.5	2.5
2.5 ≤ E < 2.7	2.5	2.5	2.5	2.5	2.5	2.5
2.7 ≤ E < 2.9	2.5	2.5	2.5	2.5	2.5	2.5
2.9 ≤ E < 3.1	2.5	2.5	2.5	2.5	2.5	2.5
3.1 ≤ E < 3.3	2.5	2.5	2.5	2.5	2.5	2.5
3.3 ≤ E < 3.5	2.5	2.5	2.5	2.5	2.5	2.5
3.5 ≤ E < 3.7	2.5	2.5	2.5	2.5	2.5	2.5
3.7 ≤ E < 3.9	2.5	2.5	2.5	2.5	2.5	2.5
3.9 ≤ E < 4.1	2.5	2.5	2.5	2.5	2.5	2.5
4.1 ≤ E < 4.3	2.5	2.5	2.5	2.5	2.5	2.5
4.3 ≤ E < 4.5	2.5	2.5	2.5	2.5	2.5	2.5
4.5 ≤ E < 4.7	2.5	2.5	2.5	2.5	2.5	2.5
4.7 ≤ E < 4.9	2.5	2.5	2.5	2.5	2.5	2.5
E ≥ 4.9	2.5	2.5	2.5	2.5	2.5	2.5

PROPOSED

Table B2-28 Loading Table for PWR Fuel – 1800 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	32.5< B ≤35	35< B ≤37.5	37.5< B ≤40	40< B ≤41	41< B ≤42	42< B ≤43
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	2.6	2.7	-	-	-	-
2.5 ≤ E < 2.7	2.5	2.7	2.9	2.9	3.0	3.1
2.7 ≤ E < 2.9	2.5	2.7	2.8	2.9	3.0	3.0
2.9 ≤ E < 3.1	2.5	2.6	2.8	2.9	2.9	3.0
3.1 ≤ E < 3.3	2.5	2.6	2.8	2.8	2.9	3.0
3.3 ≤ E < 3.5	2.5	2.6	2.7	2.8	2.9	2.9
3.5 ≤ E < 3.7	2.5	2.5	2.7	2.8	2.8	2.9
3.7 ≤ E < 3.9	2.5	2.5	2.7	2.7	2.8	2.9
3.9 ≤ E < 4.1	2.5	2.5	2.6	2.7	2.8	2.8
4.1 ≤ E < 4.3	2.5	2.5	2.6	2.7	2.8	2.8
4.3 ≤ E < 4.5	2.5	2.5	2.6	2.7	2.7	2.8
4.5 ≤ E < 4.7	2.5	2.5	2.6	2.6	2.7	2.8
4.7 ≤ E < 4.9	2.5	2.5	2.5	2.6	2.7	2.7
E ≥ 4.9	2.5	2.5	2.5	2.6	2.6	2.7

PROPOSED

Table B2-28 Loading Table for PWR Fuel – 1800 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU	
	43< B ≤44	44< B ≤45
1.3 ≤ E < 1.5	-	-
1.5 ≤ E < 1.7	-	-
1.7 ≤ E < 1.9	-	-
1.9 ≤ E < 2.1	-	-
2.1 ≤ E < 2.3	-	-
2.3 ≤ E < 2.5	-	-
2.5 ≤ E < 2.7	3.1	-
2.7 ≤ E < 2.9	3.1	3.2
2.9 ≤ E < 3.1	3.1	3.1
3.1 ≤ E < 3.3	3.0	3.1
3.3 ≤ E < 3.5	3.0	3.1
3.5 ≤ E < 3.7	3.0	3.0
3.7 ≤ E < 3.9	2.9	3.0
3.9 ≤ E < 4.1	2.9	3.0
4.1 ≤ E < 4.3	2.9	2.9
4.3 ≤ E < 4.5	2.8	2.9
4.5 ≤ E < 4.7	2.9	2.9
4.7 ≤ E < 4.9	2.8	2.9
E ≥ 4.9	2.8	2.8

PROPOSED

Table B2-29 Loading Table for PWR Fuel – 830 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	B ≤10	10< B ≤15	15< B ≤20	20< B ≤25	25< B ≤30	30< B ≤32.5
1.3 ≤ E < 1.5	2.5	-	-	-	-	-
1.5 ≤ E < 1.7	2.5	2.7	-	-	-	-
1.7 ≤ E < 1.9	2.5	2.7	3.2	-	-	-
1.9 ≤ E < 2.1	2.5	2.7	3.2	3.8	-	-
2.1 ≤ E < 2.3	2.5	2.6	3.1	3.7	4.4	4.7
2.3 ≤ E < 2.5	2.5	2.6	3.1	3.7	4.3	4.6
2.5 ≤ E < 2.7	2.5	2.6	3.1	3.6	4.3	4.6
2.7 ≤ E < 2.9	2.5	2.6	3.0	3.6	4.2	4.5
2.9 ≤ E < 3.1	2.5	2.5	3.0	3.6	4.2	4.5
3.1 ≤ E < 3.3	2.5	2.5	3.0	3.5	4.2	4.5
3.3 ≤ E < 3.5	2.5	2.5	3.0	3.5	4.1	4.4
3.5 ≤ E < 3.7	2.5	2.5	3.0	3.5	4.1	4.4
3.7 ≤ E < 3.9	2.5	2.5	3.0	3.5	4.0	4.4
3.9 ≤ E < 4.1	2.5	2.5	2.9	3.5	4.0	4.3
4.1 ≤ E < 4.3	2.5	2.5	2.9	3.4	4.0	4.3
4.3 ≤ E < 4.5	2.5	2.5	2.9	3.4	4.0	4.3
4.5 ≤ E < 4.7	2.5	2.5	2.9	3.4	4.0	4.2
4.7 ≤ E < 4.9	2.5	2.5	2.9	3.4	3.9	4.2
E ≥ 4.9	2.5	2.5	2.9	3.4	3.9	4.2

PROPOSED

Table B2-29 Loading Table for PWR Fuel – 830 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	32.5< B ≤35	35< B ≤37.5	37.5< B ≤40	40< B ≤41	41< B ≤42	42< B ≤43
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	5.1	5.6	-	-	-	-
2.5 ≤ E < 2.7	5.0	5.6	6.1	6.4	6.8	7.1
2.7 ≤ E < 2.9	5.0	5.5	6.0	6.3	6.6	6.9
2.9 ≤ E < 3.1	4.9	5.4	6.0	6.2	6.5	6.8
3.1 ≤ E < 3.3	4.9	5.4	5.9	6.1	6.4	6.7
3.3 ≤ E < 3.5	4.8	5.3	5.8	6.0	6.3	6.6
3.5 ≤ E < 3.7	4.8	5.2	5.8	6.0	6.3	6.6
3.7 ≤ E < 3.9	4.7	5.2	5.7	5.9	6.2	6.5
3.9 ≤ E < 4.1	4.7	5.1	5.7	5.9	6.1	6.4
4.1 ≤ E < 4.3	4.6	5.1	5.6	5.8	6.0	6.3
4.3 ≤ E < 4.5	4.6	5.0	5.6	5.8	6.0	6.2
4.5 ≤ E < 4.7	4.6	5.0	5.5	5.7	5.9	6.2
4.7 ≤ E < 4.9	4.5	5.0	5.5	5.7	5.9	6.1
E ≥ 4.9	4.5	4.9	5.4	5.6	5.9	6.0

PROPOSED

Table B2-29 Loading Table for PWR Fuel – 830 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU	
	43< B ≤44	44< B ≤45
1.3 ≤ E < 1.5	-	-
1.5 ≤ E < 1.7	-	-
1.7 ≤ E < 1.9	-	-
1.9 ≤ E < 2.1	-	-
2.1 ≤ E < 2.3	-	-
2.3 ≤ E < 2.5	-	-
2.5 ≤ E < 2.7	7.5	-
2.7 ≤ E < 2.9	7.3	7.7
2.9 ≤ E < 3.1	7.2	7.6
3.1 ≤ E < 3.3	7.0	7.5
3.3 ≤ E < 3.5	6.9	7.3
3.5 ≤ E < 3.7	6.8	7.2
3.7 ≤ E < 3.9	6.8	7.1
3.9 ≤ E < 4.1	6.7	7.0
4.1 ≤ E < 4.3	6.6	6.9
4.3 ≤ E < 4.5	6.6	6.8
4.5 ≤ E < 4.7	6.5	6.8
4.7 ≤ E < 4.9	6.4	6.7
E ≥ 4.9	6.4	6.7

PROPOSED

Note: **For fuel assembly average burnup greater than 45 GWd/MTU, cool time tables have been revised to account for a 5% margin in heat load.**

Table B2-30 Loading Table for PWR Fuel – 487 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	45< B ≤46	46< B ≤47	47< B ≤48	48< B ≤49	49< B ≤50	50< B ≤51
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	27.9	29.3	30.7	32.0	-	-
2.9 ≤ E < 3.1	27.6	29.0	30.4	31.8	32.7	33.9
3.1 ≤ E < 3.3	27.4	28.8	30.2	31.6	32.4	33.7
3.3 ≤ E < 3.5	27.1	28.5	30.0	31.4	32.2	33.6
3.5 ≤ E < 3.7	26.9	28.3	29.7	31.1	32.0	33.3
3.7 ≤ E < 3.9	26.7	28.1	29.5	30.9	31.8	33.1
3.9 ≤ E < 4.1	26.6	27.9	29.4	30.8	31.6	32.9
4.1 ≤ E < 4.3	26.3	27.8	29.2	30.6	31.4	33.5
4.3 ≤ E < 4.5	26.1	27.5	29.0	30.3	31.2	32.6
4.5 ≤ E < 4.7	26.0	27.4	28.8	30.2	31.1	32.4
4.7 ≤ E < 4.9	25.9	27.3	28.6	30.1	30.9	32.3
E ≥ 4.9	25.8	27.1	28.5	30.0	30.8	32.1

PROPOSED

Table B2-30 Loading Table for PWR Fuel – 487 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	51< B ≤52	52< B ≤53	53< B ≤54	54< B ≤55	55< B ≤56	56< B ≤57
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-
2.9 ≤ E < 3.1	35.2	36.4	37.7	-	-	-
3.1 ≤ E < 3.3	35.0	36.2	37.4	38.8	39.8	41.0
3.3 ≤ E < 3.5	34.8	36.0	37.2	38.5	39.6	40.9
3.5 ≤ E < 3.7	34.5	35.9	37.1	38.4	39.5	40.7
3.7 ≤ E < 3.9	34.3	35.6	36.9	38.2	39.4	40.5
3.9 ≤ E < 4.1	34.2	35.4	36.7	38.1	39.2	40.4
4.1 ≤ E < 4.3	34.1	35.2	36.6	37.9	39.2	40.2
4.3 ≤ E < 4.5	33.9	35.2	36.4	37.7	39.0	40.2
4.5 ≤ E < 4.7	33.7	35.0	36.3	37.6	38.8	40.0
4.7 ≤ E < 4.9	33.5	34.8	36.1	37.4	38.7	39.8
E ≥ 4.9	33.4	34.7	35.9	37.3	38.6	39.7

PROPOSED

Table B2-30 Loading Table for PWR Fuel – 487 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU		
	57< B ≤58	58< B ≤59	59< B ≤60
1.3 ≤ E < 1.5	-	-	-
1.5 ≤ E < 1.7	-	-	-
1.7 ≤ E < 1.9	-	-	-
1.9 ≤ E < 2.1	-	-	-
2.1 ≤ E < 2.3	-	-	-
2.3 ≤ E < 2.5	-	-	-
2.5 ≤ E < 2.7	-	-	-
2.7 ≤ E < 2.9	-	-	-
2.9 ≤ E < 3.1	-	-	-
3.1 ≤ E < 3.3	42.1	43.3	-
3.3 ≤ E < 3.5	42.0	43.1	44.1
3.5 ≤ E < 3.7	41.9	43.0	44.1
3.7 ≤ E < 3.9	41.7	42.9	43.9
3.9 ≤ E < 4.1	41.6	42.7	43.8
4.1 ≤ E < 4.3	41.5	42.6	43.7
4.3 ≤ E < 4.5	41.3	42.5	43.6
4.5 ≤ E < 4.7	41.2	42.4	43.5
4.7 ≤ E < 4.9	41.0	42.3	43.4
E ≥ 4.9	40.9	42.1	43.3

PROPOSED

Table B2-31 Loading Table for PWR Fuel – 1235 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	45< B ≤46	46< B ≤47	47< B ≤48	48< B ≤49	49< B ≤50	50< B ≤51
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	4.7	4.9	5.0	5.2	-	-
2.9 ≤ E < 3.1	4.6	4.8	4.9	5.1	5.2	5.4
3.1 ≤ E < 3.3	4.6	4.7	4.9	5.0	5.1	5.3
3.3 ≤ E < 3.5	4.5	4.6	4.8	4.9	5.0	5.2
3.5 ≤ E < 3.7	4.5	4.6	4.7	4.9	5.0	5.2
3.7 ≤ E < 3.9	4.4	4.5	4.7	4.8	4.9	5.1
3.9 ≤ E < 4.1	4.4	4.5	4.6	4.8	4.9	5.0
4.1 ≤ E < 4.3	4.3	4.4	4.5	4.7	4.8	4.9
4.3 ≤ E < 4.5	4.3	4.4	4.5	4.6	4.8	4.9
4.5 ≤ E < 4.7	4.2	4.3	4.5	4.6	4.7	4.8
4.7 ≤ E < 4.9	4.2	4.3	4.4	4.6	4.7	4.8
E ≥ 4.9	4.1	4.3	4.4	4.5	4.6	4.7

PROPOSED

Table B2-31 Loading Table for PWR Fuel – 1235 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	51< B ≤52	52< B ≤53	53< B ≤54	54< B ≤55	55< B ≤56	56< B ≤57
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-
2.9 ≤ E < 3.1	5.6	5.8	6.0	-	-	-
3.1 ≤ E < 3.3	5.5	5.7	5.9	6.1	6.4	6.7
3.3 ≤ E < 3.5	5.4	5.6	5.8	6.0	6.3	6.5
3.5 ≤ E < 3.7	5.4	5.5	5.7	5.9	6.1	6.4
3.7 ≤ E < 3.9	5.3	5.5	5.6	5.8	6.0	6.3
3.9 ≤ E < 4.1	5.2	5.4	5.6	5.8	5.9	6.1
4.1 ≤ E < 4.3	5.1	5.3	5.5	5.7	5.9	6.0
4.3 ≤ E < 4.5	5.0	5.2	5.4	5.6	5.8	6.0
4.5 ≤ E < 4.7	5.0	5.1	5.3	5.5	5.7	5.9
4.7 ≤ E < 4.9	4.9	5.1	5.3	5.5	5.6	5.8
E ≥ 4.9	4.9	5.0	5.3	5.4	5.6	5.7

PROPOSED

Table B2-31 Loading Table for PWR Fuel – 1235 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU		
	57< B ≤58	58< B ≤59	59< B ≤60
1.3 ≤ E < 1.5	-	-	-
1.5 ≤ E < 1.7	-	-	-
1.7 ≤ E < 1.9	-	-	-
1.9 ≤ E < 2.1	-	-	-
2.1 ≤ E < 2.3	-	-	-
2.3 ≤ E < 2.5	-	-	-
2.5 ≤ E < 2.7	-	-	-
2.7 ≤ E < 2.9	-	-	-
2.9 ≤ E < 3.1	-	-	-
3.1 ≤ E < 3.3	6.9	7.2	-
3.3 ≤ E < 3.5	6.8	7.0	7.4
3.5 ≤ E < 3.7	6.7	6.9	7.2
3.7 ≤ E < 3.9	6.5	6.8	7.0
3.9 ≤ E < 4.1	6.4	6.7	6.9
4.1 ≤ E < 4.3	6.3	6.5	6.8
4.3 ≤ E < 4.5	6.2	6.4	6.7
4.5 ≤ E < 4.7	6.1	6.3	6.6
4.7 ≤ E < 4.9	6.0	6.2	6.5
E ≥ 4.9	5.9	6.1	6.4

PROPOSED

Table B2-32 Loading Table for PWR Fuel – 1710 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	45< B ≤46	46< B ≤47	47< B ≤48	48< B ≤49	49< B ≤50	50< B ≤51
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	3.4	3.5	3.6	3.7	-	-
2.9 ≤ E < 3.1	3.4	3.5	3.5	3.6	3.7	3.8
3.1 ≤ E < 3.3	3.3	3.4	3.5	3.6	3.6	3.7
3.3 ≤ E < 3.5	3.3	3.4	3.4	3.5	3.6	3.7
3.5 ≤ E < 3.7	3.3	3.3	3.4	3.5	3.5	3.6
3.7 ≤ E < 3.9	3.2	3.3	3.4	3.4	3.5	3.6
3.9 ≤ E < 4.1	3.2	3.3	3.3	3.4	3.5	3.5
4.1 ≤ E < 4.3	3.1	3.2	3.3	3.4	3.4	3.5
4.3 ≤ E < 4.5	3.1	3.2	3.3	3.3	3.4	3.5
4.5 ≤ E < 4.7	3.1	3.2	3.2	3.3	3.4	3.4
4.7 ≤ E < 4.9	3.0	3.1	3.2	3.3	3.4	3.4
E ≥ 4.9	3.0	3.1	3.2	3.2	3.3	3.4

PROPOSED

Table B2-32 Loading Table for PWR Fuel – 1710 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	51< B ≤52	52< B ≤53	53< B ≤54	54< B ≤55	55< B ≤56	56< B ≤57
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-
2.9 ≤ E < 3.1	3.9	4.0	4.0	-	-	-
3.1 ≤ E < 3.3	3.8	3.9	4.0	4.1	4.2	4.3
3.3 ≤ E < 3.5	3.8	3.9	4.0	4.0	4.2	4.3
3.5 ≤ E < 3.7	3.7	3.8	3.9	4.0	4.1	4.2
3.7 ≤ E < 3.9	3.7	3.8	3.8	3.9	4.0	4.2
3.9 ≤ E < 4.1	3.6	3.7	3.8	3.9	4.0	4.1
4.1 ≤ E < 4.3	3.6	3.7	3.8	3.8	3.9	4.0
4.3 ≤ E < 4.5	3.5	3.6	3.7	3.8	3.9	4.0
4.5 ≤ E < 4.7	3.5	3.6	3.7	3.8	3.9	3.9
4.7 ≤ E < 4.9	3.5	3.5	3.6	3.7	3.8	3.9
E ≥ 4.9	3.4	3.5	3.6	3.7	3.8	3.9

PROPOSED

Table B2-32 Loading Table for PWR Fuel – 1710 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU		
	57< B ≤58	58< B ≤59	59< B ≤60
1.3 ≤ E < 1.5	-	-	-
1.5 ≤ E < 1.7	-	-	-
1.7 ≤ E < 1.9	-	-	-
1.9 ≤ E < 2.1	-	-	-
2.1 ≤ E < 2.3	-	-	-
2.3 ≤ E < 2.5	-	-	-
2.5 ≤ E < 2.7	-	-	-
2.7 ≤ E < 2.9	-	-	-
2.9 ≤ E < 3.1	-	-	-
3.1 ≤ E < 3.3	4.4	4.6	-
3.3 ≤ E < 3.5	4.4	4.5	4.6
3.5 ≤ E < 3.7	4.3	4.4	4.5
3.7 ≤ E < 3.9	4.3	4.4	4.5
3.9 ≤ E < 4.1	4.2	4.3	4.4
4.1 ≤ E < 4.3	4.1	4.2	4.3
4.3 ≤ E < 4.5	4.1	4.2	4.3
4.5 ≤ E < 4.7	4.0	4.1	4.2
4.7 ≤ E < 4.9	4.0	4.1	4.2
E ≥ 4.9	3.9	4.0	4.1

PROPOSED

Table B2-33 Loading Table for PWR Fuel – 788 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	45< B ≤46	46< B ≤47	47< B ≤48	48< B ≤49	49< B ≤50	50< B ≤51
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	9.0	9.7	10.4	11.2	-	-
2.9 ≤ E < 3.1	8.9	9.5	10.1	10.9	11.4	12.2
3.1 ≤ E < 3.3	8.7	9.2	9.9	10.6	11.1	11.9
3.3 ≤ E < 3.5	8.5	9.0	9.7	10.3	10.9	11.6
3.5 ≤ E < 3.7	8.4	8.9	9.5	10.1	10.6	11.4
3.7 ≤ E < 3.9	8.2	8.7	9.3	9.9	10.4	11.1
3.9 ≤ E < 4.1	8.1	8.6	9.1	9.7	10.2	10.9
4.1 ≤ E < 4.3	8.0	8.5	9.0	9.5	10.0	10.7
4.3 ≤ E < 4.5	7.9	8.4	8.8	9.4	9.8	10.5
4.5 ≤ E < 4.7	7.8	8.2	8.7	9.3	9.7	10.3
4.7 ≤ E < 4.9	7.7	8.1	8.6	9.1	9.5	10.2
E ≥ 4.9	7.6	8.0	8.5	9.0	9.4	10.0

PROPOSED

Table B2-33 Loading Table for PWR Fuel – 788 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU					
	51< B ≤52	52< B ≤53	53< B ≤54	54< B ≤55	55< B ≤56	56< B ≤57
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-
2.9 ≤ E < 3.1	13.1	14.0	15.0	-	-	-
3.1 ≤ E < 3.3	12.8	13.6	14.6	15.6	16.6	17.7
3.3 ≤ E < 3.5	12.4	13.3	14.2	15.3	16.2	17.3
3.5 ≤ E < 3.7	12.1	13.0	13.9	14.9	15.9	16.9
3.7 ≤ E < 3.9	11.9	13.0	13.6	14.6	15.5	16.5
3.9 ≤ E < 4.1	11.6	12.5	13.3	14.2	15.2	16.2
4.1 ≤ E < 4.3	11.4	12.2	13.1	13.9	14.9	15.9
4.3 ≤ E < 4.5	11.3	11.9	12.8	13.7	14.7	15.6
4.5 ≤ E < 4.7	11.1	11.8	12.6	13.5	14.4	15.3
4.7 ≤ E < 4.9	10.9	11.6	12.4	13.3	14.1	15.1
E ≥ 4.9	10.7	11.5	12.6	13.1	13.9	14.8

PROPOSED

Table B2-33 Loading Table for PWR Fuel – 788 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	WE 14x14 (ng14b) Assembly Average Burnup (B) GWd/MTU		
	57< B ≤58	58< B ≤59	59< B ≤60
1.3 ≤ E < 1.5	-	-	-
1.5 ≤ E < 1.7	-	-	-
1.7 ≤ E < 1.9	-	-	-
1.9 ≤ E < 2.1	-	-	-
2.1 ≤ E < 2.3	-	-	-
2.3 ≤ E < 2.5	-	-	-
2.5 ≤ E < 2.7	-	-	-
2.7 ≤ E < 2.9	-	-	-
2.9 ≤ E < 3.1	-	-	-
3.1 ≤ E < 3.3	18.7	19.7	-
3.3 ≤ E < 3.5	18.2	19.3	20.4
3.5 ≤ E < 3.7	17.9	18.9	19.9
3.7 ≤ E < 3.9	17.5	18.6	19.6
3.9 ≤ E < 4.1	17.2	18.2	19.2
4.1 ≤ E < 4.3	16.9	17.9	18.9
4.3 ≤ E < 4.5	16.6	17.6	18.6
4.5 ≤ E < 4.7	16.3	17.3	18.3
4.7 ≤ E < 4.9	16.0	17.0	18.0
E ≥ 4.9	15.8	16.8	17.8

PROPOSED

Enclosure 2

List of Changes

for

MAGNASTOR® FSAR, Amendment 5
(Docket No 72-1031)

NAC International

December 2013

List of Changes for the MAGNASTOR® FSAR, Amendment 5

Chapter/Page/ Figure/Table	Source of Change: Amendment No. 5	Description of Change
Note: The List of Effective Pages and the Chapter Table of Contents, List of Figures and List of Tables have been revised accordingly to reflect the list of changes detailed below.		
Chapter 1		
Page 1.3-7	Amendment No. 5	Modified text in section 1.3.1.5, Damaged Fuel Can.
Page 1.3-8	Amendment No. 5	Text flow changes.
Page 1.3-12	Amendment No. 5	Replaced Figure 1.3-4, MAGNASTOR Damaged Fuel Can.
Page 1.4-1	Amendment No. 5	Modified second paragraph of Section 1.4, MAGNASTOR Contents.
Chapter 2 – no changes		
Chapter 3 – no changes		
Chapter 4		
Page 4-i thru 4-iv	Amendment No. 5	Modified Table of Contents, List of Figures and List of Tables to reflect text flow changes to page numbers and the addition of new Figure 4.1-2.
Page 4.1-1 thru 4.1-3	Amendment No. 5	Modified Section 4.1, Discussion, throughout.
Page 4.1-4 thru 4.1-5	Amendment No. 5	Text flow changes.
Page 4.1-6	Amendment No. 5	Added new Figure 4.1-2, Preferential Loading Pattern for the PWR Basket with Minimum Reduced Cool Time Fuel.
Page 4.1-7 thru 4.1-8	Amendment No. 5	Text flow changes.
Page 4.4-11 thru 4.4-12	Amendment No. 5	Modified text throughout page 4.4-11 and at the top of page 4.4-12.
Page 4.4-13 thru 4.4-22	Amendment No. 5	Text flow changes.
Page 4.4-29 thru 4.4-30	Amendment No. 5	Added new text under subheading "Evaluation of TSC Loaded with PWR Minimum Reduced Cool Time Fuel Basket Assembly".
Page 4.4-31	Amendment No. 5	Text flow changes.
Page 4.4-32	Amendment No. 5	Added new text under subheading "Normal Conditions of Storage – PWR Minimum Reduced Cool Time Fuel Basket Assembly".
Page 4.4-33 thru 4.4-69	Amendment No. 5	Text flow changes.
Page 4.5-1	Amendment No. 5	Added three new sentences to the end of the first paragraph in Section 4.5-1 for PWR minimum reduced cool time fuel.
Page 4.5-2 thru 4.5-5	Amendment No. 5	Text flow changes.

Chapter/Page/ Figure/Table	Source of Change: Amendment No. 5	Description of Change
Page 4.6-1	Amendment No. 5	Added new paragraph at the end of Section 4.6, Accident Events.
Page 4.6-2 thru 4.6-4	Amendment No. 5	Text flow changes.
Chapter 5		
Page 5-i thru 5-ii	Amendment No. 5	Updated Table of Contents to reflect a text flow change to a page number, and to reflect the addition of new Section 5.9.
Page 5-viii	Amendment No. 5	Updated List of Figures to reflect the addition of Section 5.9
Page 5-xi thru 5-xii	Amendment No. 5	Updated List of Tables to reflect the addition of Section 5.9.
Page 5.1-1	Amendment No. 5	Modified second paragraph, and added the new third paragraph to Section 5.1, Cask Shielding Discussion and Dose Results.
Page 5.1-2 thru 5.1-6	Amendment No. 5	Text flow changes.
Page 5.8.4-2	Amendment No. 5	Added new first row to the embedded table near the top of the page in Section 5.8.4.2.
Page 5.8.9-56	Amendment No. 5	Added new first row to the embedded table near the top of Table 5.8.9-10, Low Burnup BWR Fuel Loading Table.
Page 5.9-1 thru 5.9.9-2	Amendment No. 5	Added new Section 5.9, Reduced Minimum Cool Time Shielding Evaluation Detail.
Chapter 6		
Page 6.1-2	Amendment No. 5	Modified the third paragraph on the page.
Page 6.1-3 thru 6.1-5	Amendment No. 5	Text flow changes.
Page 6.1-6	Amendment No. 5	Replaced Figure 6.1.1-1, 82-Assembly BWR Basket Configuration.
Page 6.1-11	Amendment No. 5	Modified Table 6.1.1-4, BWR Fuel Assembly Loading Criteria (Enrichment Limits), by adding new notes "c" and "d".
Page 6.1-13	Amendment No. 5	Modified Table 6.1.1-6, Damaged Fuel Basket Bounding PWR Fuel Assembly Loading Criteria (Enrichment/Soluble Boron Limits), by adding a new row for "CE16H1".
Page 6.4-11	Amendment No. 5	Modified Table 6.4.3-4, BWR Fuel Basket Allowable Loading (Enrichment Limits), by adding new notes "c" and "d"..
Page 6.4-12	Amendment No. 5	Modified Table 6.4.3-5, Damaged Fuel Basket PWR Fuel Assembly Loading Criteria (Enrichment/Soluble Boron Limits), by adding a new row for "CE16H1".
Page 6.7.4-1	Amendment No. 5	Modified second paragraph on the page.
Page 6.7.4-2	Amendment No. 5	Text flow changes.
Page 6.7.5-1	Amendment No. 5	Modified second paragraph of Section 6.7.5, BWR Fuel Characterization.
Page 6.7.6-1	Amendment No. 5	Modified the third paragraph of Section 6.7.6.1, Optimum System Configuration.
Page 6.7.6-4	Amendment No. 5	Modified first two paragraphs under subheading "Phase 1 Design Modifications".

Chapter/Page/ Figure/Table	Source of Change: Amendment No. 5	Description of Change
Page 6.7.6-7	Editorial Change	Corrected two typographical errors in first paragraph of Section 6.7.6.2, Allowable Loading Definitions and Maximum System Reactivities."
Page 6.7.8-4	Amendment No. 5	Changed 0.56 to 0.57 at end of second line of last paragraph on the page.
Page 6.7.8-81	Amendment No. 5	Modified Table 6.7.8-1, Sample Results for Undamaged Fuel in DFC (Damaged Fuel Basket), by adding a new row for "CE16H1".
Page 6.7.8-82	Amendment No. 5	Modified Table 6.7.8-2, DFC Unclad Rod Array Pitch Study Results, by adding a new row for CE16H1.
Page 6.7.8-83	Amendment No. 5	Modified Table 6.7.8-3, Sample Results for Unclad Rod/Loose Pellet Fuel in DFC (Damaged Fuel Basket), by adding a new row for CE16H1.
Page 6.7.8-85	Amendment No. 5	Modified Table 6.7.8-5, Sample DFC Fuel Mixture Height Study Results, by adding a new row for "CE16H1".
Page 6.7.8-86	Amendment No. 5	Modified Table 6.7.8-6, DFC Fuel Mixture Maximum Reactivity Height for 0.036 g/cm^2 ^{10}B – No Inserts, by adding a new row for "CE16H1".
Page 6.7.8-87	Amendment No. 5	Modified table 6.7.8-7, DFC Fuel Mixture Maximum Reactivity Height for 0.036 g/cm^2 ^{10}B – Inserts, by adding a new row for "CE16H1".
Page 6.7.8-90	Amendment No. 5	Modified title of Table 6.7.8-10, PWR Damaged Fuel Assembly Allowable Loading (Enrichment/Soluble Boron Limits), by adding a new row for "CE16H1."
Chapter 7 – no changes		
Chapter 8 – no changes		
Chapter 9		
Page 9.1-3	Amendment No. 5	Modified first note of Item 15 in Section 9.1.1.
Page 9.1-4	Amendment No. 5	Text flow changes.
Chapter 10		
Page 10.1-5	Amendment No. 5	Modified last section of first sentence in Section 10.1.2.3 by changing NB-6000 to NB-6200.
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Chapter 12 – no changes		
Chapter 13 – no changes		
Chapter 14 – no changes		
Chapter 15 – no changes		

Enclosure 3

Supporting Calculations:

Nuclear Data Disk 1 of 2, Reduced Min Cool Time and 4-Zone Preferential Shielding (71160-5019, Rev. 0), CE 16 × 16 Damaged Duel Criticality, and BWR 86-Assembly and Alternate 82-Assembly Increased Enrichment Limit Criticality

Nuclear Data Disk 2 of 2, Unenriched BWR Assembly Shielding

71160-3035, Rev. 0

71160-3040, Rev. 7

71160-5019, Rev. 0

for

MAGNASTOR® FSAR, Amendment 5
(Docket No. 72-1031)

December 2013

PROPRIETARY CALCULATION

71160-3035, REV. 0

WITHHELD PER 10 CFR 2.390

PROPRIETARY CALCULATION

71160-3040, REV. 7

WITHHELD PER 10 CFR 2.390

PROPRIETARY CALCULATION

71160-5019, REV. 0

WITHHELD PER 10 CFR 2.390

Enclosure 4

FSAR Changed Pages and LOEP

for

MAGNASTOR® FSAR, Amendment 5, Revision 13D
(Docket No. 72-1031)

December 2013

December 2013

Revision 13D

MAGNASTOR®

(Modular Advanced Generation Nuclear All-purpose STORage)

FINAL SAFETY ANALYSIS REPORT

NON-PROPRIETARY VERSION

Docket No. 72-1031

NAC INTERNATIONAL

Atlanta Corporate Headquarters: 3930 East Jones Bridge Road, Norcross, Georgia 30092 USA
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Page 15.3-1 ..... Revision 0

The transfer cask penetrations can also be used for the introduction of auxiliary forced air or gas to cool the exterior of the TSC. Alternately, if auxiliary cooling is required to lower fuel cladding or TSC component temperatures, the loaded TSC may be returned to the spent fuel pool or shelf for cooling.

1.3.1.5 Damaged Fuel Can

The MAGNASTOR Damaged Fuel Can (DFC), shown in Figure 1.3-4, is provided to accommodate PWR fuel assemblies or fuel debris equivalent to one PWR fuel assembly. Up to four DFCs may be loaded, one into each outer corner, in the MAGNASTOR DF Basket Assembly.

The primary function of the DFC is to confine the fuel material within the can to minimize the potential for dispersal of the fuel material into the TSC cavity. In normal operation, the DFC is in a vertical orientation.

The DFC is fabricated from Type 304 stainless steel and has an 8.7-in square inside dimension. The side plates that form the upper end of the DFC are 0.15-in thick and the tube body walls are 0.048-in thick (18-gage sheet). The DFC lid plate and bottom thicknesses total 11/16 (0.688) inch and the lid overall height is 2.32 inches. The DFC bottom plate thickness is 5/8 (0.625) inch. The DFC lid and bottom include screened drain holes.

1.3.2 Operational Features

In storage, MAGNASTOR does not require any active operational systems. The principal MAGNASTOR operational activities are loading, welding, and preparing the TSC for storage and transferring the TSC to the concrete cask. The transfer cask (MTC) is designed to meet the requirements of these operations. The transfer cask holds the TSC during fuel loading operations, provides biological shielding during TSC closure and preparation, and positions the TSC for transfer into the concrete cask. The lid design of the TSC assures structural integrity, while reducing the time and dose involved in TSC closure.

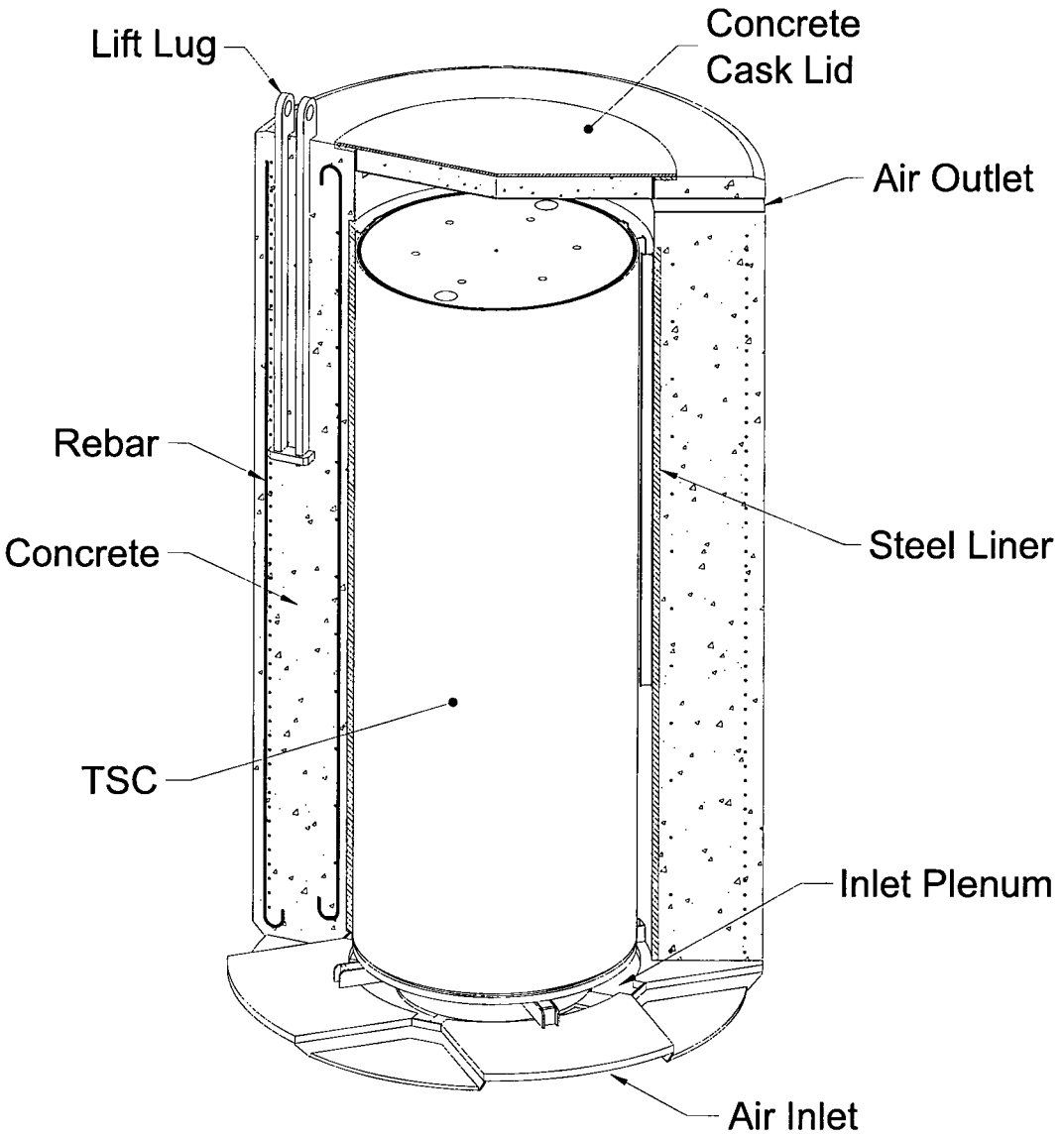
The detailed generic step-by-step operating procedures for the loading and transferring of MAGNASTOR are presented in Chapter 9. The following is a list of the major loading activities. This list assumes that the empty TSC is installed in the transfer cask.

- Fill the TSC with water or borated water if required.
- Lift the transfer cask over the pool and start the flow of water to the transfer cask annulus and lower the cask to the bottom of the pool.
- Load the selected spent fuel assemblies and damaged fuel cans (if applicable) into the TSC.
- Install the closure lid assembly.

- Remove the transfer cask from the pool and place it in the cask preparation workstation.
- Decontaminate the transfer cask.
- Lower the TSC water level and weld the closure lid to the TSC shell. Examine the weld.
- Hydrostatically test the TSC.
- Install and weld the closure ring. Examine the weld.
- Drain the remaining pool water from the TSC.
- Vacuum dry the TSC cavity. Verify cavity dryness.
- Establish a helium backfill.
- Install and weld the inner vent and drain port covers. Examine the welds.
- Helium leak test the inner vent and drain port covers.
- Install and weld the outer vent and drain port covers. Examine the welds.
- Install the TSC lifting system.
- Install the adapter plate on the concrete cask.
- Lift and place the transfer cask on the transfer adapter.
- Attach the TSC lifting system to the crane hook and raise the TSC off of the shield doors.
- Open the shield doors.
- Lower the TSC into the concrete cask (see Figure 1.3-1).
- Remove the transfer cask, transfer adapter, and TSC lifting systems.
- Install the lid on the concrete cask.
- Move the loaded concrete cask to the storage pad.
- Move the concrete cask to its designated location on the storage pad.

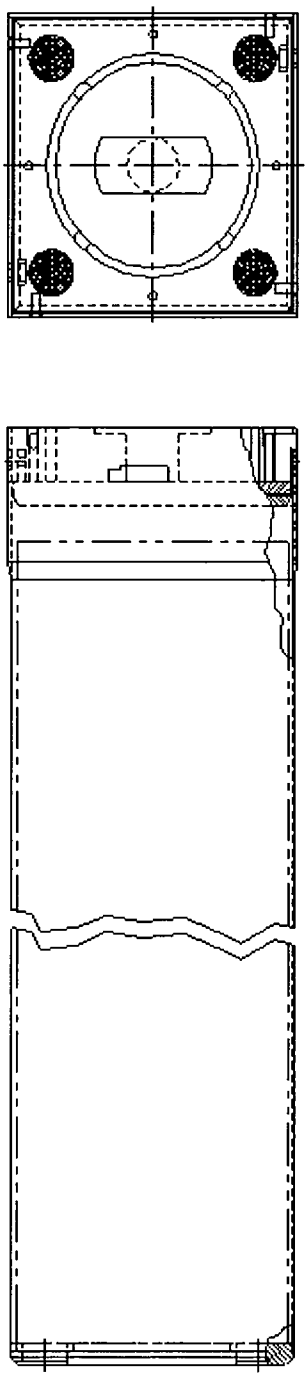
The TSC unloading and spent fuel removal from the TSC are essentially the reverse of these steps, except that weld removal and cooldown of the contents is required. This typical sequence of operations, and individual steps, may be modified by the approved site procedure to accommodate specific site requirements, as long as the requirements of the Technical Specifications and the Certificate of Compliance (CoC) are met.

Figure 1.3-3 Concrete Cask



Note: Inner rebar optional.

Figure 1.3-4 MAGNASTOR Damaged Fuel Can



1.4 MAGNASTOR Contents

The MAGNASTOR system is designed to safely store up to 37 undamaged PWR fuel assemblies in the 37 PWR basket assembly or up to 87 undamaged BWR fuel assemblies in the 87 BWR basket assembly. The system is also designed to store up to four damaged fuel cans (DFCs) in the DF Basket Assembly. The DF Basket Assembly has a capacity of up to 37 undamaged PWR fuel assemblies, including four DFC locations. DFCs may be placed in up to four of the DFC locations. Each DFC may contain an undamaged PWR fuel assembly, a damaged PWR fuel assembly, or PWR fuel debris equivalent to one PWR fuel assembly. Undamaged PWR fuel assemblies may be placed directly in the DFC locations of a DF Basket Assembly.

PWR fuel assemblies may be stored with nonfuel hardware. Nonfuel hardware stored in a damaged or undamaged fuel assembly placed into a DFC is limited to steel rod inserts for guide tube dashpots and instrument tube tie components. BWR fuel assemblies may be stored with or without channels. Assemblies may contain solid filler rods or burnable absorber rods replacing fuel rods in the assembly lattice. Irradiated (i.e., activated during in-core operation) steel filler rods are limited to five rods per assembly and there may be no more than one assembly with irradiated rods per TSC. The design content conditions are specified in the CoC for MAGNASTOR. Unenriched PWR fuel assemblies are not evaluated and are not included as allowable contents. Unenriched BWR fuel assemblies are allowed with a maximum assembly average burnup of 5,000 MWd/MTU. Assemblies may contain axial end blankets. Axial end blankets may be low enriched, be unenriched, and/or contain annular fuel pellets.

Chapter 4
Thermal Evaluation

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4.1 Discussion

MAGNASTOR consists of a TSC, concrete cask, and a transfer cask. In long-term storage, the fuel, including fuel contained in damaged fuel cans and PWR minimum reduced cool time fuel, is loaded in a basket structure positioned within the TSC. The TSC is placed in the concrete cask, which provides passive radiation shielding, structural protection and natural convection cooling. The transfer cask is used to handle the TSC. The thermal performance of the concrete cask containing a loaded TSC with design basis fuel, and the performance of the transfer cask containing a loaded TSC with design basis fuel are evaluated in this chapter.

The thermal evaluation considers normal conditions and off-normal and accident events of storage. Each of these conditions can be described in terms of the environmental temperature, use of solar insolation, and the condition of the air inlets as shown in Table 4.1-1. The evaluation of the different phases of the transfer operation is accomplished by altering the properties of the medium in the canister to correspond to water or helium.

In order for the heat from the stored spent fuel assemblies, including fuel contained in damaged fuel cans and PWR minimum reduced cool time fuel, to be rejected to the ambient environment via the concrete cask or the transfer cask, the decay heat from the contents is transferred to the TSC surface. The MAGNASTOR baskets for the PWR and the BWR fuel assemblies use all three heat transfer modes—radiation, conduction and convection—to transfer the heat to the TSC surface. The basket design enhances convection heat transfer. Helium is used as the backfill gas in the TSC because its thermal conductivity is better than other allowable backfill gases. The basket is comprised of full-length carbon steel tubes that provide a significant path for conduction heat transfer. Radiation is a significant mode of heat transfer in the fuel region and between the outer surface of the basket and the TSC shell.

The significant thermal design feature of the concrete cask is the passive convective airflow around the outside of the TSC. Cool (ambient) air enters at the bottom of the concrete cask through four air inlets. Heated air exits through the four air outlets in the upper concrete cask body. Radiant heat transfer occurs from the TSC shell to the concrete cask liner, which then transmits heat to the annular airflow. Conduction through the concrete cask, although not significant, is included in the analytical model. Natural circulation of air through the concrete cask annulus, in conjunction with radiation from the TSC surface, maintains the fuel cladding temperature and all component temperatures below their design limits.

The MAGNASTOR design basis heat load is 35.5 kW for PWR fuel. The fuel loading may be in the 37 PWR Basket Assembly, i.e., up to 37 undamaged PWR fuel assemblies, or up to 37 PWR

minimum reduced cool time fuel, or in the DF Basket Assembly, which has a capacity of up to 37 undamaged fuel assemblies including four DFC locations. Damaged fuel cans may be located in the DFC locations at the four outer corners of the DF basket assembly (Figure 2.2-3 and License Drawing 71160-675). Both the PWR fuel basket and the DF basket assembly can accommodate a uniform heat load of 959 W per assembly, or a preferential loading pattern as shown in Figure 4.1-1. The preferential loading pattern identified in Figure 4.1-1 defines three values of heat generation that place the fuel assemblies with the maximum heat generation rate in an intermediate region of fuel storage locations. The PWR fuel basket can also accommodate a various heat load per assembly for the PWR minimum reduced cool time fuel with a preferential loading pattern, as shown in Figure 4.1-2. Analyses are performed using the two-dimensional axisymmetric model with the same fluid resistances and material properties for both the preferential and uniform loading patterns of the standard PWR fuels, as well as for the preferential load pattern for the PWR minimum reduced cool time fuel. The calculated maximum fuel temperature is essentially the same for both loading configurations for standard PWR fuels. The maximum temperatures at the radial location of the center of a preferential loaded fuel assembly with the 1.2 kW heat load is determined to be 689°F. At this same radial location, the calculated temperature for the uniform heat load is 684°F. This small increase is a localized bounding temperature response due to the localized increased heat generation for the preferential loading configuration. As shown in Sections 4.4.1.6 and 4.4.3 and as concluded in Sections 4.5 and 4.6, the maximum fuel temperature for the DF basket assembly configuration is bounded by that for the standard PWR basket configuration. The analysis for the PWR minimum reduced cool time fuel with the preferential loading pattern (Figure 4.1-2) is also performed using the modified two-dimensional axisymmetric model. As shown in Sections 4.4.1 and 4.4.3 and as concluded in Sections 4.5 and 4.6, the maximum fuel temperature for the PWR minimum reduced cool time fuel configuration is bounded by that for the standard PWR basket configuration.

The identical maximum fuel cladding temperature calculated for both the PWR fuel basket and the DF basket assembly loading configurations, resulting from identical total heat and small differences in inner region heat (4%), demonstrates efficiencies in the alternate PWR preferential loading configuration. Placement of the highest heat load for the preferential loading configuration in an intermediate radial location balances system performance. The thermal loading basis for the PWR analyses in this chapter uses the preferential loading since it represents the system loading with maximum heat concentration. The maximum fuel temperature reduction for the PWR minimum reduced cool time fuel also states that placement of the highest heat load in an intermediate radial location, plus the low heat in the basket center nine

(9) slots, enhances system performance. The BWR fuel basket can accommodate 87 fuel assemblies with a uniform design basis total heat load of 33 kW, or 379 watts, per assembly.

The thermal evaluation applied different component temperature limits and allowable stress limits for long-term conditions versus short-term conditions. Normal storage operation is considered to be a long-term condition. Off-normal and accident events are considered to be short-term conditions. Thermal evaluations are performed for the design basis PWR and BWR fuels for all design conditions. The maximum allowable material temperatures for long-term and short-term conditions are provided in Table 4.1-2.

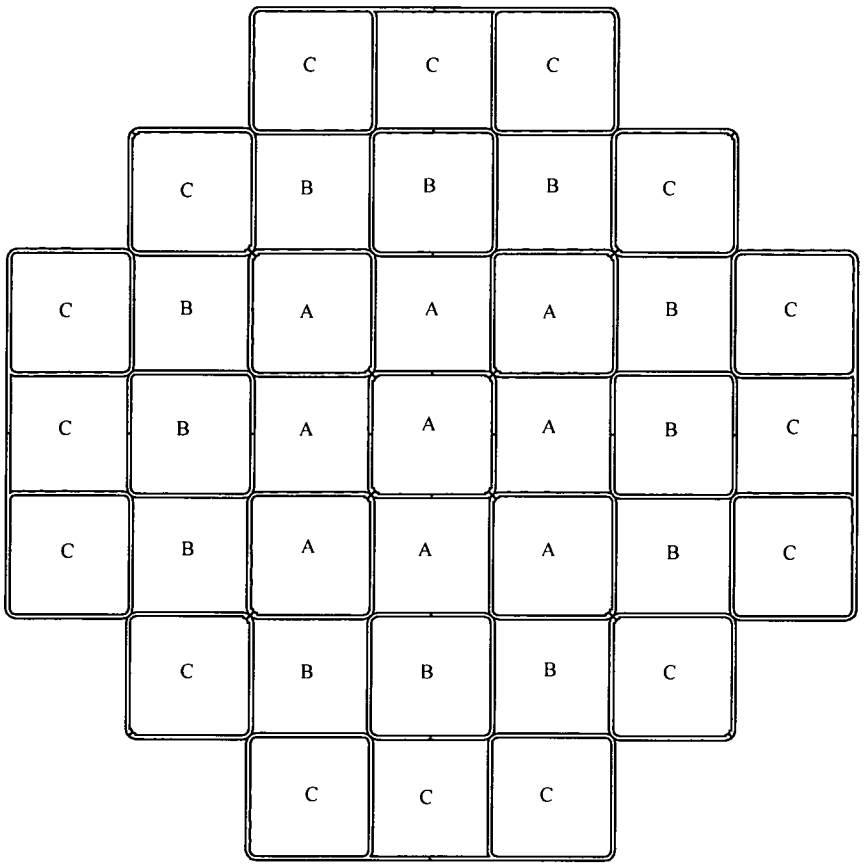
During normal conditions of storage and off-normal and accident events, the concrete cask must reject the decay heat from the TSC to the environment without exceeding the system components temperature limits. In addition, to ensure fuel rod integrity for normal conditions of storage, the spent fuel must be maintained at a sufficiently low temperature in an inert atmosphere to preclude thermally induced fuel rod cladding deterioration. To preclude fuel degradation, the maximum cladding temperature under normal conditions of storage and canister transfer operations is limited to 752°F (400°C) per ISG-11 [2]. The maximum cladding temperature for off-normal and accident events is limited to 1,058°F (570°C). For the structural components of the storage system, the thermally induced stresses, in combination with pressure and mechanical load stresses, are limited to the material allowable stress levels.

Thermal evaluations for normal conditions of storage and canister transfer operations are presented in Section 4.4. The finite element method is used to compute the effective properties for the basket, neutron absorber and fuel region. The thermal solutions for the concrete cask and transfer cask are obtained using finite element and finite volume methodologies. Thermal models used in the evaluation of normal and transfer conditions are described in Section 4.4.1.

A summary of the thermal evaluation results for normal conditions of storage is provided in Table 4.4-3 for the PWR and the BWR cases. Table 4.4-5 through Table 4.4-14 contain the maximum fuel cladding temperatures for the different phases of the transfer operations for the PWR and BWR cases. Thermal evaluation results for off-normal and accident events are presented in Sections 4.5 and 4.6, respectively. Comparison of the evaluation results shows that the standard PWR basket evaluation bounds that of the DF basket assembly and also bounds that of the PWR minimum reduced cool time fuel basket assembly. The results demonstrate that the calculated temperatures are less than the allowable fuel cladding and component temperatures for all normal (long-term) storage conditions and for short-term events. As shown in Chapter 3, the thermally induced stresses, combined with pressure and mechanical load stresses, are also within allowable limits.

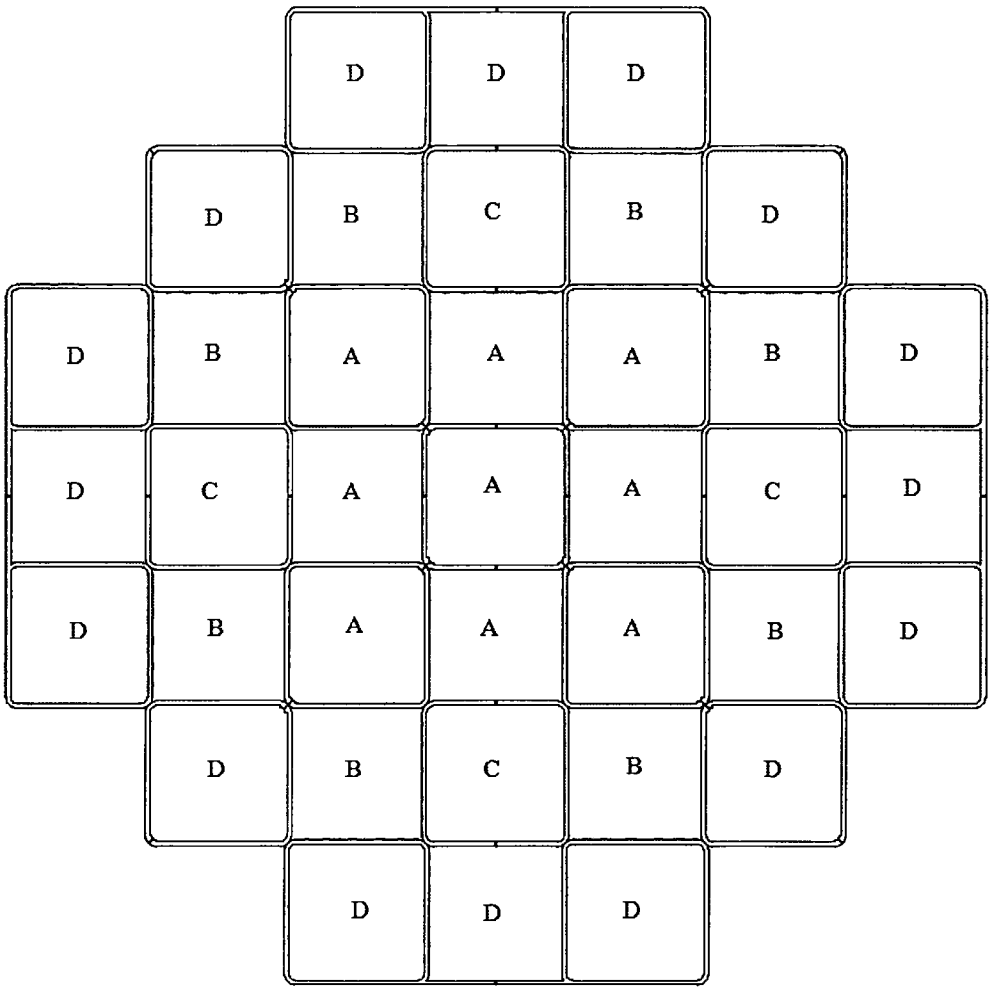
As discussed in Section 4.4.1, for TSC that is less than fully loaded, empty fuel storage locations shall begin at the center of the basket and continue outward, as required in an approximately symmetric pattern.

Figure 4.1-1 Definition of the Preferential Loading Pattern for the PWR Basket Assembly



Zone Identification	A	B	C
Maximum Heat Load per Assembly (kW)	0.922	1.20	0.80
Total Number of Fuel Assemblies	9	12	16

Figure 4.1-2 Preferential Loading Pattern for the PWR Basket with Minimum Reduced Cool Time Fuel



Zone Description	Designator	Heat Load [Watts]	No. of Assemblies
Inner Ring	A	513	9
Middle Ring	B	1300	8
Middle Ring	C	1800	4
Outer Ring	D	830	16

Table 4.1-1 Summary of Thermal Design Conditions for Storage for MAGNASTOR

Condition		Environmental Temperature (°F)	Solar Insolation [a]	Condition of Concrete Cask Inlets
Normal		76[b]	Yes	All inlets open
Off-Normal - Half Air Inlets Blocked		76	Yes	Half inlets blocked
Off-Normal - Severe Heat		106	Yes	All inlets open
Off-Normal - Severe Cold		-40	No	All inlets open
Accident - Extreme Heat		133	Yes	All inlets open
Accident - All Air Inlets Blocked		76	Yes	All inlets blocked
Accident - Fire	During Fire	1475	Yes	All inlets open
	Before and After Fire	76	Yes	All inlets open

[a] Solar Insolation per 10 CFR 71 [3]:
Curved Surface: 400 g cal/cm^2 (1475 Btu/ft^2) for a 12-hour period.
Flat Horizontal Surface: 800 g cal/cm^2 (2950 Btu/ft^2) for a 12-hour period.

[b] Maximum average annual temperature in the 48 contiguous United States is 75.6°F. [25]

Table 4.1-2 Maximum Allowable Material Temperatures

Material	Temperature Limits (°F)		Reference
	Long Term	Short Term	
Concrete	200(B)/300(L)[a]	350	ACI-349 [4] NUREG-1567 [20]
Fuel Clad PWR Fuel BWR Fuel	 752 752	 752/1,058[b] 752/1,058[b]	 ISG-11 [2] and PNL-4835 [5]
NS-4-FR	300	300	JAPC [6]
Chemical Copper Lead	600	600	Baumeister [7]
ASME SA693 17-4PH Type 630 Stainless Steel	650	800	ASME Code [8] ARMCO [9]
ASME SA240 Type 304 Stainless Steel	800	800	ASME Code [8]
ASME SA537 Class 1 Carbon Steel	800	850/1,000[c]	ASME Code [8] ASME Code Case N-707 [26]
ASTM A588 Carbon Steel	700	700	ASME Code Case N-71-17 [10] ASTM Standard [19]
ASTM A350 LF2 Carbon Steel	700	700	ASTM Standard [19]
ASTM A36 Carbon Steel	700	700	ASME Code Case N-71-17 [10] ASTM Standard [19]
ASME SA695 Type B Grade 40 and SA696 Type C Carbon Steel	800	800	ASME Code [8]

[a] B and L refer to bulk temperature and local temperature, respectively.
[b] 752°F TSC transfer operations; 1,058°F off-normal and accident events.
[c] 850°F TSC transfer operations; 1,000°F off-normal and accident events.

k_s ---------- thermal conductivity associated with the solid portion of the porous media model

The model of loaded TSC for the PWR minimum reduced cool time fuel is identical to the first model for standard PWR fuel, except for the mesh of the basket region. The basket zone is remeshed to match the variation of the heat generation of the preferential fuel heating pattern of the minimum reduced cool time fuel configuration.

Heat Generation

The heat generation for the fuel is applied to the active fuel region of the TSC model (see Figure 4.4-1) for the PWR and the BWR fuel assemblies. The maximum design basis heat loads to be considered for the PWR and the BWR fuel basket configurations are 35.5 kW and 33 kW, respectively. The maximum design basis heat load to be considered for the DF basket assembly is 35.5 kW.

For the PWR fuel basket, three patterns of heat generation are considered. First, a uniform loading of 35.5 kW or 959 W in each fuel location is considered. The axial power distribution for PWR fuel, as shown in Figure 4.4-3, is included in applying the heat generation. Secondly, an optional heat generation pattern, as shown in Figure 4.1-1 is also considered and has the same total heat load of 35.5 kW. The application of the heat generation for this condition incorporates an axial distribution and a radial distribution. The area over which each fuel assembly heat load is distributed in Figure 4.1-1 is determined on the basis of the cross-section of the fuel tubes containing the specific heat loads identified as A, B and C in Figure 4.1-1. The heat generation values specified in Figure 4.1-1 are considered to be the maximum permissible heat generation in each fuel location for this configuration. It is noted that maximum fuel assembly heat load in Figure 4.1-1 is 25% greater than the heat load for the uniform condition. The fuel heat load in the center of the basket in Figure 4.1-1, Zone A, at 0.922 kW is only 4% less than the uniform heat loading at 0.96 kW per assembly. The use of hotter assemblies in the Zone B ring results in slightly more flow in the Zone B region with the higher heat load, but simultaneously presents a bounding condition over the uniform loading of the entire basket since the edge of Zone A temperatures is increased by the influence from the higher heat in Zone B. An analysis using a 40 kW preferential loading with a more aggressive annular turbulence model (K-ε) and a reduced flow resistance showed that the preferential heat distribution increased the maximum fuel temperatures by 6°F. With the reduction of the maximum heat load to 35.5 kW, the 6°F difference in maximum fuel cladding temperature will decrease, but will still produce temperatures equal to or greater than the uniform heat load configuration. . Thirdly, an optional heat generation pattern, as shown in Figure 4.1-2 is also considered and has the same total heat load of 35.5 kW. The application of the heat generation for this condition incorporates an axial distribution and a radial distribution. The area over which each fuel assembly heat load is

distributed in Figure 4.1-2 is determined on the basis of the cross-section of the fuel tubes containing the specific heat loads identified as A, B, C and D in Figure 4.1-2. The heat generation values specified in Figure 4.1-2 are considered to be the maximum permissible heat generation in each fuel location for this configuration.

In one of the three analyses performed for the DF basket assembly, the uniform loading heat generation rate of undamaged fuel is applied to the standard fuel slots and a compacted heat generation rate (over the lower 103 inches of the active fuel region considering a 50% compaction of the fuel debris) is considered for the four damaged fuel can slots. In the other two analyses, the uniform loading heat generation rate of standard fuel assemblies is applied to the active fuel region of the basket.

For the BWR fuel basket, only a uniform thermal loading pattern is considered. The design basis heat load for BWR fuel is 33 kW, which corresponds to a maximum heat load of 379 watts for each of the 87 fuel assemblies. The axial power distribution for the BWR fuel is shown in Figure 4.4-4. For some BWR fuel assembly enrichments, the five fuel locations in the center of the BWR basket will not be loaded. In this configuration, the fuel assembly decay heat is limited to 379 watts. The configuration with a partially loaded fuel basket containing BWR fuel assemblies with a maximum heat load of 379 watts per assembly is considered to be bounded by the fully loaded BWR fuel basket configuration. Temperatures obtained from analyses performed using the maximum heat load in conjunction with a fully loaded BWR basket are considered to bound the results for a partially loaded basket.

Pressure of the Helium Backfill

To drive the convection internal to the TSC, it is necessary to increase the density of the helium. Since the free volume in the TSC remains constant, the density of the backfill gas can be increased by backfilling the TSC to a range of pressures and temperatures that would result in an increase in the density. In the MAGNASTOR design, the TSC is backfilled with helium to meet the density listed in Table 4.4-4. Since the gas in the model is characterized as an ideal gas, the increased density in the analysis can be indirectly obtained by specifying a pressure in the TSC region. For the PWR normal condition, the density of helium in the TSC associated with a pressure of 7 atm (g) is (0.76g/liter). It is important to assess the effect of the helium density on the performance of the system. The evaluation of the sensitivity of the peak fuel temperature to the pressure is performed using the PWR model described in this section. The condition requiring a change is the pressure that is applied to the TSC region of the model. The results of the model solutions for pressures of 1 atm (g), 3 atm (g), 5 atm (g) and 7 atm (g) are shown as a graph in Figure 4.4-5. As shown in Figure 4.4-5, the variation of the peak cladding temperature with the pressure specified inside the TSC is a nonlinear function. The peak cladding temperature decreases sharply when the pressure increases from 1 atm to 3 atm. Subsequent

increases in the pressure to 5 atm and 7 atm do not result in the same rate of decrease of the clad temperature as for the 1 atm and 3 atm cases. The model of the TSC in the concrete cask has two regions of convection separated by a TSC shell. Heat can only be transferred through the shell from the TSC internal region to the annulus region outside the TSC. The flow characteristics in the annulus region are primarily affected by the total heat generation being transferred through the TSC shell, as well as the geometry of the annulus. As the pressure (and the associated mass) of the gas in the TSC is increased, the buoyancy force inside the TSC is increased. This increases the mass flow rate of the TSC gas so that the ability to reject heat from the fuel is also increased. This would tend to reduce the maximum clad temperature. However, the flow in the annulus is not expected to be significantly affected by the velocity of the gas internal to the TSC. Therefore, regardless of the buoyancy force inside the TSC, the maximum clad temperature is limited by the shell temperature, which is controlled by the annulus flow. At some pressure level, an increase in the TSC pressure (and mass) of the gas would not significantly decrease the fuel clad temperature, which would imply a reduced derivative of the clad temperature with respect to the pressure. This is the characteristic of the curve in Figure 4.4-5, which implies that further increase in the pressure does not result in a significant reduction of the clad temperature. There is an advantage in operating in this regime of the curve in that the sensitivity of the clad temperature due to a reduction in the helium density is reduced. This evaluation demonstrates that even with a 10% loss of density, the peak clad fuel temperatures for the design basis heat load remain under 752°F (400°C). The calculated maximum temperatures from this evaluation show that there is an acceptable 10 psig tolerance for the minimum helium backfill pressure.

Modeling of the Air Inlet with Shield Bars

The inlet region of the CC3 concrete cask is designed with shield bars for enhanced shielding. The flow resistances of the inlet vent airway of the concrete cask, which includes shield bars, are calculated using a three-dimensional FLUENT CFD model (see Figures 4.4-20 and 4.4-21). Half of the inlet is modeled because of symmetry. The symmetry plane passes between the top and bottom walls of the air inlet. The computed viscous and inertial resistance coefficients are applied to the inlet region of the two-dimensional axisymmetric concrete cask and to the TSC model corresponding to the CC3 concrete cask. The inlet region is defined as a porous region without the geometric details of the inlet. For each applied pressure gradient between inlet and outlet boundaries, the average axial velocity in the model is determined. Five sets of the average static pressure drop between the flow inlet and outlet boundaries as a function of the average axial velocity in the domain are obtained and curve fitted as:

$$\Delta P = 0.1451 \times V + 1.222 \times V^2$$

where, ΔP is the average static pressure drop and V is the average axial velocity.

The pressure drop is related to the source term in the momentum equation for a homogenous porous medium according to:

$$\Delta P = (\frac{\mu}{\alpha} V + \frac{1}{2} C_p V^2) \Delta n$$

where Δn is the porous medium thickness, ρ is air density, μ is air viscosity, $1/\alpha$ is the viscous resistance coefficient, and C is the inertial resistance coefficient.

Comparing the previous equations and substituting the geometry of the inlet and the material properties of air at ambient temperature, the viscous resistance and inertial resistance coefficients are:

$$1/\alpha = 9051 \ 1/m^2 \quad C = 2.633 \ 1/m.$$

The viscous and inertial resistance coefficients are divided by the porosity and porosity squared, respectively, to get the resistance coefficient for the 100% open area used in modeling the inlet region as a porous zone in the concrete cask thermal analysis. The porosity of the model is determined to be 0.9282 for the air inlet with additional shield bars.

Mesh Sensitivity Evaluation

With respect to the sensitivity of the calculated fuel cladding, concrete cask and TSC temperatures to the number of divisions of the finite volume cells, this need only be addressed for the regions containing fluid flow. For the solid regions, such as the concrete or the steel components, the sensitivity evaluation of cell refinement is not required.

There are two fluid regions in the model: the airflow annulus region outside the TSC, and the helium region inside the TSC. Each of these fluid regions uses a different fluid flow model. The TSC internal flow is modeled utilizing a laminar flow model; the airflow in the annulus region is modeled using a turbulent flow model.

In the concrete cask annulus region, the modeling accuracy of the turbulent flow depends not on the usual refined mesh near the wall, as for a laminar flow condition, but on the value of y+, as previously discussed. The cell divisions in the annulus region have been set to permit the y+ to be less than unity, which is acceptable according to FLUENT documentation. Therefore, further refinement of the annulus region would not provide a more accurate temperature result.

For the helium flow in the TSC (laminar flow), the largest velocities are in the downcomer regions and, essentially, the entire heat load must be transferred to the TSC shell. The focus of the sensitivity evaluation is the number of cell divisions in the downcomer region. The largest velocity gradients in the downcomer regions occur in the radial direction, not in the axial direction. To determine the sensitivity of the radial divisions in the downcomer region, the

number of radial divisions modeled was increased by a factor of two. The axial divisions in the downcomer region remain the same. The mesh refinement in the air annulus and in the concrete cask remains unchanged. The condition used in the evaluation corresponded to the normal condition using a uniform heat loading of 40 kW, which bounds the design basis condition for the 35.5 kW. The results of this evaluation showed that the maximum fuel temperature changed by less than 1°F for the increased refinement mesh. The temperature of the TSC shell showed a decrease of 2°F for the mesh with the increased refinement. This indicates that the maximum fuel temperature is relatively insensitive to the mesh refinement in the downcomer region.

Heat Transfer by Radiation

Thermal radiation in all fluid (air and helium) regions has been considered in the model, specifically the following.

- Thermal radiation across the air annulus between the TSC shell and the concrete cask liner.
- Thermal radiation across the air gap above the TSC lid and in the isolated air region below the pedestal of the concrete cask.
- Thermal radiation across the helium downcomer region between the fuel basket and the TSC shell.

The discrete ordinates (DO) radiation model in FLUENT is used to solve the radiative heat transfer equation with emissivity values applied on the solid material surfaces.

Radiation in the porous media fuel region is modeled by using equivalent thermal conductivities that include the effects of heat transfer by radiation. The model of the porous media region in FLUENT is enclosed by a vertical wall that separates the porous region from the downcomer. The wall is comprised of two sides; one side facing the inner surface of the canister and the other facing the interior region of the porous media. An emissivity corresponding to electroless nickel is applied to the side facing the canister surface. On the side of the wall facing the interior region of the porous media, an emissivity of zero is applied to avoid incorporating the radiation already taken into account using the effective properties for the basket.

4.4.1.2 Two-Dimensional Fuel Basket Models

The purpose of the two-dimensional fuel basket model is to determine the effective thermal conductivity of the basket region in the axial and radial directions. The effective conductivities are used in the two-dimensional axisymmetric concrete cask and TSC models, and the two-dimensional axisymmetric transfer cask and TSC models. Two types of media are considered in the TSC: helium and water. The fuel assemblies and neutron absorbers in the fuel basket model are shown as homogeneous regions with effective thermal properties, which are determined by

the two-dimensional fuel assembly models and the two-dimensional fuel tube models described in Sections 4.4.1.3 and 4.4.1.4, respectively. The analyses performed in Section 4.4.1.3 identify that the PWR fuel assembly with the minimum conductivity is the 14×14. The properties of the PWR 14×14 fuel assembly are used in the evaluation of the effective properties for the PWR basket in this section. For the BWR assembly, the bounding fuel assembly type is the 10×10, which is used to determine the effective properties for the BWR basket.

Since the effective properties for the fuel basket correspond to the basket region, which is comprised of full-length fuel tubes, it is only necessary to consider a cross-section of the basket with a two-dimensional planar model. Due to symmetry of the basket designs, only a 1/8-section model is required for the PWR and the BWR fuel baskets. ANSYS is used to perform the conduction analysis using the models shown in Figure 4.4-6 for the PWR fuel basket and Figure 4.4-7 for the BWR fuel basket. The models include only radiation and conduction heat transfer. Radiation heat transfer is incorporated into the effective properties for the fuel assemblies and the neutron absorbers. Each fuel basket model takes into account the size of the cells in the basket – i.e., those cells formed directly by the fuel tube, and those cells formed by adjacent fuel tubes. The neutron poison is contained only on the inner surface of the basket tubes. The exterior tubes, which form the boundary of the downcomer region, may not have neutron absorbers on the adjacent surface of the interfacing fuel tubes. In the condition where the neutron absorber sheet is not required for criticality control, aluminum plates may be installed as an alternative to maintain thermal properties. The PWR and BWR fuel basket models evaluated in this section use the conductivity of the neutron poison defined in Chapter 8.

Additionally, it is conservatively assumed for both the PWR and BWR fuel baskets that a gap between the fuel tubes exists for the full length of the tube without any contact, as shown in Figure 4.4-6 and Figure 4.4-7. The gap between the fuel tubes is modeled as being 0.01 inch, and the conduction through the gap is based on the presence of either helium or water, depending on the condition.

The effective thermal conductivity (K_{eff}) of the fuel basket region in the radial direction is determined by considering the basket region as a solid cylinder with heat generation.

Considering the temperature at the center of the TSC to be T_{max}, the effective thermal conductivity (K_{eff}) is shown:

$$K_{eff} = \frac{Q}{4\pi H(T_{max} - T_o)} = \frac{Q}{4\pi H \Delta T} \quad [15]$$

where:

Q ---------- total heat generated by the fuel (Btu/hr)
H ---------- length of the active fuel region (in)

T_o ---------- boundary temperature of the basket
ΔT ---------- $T_{max} - T_o$ (°F)

The value of ΔT is obtained from thermal analysis using the two-dimensional models shown in Figure 4.4-6 and Figure 4.4-7, with the boundary temperature constrained to be T_o. The effective conductivity (K_{eff}) is then determined by using the stated expression. The analysis is repeated by applying different boundary temperatures so that temperature-dependent conductivities can be determined.

The effective properties for the DF basket assembly are determined using the same methodology as used for the standard PWR basket, except for the modification to the model, as listed.

1. A ¼-section model is used as shown in Figure 4.4-22.
2. The contents of the DFC locations in the DF basket assembly are conservatively modeled as helium, which has a lower conductivity.
3. Thermal conductivities of the steel plates forming the basket corner slot in the model are factored to reflect the actual plate thickness.

4.4.1.3 Two-Dimensional Fuel Assembly Models

The two-dimensional fuel assembly models include the fuel pellets, cladding, and the media occupying the space between fuel rods. The media is considered to be helium for storage conditions, and water or helium for transfer conditions. The two-dimensional finite element models of the fuel assemblies are used to determine the effective conductivities for the PWR and BWR fuel assemblies. The effective conductivities are used in the two-dimensional fuel basket models described in Section 4.4.1.2. For the PWR fuel assemblies, four separate types are considered: 14×14, 15×15, 16×16 and 17×17. For the BWR fuel assemblies, four separate types are considered: 7×7, 8×8, 9×9 and 10×10. For the BWR fuel assembly, a fuel channel is considered since it may be present and it will result in bounding fuel cladding temperatures. Therefore, it is only necessary to address a single fuel configuration for each of the fuel assembly types.

The two-dimensional fuel assembly models include the fuel pellets, cladding, media between fuel rods, media between the fuel rods and the inner surface of the fuel tube (PWR), or between the fuel rods and the inner surface of the fuel channel (BWR), and a gap between the fuel pellets and cladding. The media are considered to be helium for storage, and water or helium for transfer conditions. Modes of heat transfer modeled include conduction and radiation between individual fuel rods for the steady-state condition. ANSYS PLANE55 conduction elements and MATRIX50 radiation elements are used to model conduction and radiation. (Radiation is not considered for the water condition.) Radiation elements are defined between fuel rods and between the fuel rods and the fuel tube (PWR) or the fuel channel (BWR). A typical PWR fuel

assembly finite element model is shown in Figure 4.4-8, which corresponds to the 14×14 fuel assembly. The BWR fuel assembly model only considers the region up to the inner surface of the channel, and a typical BWR fuel assembly is shown in Figure 4.4-9, which corresponds to the 10×10 fuel assembly.

The effective conductivity for the fuel is determined by using an equation defined in a Sandia National Laboratory Report [15]. The equation is used to determine the maximum temperature of a square cross-section of an isotropic homogeneous fuel with a uniform volumetric heat generation. At the boundary of the square cross-section, the temperature is constrained to be uniform. The expression for the temperature at the center of the fuel is given by:

$$T_c = T_e + 0.29468\ (Qa^2 / K_{eff})$$

where:

T_c ---------- the temperature at the center of the fuel (°F)
T_e ---------- the temperature applied to the exterior of the fuel (°F)
Q ---------- volumetric heat generation rate (Btu/hr-in^3)
a ---------- half length of the square cross-section of the fuel (inch)
K_{eff} ---------- effective thermal conductivity for the isotropic homogeneous fuel (Btu/hr-in-°F)

Volumetric heat generation (Btu/hr-in^3) based on the design heat load is applied to the pellets. The effective conductivity is determined based on the heat generated and the temperature difference from the center of the model to the edge of the model. Temperature-dependent effective properties are established by performing multiple analyses using different boundary temperatures. The effective conductivity in the axial direction and the effective density of the fuel assembly are calculated on the basis of the material area ratio. The effective specific heat is computed on the basis of a weighted mass average.

For the PWR fuel assemblies, the 14×14 fuel assembly is shown to have the effective properties that correspond to the minimum values, as shown in Table 4.4-1 for both fuel tube configurations, i.e., with and without neutron absorber.

For the BWR fuel assemblies, the 10×10 fuel assembly is shown to have the effective properties that correspond to the minimum values, as shown in Table 4.4-2.

4.4.1.4 Two-Dimensional Neutron Absorber Models

The two-dimensional neutron absorber model is used to calculate the effective conductivities of the neutron absorber, the neutron absorber retainer, and the fuel channel (for BWR only). These effective conductivities are used in the two-dimensional fuel basket models (Section 4.4.1.2). A

total of three neutron absorber models is required: one PWR model (for the PWR 14×14) and two BWR models—one with the neutron absorber plate and channel, and one with the channel but without the neutron absorber plate, corresponding to the enveloping configurations of the 10×10 BWR fuel assembly.

The configurations shown in the neutron absorber models in Figure 4.4-10 and Figure 4.4-11 for PWR and BWR fuel, respectively, incorporate the neutron absorber (and the channel for the BWR). The configuration shown in Figure 4.4-12 is for the BWR fuel tube with the channel, but without the neutron absorber.

As shown in Figure 4.4-10, the PWR fuel tube model includes the neutron absorber, the stainless steel retainer, and the gaps between the neutron absorber and the stainless steel retainer and the surface of the fuel tube. Two conditions of media are considered in the gaps: helium and water.

ANSYS PLANE55 conduction elements and LINK31 radiation elements are used to construct the model. The model consists of four layers of conduction elements and two sets of radiation elements (radiation elements are not used for the water condition) that are defined at the gaps (two for each gap). The thickness of the model (x-direction) is the distance measured from the outside surface of the stainless steel retainer to the inside surface of the fuel tube (assuming the neutron absorber is centered between the retainer and the fuel tube, and there is no contact for the length of the basket). The gap size between the neutron absorber and the adjacent surfaces is 0.002 inch.

The BWR fuel assemblies may include a fuel channel, as compared to the PWR assemblies, which have no fuel channel. Therefore, two effective conductivity models are necessary for the BWR: one model with the neutron absorber plate (a total of six layers of materials) and a fuel channel; and the other model with a fuel channel, but with a gap replacing the neutron absorber plate (a total of two layers of materials).

As shown in Figure 4.4-11, the first BWR neutron absorber model includes the fuel channel, the retainer, the neutron absorber and associated gaps. As shown in Figure 4.4-12, the second BWR neutron absorber model includes the fuel channel and the gap between the fuel channel and the fuel tube surface.

Heat flux is applied at the left side of the model (retainer for PWR model and fuel channel for BWR model), and the temperature at the right boundary of the model is specified. The heat flux is determined based on the design heat load. The maximum temperature of the model (at the left boundary) and the temperature difference (ΔT) across the model are calculated by the ANSYS model. The effective conductivity (K_{xx}) is determined using the following formula.

$$q = K_{xx} (A/L) \Delta T$$

or

$$K_{xx} = q\ L / (A\ \Delta T)$$

where:

K_{xx} ---------- effective conductivity (Btu/hr-in-°F) in X direction in Figure 4.4-10 through Figure 4.4-12
q ---------- heat rate (Btu/hr)
A ---------- area (in^2)
L ---------- length (thickness) of model (in)
ΔT ---------- temperature difference across the model (°F)

The temperature-dependent conductivity is determined by varying the temperature constraints at one boundary of the model and solving for the temperature difference. The effective conductivity for the parallel path (the Y direction in Figure 4.4-10) is calculated by the following.

$$K_{yy} = \frac{\sum K_i\ t_i}{L}$$

where:

K_i ---------- thermal conductivity of each layer (Btu/hr-in-°F)
t_i ---------- thickness of each layer (in)
L ---------- total length (thickness) of the model (in)

4.4.1.5 Two-Dimensional Transfer Cask and TSC Model for Operations Involving 24-Hour Cooling

During the transfer condition, the TSC in the transfer cask is subjected to four separate conditions.

- The water phase when the lid is being welded to the TSC.
- The drying phase during which helium is present while vacuum drying to remove moisture from the TSC and the annulus circulating water cooling system is operating.
- The helium backfilled phase when the TSC closure is completed and the transfer cask cooling water system is operating (24 hours of cooling).
- The operation of transferring the helium-backfilled TSC into the concrete cask with the transfer cask annulus circulating water cooling system drained.

In this section, analyses are performed to support the use of 24-hour cooling after the drying phase and prior to loading of the canister into the concrete cask. The use of the 24-hour cooling permits the maximum time for the drying phase and the maximum time to transfer the canister into the concrete cask. Section 4.4.1.6 describes the evaluation of an alternate system drying

operational cycle permitting the cool time to be minimized and the loading of the canister into the concrete cask to be limited to eight hours.

The first step is considered to be steady-state conditions for all heat loads. For vacuum drying operations, there is no time limit for the PWR basket with heat loads less than or equal to 25 kW, and no time limit for the BWR basket with heat loads less than or equal to 29 kW. The time in vacuum drying is administratively controlled for the PWR basket with heat loads greater than 25 kW, and for the BWR basket with heat loads greater than 29 kW, to ensure the maximum fuel cladding temperature is less than the allowable temperature. For high heat loads greater than 25 kW for the PWR basket and greater than 29 kW for the BWR basket, the 24-hour helium-backfilled phase is needed for both systems. The maximum time allowed for loading the helium-backfilled TSC into the concrete cask without operating the transfer cask annulus circulating water cooling system is determined by transient analyses. During the operational sequence of TSC loading, an Annulus Circulating Water cooling System (ACWS) may be used to flow water through the annulus to cool and maintain a specified temperature for the TSC external shell. Alternative cooling methods, such as reverse ACWS, or any other equivalent site-approved annulus cooling system or by fully submerging the TSC with the lid removed or the transfer cask annulus seals deflated, may also be used. The annulus cooling methods, when used, are designed to accommodate design basis heat loads without additional heat rejection from the transfer cask to the environment.

Note that the MAGNASTOR transfer cask is provided in two configurations, MTC1 and MTC2. The main difference between these two configurations is the material used for the cask shells and shield door (carbon steel for MTC1 and stainless steel for MTC2). The thermal models described in the following sections consider carbon steel properties for the cask shells and shield door. Since the radial conductance of the cask body is governed by the NS-4-FR material, and the water or air in the annulus between the canister and the cask shells carries out the majority of the heat, the cask shell material has an insignificant effect on the TSC and its contents. Therefore, the thermal models are applicable to both the MTC1 and MTC2 configurations.

Evaluation of the Water Phase With Annulus Circulating Water Cooling System

The model that includes water in the TSC treats the entire cavity as though it is filled with water. Since it is necessary to remove some water from the TSC during the closure lid welding operation, the water level in the TSC may be below the top of the fuel basket. The fuel tubes are designed with holes in the sides to permit the water to flow from the center of the TSC to the downcomer region of the TSC. The two-dimensional axisymmetric transfer cask and TSC models are used to evaluate the transfer operation for PWR fuels and BWR fuels. The components comprising the transfer cask and TSC model are shown in Figure 4.4-13 for the PWR configuration. The BWR model is identical to the PWR model except for a slight difference in the dimensions. The TSC portion of the model is identical to the model employed

in Section 4.4.1.1, with the exception that one of the conditions in the transfer operations uses water in the TSC instead of helium. The model for the TSC, described in Section 4.4.1.1, uses effective properties for the fuel basket region. For the water condition, the methodology described in Sections 4.4.1.2, 4.4.1.3, and 4.4.1.4 is used to determine the effective properties for the fuel basket region. For the condition of water in the TSC, no contribution due to radiation was considered; only conduction was taken into account for the effective properties. The porous media constants for the fuel basket region need not be recomputed since they are dependent on the fuel assembly and fuel basket geometry only. However, during the analytical evaluation of the water phase, the pressure drop in the fuel basket region due to the water requires the use of the viscosity, which is input as a material property. Since the maximum water temperature in the TSC is significantly below 212°F, the water is expected to remain in the liquid state, and the use of properties for the liquid state is acceptable. The transfer cask and the water annulus between the transfer cask and the TSC are also included in the model. The transfer cask is represented by effective properties. The transfer cask wall is comprised of four different materials: 1) a carbon steel inner shell; 2) a lead gamma shield layer; 3) an NS-4-FR neutron absorber layer; and 4) a carbon steel outer shell. Effective thermal conductivity for the transfer cask in the radial direction treats the four different cask wall materials as being in series. The effective thermal conductivity for the transfer cask wall in the axial direction treats the four different cask wall materials as being in parallel. The model also contains the shield doors of the transfer cask. While the inlets to the transfer cask are tubes in the side walls of the transfer cask, they are included in the model as straight sections parallel to the annulus. The following conditions are applied to the model for the steady-state evaluation of the water phase with the annulus circulating water cooling system.

- The outer surfaces of the transfer cask are considered to be adiabatic and without the application of solar insolance.
- The inlet water temperature for the annulus between the TSC and the transfer cask is specified to be 100°F.
- The driving force for the water flow in the annulus between the TSC and the transfer cask is natural convection. Water is supplied to the annulus inlets by an annulus circulating water cooling system.
- The heat generation internal to the TSC is modeled as 15, 20, 25, 30 and 35.5 kW for PWR fuels. The heat loads in Zones A, B and C, as defined in Figure 4.1-1, are factored based on the heat load for heat loads other than 35.5 kW. For the heat load of 35.5kW, the heat loads in Zones A, B and C are 0.922 kW, 1.20 kW and 0.80 kW, respectively. The heat generation internal to the TSC is modeled as 15, 20, 25, 30 and 33 kW for BWR fuels with a uniform heat distribution.
- The flow in the TSC and in the annulus region is treated as being laminar for both the water and helium conditions of the TSC.
- Radiation heat transfer is removed from the solution.

Evaluation of TSC Loaded with DF Basket Assembly

The flow resistance for a single zone DF basket assembly is slightly lower than the flow resistance for the standard PWR basket. The thicker side plates forming the basket corner slots for the damaged fuel can enhance the basket assembly conductance in the basket axial direction. Therefore, the thermal analysis results for the standard PWR basket bound the results for the DF basket assembly, as demonstrated by three representative analyses performed for the DF basket assembly for the transfer condition. Maximum fuel temperatures for all three analyses for the DF basket assembly are lower than those for the standard PWR basket. The three analyses are: 1) For the water phase, the 35.5 kW steady-state case (FLUENT CFD analysis) with helium inside the canister and water in the annulus between the canister and the transfer cask inner shell; 2) For the drying phase, the 25 kW steady-state case (ANSYS analysis) with helium inside the canister and water in the annulus between the canister and the transfer cask inner shell; 3) For the drying phase, the 35.5 kW transient case (ANSYS analysis) with helium inside the canister and water in the annulus between the canister and the transfer cask inner shell. Cases with helium inside the canister are selected because they yield higher fuel temperatures than cases with water inside the canister.

Evaluation of TSC Loaded with PWR Minimum Reduced Cool Time Fuel Basket Assembly

The PWR minimum reduced cool time fuel basket assembly loads the four (4) hottest fuel of 1.8kW at the outer zone of the basket (Zone C, Figure 4.1-2), in addition to all center nine (9) fuels with low heat loads of 513Watts. This loading pattern significantly removes the heat from the basket center, consequently, reduces the maximum fuel temperature, compared with the maximum fuel temperature for the standard PWR basket assembly with the same total heat load. Therefore, the thermal analysis results for the standard PWR basket bound the results for the PWR minimum reduced cool time fuel basket assembly, as demonstrated by the analysis performed for the PWR minimum reduced cool time fuel basket assembly for the vacuum drying condition. The transient analysis (ANSYS analysis) with helium inside the canister and water in the annulus between the canister and the transfer cask inner shell is performed for the same duration (24 hours) of vacuum drying and same heat load (35.5kW) for the PWR minimum reduced cool time fuel basket assembly as for the standard PWR basket assembly. The maximum fuel temperature for the vacuum transient analysis is 630°F or 10°F lower than the standard PWR basket assembly at the end of 24 hour vacuum drying of 640°F (Table 4.4-9). The vacuum transient analysis for the canister is selected because it yields higher fuel temperature than the steady state analyses with helium (with convection) or water inside the

canister for the same heat load. The reduction in the maximum temperature is expected since the maximum heat load is removed from the center of the basket.

4.4.2 Test Model

MAGNASTOR is conservatively designed by analysis. Therefore, no physical model is employed for thermal analysis. The benchmark provided in Section 4.8.1 provides confirmation that the analysis methodology employed for the MAGNASTOR design is conservative.

4.4.3 Maximum Temperatures for PWR and BWR Fuel Configurations

Normal Conditions of Storage

The temperature distributions and maximum component temperatures for MAGNASTOR for normal conditions of storage are provided in this section. System components of the CC1/CC2 concrete cask containing a PWR and BWR TSC and the CC3 concrete cask containing a PWR TSC are addressed separately. The temperature distributions in the CC1/CC2 concrete cask containing the BWR TSC are similar to those of the same system with the PWR TSC and are, therefore, not presented.

The temperature distribution in the CC1/CC2 concrete cask and the TSC containing the PWR design basis fuel (uniform heat load) for normal conditions of storage is shown in Figure 4.4-14. The air velocity distribution in the annulus between the TSC and the concrete cask liner for the normal conditions of storage for PWR fuel for the CC1/CC2 configuration is shown in Figure 4.4-15. The maximum component temperatures for the normal conditions of storage are summarized in Table 4.4-3. Note that the bounding temperatures from CC1/CC2 and CC3 analyses are conservatively used as the maximum component temperatures for the CC4 configuration. It is noted that these system thermal performance results are based on an average annual ambient temperature of 76°F at sea level pressure and standard air density properties. Site-specific conditions are to be evaluated to assure thermal margins are maintained for steady-state storage conditions at the intended MAGNASTOR ISFSI site.

As shown in Figure 4.4-14, the peak fuel temperature for the normal storage condition occurs near the top of the fuel basket and, based on the uniform spacing of the isotherms at the centerline of the TSC, the temperature varies monotonically from the TSC bottom to the peak near the top of the fuel basket. This is indicative that the dominant mode of heat rejection from the fuel is by convection due to the helium flow circulating within the TSC.

The calculated temperatures at the TSC surface for the normal storage condition are higher than the concrete liner or surface, indicating that radiation heat transfer occurs across the concrete cask to TSC annulus.

To confirm that the concrete cask heat removal system is operable, one of the following two surveillance options with a frequency of 24 hours is required: (1) Visually verify all concrete cask air inlet and outlet screens are free of blockage; (2) Verify the difference between the concrete cask air outlet average temperature and the ambient temperature is less than 119°F, 130°F, 134°F and 119°F for the concrete cask configuration CC1/CC2-PWR, CC1/CC2-BWR, CC3-PWR and CC4-PWR, respectively. The allowable temperature differences are determined based on the maximum calculated temperature difference between air outlet and ambient and the calculated minimum temperature margin for concrete and fuel temperatures for all normal and off-normal conditions.

Normal Conditions of Storage – PWR Configuration with DF Basket Assembly

The thermal evaluation for the concrete cask loaded with a TSC containing a DF basket assembly in storage conditions is performed based on configuration CC3 using the two-dimensional axisymmetric FLUENT CFD models described in Section 4.4.1.1. Three cases are considered:

Case 1: The active fuel region is modeled as a single porous zone with a single lumped resistance coefficient. The uniform loading heat generation rate (based on a total heat load of 35.5 kW) is applied to the active fuel region. The calculated maximum fuel temperature is 704°F.

Case 2: The active fuel region is modeled as two parallel porous zones radially, with a resistance coefficient for the outer zone of 16 basket slots (which include the four damaged fuel can slots) and a separate resistance coefficient for the inner zone of 21 basket slots. The uniform loading heat generation rate is applied to the active fuel region. The calculated maximum fuel temperature is 707°F.

Case 3: The active fuel region is modeled the same way as in Case 2. The uniform loading heat generation rate is considered for the standard fuel assemblies. The decay heat is considered to be concentrated at the lower 103 inches of the active fuel region based on a 50% compaction ratio of debris for the four damaged fuel can slots. The calculated maximum fuel temperature is 709°F.

The maximum fuel temperatures from the Case 1 through Case 3 analyses are lower than the maximum fuel temperature (718°F) for the corresponding standard PWR basket, as shown in Table 4.4-3. Therefore the standard PWR basket analyses bound those for the DF basket assembly.

Normal Conditions of Storage – PWR Minimum Reduced Cool Time Fuel Basket Assembly

The thermal evaluation for the concrete cask loaded with a TSC containing the PWR minimum reduced cool time fuel basket assembly for normal storage condition is performed based on configuration CC3 using the modified two-dimensional axisymmetric FLUENT CFD model described in Section 4.4.1.1. The model used for the analysis of TSC containing PWR minimum reduced cool time fuel basket assembly for normal storage condition is identical to the model described in Section 4.4.1.1, except for the re-meshed basket zones in basket radial direction to match locations of the heat generation due to the preferential loading.

The maximum fuel temperature of the analysis is 698°F or 20°F lower than the maximum fuel temperature (718°F) for the corresponding standard PWR basket, as shown in Table 4.4-3. The maximum temperature for the fuel heat load in Figure 4.1-2 is lower since the maximum fuel heat load is no longer at the center of the basket. Therefore the standard PWR basket analyses bound those for the PWR minimum reduced cool time fuel basket assembly.

Transfer Condition for 24-Hour Cooling and Multiple Vacuum Drying Cycles

The maximum component temperatures for MAGNASTOR during the transfer operation are reported in this section for operational procedures using 24 hours of cooling. The transfer operation is comprised of four separate phases: the water phase, the drying phase, the helium phase, and the TSC transfer phase. The water phase and the helium phase are not time limited due to the normal use of the transfer cask annulus cooling water system (ACWS), reverse ACWS, or site-approved ACWS equivalent. The transfer cask annulus cooling system is an operational convenience and not a safety-related system, since the transfer cask can be fully submerged (with the annulus seals deflated) in the spent fuel pool at any point in time during the transfer operation without resulting in thermal shock to the transfer cask system. The annulus cooling system maintains the TSC shell at a temperature significantly lower than the temperature corresponding to the normal conditions of storage. The maximum temperatures for the water phase are listed in Table 4.4-5 and Table 4.4-6 for PWR fuel and BWR fuel, respectively. The maximum temperatures for the helium phase are listed in Table 4.4-7 and Table 4.4-8 for PWR fuel and BWR fuel, respectively. Using the reverse ACWS model described in Section 4.4.1.5, the maximum fuel temperature of 422°F from the reverse flow analysis, corresponding to the [redacted] that the reverse ACWS cooling operation provides lower system temperatures for all phases of fuel loading and is therefore an acceptable equivalent cooling method. Table 4.4-9 and Table 4.4-10 present times for the vacuum drying for heat loads greater than 25 kW for PWR fuel and

greater than 29 kW for BWR fuel that are administratively controlled to maintain the fuel cladding temperature below the 752°F limit.

If additional vacuum drying is required for heat loads requiring administrative controls to meet the specified cavity dryness criteria, additional drying cycles can be performed following 24 hours of cooling the TSC, either with the annulus cooling water system or by returning the transfer cask and TSC to the spent fuel pool. Table 4.4-11 and Table 4.4-12 show the second vacuum time and maximum fuel temperatures at the end of the duration for PWR fuel and BWR fuel, respectively. Note that the PWR fuel cladding temperatures shown in Table 4.4-5, 4.4-7, and 4.4-9 are bounded by the PWR fuel cladding temperatures for the normal storage steady-state conditions in Table 4.4-3. Therefore, the normal condition design bases PWR heat load fuel cladding and component temperatures, such as for the fuel basket (including damaged fuel cans, as applicable) and the TSC, bound the maximum temperatures for any phase of the transfer condition for the fuel basket and TSC components.

The time for TSC transfer to the concrete cask is administratively limited to ensure that the maximum fuel cladding temperature is bounded by the design bases heat load normal condition storage temperature. Table 4.4-13 and Table 4.4-14 show the duration and the maximum fuel temperature at the end of the TSC placement in the concrete cask for both PWR fuel and BWR fuel, respectively. The time duration for the transfer operation is determined by modeling the water material properties in the annulus as air, as described in Section 4.4.1.5.

[redacted]

The off-normal condition for use of the annulus cooling system corresponds to loss of cooling by the ACWS, or equivalent site-approved annulus cooling system. This can occur during the water phase or the drying phase of transfer operations.

[redacted]

[redacted]

In the event of loss of cooling occurring during the vacuum drying phase, the TSC is first backfilled with 75 psig (+10, -0 psi) helium, and is then returned to the pool, where it is cooled for a minimum of 24 hours prior to continuing vacuum drying operations.

The loading procedures in Chapter 9 provide normal operational loading sequences. The MAGNASTOR System Operating Manual prepared in accordance with the FSAR analyses provides cask loading and unloading sequence alternatives, including time limitations for all evaluated loss of cooling and off-normal conditions. [redacted] These operational sequences, time limits and corrective actions will ensure that the fuel cladding and system component temperatures do not exceed design allowable values.

Transfer Condition for Minimum Cooling Time and Eight Hours of Canister Transfer

The maximum component temperatures for MAGNASTOR during the transfer operation are reported in this section for operational procedures using the minimum cooling time and eight hours of TSC transfer time (as determined by the evaluation in Section 4.4.1.6). The transfer operation is comprised of four separate phases: the water phase, the drying phase (reduced time as compared to the evaluations in Section 4.4.1.5), the helium phase (minimized cooling time), and the TSC transfer phase (limited to eight hours). The water phase and the helium phase permit indefinite time due to the normal use of the transfer cask annulus cooling system, or an

equivalent cooling system. The annulus cooling system maintains the TSC shell at a temperature significantly lower than the temperature corresponding to the normal conditions of storage. The maximum temperatures for the water phase are listed in Table 4.4-5 and Table 4.4-6 for PWR fuel and BWR fuel, respectively.

Heat load-dependent vacuum drying times reported in Table 4.4-9 and Table 4.4-10 confirm that for the same heat loads, the PWR fuel clad temperatures bound the BWR fuel clad temperatures. The temperatures reported in Table 4.4-15 and Table 4.4-16 are for the maximum PWR and BWR clad temperatures, respectively, at the end of the reduced vacuum time, the reduced cool time, and the eight hours of transfer time. These results confirm that the maximum clad temperatures have significant margin relative to the 752°F fuel clad temperature limit.

For system operations that are outside the sequence presented in Table 4.4-15 or Table 4.4-16, as a result of equipment failure or some other event that extends drying and transfer operations, additional vacuum drying, helium cooling, and/or transfer times will be implemented in accordance with the actions described in the preceding section, "Transfer Condition for 24-Hour Cooling and Multiple Vacuum Drying Cycles."

4.4.4 Maximum Internal Pressures for PWR and BWR TSCs

The maximum TSC internal operating pressures for normal conditions of storage are calculated in the following sections for the TSCs containing PWR and BWR design basis fuel assemblies.

Maximum Internal Pressure for the TSC Containing PWR Fuel

The internal pressure of a TSC containing PWR fuel assemblies is a function of fuel type, burnup, initial enrichment, cool time, fuel condition (failure fraction), presence or absence of nonfuel hardware, TSC length, and the backfill gases in the TSC. Gases included in the pressure evaluation of a TSC containing PWR fuel include fuel rod fission, decay, backfill gases and integral fuel burnable absorber (IFBA) generated gas, gas generated by the nonfuel hardware components (assembly control components contain boron as the absorber material), and TSC backfill gases. Each of the PWR fuel types is separately evaluated to determine a bounding pressure for a TSC containing PWR fuel assemblies. Evaluations are performed for all contents in the standard basket (undamaged fuel) and in the damaged fuel basket configuration. The damaged fuel basket represents a bounding configuration due to the additional volume displacement by the thicker corner weldment plates and the presence of the DFC canisters themselves.

Fission gases include all fuel material generated gases, including helium generated by long-term actinide decay. Based on detailed SAS2H calculations, the quantity of fission and decay gases

rises as burnup and cool time are increased and enrichment is decreased. The maximum gas available for release is calculated based on 70,000 MWd/MTU burnup cases at an enrichment of 1.9 wt % ^{235}U and a cool time of 40 years for maximum fissile material assemblies in each major PWR fuel class. For other PWR fuel assembly types, fission and decay gases are determined by ratioing the fissile material mass to the maximum fissile material mass assemblies.

Fuel rod backfill pressure varies significantly among the PWR fuel types. Based on a literature review, a 500 psig backfill is assigned to Westinghouse and CE core fuel types. A maximum backfill pressure of 435 psig is assigned to B&W core assemblies. Backfill gas quantities are based on the fresh fuel free volume between the fuel pellet stack and the fuel rod cladding, including the plenum volume, and a backfill temperature of 68°F.

Burnable poison rod assemblies (BPRAs) placed within the TSC may contribute additional gas quantities due to n-alpha reaction of ^{10}B during in-core operation. A portion of the neutron poison population is formed by ^{10}B. Other neutron poisons, such as gadolinium and erbium, do not produce a significant amount of helium nuclides (alpha particles). BPRAs in this section is a general term used to describe a range of absorbers including, but not necessarily limited to, Westinghouse Pyrex (borosilicate glass) BPRAs and WABA (wet annular burnable absorber) configurations, as well as B&W BPRAs and shim rods used in CE cores. The CE shim rods replace standard fuel rods to form a complete assembly array. The quantity of helium available for release from the BPRAs is directly related to the initial boron content of the fuel rods and the release fraction of gas from the matrix material. The gas released from either of the low-temperature, solid matrix BPRA materials is likely to be limited, but no release fractions were available in open literature. Consequently, a 100% release fraction is applied. Initial boron content in the Westinghouse and B&W BPRAs is based on a uniform absorber concentration of 0.0063 g/cm ^{10}B. The maximum number of poison rods is 16 for Westinghouse 14×14 fuel assemblies, 20 for Westinghouse and B&W 15×15 fuel assemblies, and 24 for Westinghouse and B&W 17×17 fuel assemblies. The length of the absorber rods is conservatively taken as the active fuel length. CE core shim rods are modeled at 0.0126 g/cm ^{10}B for 16, 12, and 12 rods applied to CE-manufactured 14×14, 15×15, and 16×16 fuel assemblies, respectively.

Fuel rods may contain integral fuel burnable absorbers (IFBAs). The absorber is typically zirconium diboride and, as such, will generate helium gas as part of the neutron capture process. IFBA assemblies are generally used as an alternative or augmentation to BPRA use. The IFBA loading employed in the pressure analysis is based on NUREG-6760 as 2.355 mg ^{10}B/inch in 156 rods. To bound the presence of both BPRA and IFBA materials in a fuel assembly, when loaded, the cask pressure calculations assume a design basis IFBA loading in the fuel assembly with a design basis BPRA inserted into the assembly guide tubes prior to loading into the storage system. Rather than accounting for the IFBA rods as an individual component, the pressure

calculations double the BPRA gases for non-CE fuel assembly types (bound the combined inventory of IFBA and BPRA based on linear loading and number of rods affected).

Under normal operating conditions, the helium backfill for a TSC containing PWR fuel assemblies is at a maximum average gas temperature of 465°F and a pressure of 103 psig. Nominal helium densities for both PWR and BWR fuel types are shown in Table 4.4-4. Maximum system backfill pressure at operating conditions is set by the use of the operating procedures documented in Chapter 9. This approach ensures that an acceptable helium density is established in the canister prior to sealing. Free volumes inside the two classes of TSCs containing PWR fuel are 9,900 and 10,300 liters for TSCs containing the undamaged fuel basket and 9,600 liters for the TSCs containing the damaged fuel basket. The free volumes do not include PWR fuel assembly and nonfuel hardware components, since these vary for each assembly type, but do account for axial spacers and DFC displaced volume in the case of the damaged fuel basket. The free volume of the TSC is obtained by subtracting the assembly volume. The assembly volume includes the fuel skeleton, fuel rods and nonfuel hardware. For the Westinghouse BPRAs, the Pyrex volume is employed since it displaces more volume than the WABA rods.

The TSC internal pressure is determined by summing the partial pressures of the TSC helium backfill gas and the released gases from the fuel and the poison rods. The partial pressure due to the fuel and neutron poison rod gases is determined by the ideal gas correlation (PV=nRT) and the applicable rod release fractions and failure rates. For normal conditions, a 1% rod failure fraction is applied. For failed fuel rods, the releasable molar quantity of the fission and actinide decay gas is 30%, with 100% of the rod backfill gas being released. The normal condition average temperature of the gases released from the fuel rods and neutron poison inserts is conservatively set to 485°F (525 K) in the partial pressure calculation.

The TSC is evaluated for normal condition pressure for each of the PWR fuel types, with insert. The maximum normal condition pressure for a TSC containing PWR fuel assemblies is 104 psig. At a 1% rod failure fraction, the quantity of gas released from the fuel and neutron poison rods is minimal, resulting in no significant effect on system pressure.

The calculated maximum pressure of 104 psig allows for a 6 psig tolerance on the TSC helium backfill prior to reaching the 110 psig system pressure used in the Chapter 3 normal condition structural evaluations. Significantly higher pressure margins exist in the off-normal and accident pressures. Off-normal and accident pressures were calculated at 119 psig (10% fuel failure and off-normal thermal conditions) and 226 psig (100% fuel failure, see Section 4.6.4), and these calculated values are significantly lower than the established pressure limits of 130 psig for off-normal and 250 psig for accident condition pressures that are used in the structural calculations.

Maximum Internal Pressure for the TSC Containing BWR Fuel

Maximum internal pressures are determined for the BWR fuel in the same manner as those documented for the TSC containing PWR fuel. Primary differences for the BWR evaluations, versus those for the PWR, include a rod backfill gas pressure of 132 psig, a maximum burnup of 60,000 MWd/MTU used to generate fission gases, and the absence of neutron poison gases (no nonfuel hardware in the BWR system). The 132 psig rod backfill pressure used in this analysis is significantly higher than the 6 atmosphere (g) maximum pressure reported in open literature. Free volumes, without fuel assemblies, in the TSC containing BWR fuel types are 9,900 and 10,300 liters.

A bounding normal condition average temperature of 525 K is used for the partial pressure analysis of the fuel rod gases. The maximum normal condition pressure for a TSC containing BWR fuel is 104 psig.

The calculated maximum pressure of 104 psig allows for a 6 psig tolerance on the TSC helium backfill prior to reaching the 110 psig system pressure employed in the Chapter 3 normal condition structural evaluations. Significantly higher pressure margins exist in the off-normal and accident pressures. Off-normal and accident pressures were calculated at 112 psig (10% fuel failure and off-normal thermal conditions) and 159 psig (100% fuel failure, see Section 4.6.4) and are conservatively bounded by the 130 psig off-normal and 250 psig accident condition pressures that were employed in the structural calculations.

TSC Backfill Helium Tolerances

Due to measurement and instrument uncertainties in the canister backfill operation, a range of allowed helium backfill density (g/liter) is determined in this section.

Any increase in backfill density is limited by the associated rise in pressure, which in turn is limited to the structural analysis inputs (110 psig for the limiting normal condition). As documented in the pressure evaluations, a 6 psi tolerance is acceptable prior to reaching system pressures employed in the structural analysis. Assuming a constant temperature, which is conservative as increased backfill density would enhance heat transfer and increase system pressure, and applying the ideal gas law make backfill density directly proportional to pressure. Relying on a 6 psi tolerance on a nominal pressure of 104 psig (119 psia) allows for a 5% increase in backfill density.

A decrease in backfill density is limited by thermal constraints. Lower helium density reduces convective heat capability of the system and, thereby, raises fuel clad temperature. Thermal analysis in Section 4.4.1.1 states that a 10% decrease in backfill density is acceptable while remaining below the maximum allowed clad temperature limit of 752°F.

Table 4.4-4 lists the pressure and temperature limited upper and lower bound helium backfill densities.

Figure 4.4-1 Two-Dimensional Model of Concrete Cask Loaded with PWR TSC

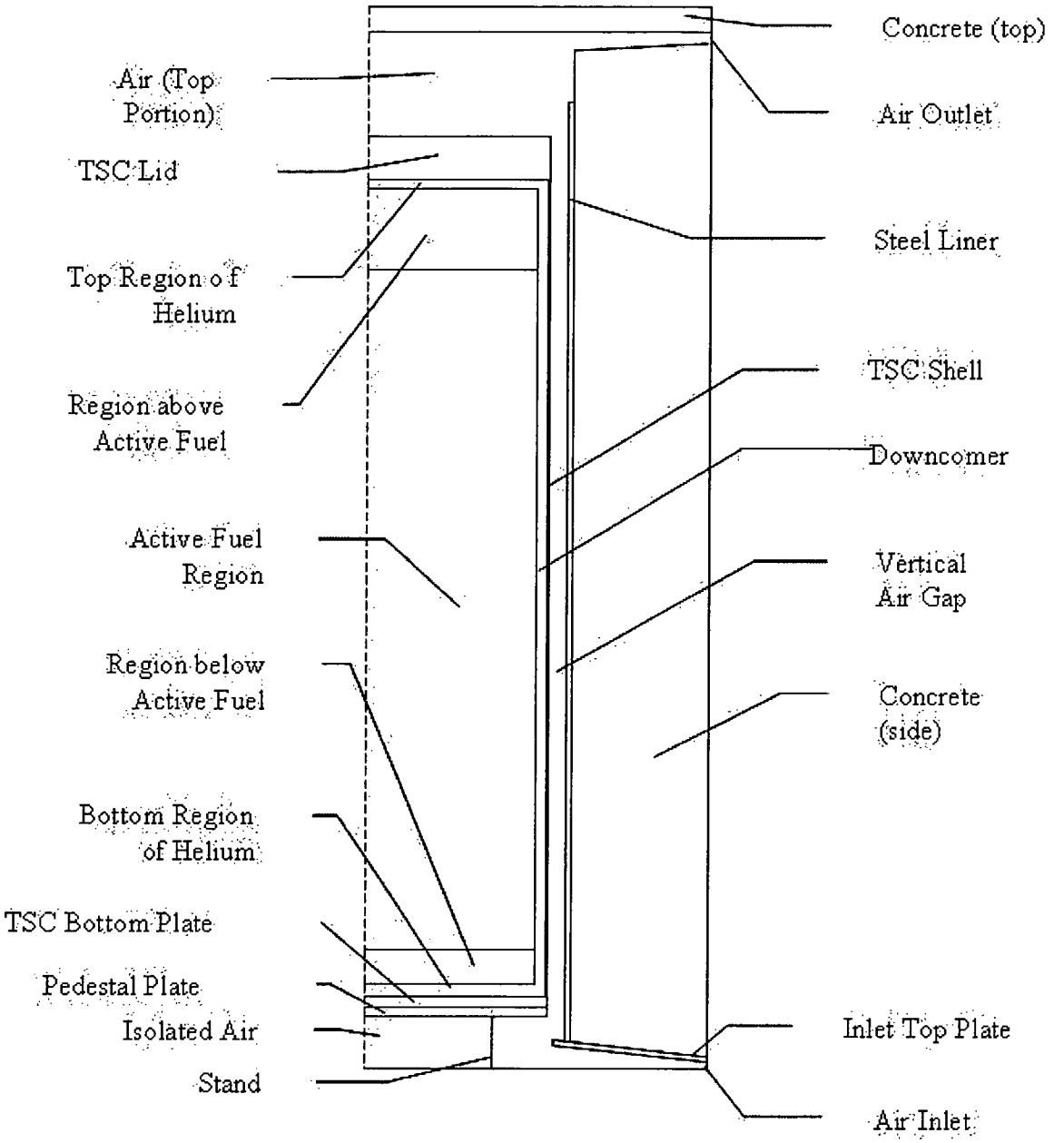


Figure 4.4-2 Computational Mesh for the Two-Dimensional Axisymmetric CFD Model of the Concrete Cask

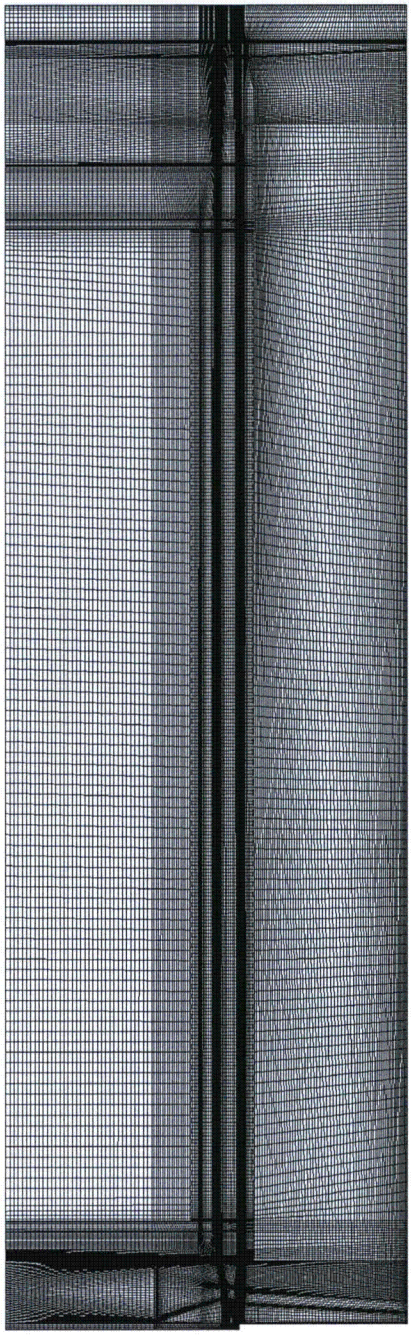


Figure 4.4-3 Axial Power Distribution for the PWR Fuel Assembly

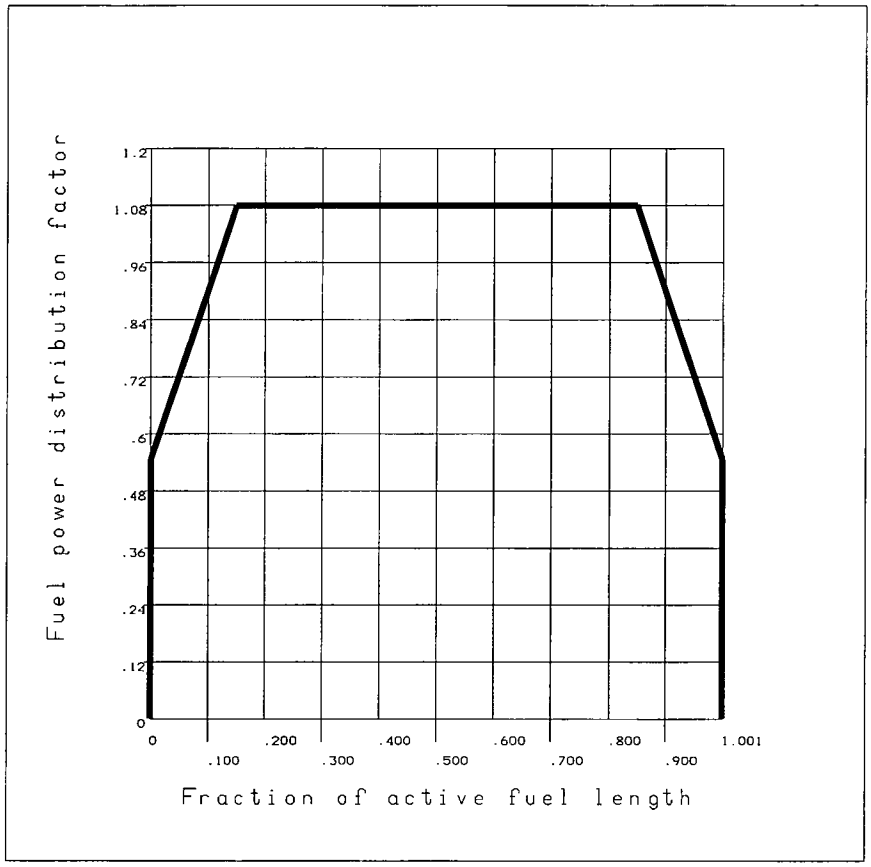


Figure 4.4-4 Axial Power Distribution for the BWR Fuel Assembly

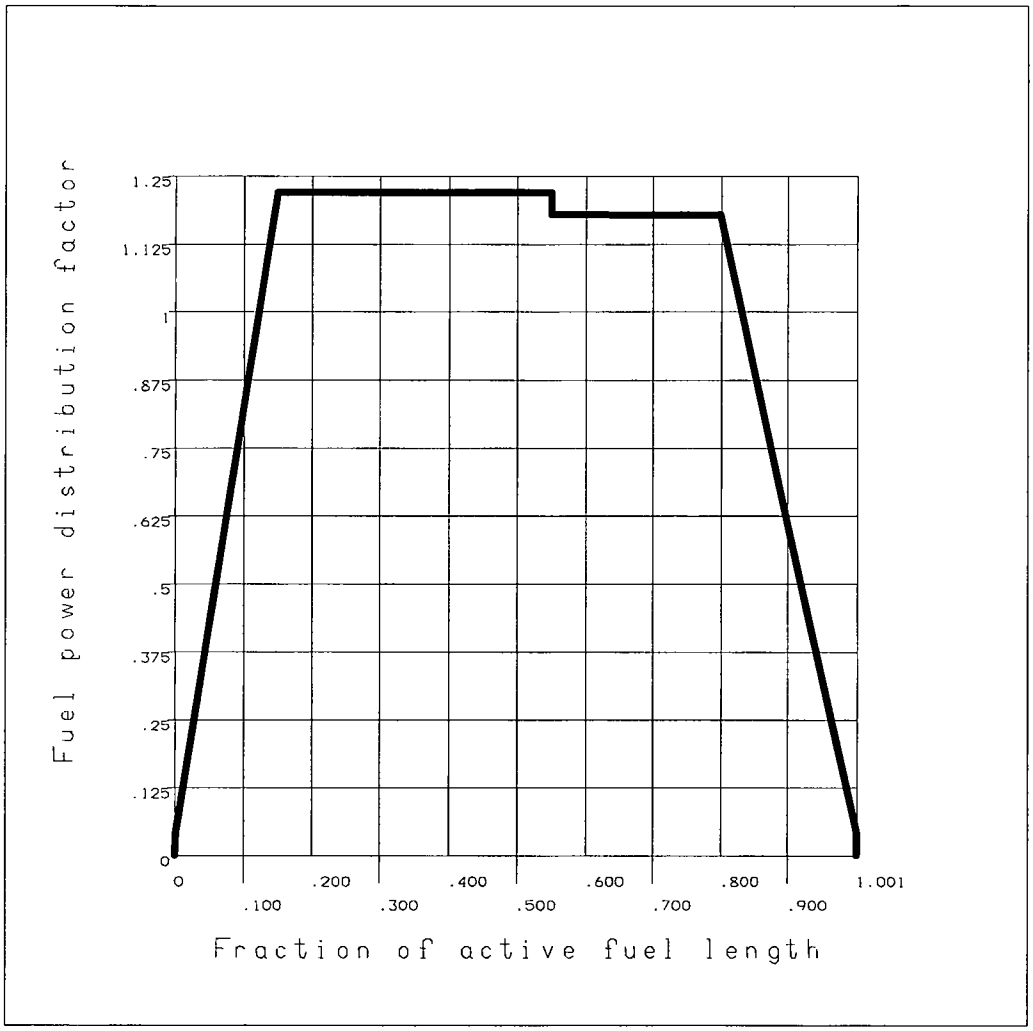


Figure 4.4-5 PWR Peak Fuel Cladding Temperature versus TSC Internal Pressure

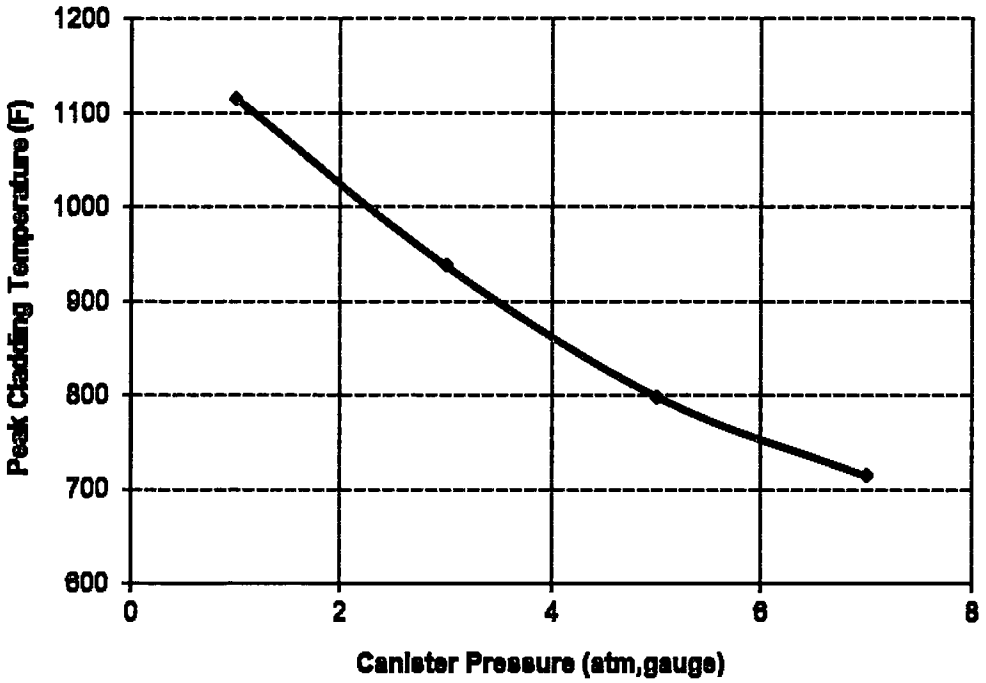


Figure 4.4-6 Two-Dimensional Finite Element Model of the PWR Fuel Basket

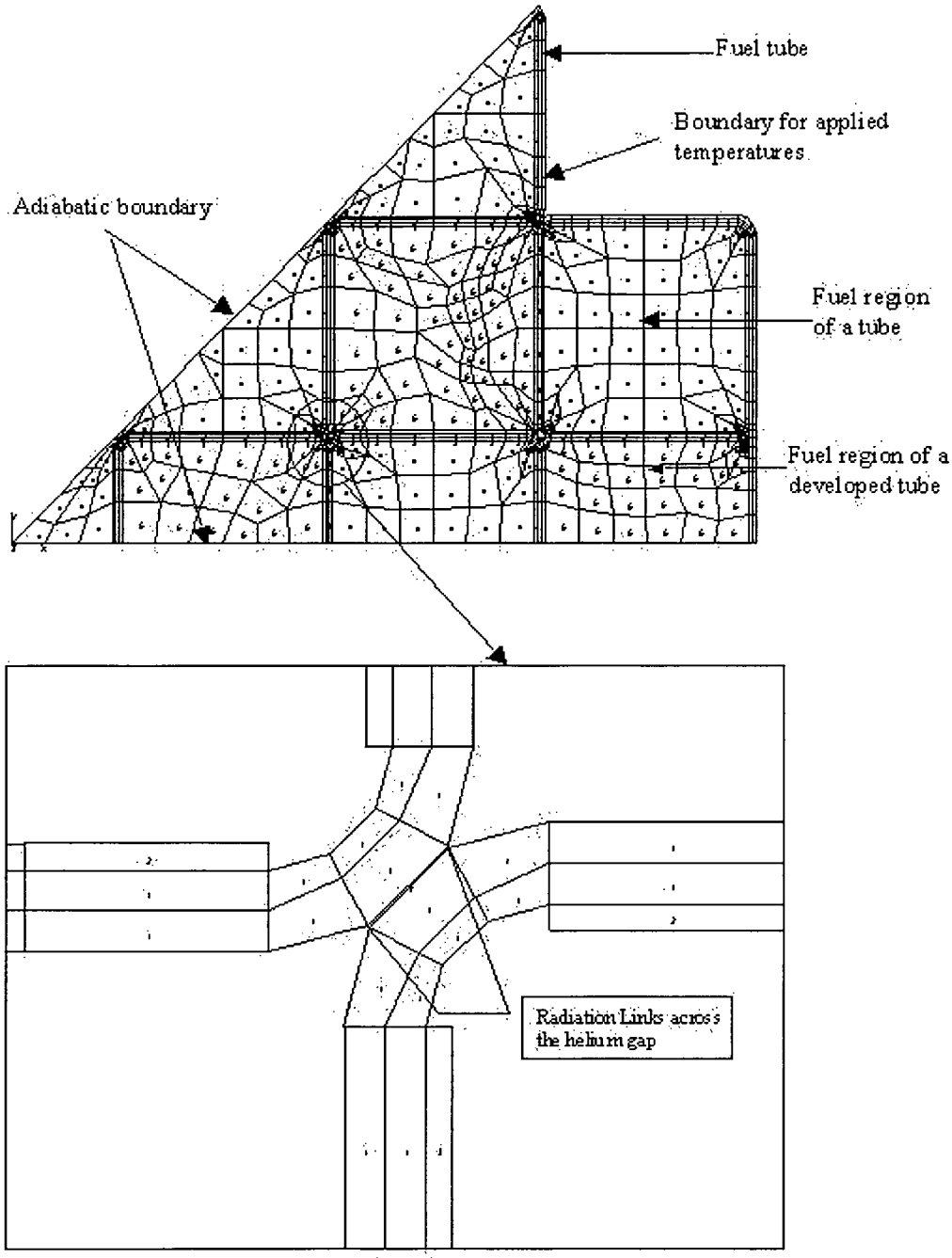


Figure 4.4-7 Two-Dimensional Finite Element Model of the BWR Fuel Basket

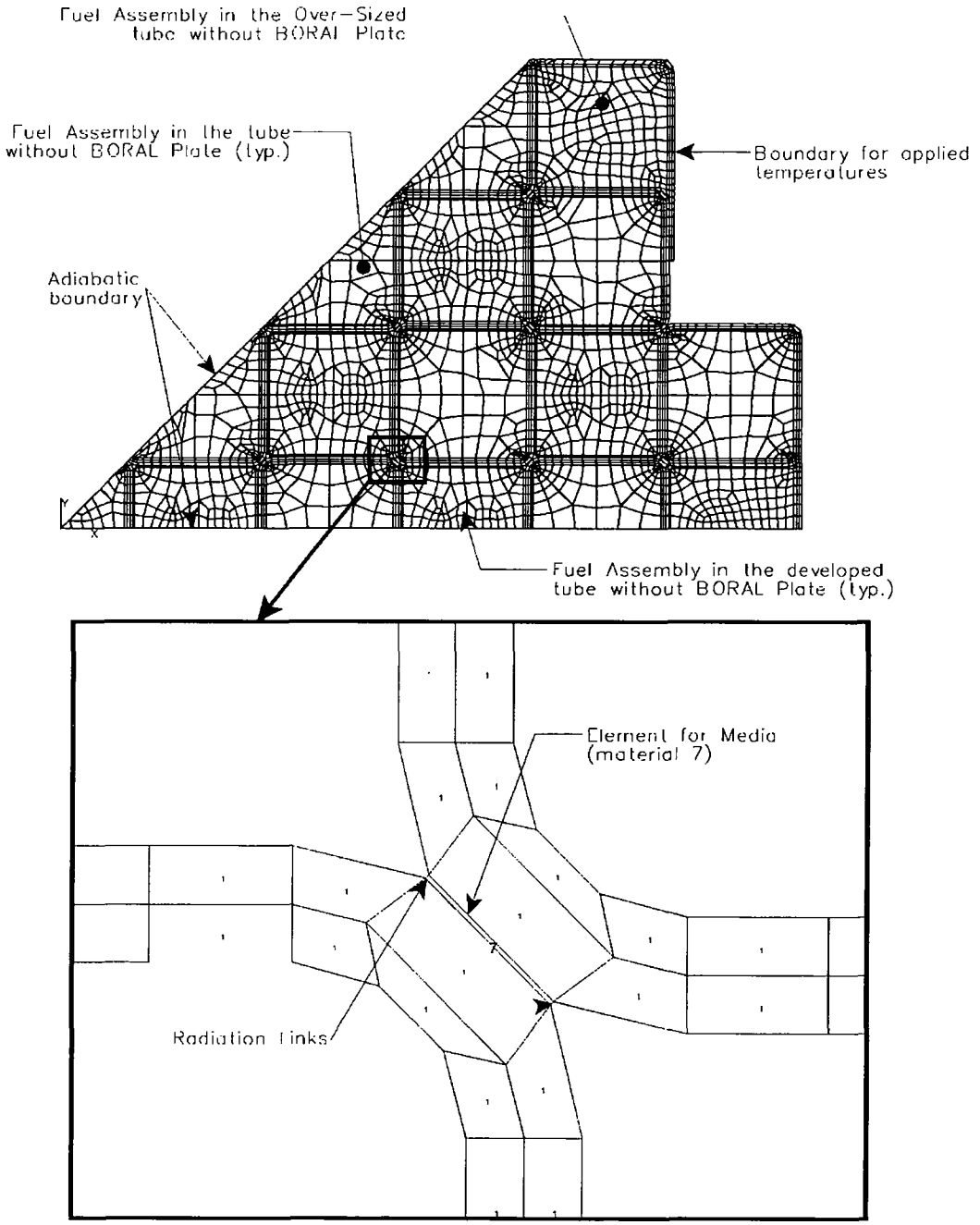
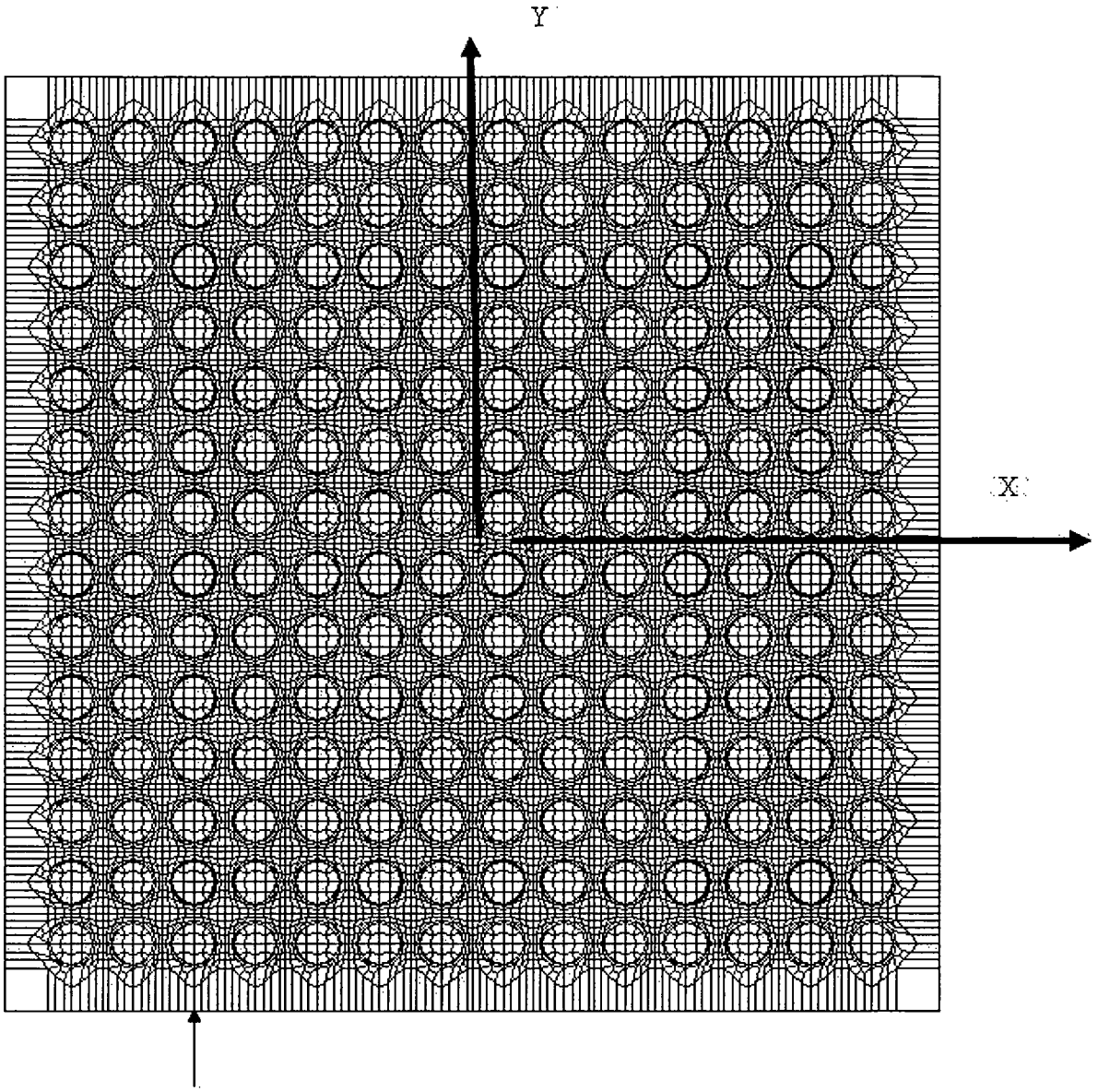


Figure 4.4-8 14×14 PWR Fuel Assembly Two-Dimensional Model



Temperature boundary condition applied along the edge of the model.

Note: X and Y correspond to the in-plane directions of the fuel assembly, while Z is out of the plane and corresponds to the axial direction of the fuel assembly.

Figure 4.4-9 10×10 BWR Fuel Assembly Two-Dimensional Model

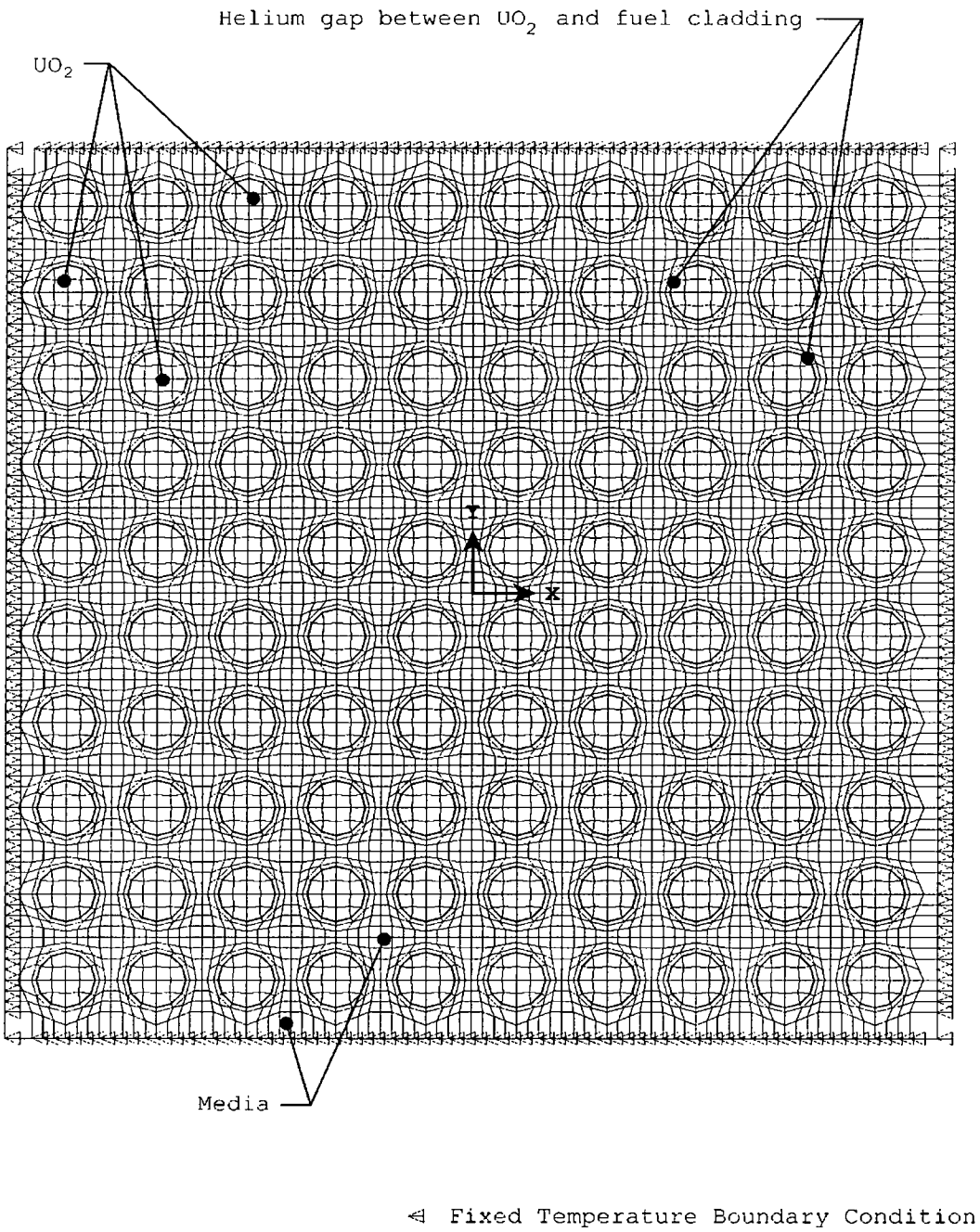
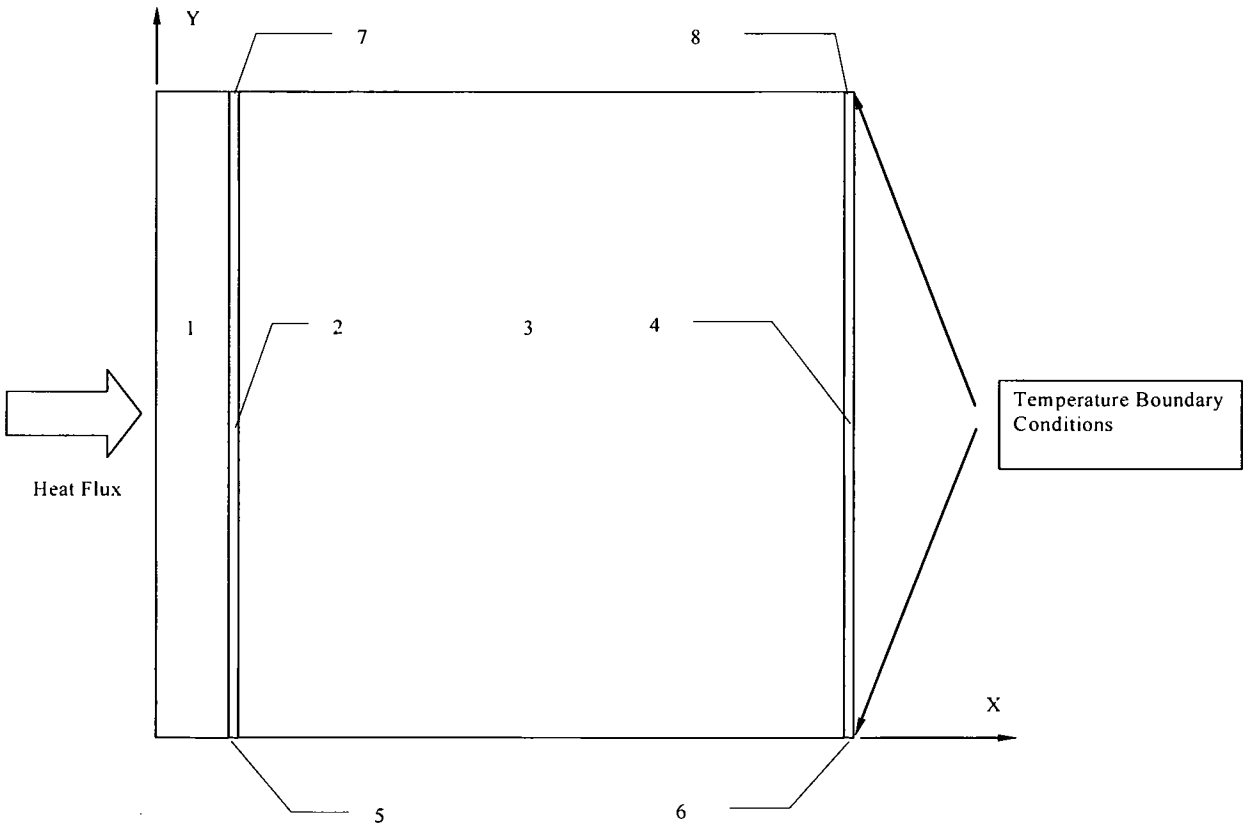
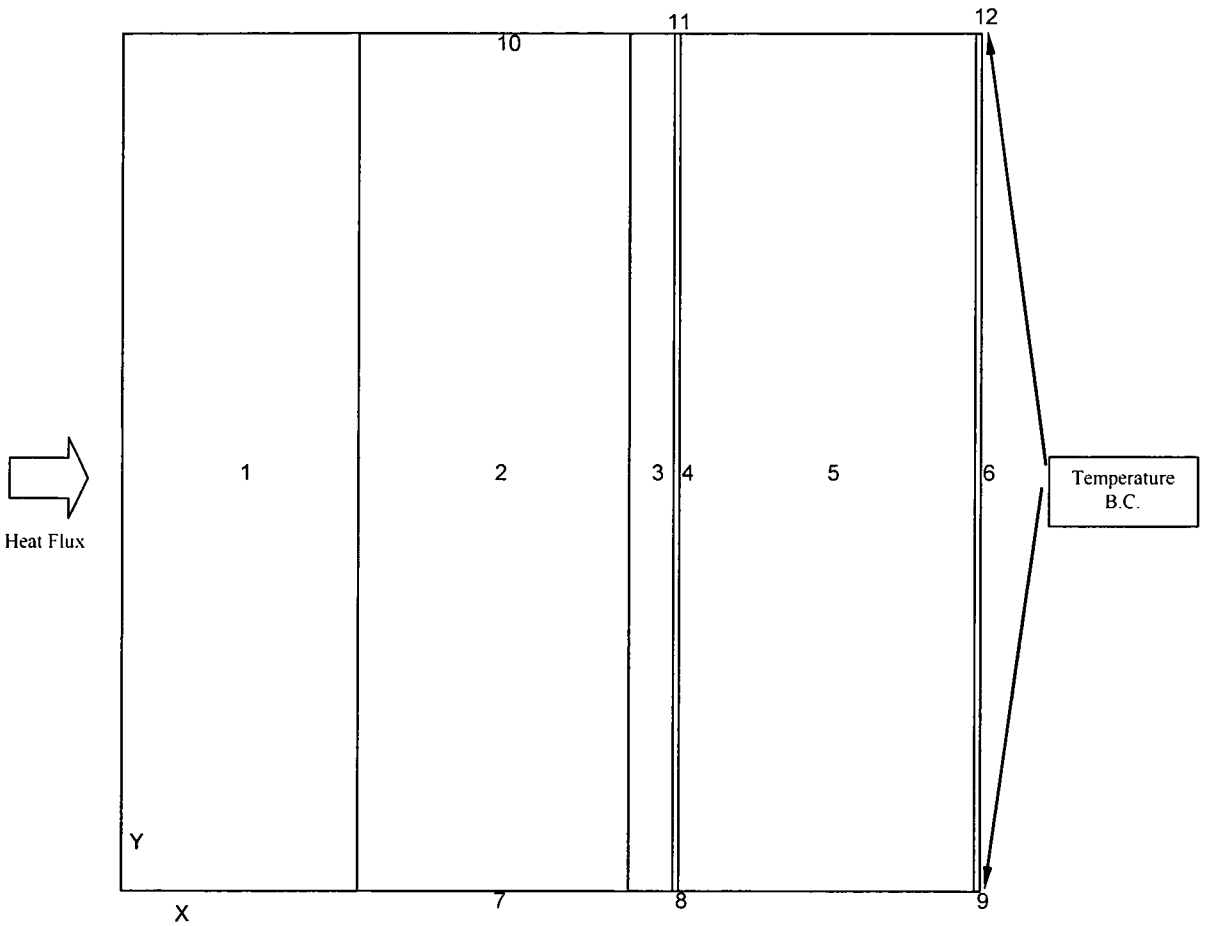


Figure 4.4-10 Neutron Absorber Model for PWR Fuel Tube



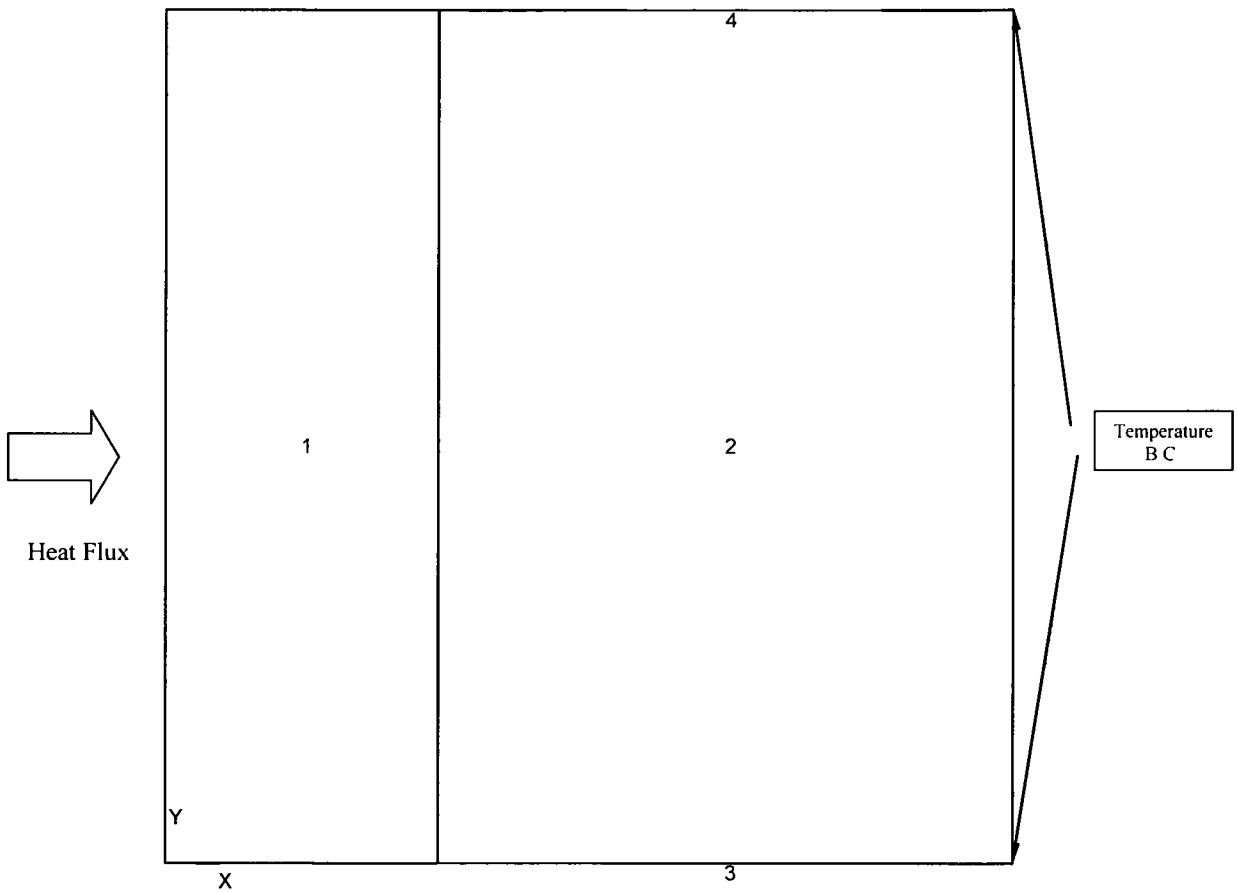
Element Number	Description
1	Stainless Steel Retainer Strip
2	Media – Helium or water
3	Neutron Absorber
4	Media – Helium
5,7	Radiation Links (between stainless steel and neutron absorber)
6,8	Radiation Links (between aluminum and nickel plated carbon steel)

Figure 4.4-11 BWR Fuel Tube Configuration with Channel and Neutron Absorber



Element Number	Description
1	Zirconium-based alloy (BWR fuel channel)
2, 4, 6	Media – Helium or water
3	Stainless Steel Retainer Strip
5	Neutron Absorber
7, 10	Radiation Links (between zirconium-based alloy and stainless steel)
8, 11	Radiation Links (between stainless steel and aluminum)
9, 12	Radiation Links (between aluminum and nickel-plated carbon steel)

Figure 4.4-12 BWR Fuel Tube Configuration with Channel, but without the Neutron Absorber



Element Number	Description
1	Zirconium-based alloy (BWR fuel channel)
2	Media ---- Helium or water
3, 4	Radiation Links (between zirconium-based alloy and nickel-plated carbon steel)

Figure 4.4-13 Two-Dimensional Model of Transfer Cask Loaded with a PWR TSC

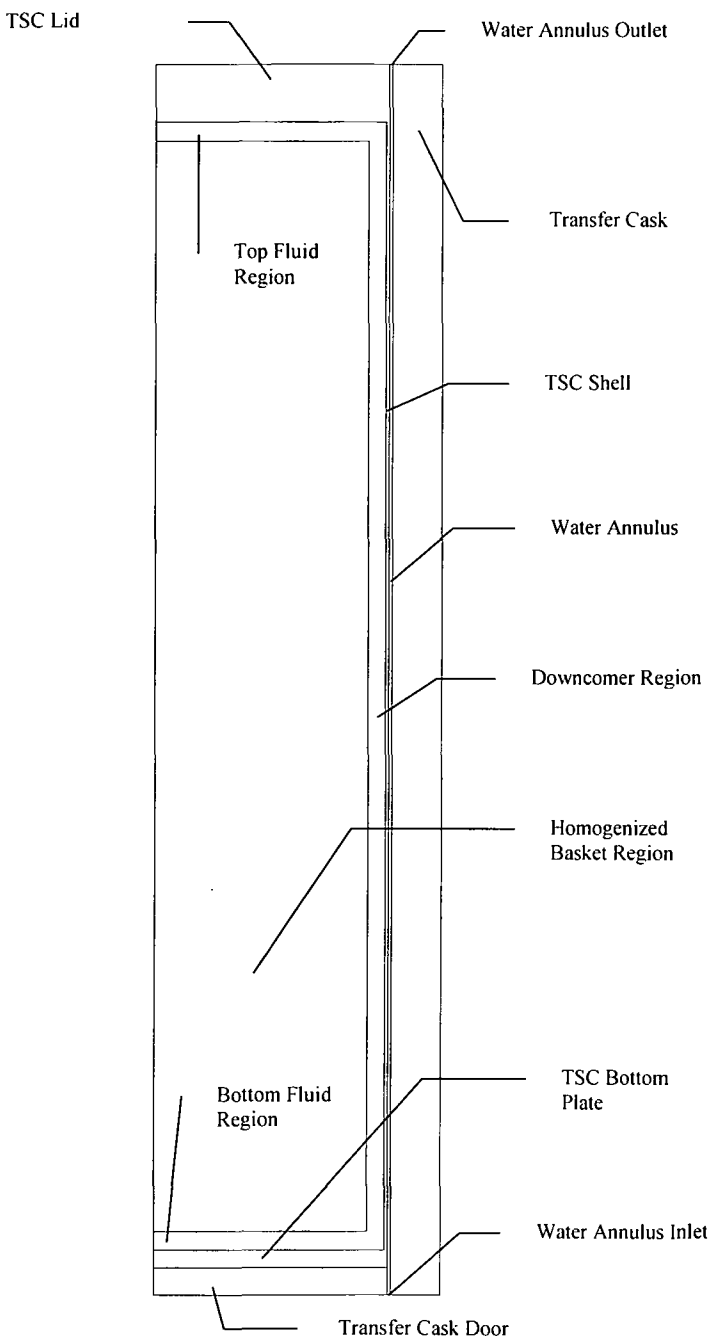


Figure 4.4-14 Temperature (°F) Distribution for the CC1/CC2 Concrete Cask and TSC Containing a Design Basis PWR Heat Load

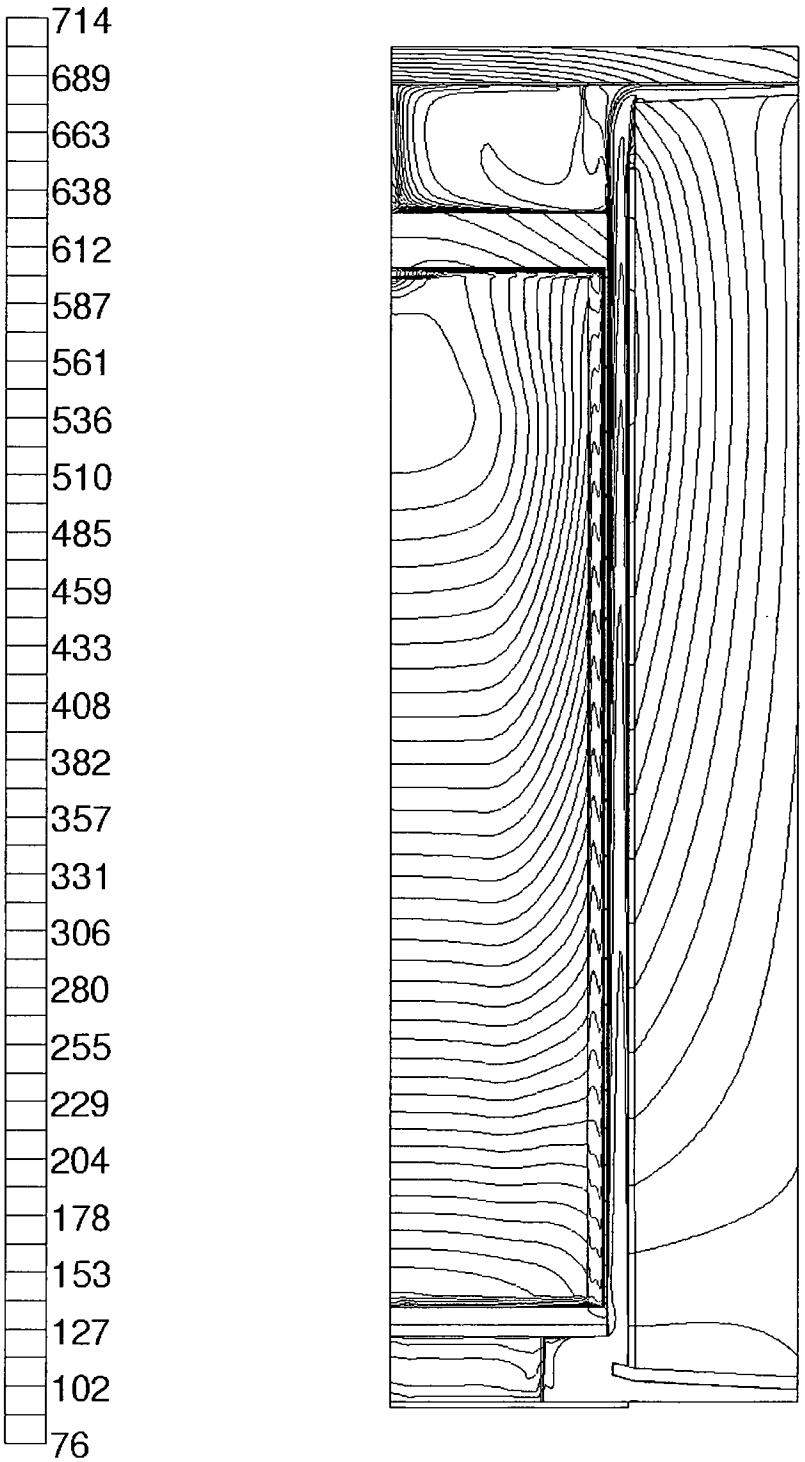


Figure 4.4-15 Air Velocity (m/s) in the CC1/CC2 Concrete Cask Annulus for the Design Basis PWR Heat Load

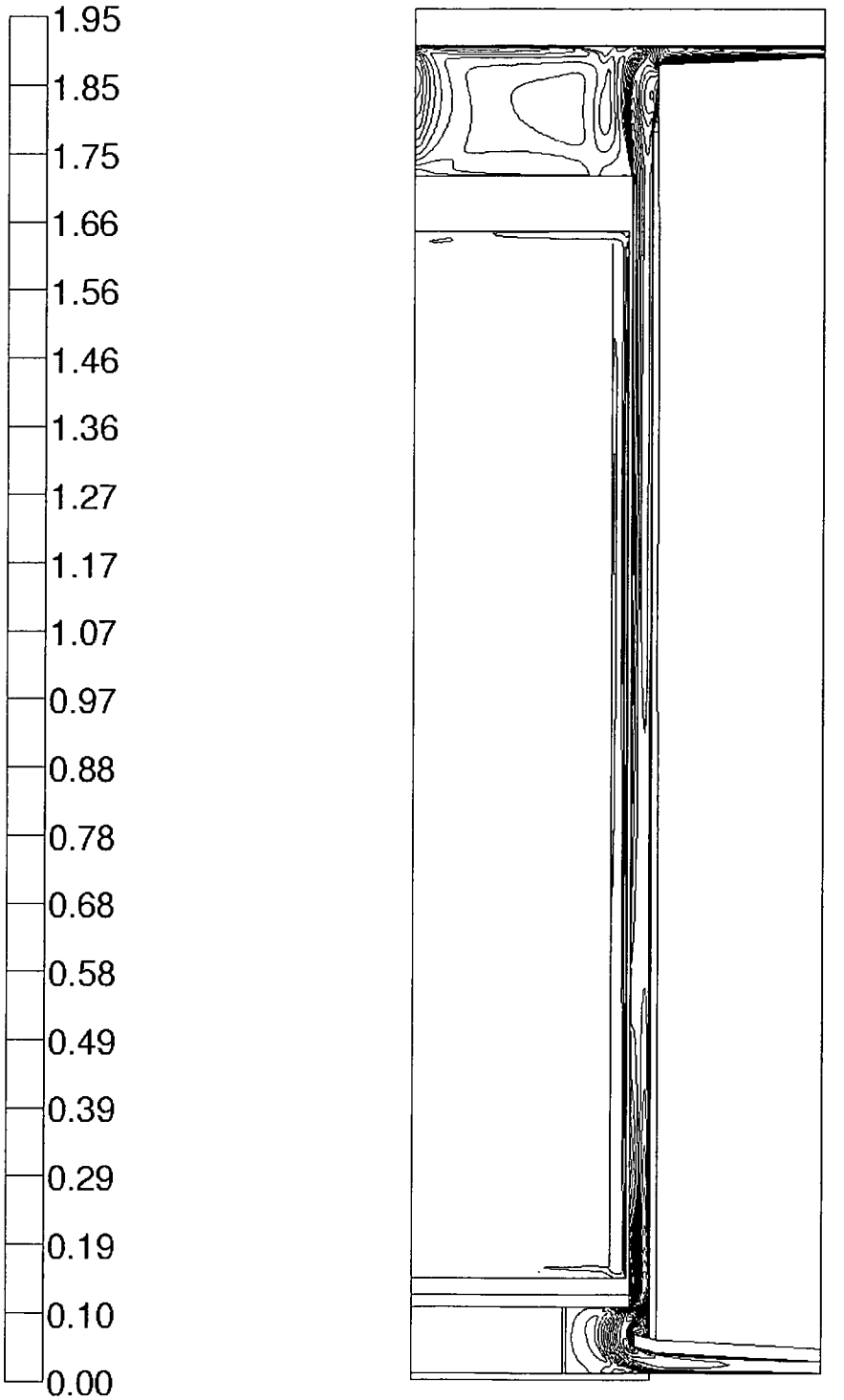


Figure 4.4-16 Three-Dimensional ANSYS Model of the PWR Canister for Vacuum Drying Condition

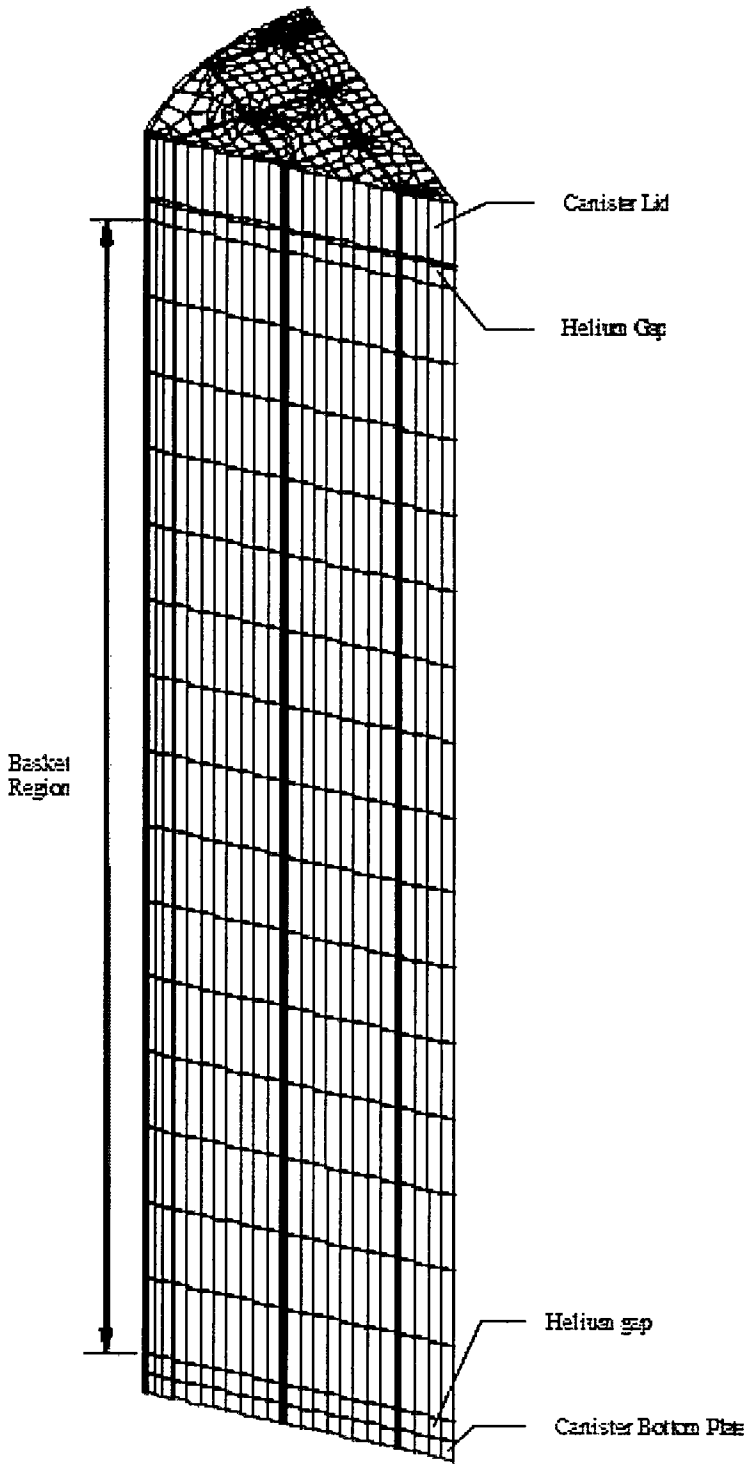


Figure 4.4-17 Detailed View of the Three-Dimensional ANSYS Model of the PWR Canister for Vacuum Drying Condition

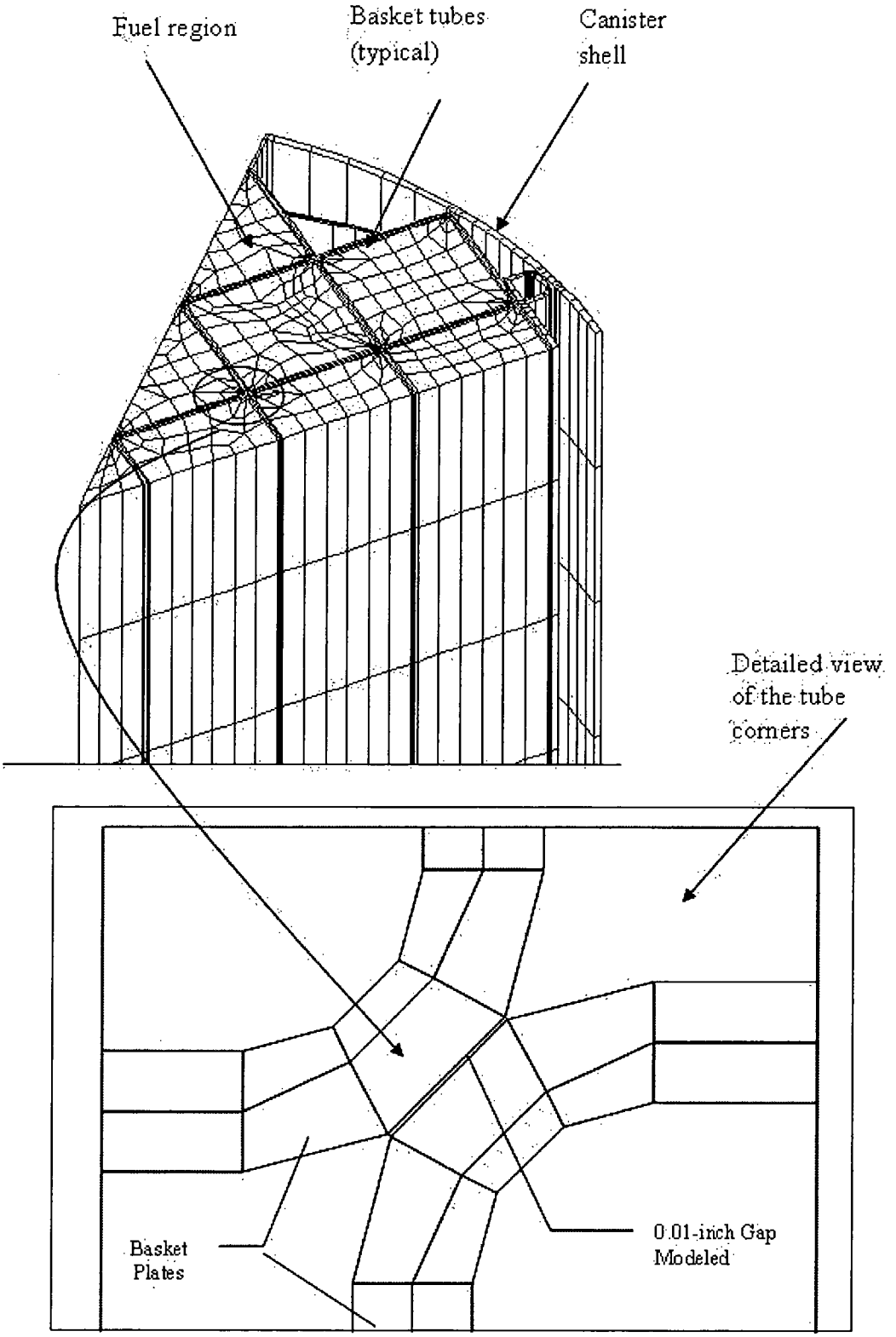


Figure 4.4-18 Three-Dimensional ANSYS Model of the BWR Canister for TFR Vacuum Drying Analyses

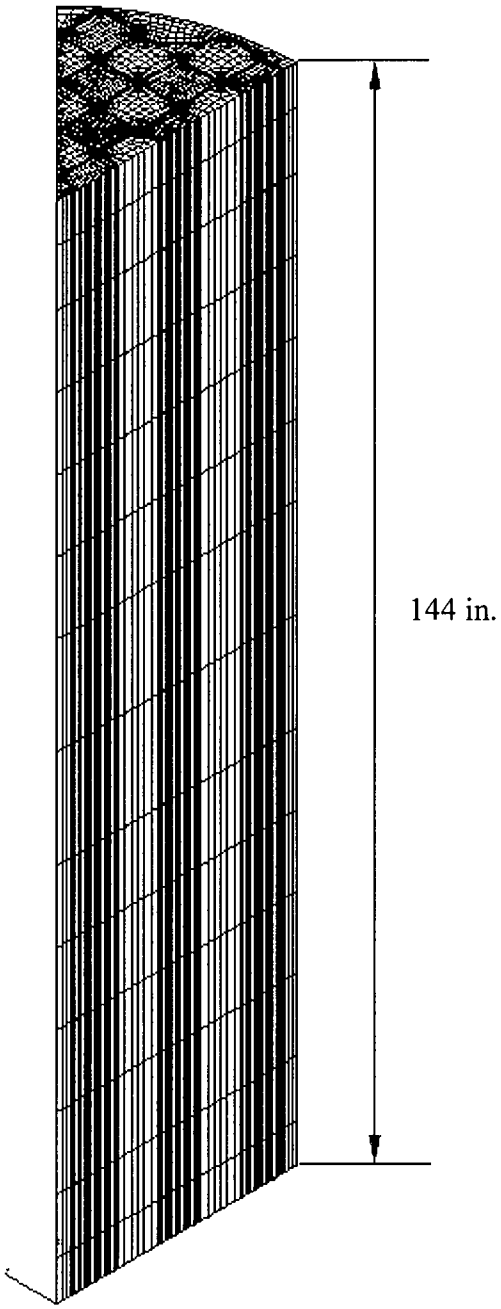


Figure 4.4-19 Detailed View of the Three-Dimensional ANSYS Model of the BWR Canister for TFR Vacuum Drying Analyses

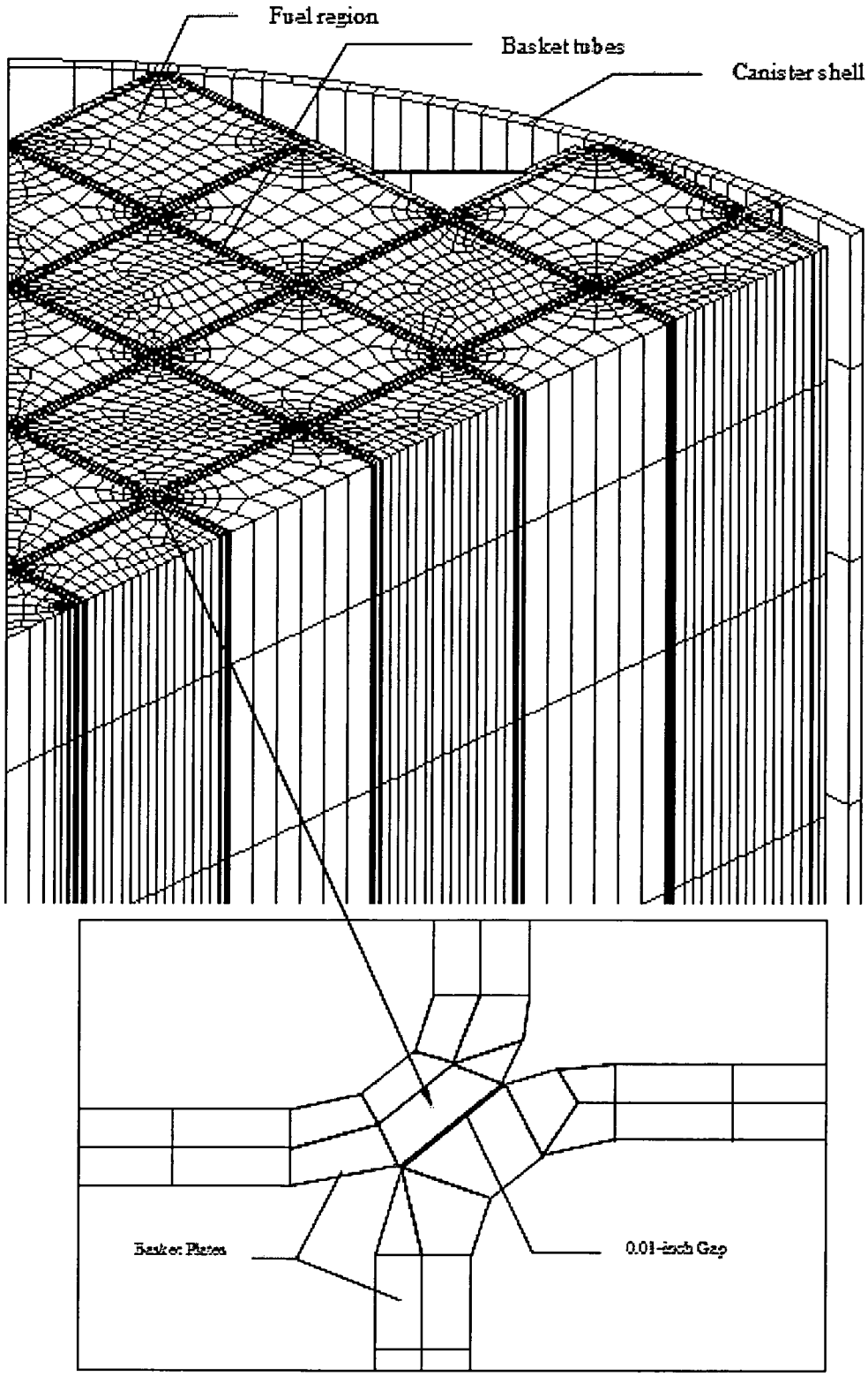


Figure 4.4-20 CC3 Concrete Cask Inlet Model Geometry

Note: The symmetry plane is the top surface (not shown).

Figure 4.4-21 CC3 Concrete Cask Inlet Model Mesh (Bottom Surface)

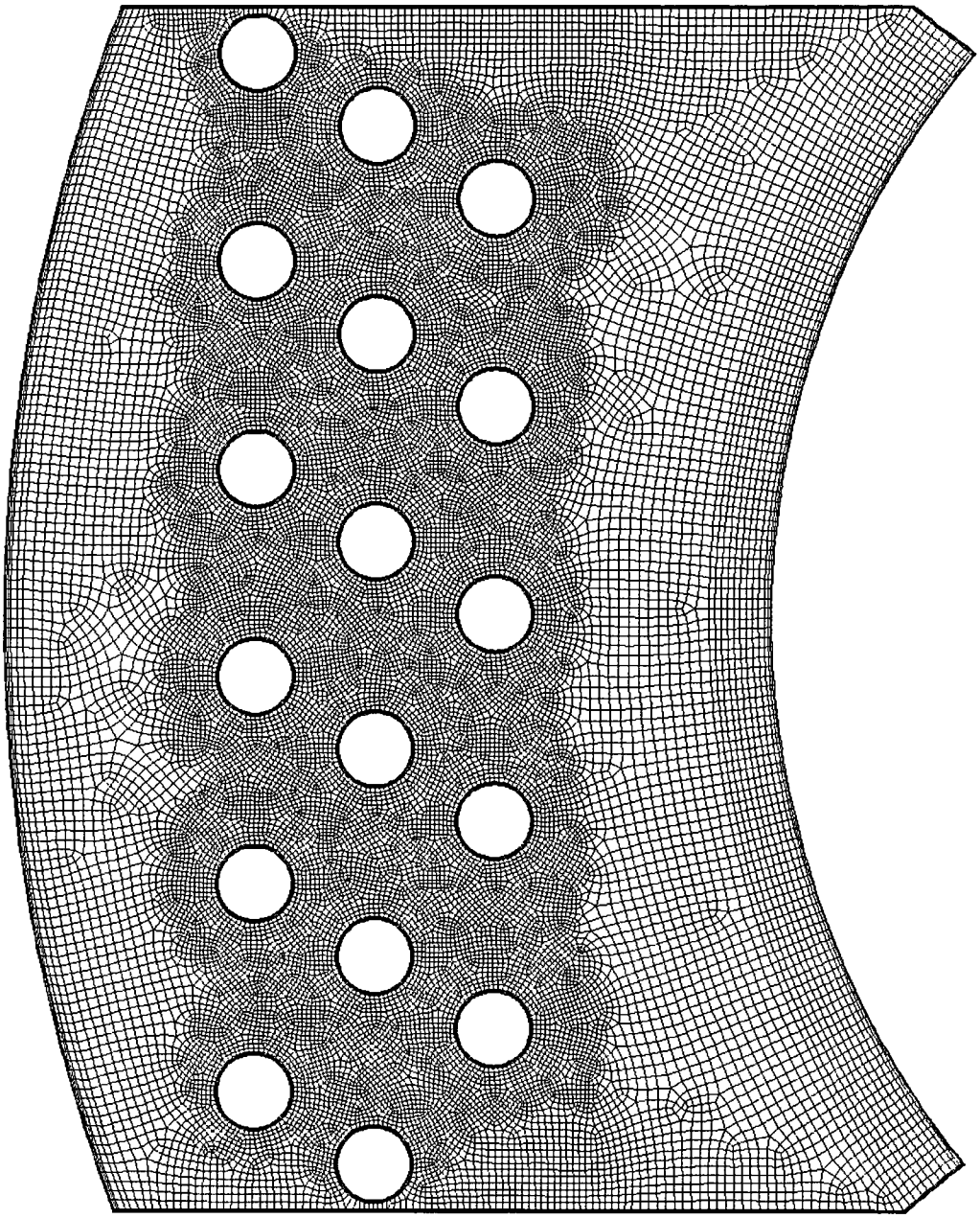


Figure 4.4-22 Two-Dimensional Finite Element Model of the DF Basket Assembly

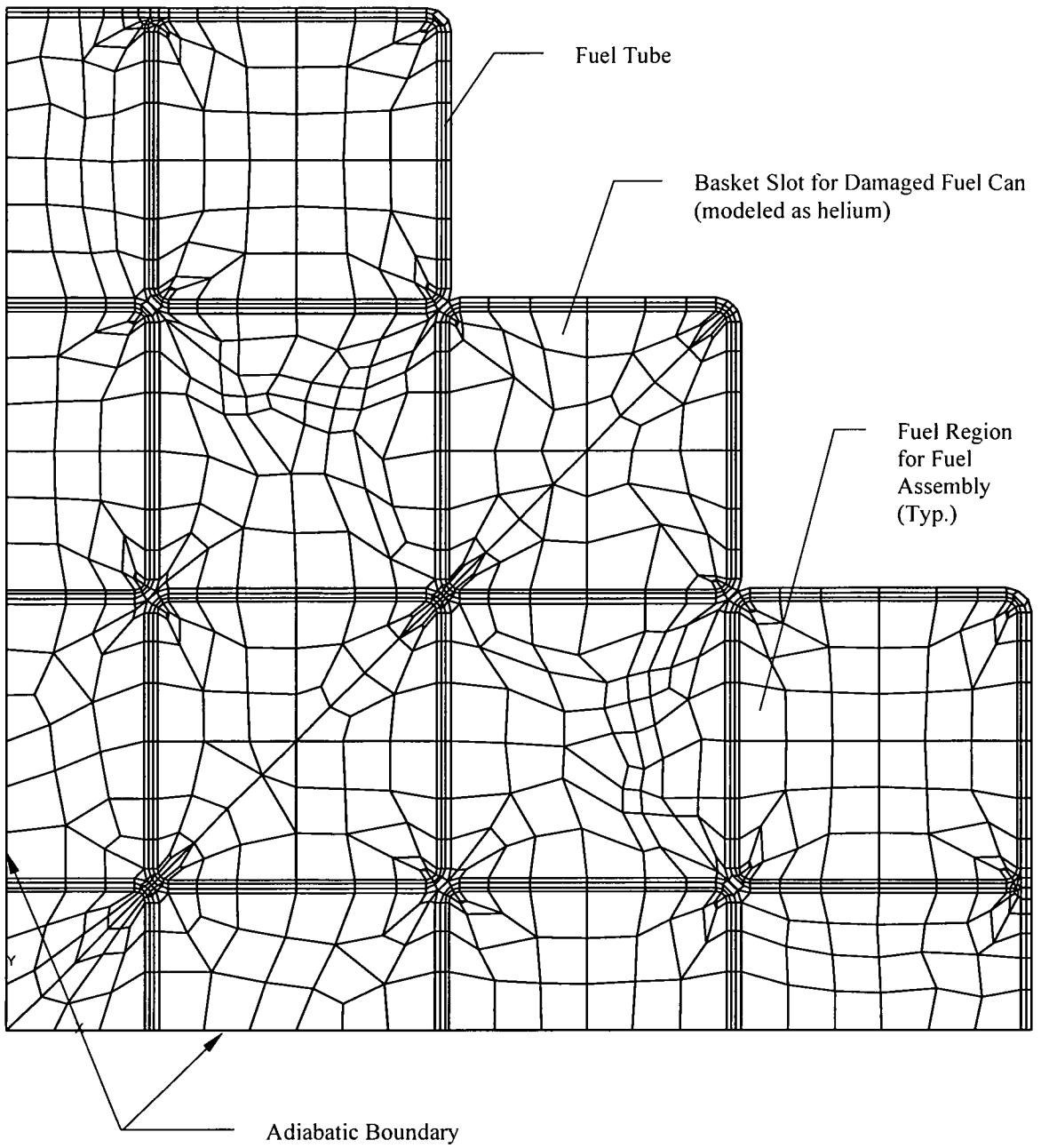


Table 4.4-1 Effective Thermal Conductivities for 14×14 PWR Fuel Assemblies for Helium Backfill

For fuel assemblies in fuel tubes with the neutron absorber:

Conductivity [a] (Btu/hr-in-°F)	Temperature (°F)			
	221	415	612	813
K_{xx}	0.019	0.026	0.036	0.048
K_{yy}	0.019	0.026	0.036	0.048
K_{zz}	0.124	0.115	0.111	0.112

For fuel assemblies in positions without the neutron absorber:

Conductivity [a] (Btu/hr-in-°F)	Temperature (°F)			
	222	417	615	816
K_{xx}	0.019	0.025	0.034	0.044
K_{yy}	0.019	0.025	0.034	0.044
K_{zz}	0.127	0.117	0.114	0.115

Table 4.4-2 Effective Thermal Conductivities for 10×10 BWR Fuel Assemblies for Helium Backfill

Conductivity [a] (Btu/hr-in-°F)	Temperature (°F)			
	192	394	597	801
K_{xx}	0.021	0.028	0.039	0.053
K_{yy}	0.021	0.028	0.039	0.053
K_{zz}	0.176	0.161	0.152	0.151

[a] K_{xx} and K_{yy} correspond to the in-plane directions and K_{zz} corresponds to the axial direction in the basket.

Table 4.4-3 Maximum Component Temperatures for Normal Condition Storage of Design Basis PWR and BWR Heat Loads

Component		Maximum Temperatures (°F) CC1/CC2 PWR	CC1/CC2 BWR	CC3 PWR	CC4 PWR	Allowable Temperature (°F)
Fuel Cladding		714	682	718	718	752
Fuel Basket [a]		714	682	718	718	800
TSC Shell		457	431	462	462	800
Concrete	local	271	243	256	271	300
	bulk	160	153	155	160	200

Table 4.4-4 Helium Mass Per Unit Volume for MAGNASTOR TSCs

Fuel Type	Helium Density (g/liter) Nominal	Lower Bound	Upper Bound
PWR	0.763	0.694	0.802
BWR	0.774	0.704	0.814

[a] The maximum fuel cladding temperature is conservatively used.

Table 4.4-5 Maximum Fuel Temperature for Water Phase – PWR

HEAT LOAD (KW)	T_{MAX} OF FUEL (°F)	T_{MAX} OF CANISTER OD (°F)
35.5	131	118
30	127	116
25	124	114
20	120	112
15	116	109

Table 4.4-6 Maximum Fuel Temperature for Water Phase – BWR

HEAT LOAD (KW)	T_{MAX} OF FUEL (°F)	T_{MAX} OF CANISTER OD (°F)
33	126	113
30	124	112
25	120	110
20	117	108
15	113	106

Table 4.4-7 Maximum Fuel Temperature for Helium Phase – PWR

HEAT LOAD (KW)	T_{MAX} OF FUEL (°F)	T_{MAX} OF CANISTER OD (°F)
35.5	424	124
30	388	122
25	350	119
20	311	116
15	273	113

Table 4.4-8 Maximum Fuel Temperature for Helium Phase – BWR

HEAT LOAD (KW)	T_{MAX} OF FUEL (°F)	T_{MAX} OF CANISTER OD (°F)
33	410	117
30	387	116
25	351	114
20	314	111
15	275	109

Table 4.4-9 Durations and the Temperature at the End of the Duration for the First Vacuum Stage (PWR)

Heat Load (kW)	Vacuum Duration (hours)	T_{MAX} at Steady State or at the End of the Duration (°F)	
		Fuel	Basket
15	No limit	509	483
20	No limit	627	599
25	No limit	739	709
30	32	643	614
35.5	24	640	612

Table 4.4-10 Durations and the Temperature at the End of the Duration for the First Vacuum Stage (BWR)

Heat Load (kW)	Vacuum Duration (hours)	T_{MAX} at Steady State or at the End of the Duration (°F)	
		Fuel	Basket
15	No limit	441	428
20	No limit	543	528
25	No limit	641	625
29	No limit	717	700
30	44	641	624
33	33	630	613

Table 4.4-11 Durations and the Temperature at the End of the Duration for the Second Vacuum Stage* (PWR)

Heat Load (kW)	Helium Backfill Duration (hours)	T_{MAX} of Fuel/Basket at the End of the Helium Backfill (°F)	Second Vacuum Duration (hours)	T_{MAX} of Fuel/Basket at the End of the Second Vacuum (°F)
35.5	24	460	11	640

* For the cases with heat load higher than 25 kW, the duration and temperatures at the end of the duration shown in this table can be conservatively used.

Table 4.4-12 Durations and the Temperature at the End of the Duration for the Second Vacuum Stage* (BWR)

Heat Load (kW)	Helium Backfill Duration (hours)	T_{MAX} of Fuel/Basket at the End of the Helium Backfill (°F)	Second Vacuum Duration (hours)	T_{MAX} of Fuel/Basket at the End of the Second Vacuum (°F)
33	24	432	16	630

* For the cases with heat load larger than 29 kW, the duration and temperatures at the end of the duration shown in this table can be conservatively used.

Table 4.4-13 TFR to Concrete Cask (PWR) Transfer Times and Temperatures

[redacted]

Table 4.4-14 TFR to Concrete Cask (BWR) Transfer Times and Temperatures

[redacted]

Table 4.4-15 Durations Allowed and the Maximum PWR Fuel Clad Temperatures for the Operation Using Reduced Vacuum Times, Reduced Cooling Time and Eight Hours of Handling

[redacted]

Table 4.4-16 Durations Allowed and the Maximum BWR Fuel Clad Temperatures for the Operation Using Reduced Vacuum Times, Reduced Cooling Time and Eight Hours of Handling

[redacted]

4.5 Off-Normal Events

This section evaluates postulated off-normal storage and off-normal transfer phase events that might occur once during any calendar year of operation. The actual occurrence of any of these events is, therefore, infrequent.

4.5.1 Off-Normal Storage Events

The concrete cask and TSC model described in Section 4.4.1.1 is used for the evaluation of the concrete cask and TSC for the off-normal events: severe ambient temperature conditions (106°F and -40°F) and the half-blocked air inlets condition. The evaluation of the off-normal events for variations in the ambient temperature only requires a change to the boundary condition temperature. For the half-blocked air inlets condition, the air inlet condition is modified to permit only half of the air flow into the inlet. The design basis heat loads of 35.5 kW and 33 kW are used in the evaluations of the concrete cask and TSC containing PWR and BWR fuels, respectively. As shown in Section 4.4.1 and Section 4.4.3, the analysis results for the standard PWR basket bound the analysis results for the DF basket assembly for normal conditions due to the higher thermal conductivity of the DF basket assembly. This conclusion is valid for the off-normal conditions for the same reasons. As shown in Section 4.4.3, the analysis results for the standard PWR basket bound the analysis results for the PWR minimum reduced cool time fuel basket assembly for normal conditions due to the heat distribution of the preferential loading of PWR minimum reduced cool time fuel basket assembly. The heat distribution for the preferential loading removes the maximum heat load from the basket center. This conclusion is valid for the off-normal conditions for the same reasons.

The principal component temperatures for each of the off-normal events, discussed previously, are summarized in the following tables, along with the allowable temperatures. Note that the maximum fuel cladding temperatures are conservatively used as the maximum fuel basket temperatures. As the tables show, the component temperatures for the concrete cask and TSC containing PWR and BWR fuels are within the allowable values for the off-normal storage events.

Principal Component Temperatures – Off-Normal Storage of CC1/CC2 with PWR TSC

Component	106°F Ambient, Maximum Temperatures (°F)	-40°F Ambient, Maximum Temperatures (°F)	76°F Ambient/Half Blocked Air Inlets Temperatures (°F)	Allowable Temperature (°F)
Fuel Cladding	752	603	717	1,058
Fuel Basket	752	603	717	1,000
TSC Shell	485	336	459	800
Concrete	311	118	274	350

Principal Component Temperatures – Off-Normal Storage of CC3 with PWR TSC

Component	106°F Ambient, Maximum Temperatures (°F)	-40°F Ambient, Maximum Temperatures (°F)	76°F Ambient/Half Blocked Air Inlets Temperatures (°F)	Allowable Temperature (°F)
Fuel Cladding	756	617	720	1,058
Fuel Basket	756	617	720	1,000
TSC Shell	490	353	465	800
Concrete	296	96	259	350

Principal Component Temperatures – Off-Normal Storage of CC4 with PWR TSC

Component	106°F Ambient, Maximum Temperatures (°F)	-40°F Ambient, Maximum Temperatures (°F)	76°F Ambient/Half Blocked Air Inlets Temperatures (°F)	Allowable Temperature (°F)
Fuel Cladding	756	617	720	1,058
Fuel Basket	756	617	720	1,000
TSC Shell	490	353	465	800
Concrete	311	118	274	350

Principal Component Temperatures – Off-Normal Storage of CC1/CC2 with BWR TSC

Component	106°F Ambient, Maximum Temperatures (°F)	-40°F Ambient, Maximum Temperatures (°F)	76°F Ambient/Half Blocked Air Inlets Temperatures (°F)	Allowable Temperature (°F)
Fuel Cladding	719	569	684	1,058
Fuel Basket	719	569	684	1,000
TSC Shell	459	312	433	800
Concrete	282	93	246	350

There are no adverse consequences due to these off-normal events. The maximum component temperatures are less than the allowable temperature limits.

Off- Normal Event TSC Internal Pressures

Off-normal event TSC internal pressures are evaluated using the method and inputs documented in the normal condition pressure evaluations (Section 4.4.4). The off-normal event TSC internal pressure analysis considers a 10% rod failure fraction and a TSC backfill temperature at 495°F and a pressure of 106 psig. The higher backfill temperature, and associated pressure, is the result of the "severe heat" off-normal thermal evaluation. The maximum TSC internal pressures calculated for off-normal events are 118 psig for the PWR system, 119 psig for the damaged fuel PWR system, and 112 psig for the BWR system.

4.5.2 Off-Normal Transfer Phase Events for PWR Fuel

Crane Failure During Transfer Cask Movements

While maneuvering the transfer cask in preparation for transfer operations, a mechanical or electrical malfunction could temporarily disable the crane and inhibit movement of the transfer cask and TSC. Such an occurrence would eliminate the option of submerging the transfer cask and TSC in the spent fuel pool for cooling and might make it difficult to establish an annulus cooling system flow. If operability of the crane can be restored within the normal transfer time limits, the transfer operation may be completed and no special actions are required. However, if the crane cannot be repaired in a timely manner it may not be possible to complete or abort the transfer operation within the normal limits. This condition is considered an off-normal event.

The two dimensional FLUENT model of the TSC and transfer cask with reduced annulus inlet, described in the transfer phase evaluation in Section 4.4.1.5, is used to perform steady state evaluations to determine the maximum heat load at which steady state fuel temperatures are below the off-normal allowable temperature limits. [redacted]

Crane/Hoist System Failure During TSC Transfer to VCC

With the transfer cask in place on top of the VCC, the TSC is lifted, the transfer cask doors are opened, and the TSC is lowered into the VCC. A mechanical or electrical malfunction of the

crane could strand the TSC in the transfer cask/VCC cavity. Such an occurrence would eliminate the option of submerging the transfer cask and TSC in the spent fuel pool for cooling, and might make it difficult to establish an annulus cooling water flow. If operability of the crane can be restored within the normal transfer time limits, transfer of the TSC into the VCC may be completed, and no special actions are required. However, if the crane cannot be repaired in a timely manner it may not be possible to complete or abort the transfer operation within the normal limits. This condition is considered an off-normal event.

Since the transfer cask doors are open, the air flow through the annulus region is greater than that in the off-normal event discussed in the preceding section (if the doors cannot be opened then the results of the preceding section apply). The two dimensional FLUENT model used in the preceding evaluation, configured with the full annulus inlet, is used to perform steady state evaluations to determine the maximum heat load at which steady state fuel temperatures are below the off-normal allowable temperature limits. [redacted]

Retrieving a TSC from a VCC for Unloading

If a TSC must be returned to the spent fuel pool for wet unloading, an off-normal event, it will be lifted out of the VCC into the transfer cask. Considering the initial conditions to be the steady state condition in the VCC, the transient results from the transfer phase evaluation in Section 4.4.1.5 for the design basis heat load are used to determine that the normal allowable temperature limits for the TSC and its PWR contents are reached 3 hours after the TSC is removed from the VCC and off-normal allowable temperature limits for the TSC and its PWR contents are reached 11 hours after the TSC is removed from the VCC. Annulus cooling flow, or an equivalent cooling method, must be established within this time limit to maintain the TSC and its contents below the off-normal allowable temperature limits.

4.6 Accident Events

This section presents the evaluations of the thermal accident design events, which address very low probability events that might occur once during the lifetime of the ISFSI or hypothetical events that are postulated because their consequences may result in the maximum potential impact on the surrounding environment. Three thermal accident events are evaluated in this section: maximum anticipated heat load, fire accident and full blockage of the air inlets. The maximum TSC internal pressure for the bounding accident conditions is evaluated in Section 4.6.4.

The concrete cask and TSC model described in Section 4.4.1.1 is used for the evaluation of the concrete cask and TSC for these thermal accident events. Since the CC3 concrete cask containing the PWR TSC has the same heat load and almost the same thermal mass as the CC1/CC2 concrete cask containing the PWR TSC, the thermal response is essentially the same for CC1/CC2 and CC3 for the fire accident and the full blockage event.

As shown in Section 4.4.1 and Section 4.4.3, the analysis results for the standard PWR basket bound the analysis results for the DF basket assembly for normal conditions due to the higher thermal conductivity of the DF basket assembly. This conclusion is valid for the accident conditions for the same reasons.

As shown in Section 4.4.3, the analysis results for the standard PWR basket bound the analysis results for the PWR minimum reduced cool time fuel basket assembly for normal conditions due to the heat distribution of the preferential loading of PWR minimum reduced cool time fuel basket assembly. This conclusion is valid for the accident conditions for the same reasons.

4.6.1 Analysis of Maximum Anticipated Ambient Heat Load

This section evaluates the concrete cask and the TSC for the postulated accident event of an ambient temperature of 133°F. A steady state condition is considered in the thermal evaluation of the system for this accident event.

Using the same methods and thermal models described in Section 4.4.1.1 for the normal conditions of storage, thermal evaluations are performed for the concrete cask and the TSC with its contents for this accident condition. All boundary conditions in the model are the same as those used for the normal condition evaluation, except that an ambient temperature of 133°F is used. The maximum calculated temperatures of the principal PWR and BWR cask component, with the corresponding allowable temperatures, are as follows.

Component	Maximum Temperature (°F)				Allowable Temperature (°F)
	CC1/CC2		CC3	CC4	
	PWR	BWR	PWR	PWR	
Fuel Cladding	786	753	790	790	1,058
Fuel Basket	786	753	790	790	1,000
TSC Shell	510	483	514	514	850
Concrete	347	317	332	347	350

Note that the maximum fuel cladding temperatures are conservatively considered to be the maximum basket temperatures. This evaluation shows that the component temperatures are within the allowable temperatures for the extreme ambient temperature conditions.

4.6.2 Fire Accident

A fire may be caused by flammable material or by a transport vehicle. While it is possible that a transport vehicle could cause a fire while transferring a loaded storage cask at the ISFSI, this fire will be confined to the vehicle and will be rapidly extinguished by the persons performing the transfer operations or by the site fire crew. Fuel in the fuel tanks of the concrete cask transport vehicle and/or prime mover (maximum 50 gallons) is the only flammable liquid that could be near a concrete cask, and potentially at, or above, the elevation of the surface on which the cask is supported. The fuel carried by other onsite vehicles or by other equipment used for ISFSI operations and maintenance, such as air compressors or electrical generators, is considered not to be within the proximity of a loaded cask on the ISFSI pad. Site-specific analysis of fire hazards will evaluate the specific equipment used at the ISFSI and determine any additional controls required.

The analyzed area is a 15×15-foot square, less the 136 in-diameter footprint of the concrete cask, corresponding to the center-to-center distance of the concrete casks on the ISFSI pad. The potential depth (D) of the 50-gallon pool of flammable liquid is calculated as follows.

$$D = \frac{50 \times 231}{15 \times 15 \times 144 - 3.14 \times 128^2 / 4} = 0.6 \text{ in.}$$

With a burning rate of 5 in/hr, the fire would continue for 7.2 minutes. The fire accident evaluation in this section conservatively considers an 8-minute fire. The temperature of the fire is taken to be 1,475°F, which is specified for the fire accident event in 10 CFR 71.73c [3].

The fire condition is an accident event and is initiated with the concrete cask in a normal operating steady-state condition. To determine the maximum temperatures of the concrete cask components, the two-dimensional axisymmetric model of the concrete cask and TSC for the PWR configuration described in Section 4.4.1.1 is used to perform a transient analysis. The PWR

configuration is considered to bound the BWR configuration due to the higher initial temperatures of the normal condition.

The initial condition of the fire accident transient analysis is based on the steady-state analysis results for the normal condition of storage, which corresponds to an ambient temperature of 100°F in conjunction with solar insolation (as specified in Section 4.4.1.1). The fire condition is implemented by applying a boundary temperature condition of 1,475°F at the air inlet and the lower surface of the steel plate forming the top of the air inlet for eight minutes. This boundary condition temperature is applied as a stepped boundary condition. During the eight-minute fire, solar insolation is also applied to the outer surface of the concrete cask. At the end of the eight minutes, the temperature at the inlet is reset to the ambient temperature of 100°F. The cooldown phase is continued for an additional 10.7 hours to observe the maximum TSC shell temperature and the average temperature of the TSC contents.

The maximum fuel temperature increased by less than 3°F, thus remaining well below the accident event temperature limit of 1,058°F. The maximum temperature of the TSC shell increases to 512°F due to the fire condition. The limited duration of the fire, the large thermal capacitance of the concrete cask, and the minimal thermal conductivity limit the local region where the concrete temperatures exceed 300°F to less than 10 inches above the top surface of the air inlets. These results confirm that the operation of the concrete cask is not adversely affected during and after the fire accident condition.

4.6.3 Full Blockage of Concrete Cask Air Inlets

This section evaluates the concrete cask for the transient condition of full blockage of the air inlets at the normal storage condition temperature (100°F).

The accident temperature conditions are evaluated using the concrete cask and TSC thermal models described in Section 4.4.1.1. The transient analysis assumes initial normal storage conditions, with the sudden loss of convective cooling of the TSC. This is simulated by removing the inlet and outlet conditions from the model. Heat is then rejected from the TSC to the concrete cask liner only by radiation and convection. The loss of convective cooling to the ambient environment results in a sustained heat-up of the TSC and its contents and the concrete cask. The maximum fuel cladding temperature, maximum basket temperature, and the maximum concrete bulk temperature remain less than the allowable accident temperatures for approximately 72 hours after the initiation of the event. However, the internal pressure in the TSC cavity will reach the analyzed maximum pressure condition of 250 psig in approximately 58 hours after the initiation of a complete blockage event.

The evaluation demonstrates that there are no adverse consequences due to this accident, provided that debris is cleared from at least two air inlets within 58 hours based on the steady-state evaluation of the half-blocked air inlet condition in Section 4.5.

4.6.4 Maximum TSC Internal Pressure for Accident Events

Accident event pressures are evaluated with the method and inputs documented in the normal condition pressure evaluation (Section 4.4.4). System conditions incorporated in the accident analysis are an increased rod failure fraction and an increase in the average gas temperature of the TSC. A 100% rod failure fraction is applied in the system pressure calculation in conjunction with normal system temperatures. The second accident pressure evaluation applies the bounding thermal accident TSC average gas temperature to a TSC with a 1% (normal condition) fuel failure fraction. The bounding thermal accident, and associated pressure increase, is the result of the air inlets full blocked thermal evaluation. The average TSC gas temperature applied in the thermal accident pressure evaluation is a conservative 684°F compared to 677°F calculated for this condition. Maximum calculated TSC internal pressures for the PWR and BWR systems are documented as follows.

System	100% Fuel Failure	Inlets Blocked
PWR (undamaged fuel basket)	221 psig	130 psig
PWR (damaged fuel basket)	226 psig	130 psig
BWR	159 psig	129 psig

Chapter 5
Shielding Evaluation

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5.1 Cask Shielding Discussion and Dose Results

The TSC is loaded and sealed inside a transfer cask and then moved into a concrete cask for placement on the ISFSI pad. Dose evaluations are performed for the various TSC contents when the TSC is inside the transfer cask or the concrete cask.

With the exception of the offsite dose discussion, the dose results are presented based on bounding heat loads and corresponding source terms based on a 35.5 kW PWR cask heat load and a 35 kW BWR cask heat load. Offsite dose results are produced by similar bounding values of a 40 kW PWR cask heat load and a 38 kW BWR cask heat load. Thermal evaluations restrict BWR payloads to 33 kW. Cool time tables for the thermally restricting payloads are listed in Section 5.8.9. Based on the code validation discussion in Section 5.2, a 5% uncertainty is applied to the heat loads for fuel burnups above 45 GWd/MTU. This results in an extension in minimum allowed cool time for high burnup fuel assemblies. All dose rates calculated at higher cask heat loads are bounding for the reduced heat load. For any fuel type, burnup, initial enrichment, and cool time combination allowed, additional cool time and, therefore, reduced sources are associated with the lower cask heat load. This conclusion applies also to the PWR preferential loading patterns.

A reduced minimum cool time of 2.5 years and four-zone preferential loading pattern (max 1.8 kW/assy heat load) are evaluated in Section 5.9 for undamaged or damaged PWR assembles in the CC4 or MTC2.

Dose rates (detector tallies) in this chapter are calculated using Monte Carlo methods and, therefore, contain a result and statistical uncertainty of the result. The statistical uncertainty is expressed as a percentage and referred to as fractional standard deviation (FSD) or relative uncertainty.

5.1.1 Transfer Cask Shielding Discussion and Dose Results

The transfer cask radial shield is comprised of steel inner and outer shells connected by solid steel top and bottom forgings. The shell encloses a lead gamma shield and a solid borated polymer (NS-4-FR) neutron shield. The TSC shell and the basket internal structure provide additional radial shielding. The transfer operation bottom shielding is provided by the TSC bottom plate and solid steel transfer cask doors. The TSC closure lid provides radiation shielding at the top of the TSC.

The three-dimensional transfer cask shielding analysis provides a complete, nonhomogenized representation of the transfer cask and TSC structure. The model assumes the following TSC/transfer cask configuration for all dose rate evaluations.

- Dry canister cavity
  The majority of the TSC operations, in particular closure lid welding, are performed with the TSC cavity filled with water. Evaluating a dry canister cavity is conservative. Note that the water filling the TSC/transfer cask annulus between the inflatable seals is modeled. Transfer cask dose rates from a wet canister, while containing an increased neutron source due to a higher subcritical multiplication resulting from a higher keff, are lower than those of the dry system due to the additional radiation shielding provided by the water within and surrounding the source region. PWR and BWR confirmatory calculations comparing dry, wet and partially flooded canister configurations are included in Section 5.8.11.

- 6-in auxiliary weld shield
  Closure lid weld operations are typically performed with an automated weld system that is mounted on a weld platform. The presence of this platform provides significant auxiliary shielding during the TSC closure operation.

- Homogenization of the fuel assembly into five source regions
  While TSC and concrete cask features are discretely modeled, the fuel assembly is homogenized into upper and lower end-fitting (nozzle) regions, upper and lower plenum regions (lower plenum regions are modeled only for B&W fuel assemblies), and an active fuel region. For shielded applications, such as in the heavily shielded spent fuel transfer and concrete casks, homogenizing the fuel region does not introduce a significant bias in the dose results presented.

5.1.1.1 Undamaged Fuel Dose Rates

The carbon steel and stainless steel transfer cask maximum calculated dose rates are shown in Table 5.1.3-1 and Table 5.1.3-4. Payload types producing maximum surface dose rates are listed in Table 5.1.3-3 and Table 5.1.3-6. TSC surface contamination release dose rates are shown in Section 5.6.5. Dose rates are based on a three-dimensional Monte Carlo analysis using surface detectors. Uncertainty in Monte Carlo results is indicated in parentheses. Further detail on the detector geometry is included in Section 5.5. There is no design basis off-normal or accident event that will affect the shielding performance of the transfer cask.

Transfer cask top-, side-, and bottom-surface average dose rates are 254 (1.1 %) mrem/hr, 895 (<1%) mrem/hr, and 3,000 (<1%) mrem/hr, respectively. Access to the bottom of the cask is limited to pool-to-workstation transfer operations and the workstation-to-vertical concrete cask transfer operations. Site ALARA plans should specify limited access to areas below and around the loaded transfer cask during lifting and transfer operations.

5.1.1.2 Damaged PWR Fuel Dose Rates

Damaged PWR fuel assemblies may be loaded in damaged fuel cans in the four corner assembly locations of the PWR damaged fuel basket. DFC slots are locations 4, 8, 30 and 34 in Figure 5.8.12-10. To ensure that the worst case configuration is considered, two damaged fuel scenarios are evaluated.

The first scenario assumes the damaged fuel collects over the active fuel length of the fuel assembly. This scenario is modeled by filling the fuel assembly interstitial volume with UO_2 and increasing the fuel neutron, gamma and n-gamma source consistent with this increase in mass. Dose rate profiles for the 37-assembly undamaged assemblies are compared with profiles for 33 undamaged and 4 damaged assemblies in Section 5.8.12. Based on the self-shielding of the added mass compensating for the increase in source, damaged fuel dose rates for the first scenario are bounded by either the corresponding undamaged fuel dose rates or the second damaged fuel scenario.

In the second scenario, damaged fuel is assumed to migrate from the active fuel into the lower end fitting region of the fuel assembly, filling all the modeled void space. However, no credit is taken for the reduction in the lower end fitting hardware dose rate due to the added UO_2 mass and self-shielding nor for the reduction in fuel mass migrated from the active fuel region. In this case, transfer cask bottom surface dose rates increase due to the addition of damaged fuel. The transfer cask bottom axial dose rate increases 53 mrem/hr, increasing the bottom axial dose rate by approximately 0.9 percent. Radial dose rates for PWR fuel increase, but remain less than the bounding BWR fuel.

Damaged fuel dose rates are computed using the carbon steel transfer cask, as it produces higher dose rates than the stainless steel transfer cask due to the higher density of stainless steel versus carbon steel.

Damaged fuel maximum dose rates in the carbon steel transfer cask are summarized in Table 5.1.3-8.

5.1.2 Concrete Cask Shielding Discussion and Dose Results

The concrete cask is composed of body and lid components. The body contains the air inlets, air outlets, and the cavity for TSC placement. The lid provides environmental closure for the TSC.

The radial shield design is comprised of a carbon steel inner liner surrounded by concrete. The concrete contains radial and axial rebar for structural support. As in the transfer cask, the TSC shell provides additional radial shielding. The concrete cask top shielding design is comprised of the TSC lid and concrete cask lid. The concrete cask lid incorporates both concrete and steel plate to provide additional gamma shielding. The bottom shielding is comprised of the stainless steel TSC bottom plate, the pedestal/air inlet structure, and a carbon steel base plate. Radiation streaming paths consist of air inlets located at the bottom and air outlets located above the top of the TSC, and above the annulus between the concrete cask body and the TSC. Air inlets and outlets are radial openings to the concrete cask. The inlets and outlets are axially offset from the source regions to minimize dose and meet ALARA principles.

No auxiliary shielding is considered in the concrete cask shielding evaluation. All components relevant to safety performance are explicitly included in the concrete cask model. Homogenization of materials used in the models is limited to the fuel assembly as described in Section 5.1.1.

5.1.2.1 Undamaged Fuel Dose Rates

Refer to Table 5.1.3-2, Table 5.1.3-5, and Table 5.1.3-7 for a summary of the concrete cask normal condition and accident event maximum calculated dose rates for the standard (CC1/ CC2), augmented shield (CC3), and short, standard (CC4) cask configurations. Listed maximum dose rates include fuel and nonfuel hardware contributions. Payload types producing maximum surface dose rates are listed in Table 5.1.3-3, Table 5.1.3-6, and Table 5.1.3-8. Refer to Section 5.6.5 for TSC surface contamination release dose rates. Dose rates are based on three-dimensional Monte Carlo analysis using surface detectors. Further detail on the detector geometry is included in Section 5.5.

The maximum concrete cask side (cylindrical) average surface dose rate is 58 (<1%) mrem/hour. On the concrete cask top (disk), the average surface dose rate is 104 (2%) mrem/hour. Average dose rates for the standard shielding concrete cask are more than twice as high on the radial surface and approximately 20% higher on the axial surface than the augmented shielding cask configuration for the PWR system (augmented cask shield analysis limited to PWR payloads). The maximum inlet and outlet dose rates are 434 and 59 mrem/hr, respectively. No design basis normal condition or accident event exposes the bottom of the concrete cask.

5.1.2.2 Damaged PWR Fuel Dose Rates

The two damaged fuel scenarios described in Section 5.1.1.2 are also evaluated for the concrete cask.

The first scenario assumes the damaged fuel collects over the active fuel length of the fuel assembly. Dose rate profiles for the 37- undamaged assemblies are compared with profiles for 33 undamaged and 4 damaged assemblies in Section 5.8.12. Based on the self-shielding of the added mass compensating for the increase in source, damaged fuel dose rates for the first scenario are bounded by either the corresponding undamaged fuel dose rates or the second damaged fuel scenario.

In the second scenario, damaged fuel is assumed to migrate from the active fuel into the lower end fitting region of the fuel assembly, filling all the modeled void space. In this case, concrete cask inlet and radial dose rates increase due to the addition of damaged fuel. The concrete cask inlet dose rate increase is 38 mrem/hr, increasing the inlet dose rate by approximately 9 percent. The maximum concrete cask radial dose rate increases to 82.3 mrem/hr, an increase of approximately 4 percent.

Damaged fuel dose rates are computed using the standard concrete cask (CC1/CC2) or the short, standard concrete cask (CC4), as they produce higher dose rates than the augmented shield concrete cask.

Damaged fuel maximum dose rates in the standard concrete cask are summarized in Table 5.1.3-10.

5.1.3 Offsite Dose Discussion and Results

Contributions from concrete casks to site radiation dose exposure are limited to either radiation emitted from the concrete cask surface or a hypothetical release of surface contamination from the TSC. As documented in Section 5.6.5, there is no significant site dose effect from the expected surface contamination of the system. The TSCs are comprised of a welded shell, bottom plate and lid structure. The vent and drain ports in the lid are covered by redundant welded plates. There is, therefore, no credible leakage from the system, and no significant effluent source can be released from the TSC contents. Details on the TSC confinement boundary are provided in Chapter 7, with leakage test information provided in Section 10.1.3.

Controlled area boundary exposure from the concrete cask surface radiation is evaluated using the NAC-CASC code. (As previously stated, NAC-CASC is a modified version of SKYSHINE-

III.) NAC-CASC calculates the direct dose rate as well as the air scattered contribution of the total dose rate. As the detectors are below the top surface of the cask, only the cylindrical shell (radial) cask surface current contributes a direct component to the total dose rate. NAC-CASC primary enhancements to SKYSHINE-III allow the input of an angular surface current, the input of cylindrical shell (side) and disk (top) geometries, and the accounting of concrete cask self-shielding (i.e., radiation emitted from one cask intersecting another cask in the array—in particular, front/back row interaction in the array). The cylindrical shell and top surfaces are Monte Carlo sampled to generate the surface current input into the code. Each of the sampled locations represents a point source to which the SKYSHINE-III line beam response functions are applicable.

The NAC-CASC (SKYSHINE-III) method assumes that radiation emitted from the source does not interact with the cask/source structure after emission (beyond the additional routines added by NAC to account for self-shielding). This assumption does not represent a significant effect on site dose rates as the calculated surface current is near normal to the surface and any backscatter to the cask from the air surrounding the array would then require a second backscatter from the cask surface to reach a detector location. As detector locations for site exposure are at significant distances from the array (typically 100+ meters), there would not be a significant contribution from radiation having undergone such repeated large angle scatter.

Both a single cask and a 2×10 array of casks are evaluated for site exposure evaluations. Each cask in the array is assigned the maximum dose (surface current) source allowed by the cask loading tables. A combination of the maximum cask side and top dose cases provides for a conservative estimate on the controlled area boundary exposure, since the different fuel types produce the highest cask surface dose components.

The full-year exposure for site boundary (controlled area boundary) results is based on 8,760 hours of exposure.

5.8.4 87-Assembly BWR System

This section presents the detailed evaluation of the concrete and transfer casks loaded with BWR fuel assemblies.

5.8.4.1 BWR Fuel and Basket Models

The three-dimensional shielding evaluation includes a homogenized fuel assembly model and a detailed three-dimensional basket model.

5.8.4.1.1 Fuel Assembly Model

Based on the fuel assembly physical parameters provided in Table 5.8.1-4 and the hardware masses in Table 5.8.1-5, homogenized treatments of fuel assembly source regions are developed. The homogenized fuel assembly is represented in the model as a stack of boxes with width equal to the fuel assembly width. The height of each box corresponds to the modeled height of the corresponding assembly region.

Sample fuel and nonfuel hardware homogenizations for the source regions for the 08b assembly are shown in Table 5.8.4-1 and Table 5.8.4-2, respectively. The resulting fuel compositions on an atom/barn-cm basis are shown in Table 5.8.4-3. Similar compositions sets are generated for the remaining fuel assembly hybrids. Note that the Zirc-2 fuel assembly channel is not included in the model.

5.8.4.1.2 Basket Model

The basket is composed of coated carbon steel tubes, pinned together at the corners, and held together by side and corner weldments. Forty-five fuel tubes, in combination with the weldments, form 89 fuel openings. Two openings are located below the vent port covers. To minimize exposure and meet ALARA constraints, basket capacity is reduced to 87 assemblies. Pin spacers maintain the tube axial spacing within the TSC cavity. Each tube contains four metallic composite neutron absorber sheets. In dry storage and transfer, the presence of the neutron absorber sheets provides minimal shielding and could, therefore, be removed without a significant increase in exposure. Key basket characteristics are shown in Table 5.8.4-4. Radial and axial sketches of basket within the TSC are shown in Figure 5.8.4-1 and Figure 5.8.4-2.

5.8.4.2 Minimum Cool-time Specification

SAS2H generates heat loads for all BWR fuel types listed in Section 5.8.1.2. Based on a 35 kW per cask (0.402 kW per assembly) heat load, minimum allowed cool times for each fuel type are calculated. Calculated heat loads account for fuel material (actinide and fission product) and

hardware (light element) generated sources. Minimum cool times are conservatively rounded up to the nearest one-tenth of a year. A sample minimum cool time calculation for the 09b hybrid BWR assembly is shown in Table 5.8.4-5. The resulting minimum cool times are listed in an assembly specific loading table (see Table 5.8.4-6). Note that cool times for maximum assembly average burnups less than or equal to 30,000 MWd/MTU are not tabulated since they are equal to four years for all seven BWR fuel types. However, the following minimum enrichments for these assembly average burnups must be invoked.

Max. Assembly Avg. Burnup (MWd/MTU)	Min. Assembly Avg. Initial Enrichment (wt % ^{235}U)
5,000	0.7
10,000	1.3
15,000	1.5
20,000	1.7
25,000	1.9
30,000	2.1

Note that the loading table removes combinations of high burnup and low enrichment (e.g., 60 GWd/MTU and 1.9 wt% ^{235}U) from the payload definition. Source term data covering these combinations is generated, but produces unrealistic source terms due to the complete consumption of fissile uranium early in the burnup cycle and the SAS2H input of a fixed power density. To maintain power density, ORIGEN-S (SAS2H) will substantially increase flux levels, which would not occur during core operation of the assembly, to produce fissile material and to produce power by nonthermal fission. The increased flux level "breeds" higher actinides, which in turn increase source significantly. Since a high burnup and low enrichment combination would require repeated reinsertion of a burned assembly, the combination is excluded.

Minimum cool time tables for the thermal analysis limited heat load are included in Section 5.8.9.

5.8.4.3 Transfer Cask Dose Rates

Using the dose response method, cask dose rates are tabulated for all allowed cool time, assembly average burnup, and initial enrichment combinations for each of the assembly types. Maximum dose rates as a function of distance from the cask surface are shown in Figure 5.8.4-3 for the cask radial surface, Figure 5.8.4-5 for the cask top, and Figure 5.8.4-7 for the cask bottom. Breakdowns of the cask surface radial and top dose rates into the source components are shown

5.8.9.2 BWR

Thermal analysis limits the BWR cask heat load to below that used in the cask shielding analysis. Minimum fuel assembly cool times are, therefore, required for a 33 kW cask heat load (379 W/assembly). Due to potential uncertainties in the source generation abilities of SAS2H, allowed heat load is reduced by an additional 5%, to 360 W/assembly, for fuel with burnups greater than 45 GWd/MTU. Minimum cool times for fuel with burnup greater than 30 GWd/MTU, but ≤ 45 GWd/MTU, are listed in Table 5.8.9-11 with high burnup fuel cool times shown in Table 5.8.9-12.

Allowed low burnup (up to 30,000 MWd/MTU) fuel loadings are shown in Table 5.8.9-10. Note that the listed minimum cool times at each burnup step are bounding for all fuel types and initial enrichments above the minimum enrichment specified. Collapsing the fuel type and initial enrichment dependent minimum cool time matrix to a single value may result in a minimum cool time longer than individual values presented for higher burnups.

Table 5.8.9-10 Low Burnup BWR Fuel Loading Table

Max. Assembly Avg. Burnup (MWd/MTU)	Min. Assembly Avg. Initial Enrichment (wt% ^{235}U)	Minimum Cool Time (yrs)
5,000	0.7	4.0
10,000	1.3	4.0
15,000	1.5	4.0
20,000	1.7	4.0
25,000	1.9	4.0
30,000	2.1	4.3

5.9 Reduced Minimum Cool Time Shielding Evaluation Detail

This section contains evaluation detail for Westinghouse 14x14 fuel assemblies with a minimum cool time of 2.5 years loaded in the CC4 and stainless steel MTC. This section includes uniform loading, four zone preferential loading with a maximum assembly heat load of 1.8 kW, and damaged fuel evaluation. The minimum cool time for the Westinghouse 14x14 CEAs was reduced to 2.5 years from the previous minimum cool time of 10 years. The activated mass of the WE 14x14 CEA was evaluated based on the known dimensions of the WE 15x15 CEA.

5.9.1 Contents Description

Three-dimensional models of the loaded TSC within the stainless steel transfer or CC4 concrete cask require the relative elevations of the various source regions, hardware masses, and in-core condition to describe source and shielding models. The elevation of each of the assembly regions also defines the volume into which the fuel assembly is homogenized.

5.9.1.1 PWR Fuel Assembly Definitions

As described in Section 5.2, PWR fuel assemblies were surveyed to construct hybrids containing maximum fuel and hardware masses. Section 5.8.1 contains geometry data of the Westinghouse 14x14 hybrid used in this evaluation. Sample in-core characteristics are also contained in Section 5.8.1.

5.9.2 Response Function Method

The evaluation of reduced minimum cool time in the CC4 and MTC use the response function method described in Section 5.8.2.

Response functions for the transfer and storage cask (generated using MCNP) solve the particle transport equations at each relevant spectrum line using Monte Carlo techniques. The results of the individual spectrum lines are then statistically summed. As the basket is loaded uniformly (or in a four-region pattern for the 1.8 kW preferential loading pattern), the dose rate response can be calculated for a source located in multiple fuel assembly locations using Monte Carlo sampling within MCNP. For the uniform loading, the basket position variable is, therefore, not required within the summation. Note that the term is still accounted for directly within the MCNP run. For the four-region preferential loading scenario, the summation is limited to the dose rate response contribution of the four zones.

The response function method allows the MCNP weight window (acceleration) map to be optimized for a particular source energy, producing an increased number of particles scoring per source particle. The response function also allows for a significant reduction in the number of MCNP shielding runs, thereby increasing the number of particles per MCNP run (based on fixed computer resources). For example, a single PWR fuel type has approximately 20,000 source runs associated with it, requiring the same number of MCNP runs to determine a complete dose rate set. The same dose rate set for fuel gamma and neutron cases may be generated using approximately 20 MCNP runs (one per relevant neutron and gamma energy line) using the response function.

Section 5.8.2 demonstrates the applicability of the response method to determine the dose rates of the MAGNASTOR concrete cask and transfer cask systems.

5.9.3 37-Assembly PWR System

This section presents the detailed evaluations of the concrete and transfer casks loaded with PWR fuel assemblies. It primarily addresses the PWR undamaged fuel basket configuration with a payload of 37 fuel assemblies and no inserts. This section applies a uniform heat load pattern to determine system dose rates. Preferential loading for heat load is discussed in Section 5.9.6. The effects of nonfuel hardware components to dose rates and heat load are discussed in Sections 5.9.4, and 5.9.5. Model differences, dose rates, and minimum loading time impacts resulting from the damaged fuel basket configuration are discussed in Section 5.9.9.

5.9.3.1 PWR Fuel and Basket Models

The three-dimensional shielding evaluation includes a homogenized fuel assembly model and a detailed three-dimensional basket model. These models are discussed in length in Section 5.8.3.

5.9.3.2 Minimum Cool-time Specification

SAS2H generates heat loads for all PWR fuel types listed in Section 5.8.1.1. Based on the desired 35.5 kW system heat load, minimum allowed cool times for the matrix of initial enrichment and burnup are calculated. Calculated heat loads account for fuel material (actinide and fission product) and hardware (light element) generated sources. Minimum cool times are conservatively rounded up to the nearest one-tenth of a year. The resulting minimum cool times are listed in assembly specific loading tables.

The loading table removes combinations of high assembly average burnup and low enrichment (e.g., 60 GWd/MTU and 1.9 wt% ^{235}U) from the contents definition. Source term data covering these combinations produces unrealistic source terms due to the complete consumption of fissile uranium early in the burnup cycle and the SAS2H input of a fixed power density. To maintain power density, ORIGEN-S (SAS2H) will substantially increase flux levels, which would not occur during core operation of the assembly, to produce fissile material and to produce power by non-thermal fission. The increased flux level "breeds" higher actinides, which in turn increase source significantly. Since a high burnup and low enrichment combination would require repeated reinsertion of a burned assembly, the combination is excluded.

Minimum cool time tables are included in Section 5.9.8.

5.9.3.3 Stainless Steel Transfer Cask Dose Rates

Using the dose response method, transfer cask dose rates are tabulated for all allowed cool times, assembly average burnup, and initial enrichment combinations for the hybrid Westinghouse 14x14 fuel type (ng14b). Reducing the minimum cool time to 2.5 years has no impact on the bounding source terms for the stainless steel MTC. Bounding source term cool times remain above the previous minimum cool time of 4 years. No new dose rates are evaluated for the uniformly loaded stainless steel MTC.

5.9.3.4 CC4 Dose Rates

Using the dose response method, concrete cask dose rates are tabulated for all allowed cool times, assembly average burnup, and initial enrichment combinations for the hybrid Westinghouse 14x14 fuel type (ng14b). The reduction in minimum cool time results in a new bounding source term for the radial dose rates. The three other detector locations (Top, Inlet, and Outlet) remain bounded by previous evaluations.

Maximum dose rates as a function of distance from the CC4 radial surface are shown in Figure 5.9.3-1. A breakdown of the CC4 radial surface dose rates into the source components is shown in Figure 5.9.3-2. Refer to Table 5.9.3-1 for the maximum concrete cask surface dose rates and the contents that develop the dose rates. Reducing the minimum cool time to 2.5 years significantly increases radial dose rates on the CC4.

5.9.3.5 NAC-CASC Site Boundary Evaluation

The previous section demonstrated that the WE14x14 CC4 average radial dose rate is 68 mrem/hr. This evaluation was based on a bounding assessment at 2.5 year minimum cool time and 35.5 kW maximum system heat load. Design basis input to the site boundary analysis is an average radial dose rate of 57 mrem/hr, which was based on an assessment of 4.0 year minimum cool time and 40.0 kW maximum system heat load. For site boundary dose rates the increased radial dose component can be accounted for by conservatively increasing reported single cask and array yearly dose and exposure values by 20%. This will conservatively neglect the smaller height CC evaluated at the reduced cool time (with the associated lower surface area for emission) and reduced axial dose components versus the 40 kW design basis source.

Figure 5.9.3-1 Concrete Cask Side Dose Rate Profile at Various Distances – PWR (CC4)

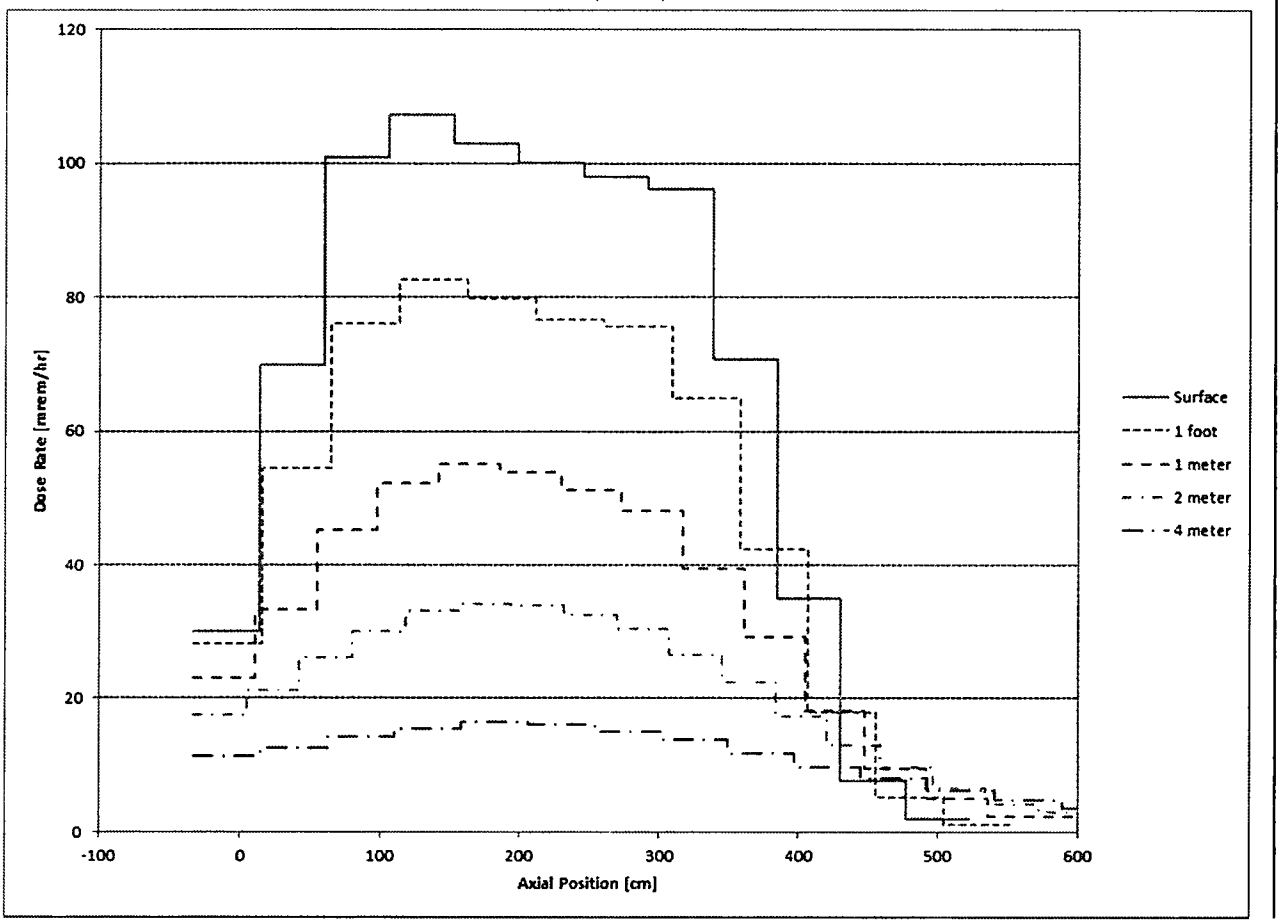

Figure 5.9.3-2 Concrete Cask Side Surface Dose Rate Profile by Source – PWR (CC4)

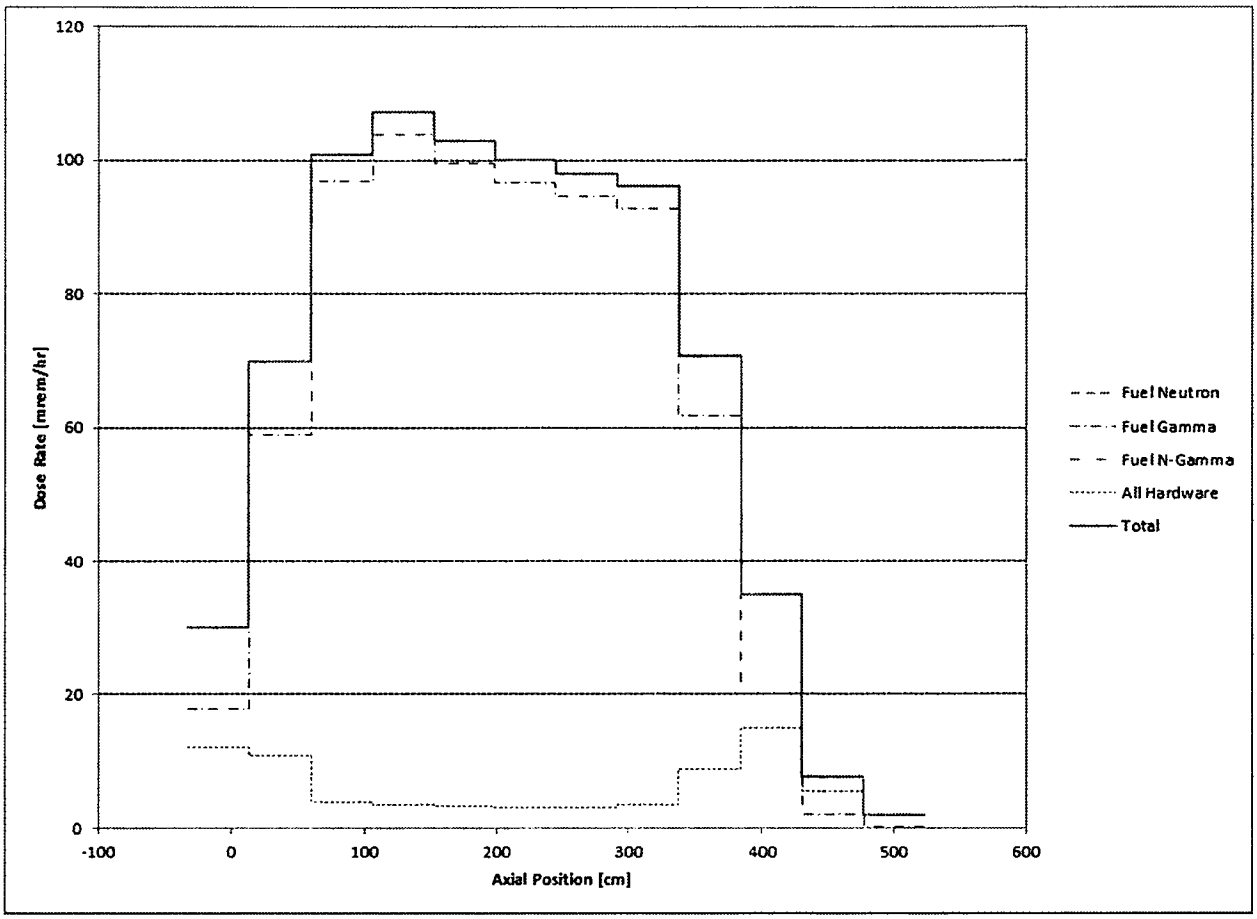

Table 5.9.3-1 Maximum CC4 Surface Dose Rates – Reduced Cool Time

Surface	Fuel Type	Cool Time (yrs)	Assembly Average Burnup (GWd/MTU)	Initial Enrichment (wt% ^{235}U)	Maximum Dose Rate (mrem/hr)	Average Dose Rate (mrem/hr)
Radial	14b	2.6	20	3.9	107.4	68.4

5.9.4 PWR Nonfuel Hardware Components - BPRA and Thimble Plug

The PWR fuel assembly basket is designed to store nonfuel components inside the fuel assembly. The BPRA and TP evaluations were not changed from Section 5.8.5; refer to that section for expanded explanation of the BPRA and TP nonfuel hardware components.

5.9.4.1 Combination of Fuel, BPRA, and Thimble Plug Dose Rates

Maximum combined dose rates at the cask radial surface are calculated for the reduced minimum cool time. The combined dose rate is listed in Table 5.9.4-1 for the uniform loading.

Table 5.9.4-1 Reduced Cool Time Combined Dose Rate Results

Cask / Dose Location	Fuel		Combined	
	Assembly	Max. Dose Rate (mrem/hr)	Assembly	Max. Dose Rate (mrem/hr)
CC4 Radial	WE 14×14	107.4	WE 14×14	113.9

5.9.5 Nonfuel Hardware Component – Reactor Control Elements

Reactor control element (e.g., CEAs and RCCAs) material quantities and the core region in which the material was exposed to the neutron activation flux were obtained from the DOE characteristics database [30] for previous sections. This database assumes the Westinghouse 14x14 CEA is fully inserted when calculating activated CEA masses which severely overestimates the activated CEA mass. During typical core operation only the tips of the CEA rods are located within a significant neutron flux field. Rod tips are above the active fuel region at full withdrawal limiting activated regions to the plenum and assembly top regions. Activation volumes and masses for the WE 14x14 assembly type CEA are calculated in this section to more accurately evaluate the heat and dose contribution from the CEAs.

As the WE 14x14 CEA rod dimensions are not known the rod dimensions of the WE 15x15 CEA are used to approximate volumes and masses for the 14x14 CEA. The WE 15x15 CEA rod to guide tube gap is applied to the WE 14x14 assembly to approximate the 14x14 CEA rod outer diameter. The cone on the bottom of the CEA rod is assumed the same length. The CEA is assumed inserted to the top of the active fuel region. Using the calculated CEA rod cross section and the length of the upper nozzle and upper plenum the activated mass of the WE 14x14 CEA is calculated.

Mass quantities activated in the assembly top and gas plenum regions are listed in Table 5.9.5-2. Similar to the fuel assembly hardware evaluation, the plenum material is activated at a 0.2 flux factor, with top material activation at a 0.1 flux factor. Material above the top is not considered to be activated to a significant extent and is, therefore, not modeled. In the shielding evaluation, the source material activated in the plenum region of the fuel assembly is located at the bottom of the active fuel region. This is the result of the full insertion of the CEA into the assembly under storage conditions. To minimize the increased dose due to loading of CEAs, only the center nine basket locations are allowed to contain the added source. The minimum cool time of the CEA is reduced to 2.5 years.

Results are shown in Table 5.9.5-3. On the sides of the concrete and transfer casks, the additive dose rate does not affect the maximum dose rates. At the concrete cask inlets and transfer cask bottom, loading of CEAs significantly increases the maximum dose rates.

The maximum decay heat produced by a loading of nine CEAs is 0.17 kW. An increase in cool time of 0.2 years provides the necessary margin to accommodate the CEAs. As an increase in cool time will also decrease the fuel source term, the strict application of increased cool time without a recalculation of fuel dose rates is conservative.

Table 5.9.5-1 Westinghouse CEA Dimensions

	Dimension	14x14 [Calculated]	15x15 [Known]
RCCA Rod OD	inch	0.398	0.4395
RCCA Rod ID	inch	0.359	0.4005
Lower Plug OD	inch	0.398	0.4395
Lower Plug Length	inch	1.125	1.125
Conical Section Length	inch	0.625	0.625

Table 5.9.5-2 Calculated WE 14x14 CEA Activated Mass

Material	Neutron Zone	WE 14x14
Steel/Inconel	Top	0.169
Ag-In-Cd	Top	0.860
Steel/Inconel	Gas Plenum	0.593
Ag-In-Cd	Gas Plenum	1.820

Table 5.9.5-3 CEA Dose Rate Contributions – Westinghouse 14×14

Cask / Dose Location	Maximum Dose (mrem/hr)	Average Dose (mrem/hr)
Stainless Steel Transfer Cask Radial	1.41	0.2
Stainless Steel Transfer Cask Bottom	1654.1	546.2
CC4 Radial	0.53	< 0.1
CC4 Inlet	3.41	--

5.9.6 Preferential Loading of PWR Fuel

In order to envelop fuel assemblies with heat loads higher than 959 W, a four-zone preferential loading pattern is proposed as follows.

Zone Description	Designator	Heat Load [W/assy]	# Assemblies
Inner Ring	A	513	9
Middle Ring	B1	1,300	8
	B2	1,800	4
Outer Ring	C	830	16

Preferential and uniform loading patterns limit total cask heat load to 35.5 kW. As will be seen in the results section, the maximum dose rate for the preferential loading pattern is less than that calculated for a uniform pattern.

A sketch of the PWR basket and loading pattern is shown in Figure 5.9.6-1.

Minimum cool time tables for the preferential heat load pattern are included in Section 5.9.8. The method and models for the preferential loading pattern shielding evaluations are identical to those of the uniform loading pattern with the exception of requiring three sets of response functions, one for each zone. Source spectrum varies as a result of changes in burnup, initial enrichment and minimum cool time and, therefore, requires cask dose responses (dose per unit source in each spectrum energy group) for each of the zones. The dose responses from each ring, accounting for the differences in the number of assemblies per zone, are added to arrive at the dose rate for a fully loaded cask.

5.9.6.1 Input File Setup

Based on a four-zone pattern, the source and tally descriptions are modified in the MCNP models to consider the sources in the appropriate basket locations with the proper scaling on the tally cards. For each cask/detector combination, three sets of runs (A, B and C) are needed to characterize the dose rate response.

5.9.6.2 Results

Maximum and average surface dose rates for the preferential pattern are shown in Table 5.9.6-1, with the corresponding limiting results for the uniform pattern. The maximum dose rates for the analyzed preferential loading pattern are less than or statistically unchanged from those

calculated for a uniform pattern at each detector surface for both casks with the exception of MTC bottom dose rates. Maximum MTC bottom dose rates are increased minimally (< 7%).

The concrete cask radial and top axial average dose rates are less than or statistically unchanged in the preferential pattern. Therefore, using the uniform pattern to characterize the restricted area and controlled area boundaries is acceptable.

Figure 5.9.6-1 Schematic of PWR Fuel 1.8 kW Preferential Loading Pattern

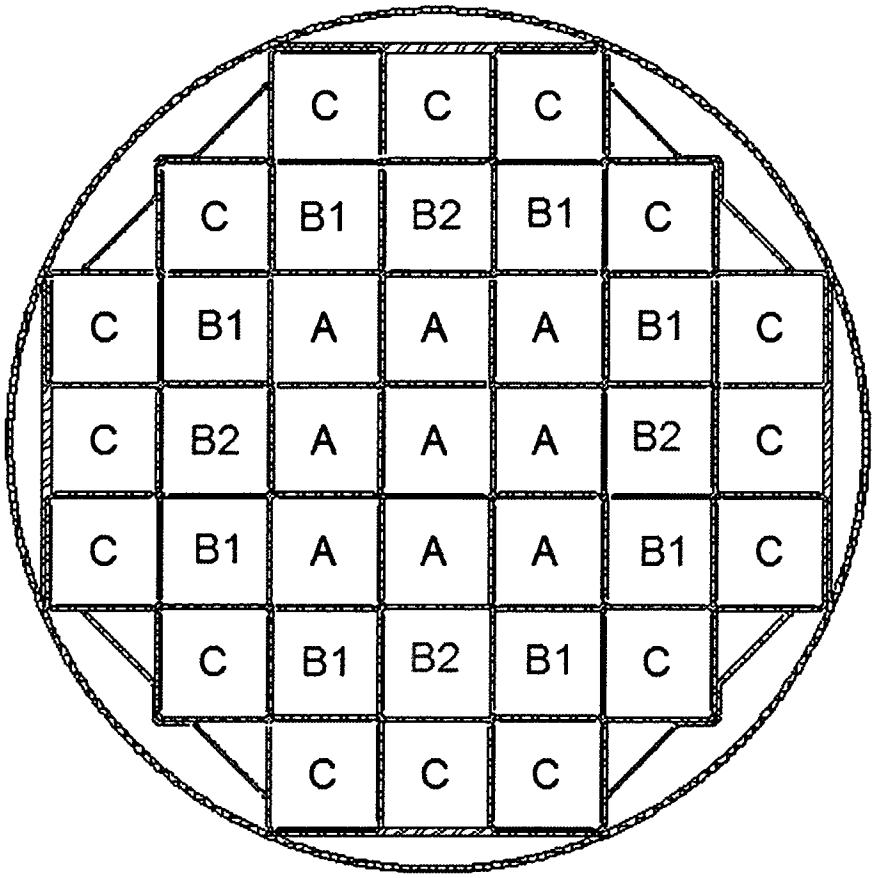

Table 5.9.6-1 Preferential Pattern Dose Rate Results

Cask / Dose Location	Uniform		Preferential	
	Avg. Dose Rate (mrem/hr)	Max. Dose Rate (mrem/hr)	Avg. Dose Rate (mrem/hr)	Max. Dose Rate (mrem/hr)
Stainless Steel MTC Radial	628	883	689	888
Stainless Steel MTC Top	216	466	221	464
Stainless Steel MTC Bottom	2,713	5,239	2,687	5,630
CC4 Radial	68.4	107.4	67.1	103.2
CC4 Top	61.5	315	58.3	288.4
CC4 Inlet	--	112.4	--	103.3
CC4 Outlet	--	35.4	--	35.7

5.9.7 Sample Input Files

This section contains sample input files for the four zone preferential loading pattern. Figure 5.9.7-1 provides the preferential zone B1 loading pattern for the stainless steel transfer cask. Figure 5.9.7-2 provides the preferential zone B2 loading pattern for concrete cask. All other modeling configurations (i.e. damaged fuel) are unchanged from those presented in Section 5.8.8.

Figure 5.9.7-1 Transfer Cask Sample Input File – Preferential Zone B1

```
MAGNASTOR Duke Transfer Cask - trfShwDryRadFg_ng14b_B107g
C Radial Biasing - Fuel Gamma Source
C Fuel Assembly Cells - ng14b - v1.0
1 1 -2.5071 -1      u=6 $ Lower Nozzle
2 2 -2.7253 -2 +1     u=6 $ Lower Plenum
3 3 -3.9171 -3 +2     u=6 $ Fuel
4 4 -1.0067 -4 +3     u=6 $ Upper Plenum
5 5 -2.8608 -5 +4     u=6 $ Upper Nozzle
6 0          +5      u=6 $ Outside
C Cells - Fuel Tube  v1.0
7 8 -7.8212 -8 +7     u=5 $ Tube
8 13 -2.6507 -9 -7     u=5 $ Poison
9 13 -2.6507 -10 -7     u=5 $ Poison
10 13 -2.6507 -11 -7     u=5 $ Poison
11 13 -2.6507 -12 -7     u=5 $ Poison
12 0          -7 #8 #9 #10 #11      u=5 $ Space Inside Tube
13 0          +7 +8     u=5 $ Space Below and Outside Tube
C Cells - PWR Basket v1.0
14 0          -13 -14 fill=5 trcl = ( -23.5331 70.5993 0.0000 )     u=4 $ Assy loc 1
15 like 14 but fill=5 trcl = ( 23.5331 70.5993 0.0000 )     u=4 $ Assy loc 3
16 like 14 but fill=5 trcl = ( -47.0662 47.0662 0.0000 )     u=4 $ Assy loc 4
17 like 14 but fill=5 trcl = ( 0.0000 47.0662 0.0000 )     u=4 $ Assy loc 6
18 like 14 but fill=5 trcl = ( 47.0662 47.0662 0.0000 )     u=4 $ Assy loc 8
19 like 14 but fill=5 trcl = ( -70.5993 23.5331 0.0000 )     u=4 $ Assy loc 9
20 like 14 but fill=5 trcl = ( -23.5331 23.5331 0.0000 )     u=4 $ Assy loc 11
21 like 14 but fill=5 trcl = ( 23.5331 23.5331 0.0000 )     u=4 $ Assy loc 13
22 like 14 but fill=5 trcl = ( 70.5993 23.5331 0.0000 )     u=4 $ Assy loc 15
23 like 14 but fill=5 trcl = ( -47.0662 0.0000 0.0000 )     u=4 $ Assy loc 17
24 like 14 but fill=5 trcl = ( 0.0000 0.0000 0.0000 )     u=4 $ Assy loc 19
25 like 14 but fill=5 trcl = ( 47.0662 0.0000 0.0000 )     u=4 $ Assy loc 21
26 like 14 but fill=5 trcl = ( -70.5993 -23.5331 0.0000 )     u=4 $ Assy loc 23
27 like 14 but fill=5 trcl = ( -23.5331 -23.5331 0.0000 )     u=4 $ Assy loc 25
28 like 14 but fill=5 trcl = ( 23.5331 -23.5331 0.0000 )     u=4 $ Assy loc 27
29 like 14 but fill=5 trcl = ( 70.5993 -23.5331 0.0000 )     u=4 $ Assy loc 29
30 like 14 but fill=5 trcl = ( -47.0662 -47.0662 0.0000 )     u=4 $ Assy loc 30
31 like 14 but fill=5 trcl = ( 0.0000 -47.0662 0.0000 )     u=4 $ Assy loc 32
32 like 14 but fill=5 trcl = ( 47.0662 -47.0662 0.0000 )     u=4 $ Assy loc 34
33 like 14 but fill=5 trcl = ( -23.5331 -70.5993 0.0000 )     u=4 $ Assy loc 35
34 like 14 but fill=5 trcl = ( 23.5331 -70.5993 0.0000 )     u=4 $ Assy loc 37
35 8 -7.8212 -15 #22 #29      u=4 $ Side support +x
36 8 -7.8212 -16 #19 #26      u=4 $ Side support -x
37 8 -7.8212 -17 #14 #15      u=4 $ Side support +y
38 8 -7.8212 -18 #33 #34      u=4 $ Side support -y
39 8 -7.8212 -19 +20 +21      u=4 $ Corner
40 8 -7.8212 -21 +22 +20  +15.2 +16.1 +17.4 +18.3
             #14 #15 #19 #22 #26 #29 #33 #34       u=4 $ Corner diagonal
41 0          #14 #15 #16 #17 #18 #19 #20 #21 #22 #23 #24
              #25 #26 #27 #28 #29 #30 #31 #32 #33 #34
              #35 #36 #37 #38 #39 #40      u=4 $ Outside Basket Structure
C Cells - PWR Canister Cavity v1.0
42 0          -23 fill=6 trcl = ( -23.5331 70.5993 0.0000 )     u=3 $ Assy loc 1
43 like 42 but fill=6 trcl = ( 0.0000 70.5993 0.0000 )     u=3 $ Assy loc 2
44 like 42 but fill=6 trcl = ( 23.5331 70.5993 0.0000 )     u=3 $ Assy loc 3
45 like 42 but fill=6 trcl = ( -47.0662 47.0662 0.0000 )     u=3 $ Assy loc 4
46 like 42 but fill=6 trcl = ( -23.5331 47.0662 0.0000 )     u=3 $ Assy loc 5
47 like 42 but fill=6 trcl = ( 0.0000 47.0662 0.0000 )     u=3 $ Assy loc 6
48 like 42 but fill=6 trcl = ( 23.5331 47.0662 0.0000 )     u=3 $ Assy loc 7
49 like 42 but fill=6 trcl = ( 47.0662 47.0662 0.0000 )     u=3 $ Assy loc 8
50 like 42 but fill=6 trcl = ( -70.5993 23.5331 0.0000 )     u=3 $ Assy loc 9
51 like 42 but fill=6 trcl = ( -47.0662 23.5331 0.0000 )     u=3 $ Assy loc 10
52 like 42 but fill=6 trcl = ( -23.5331 23.5331 0.0000 )     u=3 $ Assy loc 11
53 like 42 but fill=6 trcl = ( 0.0000 23.5331 0.0000 )     u=3 $ Assy loc 12
54 like 42 but fill=6 trcl = ( 23.5331 23.5331 0.0000 )     u=3 $ Assy loc 13
55 like 42 but fill=6 trcl = ( 47.0662 23.5331 0.0000 )     u=3 $ Assy loc 14
56 like 42 but fill=6 trcl = ( 70.5993 23.5331 0.0000 )     u=3 $ Assy loc 15
57 like 42 but fill=6 trcl = ( -70.5993 0.0000 0.0000 )     u=3 $ Assy loc 16
58 like 42 but fill=6 trcl = ( -47.0662 0.0000 0.0000 )     u=3 $ Assy loc 17
```

```
59 like 42 but fill=6 trcl = ( -23.5331 0.0000 0.0000 )    u=3 $ Assy loc 18
60 like 42 but fill=6 trcl = ( 0.0000 0.0000 0.0000 )    u=3 $ Assy loc 19
61 like 42 but fill=6 trcl = ( 23.5331 0.0000 0.0000 )    u=3 $ Assy loc 20
62 like 42 but fill=6 trcl = ( 47.0662 0.0000 0.0000 )    u=3 $ Assy loc 21
63 like 42 but fill=6 trcl = ( 70.5993 0.0000 0.0000 )    u=3 $ Assy loc 22
64 like 42 but fill=6 trcl = ( -70.5993 -23.5331 0.0000 )    u=3 $ Assy loc 23
65 like 42 but fill=6 trcl = ( -47.0662 -23.5331 0.0000 )    u=3 $ Assy loc 24
66 like 42 but fill=6 trcl = ( -23.5331 -23.5331 0.0000 )    u=3 $ Assy loc 25
67 like 42 but fill=6 trcl = ( 0.0000 -23.5331 0.0000 )    u=3 $ Assy loc 26
68 like 42 but fill=6 trcl = ( 23.5331 -23.5331 0.0000 )    u=3 $ Assy loc 27
69 like 42 but fill=6 trcl = ( 47.0662 -23.5331 0.0000 )    u=3 $ Assy loc 28
70 like 42 but fill=6 trcl = ( 70.5993 -23.5331 0.0000 )    u=3 $ Assy loc 29
71 like 42 but fill=6 trcl = ( -47.0662 -47.0662 0.0000 )    u=3 $ Assy loc 30
72 like 42 but fill=6 trcl = ( -23.5331 -47.0662 0.0000 )    u=3 $ Assy loc 31
73 like 42 but fill=6 trcl = ( 0.0000 -47.0662 0.0000 )    u=3 $ Assy loc 32
74 like 42 but fill=6 trcl = ( 23.5331 -47.0662 0.0000 )    u=3 $ Assy loc 33
75 like 42 but fill=6 trcl = ( 47.0662 -47.0662 0.0000 )    u=3 $ Assy loc 34
76 like 42 but fill=6 trcl = ( -23.5331 -70.5993 0.0000 )    u=3 $ Assy loc 35
77 like 42 but fill=6 trcl = ( 0.0000 -70.5993 0.0000 )    u=3 $ Assy loc 36
78 like 42 but fill=6 trcl = ( 23.5331 -70.5993 0.0000 )    u=3 $ Assy loc 37
79 0         #42 #43 #44 #45 #46 #47 #48 #49 #50 #51 #52 #53 #54
             #55 #56 #57 #58 #59 #60 #61 #62 #63 #64 #65 #66 #67
             #68 #69 #70 #71 #72 #73 #74 #75 #76 #77 #78      fill=4 u=3 $ Cavity
C Cells - Canister w/Weld Shield v1.0
80 0         -24 #92  #93  fill=3    u=2 $ Cavity
81 7 -7.9400 -31 +24.3      u=2 $ Canister Bottom
82 0         -25 +24.2 -28 trcl = ( 62.7565 43.1314 0.0000 )    u=2 $ Bottom Drain Port
83 14 -3.9700 -26 +28 -30 trcl = ( 62.7565 43.1314 0.0000 )    u=2 $ Middle Drain Port
84 0         -27 +30 -31.2 trcl = ( 62.7565 43.1314 0.0000 )    u=2 $ Top Drain Port
85 like 82 but   trcl = ( -62.7565 -43.1314 0.0000 )    u=2 $ Bottom Vent Port
86 like 83 but   trcl = ( -62.7565 -43.1314 0.0000 )    u=2 $ Middle Vent Port
87 like 84 but   trcl = ( -62.7565 -43.1314 0.0000 )    u=2 $ Top Vent Port
88 7 -7.9400 -31 -24.3 +24.1     u=2 $ Canister Shell
89 8 -7.8212 -31 -24.1 +24.2 -29 #82 #83  #85 #86   u=2 $ Lower lid
90 7 -7.9400 -31 -24.1 +29 #83 #84  #86 #87    u=2 $ Upper lid
91 7 -7.9400 (-32 +35 +36) : (-33 +35 +36) : (-34 +35 +36)       u=2 $ Weld Shield
92 8 -7.8212 -39 +38 +37 -24.2 trcl = ( 62.7565 43.1314 0.0000 )   u=2 $ Drain port
shield
93 8 -7.8212 -39 +38 +37 -24.2 trcl = ( -62.7565 -43.1314 0.0000 )   u=2 $ Vent port
shield
94 0         +31 #91       u=2 $ Outside void
C Transfer Cask Cells - v1.2_ng14b
95 0         -57  #108  fill=2 ( 0.0000 0.0000 7.0350 )   u=1 $ Canister and Weld Shield
96 0         -40 -41 +57 -48   u=1 $ Gap MTC to Canister below seal
97 6 -0.9982 -40 -41 +57 -49 +48  u=1 $ Gap between seals
98 0         -40 -41 +57 +49 #108   u=1 $ Gap MTC to Canister above seal
99 7 -7.9400 -40 +41 -46    u=1 $ Bottom forging
100 7 -7.9400 -42 +41 +46 -47   u=1 $ Inner shell
101 0         -43 +42 +46 -47   u=1 $ Gap
102 10 -11.344 -44 +43 +46 -47   u=1 $ Lead shell
103 11 -1.6316 -45 +44 +46 -47   u=1 $ NS4FR shell
104 7 -7.9400 -40 +45 +46 -47   u=1 $ Outer shell
105 7 -7.9400 -40 +41 +47    u=1 $ Top forging
106 7 -7.9400 (-50 +51 -56) : (-50 -52 -56)      u=1 $ Door rail
107 7 -7.9400 -55 -53 +54 -56 +57  u=1 $ Door steel
108 7 -7.9400 -59 +58 -40    u=1 $ Weld bar
109 0         +40 #106  #107  +57   u=1 $ Void
C Detector Cells - Radial Biasing
400  0  -400  fill=1  $ Surface
500  0  -500  +400  $ 1ft
600  0  -600  +400  +500  $ 1m
700  0  -700  +400  +500  +600  $ 2m
800  0  -800  +400  +500  +600  +700  $ 4m
900  0  +400  +500  +600  +700  +800  $ Exterior

C Fuel Assembly Surfaces - ng14b - v1.0
1 RPP -9.8590 9.8590 -9.8590 9.8590 0.0000 8.0975  $ Lower Nozzle
2 RPP -9.8590 9.8590 -9.8590 9.8590 0.0000 9.8374  $ Lower Plenum
3 RPP -9.8590 9.8590 -9.8590 9.8590 0.0000 378.6454  $ Fuel
```

```
4 RPP -9.8590 9.8590 -9.8590 9.8590 0.0000 400.3040  $ Upper Plenum
5 RPP -9.8590 9.8590 -9.8590 9.8590 0.0000 409.1940  $ Upper Nozzle
6 PZ 255.7094       $ Flood elevation
C Surfaces - Fuel Tube v1.0
7 RPP -11.6015 11.6015 -11.6015 11.6015 7.6200 439.4200  $ Tube void
8 RPP -12.3952 12.3952 -12.3952 12.3952 7.6200 430.5300  $ Tube
9 RPP -11.6015 -11.2840 -10.2362 10.2362 9.2075 428.9425  $ Poison left
10 RPP 11.2840 11.6015 -10.2362 10.2362 9.2075 428.9425  $ Poison right
11 RPP -10.2362 10.2362 11.2840 11.6015 9.2075 428.9425  $ Poison top
12 RPP -10.2362 10.2362 -11.6015 -11.2840 9.2075 428.9425  $ Poison bottom
C Surfaces - PWR Basket v1.0
13  RPP -12.3952 12.3952 -12.3952 12.3952 0.0000 439.4200  $ Tube opening
14 8 RPP -16.6370 16.6370 -16.6370 16.6370 0.0000 439.4200  $ Tube radius
15  RPP 81.8833 83.7883 -33.1851 33.1851 7.6200 430.5300  $ Side support +x
16  RPP -83.7883 -81.8833 -33.1851 33.1851 7.6200 430.5300  $ Side support -x
17  RPP -33.1851 33.1851 81.8833 83.7883 7.6200 430.5300  $ Side support +y
18  RPP -33.1851 33.1851 -83.7883 -81.8833 7.6200 430.5300  $ Side support -y
19  RPP -60.2552 60.2552 -60.2552 60.2552 7.6200 430.5300  $ Corner outer
20  RPP -59.4614 59.4614 -59.4614 59.4614 7.6200 430.5300  $ Corner inner
21 8 RPP -78.6267 78.6267 -78.6267 78.6267 7.6200 430.5300  $ Corner dia. outer
22 8 RPP -77.8329 77.8329 -77.8329 77.8329 7.6200 430.5300  $ Corner dia. inner
C Surfaces - PWR Canister Cavity v1.0
23 RPP -9.8595 9.8595 -9.8595 9.8595 0.0000 409.1941   $ Assy opening
C Surfaces - Canister w/Weld Shield v1.0
24 RCC 0.0000 0.0000 0.0000 0.0000 0.0000 439.4200 90.1700   $ Cavity
25 CZ 2.6924         $ Bot Cylinder Radius
26 CZ 6.7691         $ Mid Cyclinder Radius
27 CZ 7.4041         $ Top Cylinder Radius
28 PZ 450.8500         $ Port plane bot/mid
29 PZ 452.1200         $ Lower/upper lid
30 PZ 459.4860         $ Port plane mid/top
31 RCC 0.0000 0.0000 -6.9950 0.0000 0.0000 469.2750 91.4500   $ Canister
32 RCC 0.0000 0.0000 462.2800 0.0000 0.0000 5.0800 78.1050   $ Weld shield bot
33 RCC 0.0000 0.0000 467.3600 0.0000 0.0000 5.0800 71.7550   $ Weld shield mid
34 RCC 0.0000 0.0000 472.4400 0.0000 0.0000 5.0900 66.6750   $ Weld shield top
35 RCC 62.7565 43.1314 462.2800 0.0000 0.0000 15.2500 8.8900   $ Weld shield cutout +x+y
36 RCC -62.7565 -43.1314 462.2800 0.0000 0.0000 15.2500 8.8900   $ Weld shield cutout -x-
y
37 PZ 433.0700         $ Port shield elevation
38 CZ 2.8575         $ Port shield ID
39 CZ 5.0800         $ Port shield OD
C Transfer Cask Surfaces - v1.2_ng14b
40 RCC 0.0000 0.0000 0.0000 0.0000 0.0000 471.1700 111.7600  $ Cask (Without Rail /
Doors)
41 CZ 92.7100        $ Cavity
42 CZ 94.6150        $ Inner shell
43 CZ 94.7420        $ Gap
44 CZ 102.8700        $ Lead shell
45 CZ 108.5850        $ NS4FR shell
46 PZ 30.4800        $ Bottom forging
47 PZ 435.6100        $ Top forging
48 PZ 3.9116        $ Lower Elevation Water Jaccket
49 PZ 463.3214        $ Upper Elevation Water Jaccket
50 RPP -104.0765 104.0765 -111.7600 111.7600 -12.7000 0.0000   $ Door container
51 PY 97.0026        $ Inside rail +y
52 PY -97.0026        $ Inside rail -y
53 PY 96.5200        $ Door +y
54 PY -96.5200        $ Door -y
55 RHP 0.0000 0.0000 -12.7000 0.0000 0.0000 12.7000   $ Door prism
       108.4699 0.0000 0.0000 89.7374 -73.7172 0.0000
       -89.7374 -73.7172 0.0000
56 RCC 0.0000 0.0000 -12.7000 0.0000 0.0000 12.7000 111.7600  $ Door container
57 RCC 0.0000 0.0000 0.0500 0.0000 0.0000 484.5550 91.4400  $ Canister and Weld Shield
58 CZ 90.8049        $ Weld bar inner
59 RCC 0.0000 0.0000 469.3150 0.0000 0.0000 1.9050 92.7100  $ Weld bar outer
C Radial Detector DRA (Surface)
400  RCC  0.0000  0.0000  -12.8000  0.0000  0.0000  497.4550  111.8600
401  PZ  20.3637
402  PZ  53.5273
```

```
403  PZ  86.6910
404  PZ  119.8547
405  PZ  153.0183
406  PZ  186.1820
407  PZ  219.3457
408  PZ  252.5093
409  PZ  285.6730
410  PZ  318.8367
411  PZ  352.0003
412  PZ  385.1640
413  PZ  418.3277
414  PZ  451.4913
C Radial Detector DRB (1ft)
500  RCC  0.0000  0.0000  -43.2800  0.0000  0.0000  558.4150  142.3400
501  PZ  -6.0523
502  PZ  31.1753
503  PZ  68.4030
504  PZ  105.6307
505  PZ  142.8583
506  PZ  180.0860
507  PZ  217.3137
508  PZ  254.5413
509  PZ  291.7690
510  PZ  328.9967
511  PZ  366.2243
512  PZ  403.4520
513  PZ  440.6797
514  PZ  477.9073
C Radial Detector DRC (1m)
600  RCC  0.0000  0.0000  -112.8000  0.0000  0.0000  697.4550  211.8600
601  PZ  -77.9273
602  PZ  -43.0545
603  PZ  -8.1817
604  PZ  26.6910
605  PZ  61.5638
606  PZ  96.4365
607  PZ  131.3093
608  PZ  166.1820
609  PZ  201.0548
610  PZ  235.9275
611  PZ  270.8003
612  PZ  305.6730
613  PZ  340.5458
614  PZ  375.4185
615  PZ  410.2913
616  PZ  445.1640
617  PZ  480.0368
618  PZ  514.9095
619  PZ  549.7823
C Radial Detector DRD (2m)
700  RCC  0.0000  0.0000  -212.8000  0.0000  0.0000  897.4550  311.8600
701  PZ  -167.9273
702  PZ  -123.0545
703  PZ  -78.1818
704  PZ  -33.3090
705  PZ  11.5638
706  PZ  56.4365
707  PZ  101.3093
708  PZ  146.1820
709  PZ  191.0548
710  PZ  235.9275
711  PZ  280.8003
712  PZ  325.6730
713  PZ  370.5458
714  PZ  415.4185
715  PZ  460.2913
716  PZ  505.1640
717  PZ  550.0368
718  PZ  594.9095
```

```
719  PZ  639.7823
C Radial Detector DRE (4m)
800  RCC  0.0000  0.0000  -412.8000  0.0000  0.0000  1297.4550  511.8600
801  PZ  -347.9273
802  PZ  -283.0545
803  PZ  -218.1818
804  PZ  -153.3090
805  PZ  -88.4363
806  PZ  -23.5635
807  PZ  41.3093
808  PZ  106.1820
809  PZ  171.0548
810  PZ  235.9275
811  PZ  300.8003
812  PZ  365.6730
813  PZ  430.5458
814  PZ  495.4185
815  PZ  560.2913
816  PZ  625.1640
817  PZ  690.0368
818  PZ  754.9095
819  PZ  819.7823

C
C Materials List - Common Materials - v1.0
C
C Homogenized Lower Nozzle
m1    24000 -1.9000E-01 25055 -2.0000E-02 26000 -6.9500E-01
      28000 -9.5000E-02
C Homogenized Lower Plenum
m2    24000 -1.0000E-03 50000 -1.5000E-02
      26000 -1.2500E-03  7014 -5.0000E-04
      40000 -9.8225E-01
C Homogenized UO2 Fuel - Dry
m3    92235 -3.6891E-02 40000 -1.6011E-01 24000 -1.6300E-04
      92238 -7.0092E-01 50000 -2.4450E-03  7014 -8.1499E-05
       8016 -9.9186E-02 26000 -2.0375E-04
C Homogenized Upper Plenum
m4    24000 -1.4890E-01 50000 -3.2622E-03 25055 -1.5650E-02
      26000 -5.4413E-01  7014 -1.0874E-04 28000 -7.4340E-02
      40000 -2.1362E-01
C Homogenized Upper Nozzle
m5    24000 -1.9000E-01 25055 -2.0000E-02 26000 -6.9500E-01
      28000 -9.5000E-02
C Water
m6    1001 2 8016 1
C Stainless Steel
m7    24000 -0.190 25055 -0.020 26000 -0.695
      28000 -0.095
C Carbon Steel
m8    26000 -0.99  6012 -0.01
C Aluminum
m9    13027 -1.0
C Lead
m10   82000 -1.0
C NS-4-FR
m11   5010 -9.3127E-04 13027 -2.1420E-01 6000 -2.7627E-01
      5011 -3.7721E-03 1001 -6.0012E-02 7014 -1.9815E-02
      8016 -4.2500E-01
C Concrete
m12   26000 -0.014 20000 -0.044 14000 -0.337
       1001 -0.010  8016 -0.532 11023 -0.029
      13027 -0.034
C Vent Port Middle Cylinder
m14   24000 -0.190 25055 -0.020 26000 -0.695
      28000 -0.095
C Neutron Absorber
m13   13027 -0.7470 5010 -0.0356 5011 -0.1624
      6012 -0.0549
```

```
phys:p 100 0 0 0 1    $ Disable Doppler energy broadening
C
C Cell Importances
C
imp:p 1 113r 0
C
C PWR Source Definition - Fuel Gamma Response to Group 7
C
sdef x=d1 y=d2 z=d3 erg=d4 cell=400:95:80:d5:3
si1   -9.85901 9.85901
sp1   0 1
si2   -9.85901 9.85901
sp2   0 1
si3 a 9.8374 19.0576 28.2778 37.4980 46.7182 55.9384 65.1586
      323.3242 332.5444 341.7646 350.9848 360.2050 369.4252 378.6454
sp3 d 0.5470 0.6358 0.7247 0.8135 0.9023 0.9912 1.0800
      1.0800 0.9912 0.9023 0.8135 0.7247 0.6358 0.5470
si4   3.000E+00 4.000E+00
sp4   0 1
C Source Information
si5 l       42 43 44
         45 46 47 48 49
      50 51 52 53 54 55 56
      57 58 59 60 61 62 63
      64 65 66 67 68 69 70
         71 72 73 74 75
            76 77 78
C Source Probability
sp5           0.0 0.0 0.0
          0.0 1.0 0.0 1.0 0.0
      0.0 1.0 0.0 0.0 0.0 1.0 0.0
      0.0 0.0 0.0 0.0 0.0 0.0 0.0
      0.0 1.0 0.0 0.0 0.0 1.0 0.0
          0.0 1.0 0.0 1.0 0.0
              0.0 0.0 0.0
mode p
nps 400000000
C
C ANSI/ANS-6.1.1-1977 - Gamma Flux-to-Dose Rate Conversion Factors
C (mrem/hr)/(photons/cm2-sec)
C
de0   0.01 0.03 0.05 0.07 0.1 0.15 0.2
      0.25 0.3 0.35 0.4 0.45 0.5 0.55
      0.6 0.65 0.7 0.8 1 1.4 1.8
      2.2 2.6 2.8 3.25 3.75 4.25 4.75
      5 5.25 5.75 6.25 6.75 7.5 9
      11 13 15
df0   3.96E-03 5.82E-04 2.90E-04 2.58E-04 2.83E-04 3.79E-04 5.01E-04
      6.31E-04 7.59E-04 8.78E-04 9.85E-04 1.08E-03 1.17E-03 1.27E-03
      1.36E-03 1.44E-03 1.52E-03 1.68E-03 1.98E-03 2.51E-03 2.99E-03
      3.42E-03 3.82E-03 4.01E-03 4.41E-03 4.83E-03 5.23E-03 5.60E-03
      5.80E-03 6.01E-03 6.37E-03 6.74E-03 7.11E-03 7.66E-03 8.77E-03
      1.03E-02 1.18E-02 1.33E-02
C
C Weight Window Generation - Radial
C
wwg 2 0 0 0 0
wwp:p 5 3 5 0 -1 0
mesh geom=cyl ref=65 0 201 origin=0.1 0.1 -513
     imesh 90.2 91.4 92.7 94.6 102.9 108.6 111.8 611.8
     iints 5 1 1 1 3 1 1 1
     jmesh 500 513 520 528 530 898 920 929 959 997 1497
     jints 1 1 1 1 1 1 1 1 1 1 1
     kmesh 1
     kints 1
C wwge:p  1e-3 1 20
fc2 Radial Surface Tally
f2:p +400.1
fm2 8.0000E+00
```

```
fs2  -401  -402  -403  -404  -405  -406
     -407  -408  -409  -410  -411  -412
     -413  -414  T
tf2
fc12 Radial 1ft Tally
f12:p +500.1
fm12 8.0000E+00
fs12  -501  -502  -503  -504  -505  -506
     -507  -508  -509  -510  -511  -512
     -513  -514  T
tf12
fc22 Radial 1m Tally
f22:p +600.1
fm22 8.0000E+00
fs22  -601  -602  -603  -604  -605  -606
     -607  -608  -609  -610  -611  -612
     -613  -614  -615  -616  -617  -618
     -619  T
tf22
fc32 Radial 2m Tally
f32:p +700.1
fm32 8.0000E+00
fs32  -701  -702  -703  -704  -705  -706
     -707  -708  -709  -710  -711  -712
     -713  -714  -715  -716  -717  -718
     -719  T
tf32
fc42 Radial 4m Tally
f42:p +800.1
fm42 8.0000E+00
fs42  -801  -802  -803  -804  -805  -806
     -807  -808  -809  -810  -811  -812
     -813  -814  -815  -816  -817  -818
     -819  T
tf42
C
C
C Print Control
C
prdmp -30 -60 1 2
print
C
C Random Number Generator
C
rand gen=2 seed=19073486328125 stride=152917 hist=1
C
C Rotation Matrix
C
C 5.625 degree rotation around z-axis
*TR1 0.0 0.0 0.0 5.625 95.625 90 -84.375 5.625 90 90 90 0
C 11.25 degree rotation around z-axis
*TR2 0.0 0.0 0.0 11.250 101.250 90 -78.750 11.250 90 90 90 0
C 16.875 degree rotation around z-axis
*TR3 0.0 0.0 0.0 16.875 106.875 90 -73.125 16.875 90 90 90 0
C 22.5 degree rotation around z-axis
*TR4 0.0 0.0 0.0 22.500 112.500 90 -67.500 22.500 90 90 90 0
C 28.125 degree rotation around z-axis
*TR5 0.0 0.0 0.0 28.125 118.125 90 -61.875 28.125 90 90 90 0
C 33.75 degree rotation around z-axis
*TR6 0.0 0.0 0.0 33.750 123.750 90 -56.250 33.750 90 90 90 0
C 39.375 degree rotation around z-axis
*TR7 0.0 0.0 0.0 39.375 129.375 90 -50.625 39.375 90 90 90 0
C 45 degree rotation around z-axis
*TR8 0.0 0.0 0.0 45.000 135.000 90 -45.000 45.000 90 90 90 0
C 50.625 degree rotation around z-axis
*TR9 0.0 0.0 0.0 50.625 140.625 90 -39.375 50.625 90 90 90 0
C 56.25 degree rotation around z-axis
*TR10 0.0 0.0 0.0 56.250 146.250 90 -33.750 56.250 90 90 90 0
C 61.875 degree rotation around z-axis
```

```
*TR11 0.0 0.0 0.0 61.875 151.875 90 -28.125 61.875 90 90 90 0
C 67.5 degree rotation around z-axis
*TR12 0.0 0.0 0.0 67.500 157.500 90 -22.500 67.500 90 90 90 0
C 73.125 degree rotation around z-axis
*TR13 0.0 0.0 0.0 73.125 163.125 90 -16.875 73.125 90 90 90 0
C 78.75 degree rotation around z-axis
*TR14 0.0 0.0 0.0 78.750 168.750 90 -11.250 78.750 90 90 90 0
C 84.375 degree rotation around z-axis
*TR15 0.0 0.0 0.0 84.375 174.375 90 -5.625 84.375 90 90 90 0
C 95.625 degree rotation around z-axis
*TR16 0.0 0.0 0.0 95.625 185.625 90 5.625 95.625 90 90 90 0
C 101.25 degree rotation around z-axis
*TR17 0.0 0.0 0.0 101.250 191.250 90 11.250 101.250 90 90 90 0
C 106.875 degree rotation around z-axis
*TR18 0.0 0.0 0.0 106.875 196.875 90 16.875 106.875 90 90 90 0
C 112.5 degree rotation around z-axis
*TR19 0.0 0.0 0.0 112.500 202.500 90 22.500 112.500 90 90 90 0
C 118.125 degree rotation around z-axis
*TR20 0.0 0.0 0.0 118.125 208.125 90 28.125 118.125 90 90 90 0
C 123.75 degree rotation around z-axis
*TR21 0.0 0.0 0.0 123.750 213.750 90 33.750 123.750 90 90 90 0
C 129.375 degree rotation around z-axis
*TR22 0.0 0.0 0.0 129.375 219.375 90 39.375 129.375 90 90 90 0
C 135 degree rotation around z-axis
*TR23 0.0 0.0 0.0 135.000 225.000 90 45.000 135.000 90 90 90 0
C 140.625 degree rotation around z-axis
*TR24 0.0 0.0 0.0 140.625 230.625 90 50.625 140.625 90 90 90 0
C 146.25 degree rotation around z-axis
*TR25 0.0 0.0 0.0 146.250 236.250 90 56.250 146.250 90 90 90 0
C 151.875 degree rotation around z-axis
*TR26 0.0 0.0 0.0 151.875 241.875 90 61.875 151.875 90 90 90 0
C 157.5 degree rotation around z-axis
*TR27 0.0 0.0 0.0 157.500 247.500 90 67.500 157.500 90 90 90 0
C 163.125 degree rotation around z-axis
*TR28 0.0 0.0 0.0 163.125 253.125 90 73.125 163.125 90 90 90 0
C 168.75 degree rotation around z-axis
*TR29 0.0 0.0 0.0 168.750 258.750 90 78.750 168.750 90 90 90 0
C 174.375 degree rotation around z-axis
*TR30 0.0 0.0 0.0 174.375 264.375 90 84.375 174.375 90 90 90 0
```

Figure 5.9.7-2 Storage Cask Sample Input File – Preferential Zone B2

```
MAGNASTOR VCC - strShlDryRadFg_ng14b_B207g
C Radial Biasing - Fuel Gamma Source
C Fuel Assembly Cells - ng14b - v1.1
1 1 -2.5071 -1     u=6 $ Lower Nozzle
2 2 -2.7253 -2 +1    u=6 $ Lower Plenum
3 3 -3.9171 -3 +2    u=6 $ Fuel
4 4 -1.0067 -4 +3    u=6 $ Upper Plenum
5 5 -2.8608 -5 +4    u=6 $ Upper Nozzle
6 0         +5     u=6 $ Outside
C Cells - Fuel Tube  v1.3
7 8 -7.8212 -8 +7    u=5 $ Tube
8 9 -2.6336 -9 : -10 : -11 : -12     u=5 $ Poison
9 0         #7  #8  -6   u=5 $ Outside below PFE
10 0         #7  #8  +6   u=5 $ Outside above PFE
C Cells - PWR Basket v1.5
11 0         -13 -14 fill=5 trcl = ( -23.5331 70.5993 0.0000 )    u=4 $ Assy loc 1
12 like 11 but fill=5 trcl = ( 23.5331 70.5993 0.0000 )    u=4 $ Assy loc 3
13 like 11 but fill=5 trcl = ( -47.0662 47.0662 0.0000 )    u=4 $ Assy loc 4
14 like 11 but fill=5 trcl = ( 0.0000 47.0662 0.0000 )    u=4 $ Assy loc 6
15 like 11 but fill=5 trcl = ( 47.0662 47.0662 0.0000 )    u=4 $ Assy loc 8
16 like 11 but fill=5 trcl = ( -70.5993 23.5331 0.0000 )    u=4 $ Assy loc 9
17 like 11 but fill=5 trcl = ( -23.5331 23.5331 0.0000 )    u=4 $ Assy loc 11
18 like 11 but fill=5 trcl = ( 23.5331 23.5331 0.0000 )    u=4 $ Assy loc 13
19 like 11 but fill=5 trcl = ( 70.5993 23.5331 0.0000 )    u=4 $ Assy loc 15
20 like 11 but fill=5 trcl = ( -47.0662 0.0000 0.0000 )    u=4 $ Assy loc 17
21 like 11 but fill=5 trcl = ( 0.0000 0.0000 0.0000 )    u=4 $ Assy loc 19
22 like 11 but fill=5 trcl = ( 47.0662 0.0000 0.0000 )    u=4 $ Assy loc 21
23 like 11 but fill=5 trcl = ( -70.5993 -23.5331 0.0000 )    u=4 $ Assy loc 23
24 like 11 but fill=5 trcl = ( -23.5331 -23.5331 0.0000 )    u=4 $ Assy loc 25
25 like 11 but fill=5 trcl = ( 23.5331 -23.5331 0.0000 )    u=4 $ Assy loc 27
26 like 11 but fill=5 trcl = ( 70.5993 -23.5331 0.0000 )    u=4 $ Assy loc 29
27 like 11 but fill=5 trcl = ( -47.0662 -47.0662 0.0000 )    u=4 $ Assy loc 30
28 like 11 but fill=5 trcl = ( 0.0000 -47.0662 0.0000 )    u=4 $ Assy loc 32
29 like 11 but fill=5 trcl = ( 47.0662 -47.0662 0.0000 )    u=4 $ Assy loc 34
30 like 11 but fill=5 trcl = ( -23.5331 -70.5993 0.0000 )    u=4 $ Assy loc 35
31 like 11 but fill=5 trcl = ( 23.5331 -70.5993 0.0000 )    u=4 $ Assy loc 37
32 8 -7.8212 -15 #19 #26      u=4 $ Side support +x
33 8 -7.8212 -16 #16 #23      u=4 $ Side support -x
34 8 -7.8212 -17 #11 #12      u=4 $ Side support +y
35 8 -7.8212 -18 #30 #31      u=4 $ Side support -y
36 8 -7.8212 -19 +20 +21      u=4 $ Corner
37 8 -7.8212 -21 +22 +20  +15.2 +16.1 +17.4 +18.3
             #11 #12 #16 #19 #23 #26 #30 #31       u=4 $ Corner diagonal
38 0         -6 #11 #12 #13 #14 #15 #16 #17 #18 #19 #20 #21
                #22 #23 #24 #25 #26 #27 #28 #29 #30 #31
                #32 #33 #34 #35 #36 #37      u=4 $ Basket below PFE
39 0         +6 #11 #12 #13 #14 #15 #16 #17 #18 #19 #20 #21
               #22 #23 #24 #25 #26 #27 #28 #29 #30 #31
               #32 #33 #34 #35 #36 #37      u=4 $ Basket above PFE
C Cells - PWR Canister Cavity v1.5
40 0         -23 fill=6 trcl = ( -23.5331 70.5993 0.0000 )    u=3 $ Assy loc 1
41 like 40 but fill=6 trcl = ( 0.0000 70.5993 0.0000 )    u=3 $ Assy loc 2
42 like 40 but fill=6 trcl = ( 23.5331 70.5993 0.0000 )    u=3 $ Assy loc 3
43 like 40 but fill=6 trcl = ( -47.0662 47.0662 0.0000 )    u=3 $ Assy loc 4
44 like 40 but fill=6 trcl = ( -23.5331 47.0662 0.0000 )    u=3 $ Assy loc 5
45 like 40 but fill=6 trcl = ( 0.0000 47.0662 0.0000 )    u=3 $ Assy loc 6
46 like 40 but fill=6 trcl = ( 23.5331 47.0662 0.0000 )    u=3 $ Assy loc 7
47 like 40 but fill=6 trcl = ( 47.0662 47.0662 0.0000 )    u=3 $ Assy loc 8
48 like 40 but fill=6 trcl = ( -70.5993 23.5331 0.0000 )    u=3 $ Assy loc 9
49 like 40 but fill=6 trcl = ( -47.0662 23.5331 0.0000 )    u=3 $ Assy loc 10
50 like 40 but fill=6 trcl = ( -23.5331 23.5331 0.0000 )    u=3 $ Assy loc 11
51 like 40 but fill=6 trcl = ( 0.0000 23.5331 0.0000 )    u=3 $ Assy loc 12
52 like 40 but fill=6 trcl = ( 23.5331 23.5331 0.0000 )    u=3 $ Assy loc 13
53 like 40 but fill=6 trcl = ( 47.0662 23.5331 0.0000 )    u=3 $ Assy loc 14
54 like 40 but fill=6 trcl = ( 70.5993 23.5331 0.0000 )    u=3 $ Assy loc 15
55 like 40 but fill=6 trcl = ( -70.5993 0.0000 0.0000 )    u=3 $ Assy loc 16
56 like 40 but fill=6 trcl = ( -47.0662 0.0000 0.0000 )    u=3 $ Assy loc 17
```

```
57 like 40 but fill=6 trcl = ( -23.5331 0.0000 0.0000 )    u=3 $ Assy loc 18
58 like 40 but fill=6 trcl = ( 0.0000 0.0000 0.0000 )    u=3 $ Assy loc 19
59 like 40 but fill=6 trcl = ( 23.5331 0.0000 0.0000 )    u=3 $ Assy loc 20
60 like 40 but fill=6 trcl = ( 47.0662 0.0000 0.0000 )    u=3 $ Assy loc 21
61 like 40 but fill=6 trcl = ( 70.5993 0.0000 0.0000 )    u=3 $ Assy loc 22
62 like 40 but fill=6 trcl = ( -70.5993 -23.5331 0.0000 )    u=3 $ Assy loc 23
63 like 40 but fill=6 trcl = ( -47.0662 -23.5331 0.0000 )    u=3 $ Assy loc 24
64 like 40 but fill=6 trcl = ( -23.5331 -23.5331 0.0000 )    u=3 $ Assy loc 25
65 like 40 but fill=6 trcl = ( 0.0000 -23.5331 0.0000 )    u=3 $ Assy loc 26
66 like 40 but fill=6 trcl = ( 23.5331 -23.5331 0.0000 )    u=3 $ Assy loc 27
67 like 40 but fill=6 trcl = ( 47.0662 -23.5331 0.0000 )    u=3 $ Assy loc 28
68 like 40 but fill=6 trcl = ( 70.5993 -23.5331 0.0000 )    u=3 $ Assy loc 29
69 like 40 but fill=6 trcl = ( -47.0662 -47.0662 0.0000 )    u=3 $ Assy loc 30
70 like 40 but fill=6 trcl = ( -23.5331 -47.0662 0.0000 )    u=3 $ Assy loc 31
71 like 40 but fill=6 trcl = ( 0.0000 -47.0662 0.0000 )    u=3 $ Assy loc 32
72 like 40 but fill=6 trcl = ( 23.5331 -47.0662 0.0000 )    u=3 $ Assy loc 33
73 like 40 but fill=6 trcl = ( 47.0662 -47.0662 0.0000 )    u=3 $ Assy loc 34
74 like 40 but fill=6 trcl = ( -23.5331 -70.5993 0.0000 )    u=3 $ Assy loc 35
75 like 40 but fill=6 trcl = ( 0.0000 -70.5993 0.0000 )    u=3 $ Assy loc 36
76 like 40 but fill=6 trcl = ( 23.5331 -70.5993 0.0000 )    u=3 $ Assy loc 37
77 0          #40 #41 #42 #43 #44 #45 #46 #47 #48 #49 #50 #51 #52
              #53 #54 #55 #56 #57 #58 #59 #60 #61 #62 #63 #64 #65
              #66 #67 #68 #69 #70 #71 #72 #73 #74 #75 #76      fill=4 u=3 $ Cavity
C Cells - Canister v1.3
78 0          -24 fill=3      u=2 $ Cavity
79 7 -7.9400 -31 +24.3      u=2 $ Canister Bottom
80 7 -7.9400 -25 +24.2 -28 trcl = ( 61.7220 44.7040 0.0000 )    u=2 $ Bottom Drain Port
81 7 -7.9400 -26 +28 -30 trcl = ( 61.7220 44.7040 0.0000 )    u=2 $ Middle Drain Port
82 7 -7.9400 -27 +30 -31.2 trcl = ( 61.7220 44.7040 0.0000 )    u=2 $ Top Drain Port
83 like 80 but   trcl = ( -61.7220 -44.7040 0.0000 )    u=2 $ Bottom Vent Port
84 like 81 but   trcl = ( -61.7220 -44.7040 0.0000 )    u=2 $ Middle Vent Port
85 like 82 but   trcl = ( -61.7220 -44.7040 0.0000 )    u=2 $ Top Vent Port
86 7 -7.9400 -31 -24.3 +24.1     u=2 $ Canister Shell
87 8 -7.8212 -31 -24.1 +24.2 -29 #80 #81  #83 #84   u=2 $ Lower lid
88 7 -7.9400 -31 -24.1 +29 #81 #82  #84 #85    u=2 $ Upper lid
89 0          +31       u=2 $ Outside
C VCC Cells - v1.3.1_ng14b
90 8 -7.8212 -32       u=1 $ Pedestal plate
91 8 -7.8212 -33 +34      u=1 $ Stand
92 8 -7.8212 -39 +40 +46 +47    u=1 $ Bottom plate outer
93 8 -7.8212 (-40 +41 -35) : (-40 +41 -36)       u=1 $ Bottom plate connector
94 8 -7.8212 -41       u=1 $ Bottom plate inner
95 8 -7.8212 (-34 -60 +61 -43) : (-34 -58 +59 +60 -43)       u=1 $ Support rail inside stand
96 8 -7.8212 (+33 -60 +61 -43) : (+33 -58 +59 +60 -43)       u=1 $ Support rail outside stand
97 8 -7.8212 (-51 +53 +35 +36 -44) :
             (-52 +53 +35 +36 -44 +51)       u=1 $ Air inlet top
98 8 -7.8212 (-48 +46 +50 -44 +35 +36 +39) :
             (-49 +47 +50 -44 +35 +36 +39)       u=1 $ Air inlet wall
99 8 -7.8212 (-35 +37 +33 -44 +39) : (-36 +38 +33 -44 +39)       u=1 $ Air inlet angular wall
100 8 -7.8212 (-50 -48 +46 +35 +36 +47 +39) :
              (-50 -49 +47 +35 +36 +46 +39)       u=1 $ Air inlet remaining wall
101 8 -7.8212 -54 +56 +43 -44    u=1 $ Air outlet steel X
102 8 -7.8212 -55 +57 +43 -44    u=1 $ Air outlet steel Y
103 13 -2.3234 -44 +42 +35 +36 +39 +51 +52 +48 +49 +45 +54 +55 +62
              fill=7 u=1 $ Concrete
104 13 -2.3234 -45       u=1 $ Concrete pad
105 8 -7.8212 -42 +43 +54 +55    u=1 $ Liner
106 8 -7.8212 -62 +42      u=1 $ Top flange
107 8 -7.8212 -63       u=1 $ Lid top
108 13 -2.2432 -64       u=1 $ Lid concrete
109 8 -7.8212 -65 +64      u=1 $ Lid shell
110 8 -7.8212 (-66 +78 -43) :
              (-67 +79 -43) :
              (-68 +80 -43) :
              (-69 +81 -43) :
              (-70 +82 -43) :
              (-71 +83 -43) :
              (-72 +84 -43) :
              (-73 +85 -43) :
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                (-74 +86 -43) :
                (-75 +87 -43) :
                (-76 +88 -43) :
                (-77 +89 -43)        u=1 $ Standoffs
111 8 -7.8212 -90        u=1 $ -x inlet pipe 1
112 8 -7.8212 -91        u=1 $ -x inlet pipe 2
113 8 -7.8212 -92        u=1 $ -x inlet pipe 3
114 8 -7.8212 -93        u=1 $ -x inlet pipe 4
115 8 -7.8212 -94        u=1 $ -x inlet pipe 5
116 8 -7.8212 -95        u=1 $ -x inlet pipe 6
117 8 -7.8212 -96        u=1 $ -x inlet pipe 7
118 8 -7.8212 -97        u=1 $ -x inlet pipe 8
119 8 -7.8212 -98        u=1 $ -x inlet pipe 9
120 8 -7.8212 -99        u=1 $ -x inlet pipe 10
121 8 -7.8212 -100        u=1 $ -x inlet pipe 11
122 8 -7.8212 -101        u=1 $ -x inlet pipe 12
123 8 -7.8212 -102        u=1 $ -x inlet pipe 13
124 8 -7.8212 -103        u=1 $ -x inlet pipe 14
125 8 -7.8212 -104        u=1 $ -x inlet pipe 15
126 8 -7.8212 -105        u=1 $ -x inlet pipe 16
127 8 -7.8212 -106        u=1 $ -x inlet pipe 17
128 8 -7.8212 -107        u=1 $ +x inlet pipe 1
129 8 -7.8212 -108        u=1 $ +x inlet pipe 2
130 8 -7.8212 -109        u=1 $ +x inlet pipe 3
131 8 -7.8212 -110        u=1 $ +x inlet pipe 4
132 8 -7.8212 -111        u=1 $ +x inlet pipe 5
133 8 -7.8212 -112        u=1 $ +x inlet pipe 6
134 8 -7.8212 -113        u=1 $ +x inlet pipe 7
135 8 -7.8212 -114        u=1 $ +x inlet pipe 8
136 8 -7.8212 -115        u=1 $ +x inlet pipe 9
137 8 -7.8212 -116        u=1 $ +x inlet pipe 10
138 8 -7.8212 -117        u=1 $ +x inlet pipe 11
139 8 -7.8212 -118        u=1 $ +x inlet pipe 12
140 8 -7.8212 -119        u=1 $ +x inlet pipe 13
141 8 -7.8212 -120        u=1 $ +x inlet pipe 14
142 8 -7.8212 -121        u=1 $ +x inlet pipe 15
143 8 -7.8212 -122        u=1 $ +x inlet pipe 16
144 8 -7.8212 -123        u=1 $ +x inlet pipe 17
145 8 -7.8212 -124        u=1 $ -y inlet pipe 1
146 8 -7.8212 -125        u=1 $ -y inlet pipe 2
147 8 -7.8212 -126        u=1 $ -y inlet pipe 3
148 8 -7.8212 -127        u=1 $ -y inlet pipe 4
149 8 -7.8212 -128        u=1 $ -y inlet pipe 5
150 8 -7.8212 -129        u=1 $ -y inlet pipe 6
151 8 -7.8212 -130        u=1 $ -y inlet pipe 7
152 8 -7.8212 -131        u=1 $ -y inlet pipe 8
153 8 -7.8212 -132        u=1 $ -y inlet pipe 9
154 8 -7.8212 -133        u=1 $ -y inlet pipe 10
155 8 -7.8212 -134        u=1 $ -y inlet pipe 11
156 8 -7.8212 -135        u=1 $ -y inlet pipe 12
157 8 -7.8212 -136        u=1 $ -y inlet pipe 13
158 8 -7.8212 -137        u=1 $ -y inlet pipe 14
159 8 -7.8212 -138        u=1 $ -y inlet pipe 15
160 8 -7.8212 -139        u=1 $ -y inlet pipe 16
161 8 -7.8212 -140        u=1 $ -y inlet pipe 17
162 8 -7.8212 -141        u=1 $ +y inlet pipe 1
163 8 -7.8212 -142        u=1 $ +y inlet pipe 2
164 8 -7.8212 -143        u=1 $ +y inlet pipe 3
165 8 -7.8212 -144        u=1 $ +y inlet pipe 4
166 8 -7.8212 -145        u=1 $ +y inlet pipe 5
167 8 -7.8212 -146        u=1 $ +y inlet pipe 6
168 8 -7.8212 -147        u=1 $ +y inlet pipe 7
169 8 -7.8212 -148        u=1 $ +y inlet pipe 8
170 8 -7.8212 -149        u=1 $ +y inlet pipe 9
171 8 -7.8212 -150        u=1 $ +y inlet pipe 10
172 8 -7.8212 -151        u=1 $ +y inlet pipe 11
173 8 -7.8212 -152        u=1 $ +y inlet pipe 12
174 8 -7.8212 -153        u=1 $ +y inlet pipe 13
175 8 -7.8212 -154        u=1 $ +y inlet pipe 14
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176 8 -7.8212 -155       u=1 $ +y inlet pipe 15
177 8 -7.8212 -156       u=1 $ +y inlet pipe 16
178 8 -7.8212 -157       u=1 $ +y inlet pipe 17
179 0         -39 +40 -46
              +90 +91 +92 +93 +94 +95 +96
              +97 +98 +99 +100 +101 +102 +103
              +104 +105 +106 +107 +108 +109 +110
              +111 +112 +113 +114 +115 +116 +117
              +118 +119 +120 +121 +122 +123       u=1 $ Bottom plate outer void x
180 0         -39 +40 -47
              +124 +125 +126 +127 +128 +129 +130
              +131 +132 +133 +134 +135 +136 +137
              +138 +139 +140 +141 +142 +143 +144
              +145 +146 +147 +148 +149 +150 +151
              +152 +153 +154 +155 +156 +157       u=1 $ Bottom plate outer void y
181 0         -40 +41 +35 +36    u=1 $ Bottom plate connector void
182 0         (-34 -61 -43) : (-34 -59 +60 -43)       u=1 $ Support rail inside stand void
183 0         (+33 -61 -43) : (+33 -59 +60 -43)       u=1 $ Support rail outside stand void
184 0         -46 +33 +35 +36 -44 +39
        +90 +91 +92 +93 +94 +95 +96
        +97 +98 +99 +100 +101 +102 +103
        +104 +105 +106 +107 +108 +109 +110
        +111 +112 +113 +114 +115 +116 +117
        +118 +119 +120 +121 +122 +123       u=1 $ Air inlet void x
185 0         -47 +33 +35 +36 -44 +39 +46
              +124 +125 +126 +127 +128 +129 +130
              +131 +132 +133 +134 +135 +136 +137
              +138 +139 +140 +141 +142 +143 +144
              +145 +146 +147 +148 +149 +150 +151
              +152 +153 +154 +155 +156 +157       u=1 $ Air inlet void y
186 0         -53 +33 +35 +36       u=1 $ Air inlet top void
187 0         (-37 +39 +33) : (-38 +39 +33)       u=1 $ Connector void
188 0         -34 +58 +60       u=1 $ Stand void
189 0         -56 +43 -44     u=1 $ Air outlet void X
190 0         -57 +43 -44     u=1 $ Air outlet void Y
191 0         -43 +32 +33 +58 +60 +65 #110
              fill=2 ( 0.0000 0.0000 6.9850 )       u=1 $ Cavity
192 0         +44 +42 +62 63    u=1 $ Outside
C VCC Rebar Cells - v1.3.1_ng14b
193 8 -7.8212 -158       u=7 $ Outer hoop 1
194 8 -7.8212 -159       u=7 $ Outer hoop 2
195 8 -7.8212 -160       u=7 $ Outer hoop 3
196 8 -7.8212 -161       u=7 $ Outer hoop 4
197 8 -7.8212 -162       u=7 $ Outer hoop 5
198 8 -7.8212 -163       u=7 $ Outer hoop 6
199 8 -7.8212 -164       u=7 $ Outer hoop 7
200 8 -7.8212 -165       u=7 $ Outer hoop 8
201 8 -7.8212 -166       u=7 $ Outer hoop 9
202 8 -7.8212 -167       u=7 $ Outer hoop 10
203 8 -7.8212 -168       u=7 $ Outer hoop 11
204 8 -7.8212 -169       u=7 $ Outer hoop 12
205 8 -7.8212 -170       u=7 $ Outer hoop 13
206 8 -7.8212 -171       u=7 $ Outer hoop 14
207 8 -7.8212 -172       u=7 $ Outer hoop 15
208 8 -7.8212 -173       u=7 $ Outer hoop 16
209 8 -7.8212 -174       u=7 $ Outer hoop 17
210 8 -7.8212 -175       u=7 $ Outer hoop 18
211 8 -7.8212 -176       u=7 $ Outer hoop 19
212 8 -7.8212 -177       u=7 $ Outer hoop 20
213 8 -7.8212 -178       u=7 $ Outer hoop 21
214 8 -7.8212 -179       u=7 $ Outer hoop 22
215 8 -7.8212 -180       u=7 $ Outer hoop 23
216 8 -7.8212 -181       u=7 $ Outer hoop 24
217 8 -7.8212 -182       u=7 $ Outer hoop 25
218 8 -7.8212 -183       u=7 $ Outer hoop 26
219 8 -7.8212 -184       u=7 $ Outer hoop 27
220 8 -7.8212 -185       u=7 $ Outer hoop 28
221 8 -7.8212 -186       u=7 $ Outer hoop 29
222 8 -7.8212 -187       u=7 $ Outer hoop 30
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223 8 -7.8212 -188       u=7 $ Outer hoop 31
224 8 -7.8212 -189       u=7 $ Outer hoop 32
225 8 -7.8212 -190       u=7 $ Outer hoop 33
226 8 -7.8212 -191       u=7 $ Outer hoop 34
227 8 -7.8212 -192       u=7 $ Outer hoop 35
228 8 -7.8212 -193       u=7 $ Outer hoop 36
229 8 -7.8212 -194       u=7 $ Outer hoop 37
230 8 -7.8212 -195       u=7 $ Outer hoop 38
231 8 -7.8212 -196       u=7 $ Outer hoop 39
232 8 -7.8212 -197       u=7 $ Outer hoop 40
233 8 -7.8212 -198       u=7 $ Outer hoop 41
234 8 -7.8212 -199       u=7 $ Outer hoop 42
235 8 -7.8212 -200       u=7 $ Outer hoop 43
236 8 -7.8212 -201       u=7 $ Outer hoop 44
237 8 -7.8212 -202       u=7 $ Outer hoop 45
238 8 -7.8212 -203       u=7 $ Outer hoop 46
239 8 -7.8212 -204       u=7 $ Outer hoop 47
240 8 -7.8212 -205       u=7 $ Outer hoop 48
241 8 -7.8212 -206       u=7 $ Outer hoop 49
242 8 -7.8212 -207       u=7 $ Outer hoop 50
243 13 -2.3234 #193 #194 #195 #196 #197 #198 #199
        #200 #201 #202 #203 #204 #205 #206 #207 #208 #209
        #210 #211 #212 #213 #214 #215 #216 #217 #218 #219
        #220 #221 #222 #223 #224 #225 #226 #227 #228 #229
        #230 #231 #232 #233 #234 #235 #236 #237 #238 #239
        #240 #241 #242       fill=8 u=7
244 8 -7.8212 -208   trcl = ( 160.3375 0.0000 0.0000 )    u=8 $ Outer bar 1
245 like 244 but   trcl = ( 159.3293 17.9521 0.0000 )    u=8 $ Outer bar 2
246 like 244 but   trcl = ( 156.3175 35.6785 0.0000 )    u=8 $ Outer bar 3
247 like 244 but   trcl = ( 151.3399 52.9561 0.0000 )    u=8 $ Outer bar 4
248 like 244 but   trcl = ( 144.4591 69.5678 0.0000 )    u=8 $ Outer bar 5
249 like 244 but   trcl = ( 135.7616 85.3047 0.0000 )    u=8 $ Outer bar 6
250 like 244 but   trcl = ( 125.3569 99.9688 0.0000 )    u=8 $ Outer bar 7
251 like 244 but   trcl = ( 113.3757 113.3757 0.0000 )    u=8 $ Outer bar 8
252 like 244 but   trcl = ( 99.9688 125.3569 0.0000 )    u=8 $ Outer bar 9
253 like 244 but   trcl = ( 85.3047 135.7616 0.0000 )    u=8 $ Outer bar 10
254 like 244 but   trcl = ( 69.5678 144.4591 0.0000 )    u=8 $ Outer bar 11
255 like 244 but   trcl = ( 52.9561 151.3399 0.0000 )    u=8 $ Outer bar 12
256 like 244 but   trcl = ( 35.6785 156.3175 0.0000 )    u=8 $ Outer bar 13
257 like 244 but   trcl = ( 17.9521 159.3293 0.0000 )    u=8 $ Outer bar 14
258 like 244 but   trcl = ( 0.0000 160.3375 0.0000 )    u=8 $ Outer bar 15
259 like 244 but   trcl = ( -17.9521 159.3293 0.0000 )    u=8 $ Outer bar 16
260 like 244 but   trcl = ( -35.6785 156.3175 0.0000 )    u=8 $ Outer bar 17
261 like 244 but   trcl = ( -52.9561 151.3399 0.0000 )    u=8 $ Outer bar 18
262 like 244 but   trcl = ( -69.5678 144.4591 0.0000 )    u=8 $ Outer bar 19
263 like 244 but   trcl = ( -85.3047 135.7616 0.0000 )    u=8 $ Outer bar 20
264 like 244 but   trcl = ( -99.9688 125.3569 0.0000 )    u=8 $ Outer bar 21
265 like 244 but   trcl = ( -113.3757 113.3757 0.0000 )    u=8 $ Outer bar 22
266 like 244 but   trcl = ( -125.3569 99.9688 0.0000 )    u=8 $ Outer bar 23
267 like 244 but   trcl = ( -135.7616 85.3047 0.0000 )    u=8 $ Outer bar 24
268 like 244 but   trcl = ( -144.4591 69.5678 0.0000 )    u=8 $ Outer bar 25
269 like 244 but   trcl = ( -151.3399 52.9561 0.0000 )    u=8 $ Outer bar 26
270 like 244 but   trcl = ( -156.3175 35.6785 0.0000 )    u=8 $ Outer bar 27
271 like 244 but   trcl = ( -159.3293 17.9521 0.0000 )    u=8 $ Outer bar 28
272 like 244 but   trcl = ( -160.3375 0.0000 0.0000 )    u=8 $ Outer bar 29
273 like 244 but   trcl = ( -159.3293 -17.9521 0.0000 )    u=8 $ Outer bar 30
274 like 244 but   trcl = ( -156.3175 -35.6785 0.0000 )    u=8 $ Outer bar 31
275 like 244 but   trcl = ( -151.3399 -52.9561 0.0000 )    u=8 $ Outer bar 32
276 like 244 but   trcl = ( -144.4591 -69.5678 0.0000 )    u=8 $ Outer bar 33
277 like 244 but   trcl = ( -135.7616 -85.3047 0.0000 )    u=8 $ Outer bar 34
278 like 244 but   trcl = ( -125.3569 -99.9688 0.0000 )    u=8 $ Outer bar 35
279 like 244 but   trcl = ( -113.3757 -113.3757 0.0000 )    u=8 $ Outer bar 36
280 like 244 but   trcl = ( -99.9688 -125.3569 0.0000 )    u=8 $ Outer bar 37
281 like 244 but   trcl = ( -85.3047 -135.7616 0.0000 )    u=8 $ Outer bar 38
282 like 244 but   trcl = ( -69.5678 -144.4591 0.0000 )    u=8 $ Outer bar 39
283 like 244 but   trcl = ( -52.9561 -151.3399 0.0000 )    u=8 $ Outer bar 40
284 like 244 but   trcl = ( -35.6785 -156.3175 0.0000 )    u=8 $ Outer bar 41
285 like 244 but   trcl = ( -17.9521 -159.3293 0.0000 )    u=8 $ Outer bar 42
286 like 244 but   trcl = ( 0.0000 -160.3375 0.0000 )    u=8 $ Outer bar 43
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287 like 244 but   trcl = ( 17.9521 -159.3293 0.0000 )    u=8 $ Outer bar 44
288 like 244 but   trcl = ( 35.6785 -156.3175 0.0000 )    u=8 $ Outer bar 45
289 like 244 but   trcl = ( 52.9561 -151.3399 0.0000 )    u=8 $ Outer bar 46
290 like 244 but   trcl = ( 69.5678 -144.4591 0.0000 )    u=8 $ Outer bar 47
291 like 244 but   trcl = ( 85.3047 -135.7616 0.0000 )    u=8 $ Outer bar 48
292 like 244 but   trcl = ( 99.9688 -125.3569 0.0000 )    u=8 $ Outer bar 49
293 like 244 but   trcl = ( 113.3757 -113.3757 0.0000 )    u=8 $ Outer bar 50
294 like 244 but   trcl = ( 125.3569 -99.9688 0.0000 )    u=8 $ Outer bar 51
295 like 244 but   trcl = ( 135.7616 -85.3047 0.0000 )    u=8 $ Outer bar 52
296 like 244 but   trcl = ( 144.4591 -69.5678 0.0000 )    u=8 $ Outer bar 53
297 like 244 but   trcl = ( 151.3399 -52.9561 0.0000 )    u=8 $ Outer bar 54
298 like 244 but   trcl = ( 156.3175 -35.6785 0.0000 )    u=8 $ Outer bar 55
299 like 244 but   trcl = ( 159.3293 -17.9521 0.0000 )    u=8 $ Outer bar 56
300 13 -2.3234 #244 #245 #246
        #247 #248 #249 #250 #251 #252 #253 #254 #255 #256
        #257 #258 #259 #260 #261 #262 #263 #264 #265 #266
        #267 #268 #269 #270 #271 #272 #273 #274 #275 #276
        #277 #278 #279 #280 #281 #282 #283 #284 #285 #286
        #287 #288 #289 #290 #291 #292 #293 #294 #295 #296
        #297 #298 #299        u=8
C Detector Cells - Radial Biasing
399  0  -399  fill=1  $ Cask
400  0  -400  +399  $ Surface
450  0  -450  +399  +400  $ SurfAzi
500  0  -500  +399  +400  +450  $ 1ft
600  0  -600  +399  +400  +450  +500  $ 1m
700  0  -700  +399  +400  +450  +500  +600  $ 2m
800  0  -800  +399  +400  +450  +500  +600  +700  $ 4m
900  0  +399  +400  +450  +500  +600  +700  +800  $ Exterior

C Fuel Assembly Surfaces - ng14b - v1.1
1 RPP -9.8590 9.8590 -9.8590 9.8590 0.0000 8.0975  $ Lower Nozzle
2 RPP -9.8590 9.8590 -9.8590 9.8590 0.0000 9.8374  $ Lower Plenum
3 RPP -9.8590 9.8590 -9.8590 9.8590 0.0000 378.6454  $ Fuel
4 RPP -9.8590 9.8590 -9.8590 9.8590 0.0000 400.3040  $ Upper Plenum
5 RPP -9.8590 9.8590 -9.8590 9.8590 0.0000 409.1940  $ Upper Nozzle
6 PZ 255.7094       $ Flood elevation
C Surfaces - Fuel Tube v1.3
7 RPP -11.6015 11.6015 -11.6015 11.6015 7.6200 439.4962  $ Tube void
8 RPP -12.3952 12.3952 -12.3952 12.3952 7.6200 430.5300  $ Tube
9 RPP -11.6015 -11.2840 -10.2362 10.2362 9.2075 428.9425  $ Poison left
10 RPP 11.2840 11.6015 -10.2362 10.2362 9.2075 428.9425  $ Poison right
11 RPP -10.2362 10.2362 11.2840 11.6015 9.2075 428.9425  $ Poison top
12 RPP -10.2362 10.2362 -11.6015 -11.2840 9.2075 428.9425  $ Poison bottom
C Surfaces - PWR Basket v1.5
13  RPP -12.3952 12.3952 -12.3952 12.3952 0.0000 439.4962  $ Tube opening
14 9 RPP -16.6370 16.6370 -16.6370 16.6370 0.0000 439.4962  $ Tube radius
15  RPP 81.8833 83.7883 -33.1851 33.1851 7.6200 430.5300  $ Side support +x
16  RPP -83.7883 -81.8833 -33.1851 33.1851 7.6200 430.5300  $ Side support -x
17  RPP -33.1851 33.1851 81.8833 83.7883 7.6200 430.5300  $ Side support +y
18  RPP -33.1851 33.1851 -83.7883 -81.8833 7.6200 430.5300  $ Side support -y
19  RPP -60.2552 60.2552 -60.2552 60.2552 7.6200 430.5300  $ Corner outer
20  RPP -59.4614 59.4614 -59.4614 59.4614 7.6200 430.5300  $ Corner inner
21 9 RPP -78.6267 78.6267 -78.6267 78.6267 7.6200 430.5300  $ Corner dia. outer
22 9 RPP -77.83291 77.8329 -77.8329 77.8329 7.6200 430.5300  $ Corner dia. inner
C Surfaces - PWR Canister Cavity v1.5
23 RPP -9.8595 9.8595 -9.8595 9.8595 0.0000 409.1941   $ Assy opening
C Surfaces - Canister v1.3
24 RCC 0.0000 0.0000 0.0000 0.0000 0.0000 439.4962 90.1700   $ Cavity
25 CZ 2.6924         $ Bot Cylinder Radius
26 CZ 6.7691         $ Mid Cyclinder Radius
27 CZ 7.4041         $ Top Cylinder Radius
28 PZ 450.8500         $ Port plane bot/mid
29 PZ 452.1962         $ Lower/upper lid
30 PZ 459.5114         $ Port plane mid/top
31 RCC 0.0000 0.0000 -6.9850 0.0000 0.0000 469.3412 91.4400   $ Canister
C VCC Surfaces - v1.3.1_ng14b
32  RCC 0.0000 0.0000 -5.0800 0.0000 0.0000 5.0800 91.4401  $ Pedestal plate
33  RCC 0.0000 0.0000 -30.4800 0.0000 0.0000 25.4000 63.4999  $ Stand outer
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34  RCC 0.0000 0.0000 -30.4800 0.0000 0.0000 25.4000 62.3888  $ Stand inner
35 9 RPP -100.3300 100.3300 -10.4775 10.4775 -33.0200 -16.5100   $ Connector plate A
36 10 RPP -100.3300 100.3300 -10.4775 10.4775 -33.0200 -16.5100   $ Connector plate B
37 9 RPP -99.0600 99.0600 -9.2075 9.2075 -33.0200 -16.5100   $ Air inlet angled wall A
38 10 RPP -99.0600 99.0600 -9.2075 9.2075 -33.0200 -16.5100   $ Air inlet angled wall B
39  RCC 0.0000 0.0000 -33.0200 0.0000 0.0000 2.5400 172.7200  $ Bottom plate outer
40  RCC 0.0000 0.0000 -33.0200 0.0000 0.0000 2.5400 100.3300  $ Connector radius
41  RCC 0.0000 0.0000 -33.0200 0.0000 0.0000 2.5400 63.5000  $ Bottom plate inner
42  RCC 0.0000 0.0000 -16.5100 0.0000 0.0000 538.0228 105.41  $ VCC liner outer
43  RCC 0.0000 0.0000 -16.5100 0.0000 0.0000 538.0228 100.965  $ VCC liner inner
44  RCC 0.0000 0.0000 -133.0200 0.0000 0.0000 654.5328 172.7200  $ Concrete
45  RCC 0.0000 0.0000 -133.0200 0.0000 0.0000 100.0000 172.7200  $ Concrete pad
46  RPP -172.7200 172.7200 -63.5000 63.5000 -33.0200 -21.5900   $ Air inlet void X
47  RPP -63.5000 63.5000 -172.7200 172.7200 -33.0200 -21.5900   $ Air inlet void Y
48  RPP -172.7200 172.7200 -64.7700 64.7700 -33.0200 -21.5900   $ Air inlet wall X
49  RPP -64.7700 64.7700 -172.7200 172.7200 -33.0200 -21.5900   $ Air inlet wall Y
50  RCC 0.0000 0.0000 -33.0200 0.0000 0.0000 11.4300 100.3300  $ Air inlet divider
51  RPP -172.7200 172.7200 -64.7700 64.7700 -21.5900 -16.5100   $ Air inlet top X
52  RPP -64.7700 64.7700 -172.7200 172.7200 -21.5900 -16.5100   $ Air inlet top Y
53  RCC 0.0000 0.0000 -21.5900 0.0000 0.0000 5.0800 93.9800  $ Air inlet top plate radius
54  RPP -172.7200 172.7200 -64.7700 64.7700 494.0808 505.0028   $ Air outlet steel X
55  RPP -64.7700 64.7700 -172.7200 172.7200 494.0808 505.0028   $ Air outlet steel Y
56  RPP -172.7200 172.7200 -64.1350 64.1350 494.7158 504.3678   $ Air outlet void X
57  RPP -64.1350 64.1350 -172.7200 172.7200 494.7158 504.3678   $ Air outlet void Y
58  RPP -106.6800 106.6800 -5.7150 5.7150 -16.5100 -5.0800   $ Support rail exterior X
59  RPP -106.6800 106.6800 -4.4450 4.4450 -16.5100 -5.0800   $ Support rail interior X
60  RPP -5.7150 5.7150 -106.6800 106.6800 -16.5100 -5.0800   $ Support rail exterior Y
61  RPP -4.4450 4.4450 -106.6800 106.6800 -16.5100 -5.0800   $ Support rail interior Y
62  RCC 0.0000 0.0000 518.9728 0.0000 0.0000 2.5400 118.7450  $ Top flange
63  RCC 0.0000 0.0000 521.5128 0.0000 0.0000 1.9050 116.2050  $ Lid top
64  RCC 0.0000 0.0000 506.7808 0.0000 0.0000 14.7320 99.6950  $ Lid concrete
65  RCC 0.0000 0.0000 506.1458 0.0000 0.0000 15.3670 100.3300  $ Lid shell
66  RPP -100.9650 100.9650 -0.4432 0.4432 174.8028 479.6028   $ Standoff outer 1
67 11 RPP -100.9650 100.9650 -0.4432 0.4432 174.8028 479.6028   $ Standoff outer 2
68 12 RPP -100.9650 100.9650 -0.4432 0.4432 174.8028 479.6028   $ Standoff outer 3
69 9 RPP -100.9650 100.9650 -0.4432 0.4432 174.8028 479.6028   $ Standoff outer 4
70 13 RPP -100.9650 100.9650 -0.4432 0.4432 174.8028 479.6028   $ Standoff outer 5
71 14 RPP -100.9650 100.9650 -0.4432 0.4432 174.8028 479.6028   $ Standoff outer 6
72  RPP -0.4432 0.4432 -100.9650 100.9650 174.8028 479.6028   $ Standoff outer 7
73 11 RPP -0.4432 0.4432 -100.9650 100.9650 174.8028 479.6028   $ Standoff outer 8
74 12 RPP -0.4432 0.4432 -100.9650 100.9650 174.8028 479.6028   $ Standoff outer 9
75 9 RPP -0.4432 0.4432 -100.9650 100.9650 174.8028 479.6028   $ Standoff outer 10
76 13 RPP -0.4432 0.4432 -100.9650 100.9650 174.8028 479.6028   $ Standoff outer 11
77 14 RPP -0.4432 0.4432 -100.9650 100.9650 174.8028 479.6028   $ Standoff outer 12
78  RPP -93.3450 93.3450 -0.4432 0.4432 174.8028 479.6028   $ Standoff inner 1
79 11 RPP -93.3450 93.3450 -0.4432 0.4432 174.8028 479.6028   $ Standoff inner 2
80 12 RPP -93.3450 93.3450 -0.4432 0.4432 174.8028 479.6028   $ Standoff inner 3
81 9 RPP -93.3450 93.3450 -0.4432 0.4432 174.8028 479.6028   $ Standoff inner 4
82 13 RPP -93.3450 93.3450 -0.4432 0.4432 174.8028 479.6028   $ Standoff inner 5
83 14 RPP -93.3450 93.3450 -0.4432 0.4432 174.8028 479.6028   $ Standoff inner 6
84  RPP -0.4432 0.4432 -93.3450 93.3450 174.8028 479.6028   $ Standoff inner 7
85 11 RPP -0.4432 0.4432 -93.3450 93.3450 174.8028 479.6028   $ Standoff inner 8
86 12 RPP -0.4432 0.4432 -93.3450 93.3450 174.8028 479.6028   $ Standoff inner 9
87 9 RPP -0.4432 0.4432 -93.3450 93.3450 174.8028 479.6028   $ Standoff inner 10
88 13 RPP -0.4432 0.4432 -93.3450 93.3450 174.8028 479.6028   $ Standoff inner 11
89 14 RPP -0.4432 0.4432 -93.3450 93.3450 174.8028 479.6028   $ Standoff inner 12
90  RCC -146.0500 58.4200 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 1
91  RCC -146.0500 36.5760 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 2
92  RCC -146.0500 14.7320 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 3
93  RCC -146.0500 -7.1120 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 4
94  RCC -146.0500 -28.9560 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 5
95  RCC -146.0500 -50.8000 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 6
96  RCC -133.3500 50.8000 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 7
97  RCC -133.3500 28.9560 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 8
98  RCC -133.3500 7.1120 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 9
99  RCC -133.3500 -14.7320 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 10
100  RCC -133.3500 -36.5760 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 11
101  RCC -133.3500 -58.4200 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 12
102  RCC -120.6500 43.1800 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 13
```

```
RCC -120.6500 21.3360 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 14
RCC -120.6500 -0.5080 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 15
RCC -120.6500 -22.3520 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 16
RCC -120.6500 -44.1960 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -x inlet pipe 17
RCC 146.0500 -58.4200 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 1
RCC 146.0500 -36.5760 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 2
RCC 146.0500 -14.7320 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 3
RCC 146.0500 7.1120 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 4
RCC 146.0500 28.9560 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 5
RCC 146.0500 50.8000 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 6
RCC 133.3500 -50.8000 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 7
RCC 133.3500 -28.9560 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 8
RCC 133.3500 -7.1120 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 9
RCC 133.3500 14.7320 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 10
RCC 133.3500 36.5760 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 11
RCC 133.3500 58.4200 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 12
RCC 120.6500 -43.1800 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 13
RCC 120.6500 -21.3360 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 14
RCC 120.6500 0.5080 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 15
RCC 120.6500 22.3520 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 16
RCC 120.6500 44.1960 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +x inlet pipe 17
RCC -58.4200 -146.0500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 1
RCC -36.5760 -146.0500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 2
RCC -14.7320 -146.0500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 3
RCC 7.1120 -146.0500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 4
RCC 28.9560 -146.0500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 5
RCC 50.8000 -146.0500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 6
RCC -50.8000 -133.3500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 7
RCC -28.9560 -133.3500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 8
RCC -7.1120 -133.3500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 9
RCC 14.7320 -133.3500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 10
RCC 36.5760 -133.3500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 11
RCC 58.4200 -133.3500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 12
RCC -43.1800 -120.6500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 13
RCC -21.3360 -120.6500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 14
RCC 0.5080 -120.6500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 15
RCC 22.3520 -120.6500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 16
RCC 44.1960 -120.6500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ -y inlet pipe 17
RCC 58.4200 146.0500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 1
RCC 36.5760 146.0500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 2
RCC 14.7320 146.0500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 3
RCC -7.1120 146.0500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 4
RCC -28.9560 146.0500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 5
RCC -50.8000 146.0500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 6
RCC 50.8000 133.3500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 7
RCC 28.9560 133.3500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 8
RCC 7.1120 133.3500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 9
RCC -14.7320 133.3500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 10
RCC -36.5760 133.3500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 11
RCC -58.4200 133.3500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 12
RCC 43.1800 120.6500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 13
RCC 21.3360 120.6500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 14
RCC -0.5080 120.6500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 15
RCC -22.3520 120.6500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 16
RCC -44.1960 120.6500 -33.0200 0.0000 0.0000 11.4300 3.8100  $ +y inlet pipe 17
C VCC Rebar Surfaces - v1.3.1_ng14b
TZ 0.0000 0.0000 -1.7182 162.2425 0.9525 0.9525   $ Outer hoop 1
TZ 0.0000 0.0000 7.9935 162.2425 0.9525 0.9525   $ Outer hoop 2
TZ 0.0000 0.0000 17.7053 162.2425 0.9525 0.9525   $ Outer hoop 3
TZ 0.0000 0.0000 27.4171 162.2425 0.9525 0.9525   $ Outer hoop 4
TZ 0.0000 0.0000 37.1288 162.2425 0.9525 0.9525   $ Outer hoop 5
TZ 0.0000 0.0000 46.8406 162.2425 0.9525 0.9525   $ Outer hoop 6
TZ 0.0000 0.0000 56.5524 162.2425 0.9525 0.9525   $ Outer hoop 7
TZ 0.0000 0.0000 66.2641 162.2425 0.9525 0.9525   $ Outer hoop 8
TZ 0.0000 0.0000 75.9759 162.2425 0.9525 0.9525   $ Outer hoop 9
TZ 0.0000 0.0000 85.6876 162.2425 0.9525 0.9525   $ Outer hoop 10
TZ 0.0000 0.0000 95.3994 162.2425 0.9525 0.9525   $ Outer hoop 11
TZ 0.0000 0.0000 105.1112 162.2425 0.9525 0.9525   $ Outer hoop 12
TZ 0.0000 0.0000 114.8229 162.2425 0.9525 0.9525   $ Outer hoop 13
```

```
171  TZ 0.0000 0.0000 124.5347 162.2425 0.9525 0.9525   $ Outer hoop 14
172  TZ 0.0000 0.0000 134.2465 162.2425 0.9525 0.9525   $ Outer hoop 15
173  TZ 0.0000 0.0000 143.9582 162.2425 0.9525 0.9525   $ Outer hoop 16
174  TZ 0.0000 0.0000 153.6700 162.2425 0.9525 0.9525   $ Outer hoop 17
175  TZ 0.0000 0.0000 163.3818 162.2425 0.9525 0.9525   $ Outer hoop 18
176  TZ 0.0000 0.0000 173.0935 162.2425 0.9525 0.9525   $ Outer hoop 19
177  TZ 0.0000 0.0000 182.8053 162.2425 0.9525 0.9525   $ Outer hoop 20
178  TZ 0.0000 0.0000 192.5171 162.2425 0.9525 0.9525   $ Outer hoop 21
179  TZ 0.0000 0.0000 202.2288 162.2425 0.9525 0.9525   $ Outer hoop 22
180  TZ 0.0000 0.0000 211.9406 162.2425 0.9525 0.9525   $ Outer hoop 23
181  TZ 0.0000 0.0000 221.6524 162.2425 0.9525 0.9525   $ Outer hoop 24
182  TZ 0.0000 0.0000 231.3641 162.2425 0.9525 0.9525   $ Outer hoop 25
183  TZ 0.0000 0.0000 241.0759 162.2425 0.9525 0.9525   $ Outer hoop 26
184  TZ 0.0000 0.0000 250.7876 162.2425 0.9525 0.9525   $ Outer hoop 27
185  TZ 0.0000 0.0000 260.4994 162.2425 0.9525 0.9525   $ Outer hoop 28
186  TZ 0.0000 0.0000 270.2112 162.2425 0.9525 0.9525   $ Outer hoop 29
187  TZ 0.0000 0.0000 279.9229 162.2425 0.9525 0.9525   $ Outer hoop 30
188  TZ 0.0000 0.0000 289.6347 162.2425 0.9525 0.9525   $ Outer hoop 31
189  TZ 0.0000 0.0000 299.3465 162.2425 0.9525 0.9525   $ Outer hoop 32
190  TZ 0.0000 0.0000 309.0582 162.2425 0.9525 0.9525   $ Outer hoop 33
191  TZ 0.0000 0.0000 318.7700 162.2425 0.9525 0.9525   $ Outer hoop 34
192  TZ 0.0000 0.0000 328.4818 162.2425 0.9525 0.9525   $ Outer hoop 35
193  TZ 0.0000 0.0000 338.1935 162.2425 0.9525 0.9525   $ Outer hoop 36
194  TZ 0.0000 0.0000 347.9053 162.2425 0.9525 0.9525   $ Outer hoop 37
195  TZ 0.0000 0.0000 357.6171 162.2425 0.9525 0.9525   $ Outer hoop 38
196  TZ 0.0000 0.0000 367.3288 162.2425 0.9525 0.9525   $ Outer hoop 39
197  TZ 0.0000 0.0000 377.0406 162.2425 0.9525 0.9525   $ Outer hoop 40
198  TZ 0.0000 0.0000 386.7524 162.2425 0.9525 0.9525   $ Outer hoop 41
199  TZ 0.0000 0.0000 396.4641 162.2425 0.9525 0.9525   $ Outer hoop 42
200  TZ 0.0000 0.0000 406.1759 162.2425 0.9525 0.9525   $ Outer hoop 43
201  TZ 0.0000 0.0000 415.8876 162.2425 0.9525 0.9525   $ Outer hoop 44
202  TZ 0.0000 0.0000 425.5994 162.2425 0.9525 0.9525   $ Outer hoop 45
203  TZ 0.0000 0.0000 435.3112 162.2425 0.9525 0.9525   $ Outer hoop 46
204  TZ 0.0000 0.0000 445.0229 162.2425 0.9525 0.9525   $ Outer hoop 47
205  TZ 0.0000 0.0000 454.7347 162.2425 0.9525 0.9525   $ Outer hoop 48
206  TZ 0.0000 0.0000 464.4465 162.2425 0.9525 0.9525   $ Outer hoop 49
207  TZ 0.0000 0.0000 474.1582 162.2425 0.9525 0.9525   $ Outer hoop 50
208  RCC 0.0000 0.0000 -11.4300 0.0000 0.0000 495.3000 0.9525  $ Bar
C Storage Cask & Pad Container
399  RCC  0.0000  0.0000  -133.0200  0.0000  0.0000  656.4378  172.7201
C Radial Detector DRA (Surface)
400  RCC  0.0000  0.0000  -33.0200  0.0000  0.0000  556.5378  172.8201
401  PZ  13.3582
402  PZ  59.7363
403  PZ  106.1145
404  PZ  152.4926
405  PZ  198.8708
406  PZ  245.2489
407  PZ  291.6271
408  PZ  338.0052
409  PZ  384.3834
410  PZ  430.7615
411  PZ  477.1397
C Radial Detector DRAA (SurfAzi)
450  RCC  0.0000  0.0000  16.8224  0.0000  0.0000  368.8080  172.9201
451     PX  0.0000
452  1  PX  0.0000
453  2  PX  0.0000
454  3  PX  0.0000
455  4  PX  0.0000
456     PY  0.0000
457  5  PX  0.0000
458  6  PX  0.0000
459  7  PX  0.0000
460  8  PX  0.0000
C Radial Detector DRB (1ft)
500  RCC  0.0000  0.0000  -33.0200  0.0000  0.0000  587.0178  203.3001
501  PZ  15.8982
502  PZ  64.8163
```

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503  PZ  113.7345
504  PZ  162.6526
505  PZ  211.5708
506  PZ  260.4889
507  PZ  309.4071
508  PZ  358.3252
509  PZ  407.2434
510  PZ  456.1615
511  PZ  505.0797
C Radial Detector DRC (1m)
600  RCC  0.0000  0.0000  -33.0200  0.0000  0.0000  656.5378  272.8201
601  PZ  10.7492
602  PZ  54.5184
603  PZ  98.2876
604  PZ  142.0567
605  PZ  185.8259
606  PZ  229.5951
607  PZ  273.3643
608  PZ  317.1335
609  PZ  360.9027
610  PZ  404.6719
611  PZ  448.4411
612  PZ  492.2102
613  PZ  535.9794
614  PZ  579.7486
C Radial Detector DRD (2m)
700  RCC  0.0000  0.0000  -33.0200  0.0000  0.0000  756.5378  372.8201
701  PZ  4.8069
702  PZ  42.6338
703  PZ  80.4607
704  PZ  118.2876
705  PZ  156.1145
706  PZ  193.9413
707  PZ  231.7682
708  PZ  269.5951
709  PZ  307.4220
710  PZ  345.2489
711  PZ  383.0758
712  PZ  420.9027
713  PZ  458.7296
714  PZ  496.5565
715  PZ  534.3834
716  PZ  572.2102
717  PZ  610.0371
718  PZ  647.8640
719  PZ  685.6909
C Radial Detector DRE (4m)
800  RCC  0.0000  0.0000  -33.0200  0.0000  0.0000  956.5378  572.8201
801  PZ  14.8069
802  PZ  62.6338
803  PZ  110.4607
804  PZ  158.2876
805  PZ  206.1145
806  PZ  253.9413
807  PZ  301.7682
808  PZ  349.5951
809  PZ  397.4220
810  PZ  445.2489
811  PZ  493.0758
812  PZ  540.9027
813  PZ  588.7296
814  PZ  636.5565
815  PZ  684.3834
816  PZ  732.2102
817  PZ  780.0371
818  PZ  827.8640
819  PZ  875.6909

C
```

```
C Materials List - Common Materials - v1.7
C
C Homogenized Lower Nozzle
m1     24000 -1.9000E-01 25055 -2.0000E-02 26000 -6.9500E-01
       28000 -9.5000E-02
C Homogenized Lower Plenum
m2     24000 -1.0000E-03 50000 -1.5000E-02
       26000 -1.2500E-03  7014 -5.0000E-04
       40000 -9.8225E-01
C Homogenized UO2 Fuel - Dry
m3     92235 -3.6891E-02 40000 -1.6011E-01 24000 -1.6300E-04
       92238 -7.0092E-01 50000 -2.4450E-03  7014 -8.1499E-05
        8016 -9.9186E-02 26000 -2.0375E-04
C Homogenized Upper Plenum
m4     24000 -1.4890E-01 50000 -3.2622E-03 25055 -1.5650E-02
       26000 -5.4413E-01  7014 -1.0874E-04 28000 -7.4340E-02
       40000 -2.1362E-01
C Homogenized Upper Nozzle
m5     24000 -1.9000E-01 25055 -2.0000E-02 26000 -6.9500E-01
       28000 -9.5000E-02
C Water
m6     1001 2 8016 1
C Stainless Steel
m7     24000 -0.190 25055 -0.020 26000 -0.695
       28000 -0.095
C Carbon Steel
m8     26000 -0.99  6012 -0.01
C Neutron Poison
m9     13027 -0.6605 5010 -0.0478 5011 -0.2179
       6012 -0.0737
C Aluminum
m10    13027 -1.0
C Lead
m11    82000 -1.0
C NS-4-FR
m12    5010 -9.3127E-04 13027 -2.1420E-01 6000 -2.7627E-01
       5011 -3.7721E-03 1001 -6.0012E-02 7014 -1.9815E-02
       8016 -4.2500E-01
C Concrete
m13    26000 -0.014 20000 -0.044 14000 -0.337
        1001 -0.010  8016 -0.532 11023 -0.029
       13027 -0.034
C Vent Port Middle Cylinder
m14    24000 -0.190 25055 -0.020 26000 -0.695
       28000 -0.095
C Balsa
m15    6012 6 1001 10 8016 5
C NS-4-FR (Accident)
m16    5010 -1.7596E-03 13027 -4.3257E-01 6012 -5.5793E-01
       5011 -7.7389E-03
C Copper
m17    29063 -6.8499E-01 29065 -3.1501E-01
C Damaged Fuel
m18    92235 -4.1222E-02
       92238 -7.8321E-01
        8016 -1.1083E-01
       40000 -6.3583E-02
       50000 -9.7099E-04
       26000 -8.0916E-05
       24000 -6.4732E-05
        7014 -3.2366E-05
C Damaged Lower Nozzle
m19    92235 -3.2602E-02
       92238 -6.1944E-01
        8016 -8.7656E-02
       24000 -4.9457E-02
       25055 -5.2060E-03
       26000 -1.8091E-01
       28000 -2.4728E-02
```

```
C Damaged Lower Plenum
m20    92235 -3.0443E-02
       92238 -5.7843E-01
        8016 -8.1852E-02
       24000 -3.0928E-04
       26000 -3.8660E-04
       40000 -3.0379E-01
       50000 -4.6392E-03
        7014 -1.5464E-04
C Damaged Upper Plenum
m21    92235 -3.9655E-02
       92238 -7.5344E-01
        8016 -1.0662E-01
       24000 -1.4932E-02
       26000 -5.4568E-02
       40000 -2.1423E-02
       50000 -3.2715E-04
        7014 -1.0905E-05
       25055 -1.5695E-03
       28000 -7.4552E-03
C Damaged upper Nozzle
m22    92235 -3.0832E-02
       92238 -5.8581E-01
        8016 -8.2897E-02
       24000 -5.7087E-02
       25055 -6.0091E-03
       26000 -2.0882E-01
       28000 -2.8543E-02
phys:p 100 0 0 0 1    $ Disable Doppler energy broadening
C
C Cell Importances
C
imp:p 1 306r 0
C
C Source Definition - Fuel Gamma Response to Group 7 - Symmetric Position B2
C
sdef x=d1 y=d2 z=d3 erg=d4 cell=399:191:78:d5:3
si1    -9.85901 9.85901
sp1    0 1
si2    -9.85901 9.85901
sp2    0 1
si3 a 9.8374 19.0576 28.2778 37.4980 46.7182 55.9384 65.1586
      323.3242 332.5444 341.7646 350.9848 360.2050 369.4252 378.6454
sp3 d 0.5470 0.6358 0.7247 0.8135 0.9023 0.9912 1.0800
      1.0800 0.9912 0.9023 0.8135 0.7247 0.6358 0.5470
sb3 d 1.00E+00 1.00E+00 1.00E+00 1.00E+00 1.00E+00 1.00E+00 1.00E+00
      1.00E+00 1.00E+00 1.00E+00 1.00E+00 1.00E+00 1.00E+00 1.00E+00
si4    3.000E+00 4.000E+00
sp4    0 1
C Source Information
si5 1        40 41 42
          43 44 45 46 47
      48 49 50 51 52 53 54
      55 56 57 58 59 60 61
      62 63 64 65 66 67 68
          69 70 71 72 73
             74 75 76
C Source Probability
sp5            0.0 0.0 0.0
           0.0000 0.0 1.0 0.0 0.0000
      0.0 0.0 0.0 0.0 0.0 0.0 0.0
      0.0 1.0 0.0 0.0 0.0 1.0 0.0
      0.0 0.0 0.0 0.0 0.0 0.0 0.0
           0.0000 0.0 1.0 0.0 0.0000
               0.0 0.0 0.0
mode p
nps 40000000
C
C ANSI/ANS-6.1.1-1977 - Gamma Flux-to-Dose Conversion Factors
```

```
C (mrem/hr)/(photons/cm2-sec)
C
de0   0.01 0.03 0.05 0.07 0.1 0.15 0.2
      0.25 0.3 0.35 0.4 0.45 0.5 0.55
      0.6 0.65 0.7 0.8 1 1.4 1.8
      2.2 2.6 2.8 3.25 3.75 4.25 4.75
      5 5.25 5.75 6.25 6.75 7.5 9
      11 13 15
df0   3.96E-03 5.82E-04 2.90E-04 2.58E-04 2.83E-04 3.79E-04 5.01E-04
      6.31E-04 7.59E-04 8.78E-04 9.85E-04 1.08E-03 1.17E-03 1.27E-03
      1.36E-03 1.44E-03 1.52E-03 1.68E-03 1.98E-03 2.51E-03 2.99E-03
      3.42E-03 3.82E-03 4.01E-03 4.41E-03 4.83E-03 5.23E-03 5.60E-03
      5.80E-03 6.01E-03 6.37E-03 6.74E-03 7.11E-03 7.66E-03 8.77E-03
      1.03E-02 1.18E-02 1.33E-02
C
C Weight Window Generation - Radial
C
wwg 2 0 0 0 0
wwp:p 5 3 5 0 -1 0
mesh geom=cyl ref=57 0 201 origin=0.1 0.1 -134
     imesh 90.2 91.4 101.0 105.4 172.7 672.7
     iints 5 1 1 1 5 1
     jmesh 101 104 112 118 129 141 151 520 550 581 603 640 656 1156
     jints 1 1 1 1 1 1 1 1 1 1 1 1 1 1
     kmesh 1
     kints 1
C wwge:p  1e-3 1 20
fc2 Radial Surface Tally
f2:p +400.1
fm2 4.0000E+00
fs2  -401  -402  -403  -404  -405  -406
     -407  -408  -409  -410  -411  T
tf2
fc12 Radial SurfAzi Tally Q1 (+x+y)
f12:p +450.1
fm12 4.0000E+00
fs12 -451  -456
     +455  +454  +453  +452  T
sd12 2.0035E+05  1.0018E+05  2.0035E+04  4r  4.0071E+05
tf12
fc22 Radial SurfAzi Tally Q2 (-x+y)
f22:p +450.1
fm22 4.0000E+00
fs22 +451  -456
     -460  -459  -458  -457  T
sd22 2.0035E+05  1.0018E+05  2.0035E+04  4r  4.0071E+05
tf22
fc32 Radial SurfAzi Tally Q3 (-x-y)
f32:p +450.1
fm32 4.0000E+00
fs32 +451  +456
     -455  -454  -453  -452  T
sd32 2.0035E+05  1.0018E+05  2.0035E+04  4r  4.0071E+05
tf32
fc42 Radial SurfAzi Tally Q4 (+x-y)
f42:p +450.1
fm42 4.0000E+00
fs42 -451  +456
     +460  +459  +458  +457  T
sd42 2.0035E+05  1.0018E+05  2.0035E+04  4r  4.0071E+05
tf42
fc52 Radial 1ft Tally
f52:p +500.1
fm52 4.0000E+00
fs52  -501  -502  -503  -504  -505  -506
     -507  -508  -509  -510  -511  T
tf52
fc62 Radial 1m Tally
f62:p +600.1
```

```
fm62 4.0000E+00
fs62  -601  -602  -603  -604  -605  -606
     -607  -608  -609  -610  -611  -612
     -613  -614  T
tf62
fc72 Radial 2m Tally
f72:p +700.1
fm72 4.0000E+00
fs72  -701  -702  -703  -704  -705  -706
     -707  -708  -709  -710  -711  -712
     -713  -714  -715  -716  -717  -718
     -719  T
tf72
fc82 Radial 4m Tally
f82:p +800.1
fm82 4.0000E+00
fs82  -801  -802  -803  -804  -805  -806
     -807  -808  -809  -810  -811  -812
     -813  -814  -815  -816  -817  -818
     -819  T
tf82
C
C
C Print Control
C
prdmp -30 -60 1 2
print
C
C Random Number Generator
C
rand gen=2 seed=19073486328125 stride=152917 hist=1
C
C Rotation Matrix
C
C 18 degree rotation around z-axis
*TR1 0.0 0.0 0.0 18 108 90 -72 18 90 90 90 0
C 36 degree rotation around z-axis
*TR2 0.0 0.0 0.0 36 126 90 -54 36 90 90 90 0
C 54 degree rotation around z-axis
*TR3 0.0 0.0 0.0 54 144 90 -36 54 90 90 90 0
C 72 degree rotation around z-axis
*TR4 0.0 0.0 0.0 72 162 90 -18 72 90 90 90 0
C 108 degree rotation around z-axis
*TR5 0.0 0.0 0.0 108 198 90 18 108 90 90 90 0
C 126 degree rotation around z-axis
*TR6 0.0 0.0 0.0 126 216 90 36 126 90 90 90 0
C 144 degree rotation around z-axis
*TR7 0.0 0.0 0.0 144 234 90 54 144 90 90 90 0
C 162 degree rotation around z-axis
*TR8 0.0 0.0 0.0 162 252 90 72 162 90 90 90 0
C 45 degree rotation around z-axis
*TR9 0.0 0.0 0.0 45 135 90 -45 45 90 90 90 0
C 135 degree rotation around z-axis
*TR10 0.0 0.0 0.0 135 225 90 45 135 90 90 90 0
C 15 degree rotation around z-axis
*TR11 0.0 0.0 0.0 15 105 90 -75 15 90 90 90 0
C 30 degree rotation around z-axis
*TR12 0.0 0.0 0.0 30 120 90 -60 30 90 90 90 0
C 60 degree rotation around z-axis
*TR13 0.0 0.0 0.0 60 150 90 -30 60 90 90 90 0
C 75 degree rotation around z-axis
*TR14 0.0 0.0 0.0 75 165 90 -15 75 90 90 90 0
```

5.9.8 Cool-Time Tables

PWR system performance is evaluated for a cask heat load of 35.5 kW with preferential (1.8 kW max) and uniform (959 W/assy) heat load patterns. Minimum cool times are summarized for the uniform and preferential heat load patterns.

Allowed low burnup (up to 30,000 MWd/MTU) fuel loadings are shown in Table 5.8.9-1. Note that the listed minimum cool times at each burnup step are bounding for all fuel types and initial enrichments above the minimum enrichment specified. Collapsing the fuel type and initial enrichment-dependent minimum cool time matrix to a single value may result in a minimum cool time longer than individual values presented for higher burnups in the detailed tables that follow.

The minimum cool time tables account for potential uncertainties in the source generation abilities of SAS2H at burnups greater than 45 GWd/MTU by reducing allowed heat loads by 5 percent. Fuel assembly loading tables at greater than 45 GWd/MTU are, therefore, generated for a cask heat load of 33.725 kW with preferential (1.71 kW max) and uniform (911 W/assy) heat load patterns.

The 5% penalty adjusted four-zone preferential loading pattern is as follows.

Zone Description	Designator	Heat Load [W/assy]	Adjusted Heat Load [W/assy]	# Assemblies
Inner Ring	A	513	487	9
Middle Ring	B1	1300	1235	8
	B2	1800	1710	4
Outer Ring	C	830	788	16

Table 5.9.8-1 contains the minimum cool times for a uniform heat load of 959 W/assy (≤ 45 GWd/MTU) PWR fuel. Greater than 45 GWd/MTU uniform heat load minimum cool times are listed in Section 5.8.9. Table 5.9.8-2 through Table 5.9.8-5 contain the minimum cool times for the preferential loading of ≤ 45 GWd/MTU with higher burnup fuel cool times listed in Table 5.9.8-6 through Table 5.9.8-9.

Decay heat associated with loading nonfuel components requires an increase in the minimum fuel assembly cool time. Reductions in minimum cool time did not change the incremental cool time increase documented in Sections 5.8.5 for the BPRAs and TPs. The incremental cool time increase to allow loading of the Westinghouse 14x14 CEAs with a minimum cool time of 2.5 years is 0.2 years.

Table 5.9.8-1 Loading Table for PWR Fuel – 959 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	B ≤10	10< B ≤15	15< B ≤20	20< B ≤25	25< B ≤30	30< B ≤32.5
1.3 ≤ E < 1.5	2.5	-	-	-	-	-
1.5 ≤ E < 1.7	2.5	2.5	-	-	-	-
1.7 ≤ E < 1.9	2.5	2.5	2.9	-	-	-
1.9 ≤ E < 2.1	2.5	2.5	2.9	3.4	-	-
2.1 ≤ E < 2.3	2.5	2.5	2.8	3.3	3.9	4.1
2.3 ≤ E < 2.5	2.5	2.5	2.8	3.3	3.8	4.1
2.5 ≤ E < 2.7	2.5	2.5	2.8	3.3	3.8	4.0
2.7 ≤ E < 2.9	2.5	2.5	2.8	3.2	3.7	4.0
2.9 ≤ E < 3.1	2.5	2.5	2.7	3.2	3.7	3.9
3.1 ≤ E < 3.3	2.5	2.5	2.7	3.2	3.7	3.9
3.3 ≤ E < 3.5	2.5	2.5	2.7	3.2	3.6	3.9
3.5 ≤ E < 3.7	2.5	2.5	2.7	3.1	3.6	3.8
3.7 ≤ E < 3.9	2.5	2.5	2.7	3.1	3.6	3.8
3.9 ≤ E < 4.1	2.5	2.5	2.6	3.1	3.6	3.8
4.1 ≤ E < 4.3	2.5	2.5	2.6	3.1	3.5	3.8
4.3 ≤ E < 4.5	2.5	2.5	2.6	3.0	3.5	3.7
4.5 ≤ E < 4.7	2.5	2.5	2.6	3.0	3.5	3.7
4.7 ≤ E < 4.9	2.5	2.5	2.6	3.0	3.5	3.7
E ≥ 4.9	2.5	2.5	2.6	3.0	3.5	3.7

Table 5.9.8-1 Loading Table for PWR Fuel – 959 W/Assembly (Continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	32.5< B ≤35	35< B ≤37.5	37.5< B ≤40	40< B ≤41	41< B ≤42	42< B ≤43
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	4.4	4.8	-	-	-	-
2.5 ≤ E < 2.7	4.4	4.7	5.2	5.4	5.6	5.8
2.7 ≤ E < 2.9	4.3	4.7	5.1	5.3	5.5	5.7
2.9 ≤ E < 3.1	4.3	4.6	5.0	5.2	5.4	5.6
3.1 ≤ E < 3.3	4.2	4.5	4.9	5.1	5.3	5.6
3.3 ≤ E < 3.5	4.2	4.5	4.9	5.1	5.3	5.5
3.5 ≤ E < 3.7	4.1	4.5	4.8	5.0	5.2	5.4
3.7 ≤ E < 3.9	4.1	4.4	4.8	4.9	5.1	5.3
3.9 ≤ E < 4.1	4.1	4.4	4.8	4.9	5.1	5.3
4.1 ≤ E < 4.3	4.0	4.4	4.7	4.9	5.0	5.2
4.3 ≤ E < 4.5	4.0	4.3	4.7	4.8	5.0	5.2
4.5 ≤ E < 4.7	4.0	4.3	4.6	4.8	4.9	5.1
4.7 ≤ E < 4.9	4.0	4.3	4.6	4.7	4.9	5.0
E ≥ 4.9	3.9	4.2	4.5	4.7	4.9	5.0

Table 5.9.8-2 Loading Table for PWR Fuel – 513 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	B ≤10	10< B ≤15	15< B ≤20	20< B ≤25	25< B ≤30	30< B ≤32.5
1.3 ≤ E < 1.5	2.9	-	-	-	-	-
1.5 ≤ E < 1.7	2.9	3.8	-	-	-	-
1.7 ≤ E < 1.9	2.9	3.7	4.5	-	-	-
1.9 ≤ E < 2.1	2.9	3.7	4.5	5.7	-	-
2.1 ≤ E < 2.3	2.8	3.7	4.5	5.7	7.5	8.9
2.3 ≤ E < 2.5	2.8	3.6	4.4	5.6	7.4	8.8
2.5 ≤ E < 2.7	2.8	3.6	4.4	5.6	7.3	8.6
2.7 ≤ E < 2.9	2.8	3.6	4.4	5.5	7.2	8.5
2.9 ≤ E < 3.1	2.8	3.5	4.4	5.5	7.1	8.5
3.1 ≤ E < 3.3	2.8	3.5	4.3	5.5	7.1	8.4
3.3 ≤ E < 3.5	2.8	3.5	4.3	5.4	7.0	8.3
3.5 ≤ E < 3.7	2.7	3.5	4.3	5.4	7.0	8.2
3.7 ≤ E < 3.9	2.7	3.5	4.3	5.4	7.0	8.1
3.9 ≤ E < 4.1	2.7	3.5	4.3	5.3	6.9	8.1
4.1 ≤ E < 4.3	2.7	3.5	4.2	5.3	6.9	8.0
4.3 ≤ E < 4.5	2.7	3.5	4.2	5.3	6.8	8.0
4.5 ≤ E < 4.7	2.7	3.5	4.2	5.2	6.8	7.9
4.7 ≤ E < 4.9	2.7	3.4	4.2	5.2	6.8	7.9
E ≥ 4.9	2.7	3.4	4.2	5.2	6.8	7.9

Table 5.9.8-2 Loading Table for PWR Fuel – 513 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	32.5< B ≤35	35< B ≤37.5	37.5< B ≤40	40< B ≤41	41< B ≤42	42< B ≤43
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	10.9	13.7	-	-	-	-
2.5 ≤ E < 2.7	10.7	13.5	16.9	18.2	19.7	21.2
2.7 ≤ E < 2.9	10.5	13.3	16.5	18.0	19.4	20.8
2.9 ≤ E < 3.1	10.4	13.1	16.3	17.7	19.2	20.6
3.1 ≤ E < 3.3	10.2	12.8	16.0	17.5	18.9	20.4
3.3 ≤ E < 3.5	10.1	12.7	15.9	17.2	18.7	20.1
3.5 ≤ E < 3.7	10.0	12.5	15.6	17.0	18.4	19.9
3.7 ≤ E < 3.9	9.9	12.4	15.5	16.8	18.2	19.6
3.9 ≤ E < 4.1	9.8	12.3	15.3	16.7	18.0	19.5
4.1 ≤ E < 4.3	9.8	12.1	15.2	16.5	17.9	19.3
4.3 ≤ E < 4.5	9.7	12.0	15.1	16.3	17.7	19.2
4.5 ≤ E < 4.7	9.7	11.9	15.0	16.2	17.6	19.0
4.7 ≤ E < 4.9	9.6	11.9	14.9	16.1	17.5	18.8
E ≥ 4.9	9.5	11.8	14.8	16.0	17.3	18.7

Table 5.9.8-2 Loading Table for PWR Fuel – 513 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU	
	43< B ≤44	44< B ≤45
1.3 ≤ E < 1.5	-	-
1.5 ≤ E < 1.7	-	-
1.7 ≤ E < 1.9	-	-
1.9 ≤ E < 2.1	-	-
2.1 ≤ E < 2.3	-	-
2.3 ≤ E < 2.5	-	-
2.5 ≤ E < 2.7	22.7	-
2.7 ≤ E < 2.9	22.3	23.8
2.9 ≤ E < 3.1	22.1	23.5
3.1 ≤ E < 3.3	21.8	23.2
3.3 ≤ E < 3.5	21.6	22.9
3.5 ≤ E < 3.7	21.3	22.7
3.7 ≤ E < 3.9	21.1	22.5
3.9 ≤ E < 4.1	20.9	22.3
4.1 ≤ E < 4.3	20.8	22.1
4.3 ≤ E < 4.5	20.6	21.9
4.5 ≤ E < 4.7	20.4	21.8
4.7 ≤ E < 4.9	20.3	21.6
E ≥ 4.9	20.1	21.5

Table 5.9.8-3 Loading Table for PWR Fuel – 1,300 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	B ≤10	10< B ≤15	15< B ≤20	20< B ≤25	25< B ≤30	30< B ≤32.5
1.3 ≤ E < 1.5	2.5	-	-	-	-	-
1.5 ≤ E < 1.7	2.5	2.5	-	-	-	-
1.7 ≤ E < 1.9	2.5	2.5	2.5	-	-	-
1.9 ≤ E < 2.1	2.5	2.5	2.5	2.7	-	-
2.1 ≤ E < 2.3	2.5	2.5	2.5	2.6	3.0	3.2
2.3 ≤ E < 2.5	2.5	2.5	2.5	2.6	3.0	3.2
2.5 ≤ E < 2.7	2.5	2.5	2.5	2.6	3.0	3.1
2.7 ≤ E < 2.9	2.5	2.5	2.5	2.6	2.9	3.1
2.9 ≤ E < 3.1	2.5	2.5	2.5	2.5	2.9	3.0
3.1 ≤ E < 3.3	2.5	2.5	2.5	2.5	2.9	3.0
3.3 ≤ E < 3.5	2.5	2.5	2.5	2.5	2.9	3.0
3.5 ≤ E < 3.7	2.5	2.5	2.5	2.5	2.8	3.0
3.7 ≤ E < 3.9	2.5	2.5	2.5	2.5	2.8	3.0
3.9 ≤ E < 4.1	2.5	2.5	2.5	2.5	2.8	2.9
4.1 ≤ E < 4.3	2.5	2.5	2.5	2.5	2.8	2.9
4.3 ≤ E < 4.5	2.5	2.5	2.5	2.5	2.8	2.9
4.5 ≤ E < 4.7	2.5	2.5	2.5	2.5	2.7	2.9
4.7 ≤ E < 4.9	2.5	2.5	2.5	2.5	2.7	2.9
E ≥ 4.9	2.5	2.5	2.5	2.5	2.7	2.8

Table 5.9.8-3 Loading Table for PWR Fuel – 1,300 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	32.5< B ≤35	35< B ≤37.5	37.5< B ≤40	40< B ≤41	41< B ≤42	42< B ≤43
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	3.4	3.6	-	-	-	-
2.5 ≤ E < 2.7	3.3	3.6	3.8	3.9	4.0	4.1
2.7 ≤ E < 2.9	3.3	3.5	3.8	3.9	4.0	4.1
2.9 ≤ E < 3.1	3.3	3.5	3.7	3.8	3.9	4.0
3.1 ≤ E < 3.3	3.2	3.4	3.7	3.8	3.9	4.0
3.3 ≤ E < 3.5	3.2	3.4	3.6	3.7	3.8	3.9
3.5 ≤ E < 3.7	3.2	3.4	3.6	3.7	3.8	3.9
3.7 ≤ E < 3.9	3.1	3.4	3.6	3.6	3.8	3.9
3.9 ≤ E < 4.1	3.1	3.3	3.5	3.6	3.7	3.8
4.1 ≤ E < 4.3	3.1	3.3	3.5	3.6	3.7	3.8
4.3 ≤ E < 4.5	3.0	3.3	3.5	3.6	3.6	3.8
4.5 ≤ E < 4.7	3.0	3.2	3.4	3.5	3.6	3.7
4.7 ≤ E < 4.9	3.0	3.2	3.4	3.5	3.6	3.7
E ≥ 4.9	3.0	3.2	3.4	3.5	3.5	3.7

Table 5.9.8-3 Loading Table for PWR Fuel – 1,300 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU	
	43< B ≤44	44< B ≤45
1.3 ≤ E < 1.5	-	-
1.5 ≤ E < 1.7	-	-
1.7 ≤ E < 1.9	-	-
1.9 ≤ E < 2.1	-	-
2.1 ≤ E < 2.3	-	-
2.3 ≤ E < 2.5	-	-
2.5 ≤ E < 2.7	4.3	-
2.7 ≤ E < 2.9	4.2	4.3
2.9 ≤ E < 3.1	4.2	4.3
3.1 ≤ E < 3.3	4.1	4.2
3.3 ≤ E < 3.5	4.0	4.2
3.5 ≤ E < 3.7	4.0	4.1
3.7 ≤ E < 3.9	4.0	4.0
3.9 ≤ E < 4.1	3.9	4.0
4.1 ≤ E < 4.3	3.9	4.0
4.3 ≤ E < 4.5	3.8	3.9
4.5 ≤ E < 4.7	3.9	3.9
4.7 ≤ E < 4.9	3.8	3.9
E ≥ 4.9	3.8	3.8

Table 5.9.8-4 Loading Table for PWR Fuel – 1,800 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	B ≤10	10< B ≤15	15< B ≤20	20< B ≤25	25< B ≤30	30< B ≤32.5
1.3 ≤ E < 1.5	2.5	-	-	-	-	-
1.5 ≤ E < 1.7	2.5	2.5	-	-	-	-
1.7 ≤ E < 1.9	2.5	2.5	2.5	-	-	-
1.9 ≤ E < 2.1	2.5	2.5	2.5	2.5	-	-
2.1 ≤ E < 2.3	2.5	2.5	2.5	2.5	2.5	2.5
2.3 ≤ E < 2.5	2.5	2.5	2.5	2.5	2.5	2.5
2.5 ≤ E < 2.7	2.5	2.5	2.5	2.5	2.5	2.5
2.7 ≤ E < 2.9	2.5	2.5	2.5	2.5	2.5	2.5
2.9 ≤ E < 3.1	2.5	2.5	2.5	2.5	2.5	2.5
3.1 ≤ E < 3.3	2.5	2.5	2.5	2.5	2.5	2.5
3.3 ≤ E < 3.5	2.5	2.5	2.5	2.5	2.5	2.5
3.5 ≤ E < 3.7	2.5	2.5	2.5	2.5	2.5	2.5
3.7 ≤ E < 3.9	2.5	2.5	2.5	2.5	2.5	2.5
3.9 ≤ E < 4.1	2.5	2.5	2.5	2.5	2.5	2.5
4.1 ≤ E < 4.3	2.5	2.5	2.5	2.5	2.5	2.5
4.3 ≤ E < 4.5	2.5	2.5	2.5	2.5	2.5	2.5
4.5 ≤ E < 4.7	2.5	2.5	2.5	2.5	2.5	2.5
4.7 ≤ E < 4.9	2.5	2.5	2.5	2.5	2.5	2.5
E ≥ 4.9	2.5	2.5	2.5	2.5	2.5	2.5

Table 5.9.8-4 Loading Table for PWR Fuel – 1,800 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	32.5< B ≤35	35< B ≤37.5	37.5< B ≤40	40< B ≤41	41< B ≤42	42< B ≤43
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	2.6	2.7	-	-	-	-
2.5 ≤ E < 2.7	2.5	2.7	2.9	2.9	3.0	3.1
2.7 ≤ E < 2.9	2.5	2.7	2.8	2.9	3.0	3.0
2.9 ≤ E < 3.1	2.5	2.6	2.8	2.9	2.9	3.0
3.1 ≤ E < 3.3	2.5	2.6	2.8	2.8	2.9	3.0
3.3 ≤ E < 3.5	2.5	2.6	2.7	2.8	2.9	2.9
3.5 ≤ E < 3.7	2.5	2.5	2.7	2.8	2.8	2.9
3.7 ≤ E < 3.9	2.5	2.5	2.7	2.7	2.8	2.9
3.9 ≤ E < 4.1	2.5	2.5	2.6	2.7	2.8	2.8
4.1 ≤ E < 4.3	2.5	2.5	2.6	2.7	2.8	2.8
4.3 ≤ E < 4.5	2.5	2.5	2.6	2.7	2.7	2.8
4.5 ≤ E < 4.7	2.5	2.5	2.6	2.6	2.7	2.8
4.7 ≤ E < 4.9	2.5	2.5	2.5	2.6	2.7	2.7
E ≥ 4.9	2.5	2.5	2.5	2.6	2.6	2.7

Table 5.9.8-4 Loading Table for PWR Fuel – 1,800 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU	
	43< B ≤44	44< B ≤45
1.3 ≤ E < 1.5	-	-
1.5 ≤ E < 1.7	-	-
1.7 ≤ E < 1.9	-	-
1.9 ≤ E < 2.1	-	-
2.1 ≤ E < 2.3	-	-
2.3 ≤ E < 2.5	-	-
2.5 ≤ E < 2.7	3.1	-
2.7 ≤ E < 2.9	3.1	3.2
2.9 ≤ E < 3.1	3.1	3.1
3.1 ≤ E < 3.3	3.0	3.1
3.3 ≤ E < 3.5	3.0	3.1
3.5 ≤ E < 3.7	3.0	3.0
3.7 ≤ E < 3.9	2.9	3.0
3.9 ≤ E < 4.1	2.9	3.0
4.1 ≤ E < 4.3	2.9	2.9
4.3 ≤ E < 4.5	2.8	2.9
4.5 ≤ E < 4.7	2.9	2.9
4.7 ≤ E < 4.9	2.8	2.9
E ≥ 4.9	2.8	2.8

Table 5.9.8-5 Loading Table for PWR Fuel – 830 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	B ≤10	10< B ≤15	15< B ≤20	20< B ≤25	25< B ≤30	30< B ≤32.5
1.3 ≤ E < 1.5	2.5	-	-	-	-	-
1.5 ≤ E < 1.7	2.5	2.7	-	-	-	-
1.7 ≤ E < 1.9	2.5	2.7	3.2	-	-	-
1.9 ≤ E < 2.1	2.5	2.7	3.2	3.8	-	-
2.1 ≤ E < 2.3	2.5	2.6	3.1	3.7	4.4	4.7
2.3 ≤ E < 2.5	2.5	2.6	3.1	3.7	4.3	4.6
2.5 ≤ E < 2.7	2.5	2.6	3.1	3.6	4.3	4.6
2.7 ≤ E < 2.9	2.5	2.6	3.0	3.6	4.2	4.5
2.9 ≤ E < 3.1	2.5	2.5	3.0	3.6	4.2	4.5
3.1 ≤ E < 3.3	2.5	2.5	3.0	3.5	4.2	4.5
3.3 ≤ E < 3.5	2.5	2.5	3.0	3.5	4.1	4.4
3.5 ≤ E < 3.7	2.5	2.5	3.0	3.5	4.1	4.4
3.7 ≤ E < 3.9	2.5	2.5	3.0	3.5	4.0	4.4
3.9 ≤ E < 4.1	2.5	2.5	2.9	3.5	4.0	4.3
4.1 ≤ E < 4.3	2.5	2.5	2.9	3.4	4.0	4.3
4.3 ≤ E < 4.5	2.5	2.5	2.9	3.4	4.0	4.3
4.5 ≤ E < 4.7	2.5	2.5	2.9	3.4	4.0	4.2
4.7 ≤ E < 4.9	2.5	2.5	2.9	3.4	3.9	4.2
E ≥ 4.9	2.5	2.5	2.9	3.4	3.9	4.2

Table 5.9.8-5 Loading Table for PWR Fuel – 830 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	32.5< B ≤35	35< B ≤37.5	37.5< B ≤40	40< B ≤41	41< B ≤42	42< B ≤43
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	5.1	5.6	-	-	-	-
2.5 ≤ E < 2.7	5.0	5.6	6.1	6.4	6.8	7.1
2.7 ≤ E < 2.9	5.0	5.5	6.0	6.3	6.6	6.9
2.9 ≤ E < 3.1	4.9	5.4	6.0	6.2	6.5	6.8
3.1 ≤ E < 3.3	4.9	5.4	5.9	6.1	6.4	6.7
3.3 ≤ E < 3.5	4.8	5.3	5.8	6.0	6.3	6.6
3.5 ≤ E < 3.7	4.8	5.2	5.8	6.0	6.3	6.6
3.7 ≤ E < 3.9	4.7	5.2	5.7	5.9	6.2	6.5
3.9 ≤ E < 4.1	4.7	5.1	5.7	5.9	6.1	6.4
4.1 ≤ E < 4.3	4.6	5.1	5.6	5.8	6.0	6.3
4.3 ≤ E < 4.5	4.6	5.0	5.6	5.8	6.0	6.2
4.5 ≤ E < 4.7	4.6	5.0	5.5	5.7	5.9	6.2
4.7 ≤ E < 4.9	4.5	5.0	5.5	5.7	5.9	6.1
E ≥ 4.9	4.5	4.9	5.4	5.6	5.9	6.0

Table 5.9.8-5 Loading Table for PWR Fuel – 830 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU	
	43< B ≤44	44< B ≤45
1.3 ≤ E < 1.5	-	-
1.5 ≤ E < 1.7	-	-
1.7 ≤ E < 1.9	-	-
1.9 ≤ E < 2.1	-	-
2.1 ≤ E < 2.3	-	-
2.3 ≤ E < 2.5	-	-
2.5 ≤ E < 2.7	7.5	-
2.7 ≤ E < 2.9	7.3	7.7
2.9 ≤ E < 3.1	7.2	7.6
3.1 ≤ E < 3.3	7.0	7.5
3.3 ≤ E < 3.5	6.9	7.3
3.5 ≤ E < 3.7	6.8	7.2
3.7 ≤ E < 3.9	6.8	7.1
3.9 ≤ E < 4.1	6.7	7.0
4.1 ≤ E < 4.3	6.6	6.9
4.3 ≤ E < 4.5	6.6	6.8
4.5 ≤ E < 4.7	6.5	6.8
4.7 ≤ E < 4.9	6.4	6.7
E ≥ 4.9	6.4	6.7

Table 5.9.8-6 Loading Table for PWR Fuel – 487 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	45< B ≤46	46< B ≤47	47< B ≤48	48< B ≤49	49< B ≤50	50< B ≤51
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	27.9	29.3	30.7	32.0	-	-
2.9 ≤ E < 3.1	27.6	29.0	30.4	31.8	32.7	33.9
3.1 ≤ E < 3.3	27.4	28.8	30.2	31.6	32.4	33.7
3.3 ≤ E < 3.5	27.1	28.5	30.0	31.4	32.2	33.6
3.5 ≤ E < 3.7	26.9	28.3	29.7	31.1	32.0	33.3
3.7 ≤ E < 3.9	26.7	28.1	29.5	30.9	31.8	33.1
3.9 ≤ E < 4.1	26.6	27.9	29.4	30.8	31.6	32.9
4.1 ≤ E < 4.3	26.3	27.8	29.2	30.6	31.4	33.5
4.3 ≤ E < 4.5	26.1	27.5	29.0	30.3	31.2	32.6
4.5 ≤ E < 4.7	26.0	27.4	28.8	30.2	31.1	32.4
4.7 ≤ E < 4.9	25.9	27.3	28.6	30.1	30.9	32.3
E ≥ 4.9	25.8	27.1	28.5	30.0	30.8	32.1

Table 5.9.8-6 Loading Table for PWR Fuel – 487 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	51< B ≤52	52< B ≤53	53< B ≤54	54< B ≤55	55< B ≤56	56< B ≤57
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-
2.9 ≤ E < 3.1	35.2	36.4	37.7	-	-	-
3.1 ≤ E < 3.3	35.0	36.2	37.4	38.8	39.8	41.0
3.3 ≤ E < 3.5	34.8	36.0	37.2	38.5	39.6	40.9
3.5 ≤ E < 3.7	34.5	35.9	37.1	38.4	39.5	40.7
3.7 ≤ E < 3.9	34.3	35.6	36.9	38.2	39.4	40.5
3.9 ≤ E < 4.1	34.2	35.4	36.7	38.1	39.2	40.4
4.1 ≤ E < 4.3	34.1	35.2	36.6	37.9	39.2	40.2
4.3 ≤ E < 4.5	33.9	35.2	36.4	37.7	39.0	40.2
4.5 ≤ E < 4.7	33.7	35.0	36.3	37.6	38.8	40.0
4.7 ≤ E < 4.9	33.5	34.8	36.1	37.4	38.7	39.8
E ≥ 4.9	33.4	34.7	35.9	37.3	38.6	39.7

Table 5.9.8-6 Loading Table for PWR Fuel – 487 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU		
	57< B ≤58	58< B ≤59	59< B ≤60
1.3 ≤ E < 1.5	-	-	-
1.5 ≤ E < 1.7	-	-	-
1.7 ≤ E < 1.9	-	-	-
1.9 ≤ E < 2.1	-	-	-
2.1 ≤ E < 2.3	-	-	-
2.3 ≤ E < 2.5	-	-	-
2.5 ≤ E < 2.7	-	-	-
2.7 ≤ E < 2.9	-	-	-
2.9 ≤ E < 3.1	-	-	-
3.1 ≤ E < 3.3	42.1	43.3	-
3.3 ≤ E < 3.5	42.0	43.1	44.1
3.5 ≤ E < 3.7	41.9	43.0	44.1
3.7 ≤ E < 3.9	41.7	42.9	43.9
3.9 ≤ E < 4.1	41.6	42.7	43.8
4.1 ≤ E < 4.3	41.5	42.6	43.7
4.3 ≤ E < 4.5	41.3	42.5	43.6
4.5 ≤ E < 4.7	41.2	42.4	43.5
4.7 ≤ E < 4.9	41.0	42.3	43.4
E ≥ 4.9	40.9	42.1	43.3

Table 5.9.8-7 Loading Table for PWR Fuel – 1235 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	45< B ≤46	46< B ≤47	47< B ≤48	48< B ≤49	49< B ≤50	50< B ≤51
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	4.7	4.9	5.0	5.2	-	-
2.9 ≤ E < 3.1	4.6	4.8	4.9	5.1	5.2	5.4
3.1 ≤ E < 3.3	4.6	4.7	4.9	5.0	5.1	5.3
3.3 ≤ E < 3.5	4.5	4.6	4.8	4.9	5.0	5.2
3.5 ≤ E < 3.7	4.5	4.6	4.7	4.9	5.0	5.2
3.7 ≤ E < 3.9	4.4	4.5	4.7	4.8	4.9	5.1
3.9 ≤ E < 4.1	4.4	4.5	4.6	4.8	4.9	5.0
4.1 ≤ E < 4.3	4.3	4.4	4.5	4.7	4.8	4.9
4.3 ≤ E < 4.5	4.3	4.4	4.5	4.6	4.8	4.9
4.5 ≤ E < 4.7	4.2	4.3	4.5	4.6	4.7	4.8
4.7 ≤ E < 4.9	4.2	4.3	4.4	4.6	4.7	4.8
E ≥ 4.9	4.1	4.3	4.4	4.5	4.6	4.7

Table 5.9.8-7 Loading Table for PWR Fuel – 1235 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	51< B ≤52	52< B ≤53	53< B ≤54	54< B ≤55	55< B ≤56	56< B ≤57
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-
2.9 ≤ E < 3.1	5.6	5.8	6.0	-	-	-
3.1 ≤ E < 3.3	5.5	5.7	5.9	6.1	6.4	6.7
3.3 ≤ E < 3.5	5.4	5.6	5.8	6.0	6.3	6.5
3.5 ≤ E < 3.7	5.4	5.5	5.7	5.9	6.1	6.4
3.7 ≤ E < 3.9	5.3	5.5	5.6	5.8	6.0	6.3
3.9 ≤ E < 4.1	5.2	5.4	5.6	5.8	5.9	6.1
4.1 ≤ E < 4.3	5.1	5.3	5.5	5.7	5.9	6.0
4.3 ≤ E < 4.5	5.0	5.2	5.4	5.6	5.8	6.0
4.5 ≤ E < 4.7	5.0	5.1	5.3	5.5	5.7	5.9
4.7 ≤ E < 4.9	4.9	5.1	5.3	5.5	5.6	5.8
E ≥ 4.9	4.9	5.0	5.3	5.4	5.6	5.7

Table 5.9.8-7 Loading Table for PWR Fuel – 1235 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU		
	57< B ≤58	58< B ≤59	59< B ≤60
1.3 ≤ E < 1.5	-	-	-
1.5 ≤ E < 1.7	-	-	-
1.7 ≤ E < 1.9	-	-	-
1.9 ≤ E < 2.1	-	-	-
2.1 ≤ E < 2.3	-	-	-
2.3 ≤ E < 2.5	-	-	-
2.5 ≤ E < 2.7	-	-	-
2.7 ≤ E < 2.9	-	-	-
2.9 ≤ E < 3.1	-	-	-
3.1 ≤ E < 3.3	6.9	7.2	-
3.3 ≤ E < 3.5	6.8	7.0	7.4
3.5 ≤ E < 3.7	6.7	6.9	7.2
3.7 ≤ E < 3.9	6.5	6.8	7.0
3.9 ≤ E < 4.1	6.4	6.7	6.9
4.1 ≤ E < 4.3	6.3	6.5	6.8
4.3 ≤ E < 4.5	6.2	6.4	6.7
4.5 ≤ E < 4.7	6.1	6.3	6.6
4.7 ≤ E < 4.9	6.0	6.2	6.5
E ≥ 4.9	5.9	6.1	6.4

Table 5.9.8-8 Loading Table for PWR Fuel – 1710 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	45< B ≤46	46< B ≤47	47< B ≤48	48< B ≤49	49< B ≤50	50< B ≤51
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	3.4	3.5	3.6	3.7	-	-
2.9 ≤ E < 3.1	3.4	3.5	3.5	3.6	3.7	3.8
3.1 ≤ E < 3.3	3.3	3.4	3.5	3.6	3.6	3.7
3.3 ≤ E < 3.5	3.3	3.4	3.4	3.5	3.6	3.7
3.5 ≤ E < 3.7	3.3	3.3	3.4	3.5	3.5	3.6
3.7 ≤ E < 3.9	3.2	3.3	3.4	3.4	3.5	3.6
3.9 ≤ E < 4.1	3.2	3.3	3.3	3.4	3.5	3.5
4.1 ≤ E < 4.3	3.1	3.2	3.3	3.4	3.4	3.5
4.3 ≤ E < 4.5	3.1	3.2	3.3	3.3	3.4	3.5
4.5 ≤ E < 4.7	3.1	3.2	3.2	3.3	3.4	3.4
4.7 ≤ E < 4.9	3.0	3.1	3.2	3.3	3.4	3.4
E ≥ 4.9	3.0	3.1	3.2	3.2	3.3	3.4

Table 5.9.8-8 Loading Table for PWR Fuel – 1710 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	51< B ≤52	52< B ≤53	53< B ≤54	54< B ≤55	55< B ≤56	56< B ≤57
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-
2.9 ≤ E < 3.1	3.9	4.0	4.0	-	-	-
3.1 ≤ E < 3.3	3.8	3.9	4.0	4.1	4.2	4.3
3.3 ≤ E < 3.5	3.8	3.9	4.0	4.0	4.2	4.3
3.5 ≤ E < 3.7	3.7	3.8	3.9	4.0	4.1	4.2
3.7 ≤ E < 3.9	3.7	3.8	3.8	3.9	4.0	4.2
3.9 ≤ E < 4.1	3.6	3.7	3.8	3.9	4.0	4.1
4.1 ≤ E < 4.3	3.6	3.7	3.8	3.8	3.9	4.0
4.3 ≤ E < 4.5	3.5	3.6	3.7	3.8	3.9	4.0
4.5 ≤ E < 4.7	3.5	3.6	3.7	3.8	3.9	3.9
4.7 ≤ E < 4.9	3.5	3.5	3.6	3.7	3.8	3.9
E ≥ 4.9	3.4	3.5	3.6	3.7	3.8	3.9

Table 5.9.8-8 Loading Table for PWR Fuel – 1710 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU		
	57< B ≤58	58< B ≤59	59< B ≤60
1.3 ≤ E < 1.5	-	-	-
1.5 ≤ E < 1.7	-	-	-
1.7 ≤ E < 1.9	-	-	-
1.9 ≤ E < 2.1	-	-	-
2.1 ≤ E < 2.3	-	-	-
2.3 ≤ E < 2.5	-	-	-
2.5 ≤ E < 2.7	-	-	-
2.7 ≤ E < 2.9	-	-	-
2.9 ≤ E < 3.1	-	-	-
3.1 ≤ E < 3.3	4.4	4.6	-
3.3 ≤ E < 3.5	4.4	4.5	4.6
3.5 ≤ E < 3.7	4.3	4.4	4.5
3.7 ≤ E < 3.9	4.3	4.4	4.5
3.9 ≤ E < 4.1	4.2	4.3	4.4
4.1 ≤ E < 4.3	4.1	4.2	4.3
4.3 ≤ E < 4.5	4.1	4.2	4.3
4.5 ≤ E < 4.7	4.0	4.1	4.2
4.7 ≤ E < 4.9	4.0	4.1	4.2
E ≥ 4.9	3.9	4.0	4.1

Table 5.9.8-9 Loading Table for PWR Fuel – 788 W/Assembly

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	45< B ≤46	46< B ≤47	47< B ≤48	48< B ≤49	49< B ≤50	50< B ≤51
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	9.0	9.7	10.4	11.2	-	-
2.9 ≤ E < 3.1	8.9	9.5	10.1	10.9	11.4	12.2
3.1 ≤ E < 3.3	8.7	9.2	9.9	10.6	11.1	11.9
3.3 ≤ E < 3.5	8.5	9.0	9.7	10.3	10.9	11.6
3.5 ≤ E < 3.7	8.4	8.9	9.5	10.1	10.6	11.4
3.7 ≤ E < 3.9	8.2	8.7	9.3	9.9	10.4	11.1
3.9 ≤ E < 4.1	8.1	8.6	9.1	9.7	10.2	10.9
4.1 ≤ E < 4.3	8.0	8.5	9.0	9.5	10.0	10.7
4.3 ≤ E < 4.5	7.9	8.4	8.8	9.4	9.8	10.5
4.5 ≤ E < 4.7	7.8	8.2	8.7	9.3	9.7	10.3
4.7 ≤ E < 4.9	7.7	8.1	8.6	9.1	9.5	10.2
E ≥ 4.9	7.6	8.0	8.5	9.0	9.4	10.0

Table 5.9.8-9 Loading Table for PWR Fuel – 788 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU					
	51< B ≤52	52< B ≤53	53< B ≤54	54< B ≤55	55< B ≤56	56< B ≤57
1.3 ≤ E < 1.5	-	-	-	-	-	-
1.5 ≤ E < 1.7	-	-	-	-	-	-
1.7 ≤ E < 1.9	-	-	-	-	-	-
1.9 ≤ E < 2.1	-	-	-	-	-	-
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	-	-	-	-
2.9 ≤ E < 3.1	13.1	14.0	15.0	-	-	-
3.1 ≤ E < 3.3	12.8	13.6	14.6	15.6	16.6	17.7
3.3 ≤ E < 3.5	12.4	13.3	14.2	15.3	16.2	17.3
3.5 ≤ E < 3.7	12.1	13.0	13.9	14.9	15.9	16.9
3.7 ≤ E < 3.9	11.9	13.0	13.6	14.6	15.5	16.5
3.9 ≤ E < 4.1	11.6	12.5	13.3	14.2	15.2	16.2
4.1 ≤ E < 4.3	11.4	12.2	13.1	13.9	14.9	15.9
4.3 ≤ E < 4.5	11.3	11.9	12.8	13.7	14.7	15.6
4.5 ≤ E < 4.7	11.1	11.8	12.6	13.5	14.4	15.3
4.7 ≤ E < 4.9	10.9	11.6	12.4	13.3	14.1	15.1
E ≥ 4.9	10.7	11.5	12.6	13.1	13.9	14.8

Table 5.9.8-9 Loading Table for PWR Fuel – 788 W/Assembly (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup (B) GWd/MTU		
	57< B ≤58	58< B ≤59	59< B ≤60
1.3 ≤ E < 1.5	-	-	-
1.5 ≤ E < 1.7	-	-	-
1.7 ≤ E < 1.9	-	-	-
1.9 ≤ E < 2.1	-	-	-
2.1 ≤ E < 2.3	-	-	-
2.3 ≤ E < 2.5	-	-	-
2.5 ≤ E < 2.7	-	-	-
2.7 ≤ E < 2.9	-	-	-
2.9 ≤ E < 3.1	-	-	-
3.1 ≤ E < 3.3	18.7	19.7	-
3.3 ≤ E < 3.5	18.2	19.3	20.4
3.5 ≤ E < 3.7	17.9	18.9	19.9
3.7 ≤ E < 3.9	17.5	18.6	19.6
3.9 ≤ E < 4.1	17.2	18.2	19.2
4.1 ≤ E < 4.3	16.9	17.9	18.9
4.3 ≤ E < 4.5	16.6	17.6	18.6
4.5 ≤ E < 4.7	16.3	17.3	18.3
4.7 ≤ E < 4.9	16.0	17.0	18.0
E ≥ 4.9	15.8	16.8	17.8

5.9.9 Damaged Fuel

Damaged PWR fuel assemblies may be loaded in damaged fuel cans in the four corner assembly locations of the PWR damaged fuel basket. DFC slots are locations 4, 8, 30 and 34 in Figure 5.9.9-1. To ensure that the worst case configuration is considered, two damaged fuel scenarios are evaluated. Damaged fuel includes fuel debris.

The first scenario assumes the damaged fuel collects over the active fuel length of the fuel assembly. This scenario is modeled by filling the fuel assembly interstitial volume with UO_2 and increasing the fuel neutron, gamma and n-gamma source consistent with this increase in mass.

In the second scenario, damaged fuel is assumed to migrate from the active fuel into the lower end fitting region of the fuel assembly, filling all the modeled void space. However, no credit is taken for the reduction in lower end fitting hardware dose rate due to the added UO_2 mass and self-shielding nor for the reduction in fuel mass migrated from the active fuel region.

The resulting material compositions are shown in Table 5.9.9-1 for WE 14×14 (14b) PWR fuel.

In the model, no credit is taken for the thicker plates in the corner locations of the damaged fuel basket or the thickness of the damaged fuel cans themselves.

The 1.8 kW preferential loading is also evaluated under both damaged fuel scenarios. Only zone C, where the damaged fuel is located, needs to be evaluated under the damaged fuel scenarios.

The four-zone preferential loading damaged fuel dose rates are statistically unchanged or less than the uniform loading damaged fuel dose rates.

5.9.9.1 Transfer Cask Dose Rates

As the reduction in minimum cool time has no impact on the bounding source terms of the stainless steel MTC, no additional uniform loading damaged fuel evaluations are run for the MTC. See section 5.8.12 for uniformly loaded MTC damaged fuel evaluation.

5.9.9.1.1 Preferential Loading Active Fuel Scenario - MTC

Transfer cask dose rates are computed using the bounding fuel assembly source terms from Section 5.9.6 for the first scenario (fuel material filling void space at the active fuel region elevation).

On the radial and bottom surfaces of the cask, the damaged PWR fuel results are greater than those in section 5.9.6. In order to compare the radial and bottom results to the lower nozzle scenario, the remaining source regions and BPRA results are added to the surface dose rates resulting in maximum dose rates of 1,029 mrem/hr and 5,740 mrem/hr, respectively. The radial

surface dose rate is greater than the lower nozzle scenario maximum dose rate of 952 mrem/hr. The bottom surface dose rate is less than the lower nozzle scenario maximum dose rate of 5,969 mrem/hr.

5.9.9.1.2 Preferential Loading Lower End Fitting Scenario - MTC

Transfer cask dose rates are computed using the bounding fuel assemblies from Section 5.9.6 for the second scenario.

Damaged fuel maximum dose rates are greater than those in Section 5.9.6. Dose rates are summarized in Table 5.9.9-2.

5.9.9.2 CC4 Dose Rates

As only the CC4 radial bounding source term was affected by the decrease in minimum cool time, only the uniformly loaded CC4 radial detector is evaluated with damaged fuel in this section. Section 5.8.12 contains the damaged fuel results for the remaining detectors. The 1.8 kW four zone preferential pattern is evaluated under both damaged fuel scenarios.

5.9.9.2.1 Uniform Loading Active Fuel Scenario – CC4

Uniformly loaded CC4 dose rates are computed using the bounding fuel assembly source terms from Section 5.9.3 for the first scenario. At the radial surface of the cask, maximum and average dose rates for the damaged PWR fuel model are statistically equivalent to those of the undamaged fuel model.

5.9.9.2.2 Uniform Loading Lower End Fitting Scenario – CC4

Uniformly loaded CC4 dose rates are computed using the bounding fuel assemblies from Section 5.9.3 for the second scenario. Damaged fuel maximum radial dose rates are statistically unchanged from those in Section 5.9.4.1. Dose rates are summarized in Table 5.9.9-3.

5.9.9.2.3 Preferential Loading Active Fuel Scenario – CC4

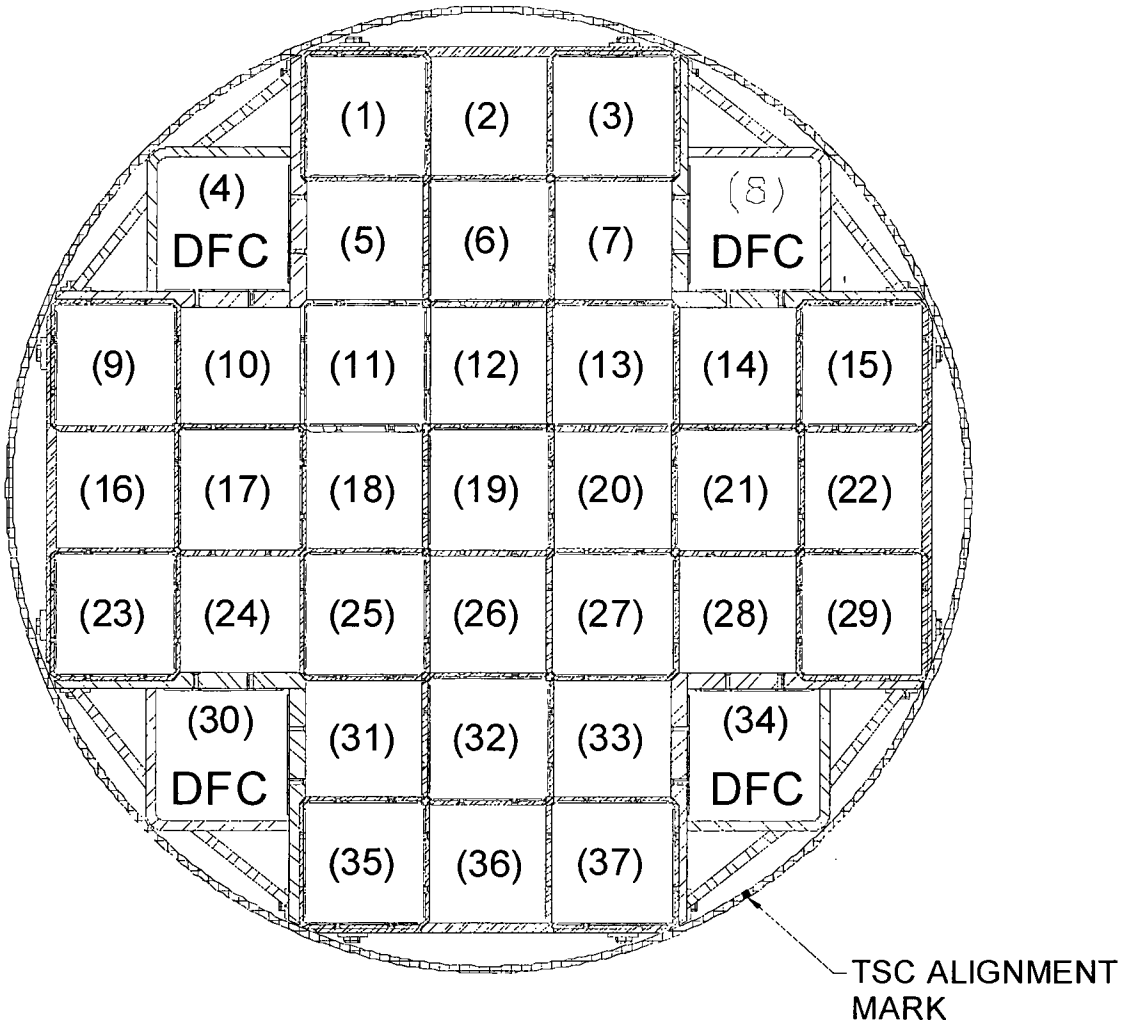
Preferentially loaded CC4 dose rates are computed using the bounding fuel assembly source terms from Section 5.9.6 for the first scenario. At the radial and inlet surfaces of the cask, maximum and average dose rates for the damaged PWR fuel model are slightly higher than those of the undamaged fuel model. All preferentially loaded CC4 damaged fuel dose rates remain below the dose rates of the uniformly loaded CC4 damaged fuel dose rates.

5.9.9.2.4 Preferential Loading Lower End Fitting Scenario – CC4

CC4 dose rates are computed using the bounding fuel assemblies from Section 5.9.6 for the second scenario. There is no change in radial dose rates from the damaged fuel in the lower end fitting region. There is an 8.7 mrem/hr increase in inlet dose rate from damaged fuel in the lower end fitting region of the four damaged fuel can basket. Inlet dose rates are increased for the

preferentially loaded CC4 damaged fuel but are bounded by the uniformly loaded CC4 damaged fuel dose rates. Dose rates are summarized in Table 5.9.9-4.

Figure 5.9.9-1 Schematic of DF Basket Assembly Configuration for PWR SNF with DFCs



DFC designated locations may contain a loaded DFC or a PWR UNDAMAGED SNF ASSEMBLY.

Table 5.9.9-1 Damaged Fuel Material Summary – 14b PWR Fuel

Material	Element/ Isotope	Density [atom/-b-cm]	Density [g/cm³]
Damaged Fuel (Lower Nozzle)	Chromium	5.5169E-03	9.6315
	Manganese	5.4963E-04	
	Iron	1.8789E-02	
	Nickel	2.4436E-03	
	Uranium 235	8.0452E-04	
	Uranium 238	1.5093E-02	
	Oxygen	3.1786E-02	
Damaged Fuel (Active Fuel)	Zirconium	3.6954E-03	9.8635
	Chromium	6.6005E-06	
	Tin	4.3366E-05	
	Nitrogen	1.2255E-05	
	Iron	7.6817E-06	
	Uranium 235	1.0495E-03	
	Uranium 238	1.9688E-02	
	Oxygen	4.1462E-02	

Table 5.9.9-2 Preferentially Loaded Stainless Steel MTC Maximum Damaged Fuel Dose Rates

		Surface		1 meter	
Detector	Source	mrem/hr	FSD[a]	mrem/hr	FSD
Radial	Neutron	231	0.2%	82	0.2%
	Gamma	734	2.2%	318	1.2%
	BPRA	64	2.2%	29	1.2%
	Total	1029	1.6%	429	0.9%
Bottom	Undamaged	5630	0.6%	2402	0.9%
	BPRA	79	1.8%	43	1.9%
	Damaged Neutron	85	0.2%	25	0.3%
	Damaged Gamma	175	9.7%	95	8.3%
	Total	5969	0.6%	2565	0.9%

[a] Fractional standard deviation.

Table 5.9.9-3 Uniformly Loaded CC4 Maximum Damaged PWR Fuel Dose Rates

Detector	Source	Surface		1 meter	
		mrem/hr	FSD	mrem/hr	FSD
Radial	Undamaged	107.2	1.9%	55.2	1.4%
	BPRA	6.6	0.8%	3.30	0.53%
	Damaged Neutron	< 0.1	3.0%	< 0.1	0.9%
	Damaged Gamma	< 0.1	14.8%	0.1	3.9%
	Total	113.9	1.8%	58.6	1.3%

Table 5.9.9-4 Preferentially Loaded CC4 Maximum Damaged PWR Fuel Dose Rates

Detector	Source	Surface		1 meter	
		mrem/hr	FSD	mrem/hr	FSD
Radial	Neutron	0.4	2.0%	0.2	1.3%
	Gamma	105.8	2.2%	55.0	1.5%
	BPRA	6.5	1.1%	3.3	0.7%
	Total	112.7	2.1%	58.5	1.4%
Inlet	Undamaged	103.7	1.0%	14.1	2.1%
	BPRA	8.7	3.5%	1.3	5.7%
	Damaged Neutron	2.5	0.5%	0.3	1.2%
	Damaged Gamma	6.0	5.3%	0.5	12.7%
	Total	120.9	0.9%	16.2	1.9%

6.1 Discussion and Results

6.1.1 MAGNASTOR System Criticality Evaluation

MAGNASTOR consists of a TSC (Transportable Storage Canister), a transfer cask, and a concrete cask. The system is designed to safely store up to 37 undamaged PWR fuel assemblies in the 37 PWR basket assembly or up to 87 undamaged BWR fuel assemblies in the 87 BWR basket assembly. The system is also designed to store up to four damaged fuel cans (DFCs) in the DF Basket Assembly. The DF Basket Assembly has a capacity of up to 37 undamaged PWR fuel assemblies, including 4 DFC locations. DFCs may be placed in up to four of the DFC locations. Each DFC may contain an undamaged PWR fuel assembly, a damaged PWR fuel assembly, or PWR fuel debris equivalent to one PWR fuel assembly. Undamaged PWR fuel assemblies may be placed directly in the DFC locations of a DF Basket Assembly.

The TSC is comprised of a stainless steel canister and a basket within which fuel is loaded. The PWR and BWR system each includes two TSC lengths to store fuel assemblies without the requirement of spacers. Spacers may be employed to simplify loading or unloading operations. The TSC is loaded into the concrete cask for storage. A transfer cask is used for handling the TSC during loading of spent fuel. Fuel is loaded into the TSC contained within the transfer cask underwater in the spent fuel pool. Once loaded with fuel, the TSC closure lid is welded and the TSC is drained, dried and backfilled with helium. The transfer cask is then used to move the TSC into or out of the concrete cask. The transfer cask provides shielding during the TSC loading and transfer operations. Multiple-size concrete and transfer casks accommodate all of the PWR and BWR TSCs.

Under normal conditions, such as loading in a spent fuel pool, moderator (water) is present in the TSC during the initial stages of fuel transfer. During draining and drying operations, moderator with varying density is present. Thus, the criticality evaluation of the transfer cask includes a variation in moderator density and a determination of optimum moderator density. Cask accident conditions are bounded by inclusion in the analysis of the most reactive mechanical basket configuration as well as moderator intrusion into the fuel cladding. The PWR TSC is evaluated at minimum soluble boron levels during flooded conditions.

Structural analyses demonstrate that the TSC confinement boundary remains intact through all storage operating conditions. Therefore, moderator is not present in the TSC while it is in the concrete cask. However, access to the concrete cask interior environment is possible via the air inlets and outlets and the heat transfer annulus between the TSC and the cask steel liner. This access provides paths for moderator intrusion during a flood. Under off-normal and accident conditions, moderator intrusion into the convective heat transfer annulus is evaluated.

PWR system criticality control is achieved through a combination of neutron absorber sheets on the interior faces of the fuel tubes/developed cells and soluble boron. BWR system criticality control relies solely on the absorber sheets. Individual fuel assemblies are held in place by the fuel tubes, by developed cells formed from fuel tubes, or by a combination of fuel tubes and side or corner weldments. The neutron absorber modeled is a borated aluminum sheet. Any material meeting the physical dimension requirements specified on the License Drawings and the effective ^{10}B areal density specified in Table 6.1.1-5 will produce similar reactivity results. A combination of steel cover sheets and weld posts holds the neutron absorber sheets in place. The PWR undamaged fuel basket design includes 21 fuel tubes forming 37 fuel-assembly-sized openings while the PWR damaged fuel basket design includes 17 fuel tubes and four corner weldments forming 37 openings. A sketch of a cross-section of the damaged fuel basket is shown in figure 6.1.1-2. The BWR basket contains 45 fuel tubes forming 89 fuel-assembly-sized openings.

The combination of 45 BWR fuel tubes with four corner and four side weldments form 89 fuel-assembly-sized openings; however, two openings are below the vent and drain ports and are not loaded. For simplicity and cask symmetry, all 89 slots are modeled as filled with fuel.

An optional "86-assembly" configuration of the BWR basket is evaluated where the center basket location is left unoccupied. An optional "82-assembly" configuration of the BWR basket is evaluated, where five center openings in an "X" pattern are left unoccupied (the basket model fills the openings below the port cover and, therefore, contains 84 assemblies). An alternate 82-assembly configuration is also evaluated with the empty basket locations moved further out from the center of the basket. See Figure 6.1.1-1 for the loadable basket locations in the 82-assembly basket configuration.

Initial criticality evaluations rely on neutron absorber sheet effective ^{10}B loadings of 0.036 g/cm^2 and 0.027 g/cm^2 for the PWR and BWR system, respectively. The system is also evaluated for effective ^{10}B loading of 0.030 and 0.027 g/cm^2 for PWR baskets and 0.0225 and 0.020 g/cm^2 for BWR baskets. Depending on the PWR payload, variable soluble boron concentrations in the pool water are necessary to achieve sufficient neutron absorber content in the system. The soluble boron absorbs thermal neutrons inside the assembly, in addition to the neutrons removed by the absorber sheets on the tubes.

The minimum as-manufactured loading of the neutron absorber sheets depends on the effectiveness of the absorber and the minimum effective absorber areal density. Effectiveness of the absorber is influenced by the uniformity and quantity of the ^{10}B nuclide within the absorber base material. Table 6.1.1-5 translates the effective absorber content to absorber materials at 75% and 90% credit.

MCNP, a three-dimensional Monte Carlo code, is used in the system criticality analysis. Evaluations are primarily based on the ENDF/B-VI continuous energy neutron cross-section library [4] available in the MCNP distribution. Nuclides for which no ENDF/B-VI data is available are set to the latest cross-section sets available in the code distribution. The code and cross-section libraries are benchmarked by comparison to a range of critical experiments relevant to light water reactor fuel in storage and transport casks. An upper subcritical limit (USL) for the system is determined based on guidance given in NUREG/CR-6361 [10].

Key assembly physical characteristics, maximum initial enrichment, and soluble boron requirements (PWR only) for each PWR and BWR fuel assembly type are shown in Table 6.1.1-1, Table 6.1.1-2 and Table 6.1.1-6 for the PWR system and Table 6.1.1-3 and Table 6.1.1-4 for the BWR system. PWR results represent the bounding values for fuel assemblies with and without nonfuel inserts in the guide tubes. Maximum enrichment is defined as peak rod enrichment for PWR assemblies and the maximum peak planar-average enrichment for BWR assemblies. The maximum initial peak planar-average enrichment is the maximum planar-average enrichment at any height along the axis of the fuel assembly.

Assemblies are evaluated with a full, nominal set of fuel rods. Fuel rod (lattice) locations may contain filler rods. A filler rod must occupy, at a minimum, a volume equivalent to the fuel rod it displaces. Filler rods may be placed into the lattice after assembly in-core use or be designed to replace fuel rods prior to use, such as integral burnable absorber rods.

The assembly must contain its nominal set of guide and instrument tubes (PWR), and water rods (BWR). Analysis demonstrated that variations in the guide/instrument tube and water rod thickness and diameter have no significant effect on system reactivity.

6.1.1.1 Undamaged Fuel Criticality Results

The maximum multiplication factors (k_{eff} +2σ) are calculated, using conservative assumptions, for the transfer and concrete cask. The USL applied to the analysis results is 0.9376 per Section 6.5.2. The results of the analyses are presented in detail in Sections 6.4.3 and 6.7, and are summarized as follows.

Cask Body	Gap Condition	Operating Condition	Water Density (g/cc) Interior	Water Density (g/cc) Exterior	PWR $k_{eff} + 2\sigma$	BWR $k_{eff} + 2\sigma$
Transfer	Dry	Normal	0.9982	0.0001	0.93183	0.92900
Transfer	Wet	Normal	0.9982	0.0001	0.93712	0.93679
Transfer	Dry	Normal	0.9982	0.9982	0.92975	0.92839
Transfer	Wet	Normal	0.9982	0.9982	0.93615	0.93674
Storage	Dry	Normal	0.0001	0.0001	0.48145	0.43685
Storage	Dry	Accident	0.0001	0.9982	0.47104	0.42991

Analysis of simultaneous moderator density variation inside and outside either the transfer or concrete cask shows a monotonic decrease in reactivity with decreasing moderator density. For the BWR system, there is a statistically significant increase in reactivity when moving from void to full moderator density. In the PWR system, reactivity increases as moderator density rises from void conditions, but there is no significant reactivity difference at water densities above 0.9 g/cm^3. The use of soluble boron in PWR systems, specified in parts per million of moderator, flattens out the reactivity curve by increasing absorber quantity in conjunction with increasing moderator. The full moderator density TSC interior condition bounds any off-normal or accident condition. Analysis of moderator intrusion into the concrete cask heat transfer annulus with the dry TSC shows a slight decrease in reactivity from the completely dry condition.

6.1.1.2 Damaged PWR Fuel Criticality Results

The PWR system is designed to safely store up to 37 PWR fuel assemblies of which up to 4 may be classified as damaged and be placed into damaged fuel cans (DFCs) in the four corner basket locations. The DFC provides a screened container to prevent gross fissile material release into the TSC cavity from failed fuel rod cladding. The results of the analyses are presented in detail in Section 6.7.8 and are summarized as follows. All results are below the USL of 0.9376.

Cask Body	Gap Condition	Operating Condition	Water Density (g/cc) Interior	Water Density (g/cc) Exterior	PWR $k_{eff} + 2\sigma$
Transfer	Wet	Normal	0.9982	N/A[a]	0.93757
Storage	Dry	Normal	0.0001	0.0001	0.49142
Storage	Dry	Accident	0.0001	0.9982	0.48211

[a] Exterior moderator has been demonstrated in Section 6.7.3 to not affect system reactivity for a fully flooded TSC.

Three damaged fuel configurations are evaluated. Damaged fuel includes fuel debris. In the first configuration, undamaged fuel is loaded into a DFC to demonstrate the effect of the additional stainless steel from the DFC and the DFC corner weldments. In the second configuration, damaged fuel is postulated to lose its cladding and the array is modeled at an increased pitch. In the third configuration, mixtures of fuel and water simulate small fuel rubble inside the DFC.

Three moderator configurations are evaluated. Moderator density studies are performed on the preferentially flooded DFC, partially flooded cask, and mixture moderator density. In the preferentially flooded DFC scenario, the DFC is assumed to vary in moderator density with a wet and dry canister. A partial draindown of the TSC to the top of the active fuel is referred to as partial flooding. A study on the mixture moderator density is performed to ensure that the homogenized mixture remains undermoderated.

For each of the fuel types, with and without nonfuel inserts in the active fuel region of the undamaged assemblies, several combinations of minimum soluble boron and maximum initial enrichments are determined. The allowable loadings are documented in Table 6.1.1-6.

Figure 6.1.1-1 82-Assembly BWR Basket Configuration

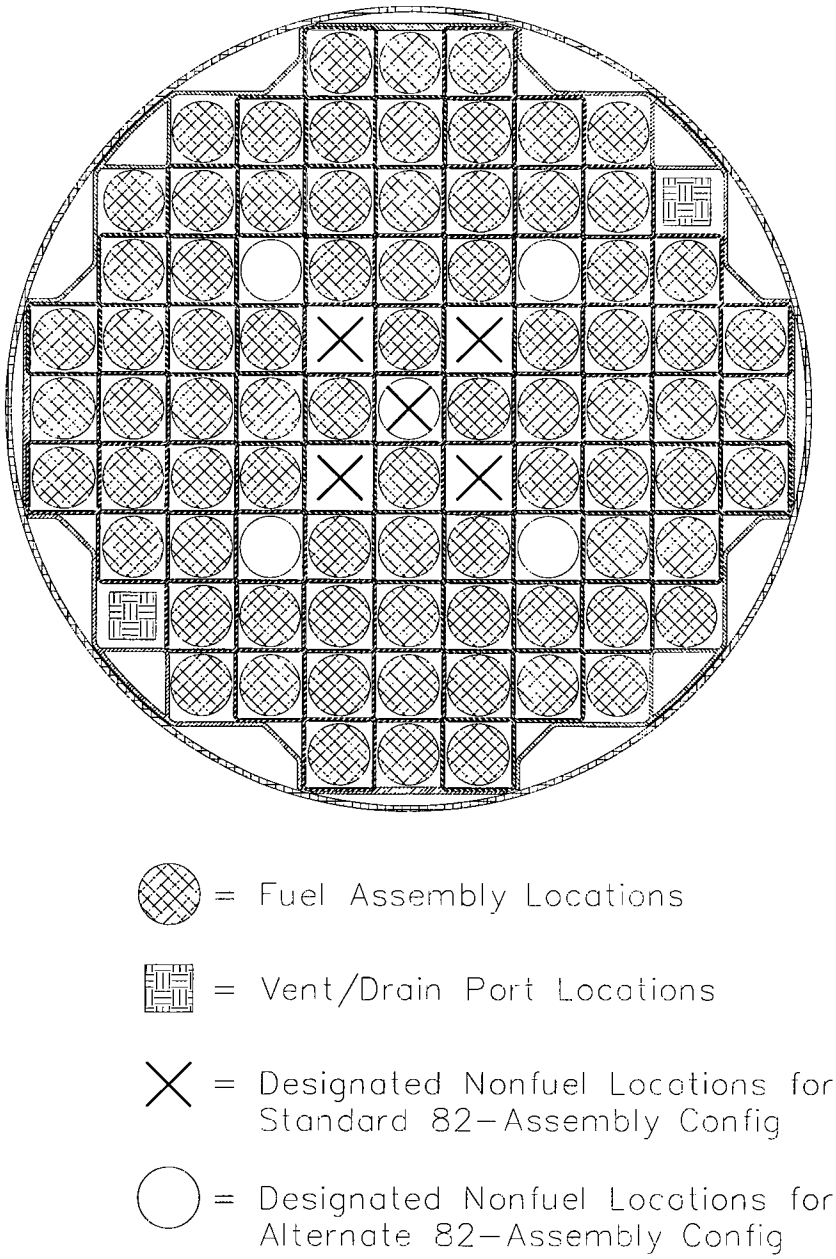


Table 6.1.1-4 BWR Fuel Assembly Loading Criteria (Enrichment Limits)

	Max. Initial Enrichment[a] (wt % ^{235}U)					
	Absorber[b] 0.027 ^{10}B g/cm^2		Absorber 0.0225 ^{10}B g/cm^2		Absorber 0.02 ^{10}B g/cm^2	
	87-Assy Basket	82-Assy Basket	87-Assy Basket	82-Assy Basket	87-Assy Basket	82-Assy Basket
B7_48A	4.0%	4.5%	3.7%	4.5%	3.6%	4.4%
B7_49A	3.8%	4.5%	3.6%	4.4%	3.5%	4.3%
B7_49B	3.8%	4.5%	3.6%	4.4%	3.5%	4.2%
B8_59A	3.9%	4.5%	3.7%	4.5%	3.6%	4.3%
B8_60A	3.8%	4.5%	3.7%	4.4%	3.5%	4.2%
B8_60B	3.8%	4.5%	3.6%	4.3%	3.5%	4.2%
B8_61B	3.8%	4.5%	3.6%	4.3%	3.5%	4.2%
B8_62A	3.8%	4.5%	3.6%	4.3%	3.5%	4.1%
B8_63A	3.8%	4.5%	3.6%	4.3%	3.4%	4.2%
B8_64A	3.8%	4.5%	3.6%	4.3%	3.5%	4.2%
B8_64B	3.6%	4.3%	3.4%	4.1%	3.3%	4.0%
B9_72A	3.8%	4.5%	3.6%	4.3%	3.4%	4.1%
B9_74A	3.7%[c]	4.3%	3.4%	4.1%	3.4%	4.0%
B9_76A	3.5%	4.2%	3.4%	4.0%	3.3%	3.9%
B9_79A	3.7%	4.4%	3.4%	4.2%	3.3%	4.0%
B9_80A	3.8%	4.5%	3.6%	4.3%	3.5%	4.2%
B10_91A	3.7%	4.5%[d]	3.6%	4.3%	3.5%	4.1%
B10_92A	3.8%	4.5%[d]	3.6%	4.3%	3.5%	4.1%
B10_96A	3.7%	4.3%	3.5%	4.1%	3.4%	4.0%
B10_100A	3.6%	4.4%	3.5%	4.1%	3.4%	4.0%

[a] Maximum planar average.

[b] Borated aluminum neutron absorber sheet effective areal ^{10}B density.

[c] 3.85% in the 86-assembly basket configuration.

[d] 4.55% in the alternate 82-assembly basket configuration.

Table 6.1.1-5 Effective Areal Density as a Function of Absorber Credit

	Effective[a] $g^{10}B/cm^2$	75% Credit $g^{10}B/cm^2$	90% Credit $g^{10}B/cm^2$
PWR	0.036	0.048	0.040
	0.030	0.040	0.0334
	0.027	0.036	0.30
BWR	0.027	0.036	0.030
	0.0225	0.030	0.025
	0.020	0.0267	0.0223

Note: The effective column contains the ^{10}B content modeled in the criticality evaluations. The 75% and 90% credit columns contain the minimum as manufactured ^{10}B content requirements. Effective contents equals as manufactured content times the percent credit permitted (also termed percent effectiveness).

[a] The effective areal density represents the value input into the criticality model and is, therefore, the "100% credit" value.

Table 6.1.1-6 Damaged Fuel Basket Bounding PWR Fuel Assembly Loading Criteria (Enrichment/Soluble Boron Limits)

	Max. Initial Enrichment (wt % ^{235}U)														
	Absorber[a] 0.036 ^{10}B g/cm^2					Absorber[a] 0.030 ^{10}B g/cm^2					Absorber[a] 0.027 ^{10}B g/cm^2				
Soluble Boron	1500 (ppm)	1750 (ppm)	2000 (ppm)	2250 (ppm)	2500 (ppm)	1500 (ppm)	1750 (ppm)	2000 (ppm)	2250 (ppm)	2500 (ppm)	1500 (ppm)	1750 (ppm)	2000 (ppm)	2250 (ppm)	2500 (ppm)
BW15H1	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	3.9%	4.2%	4.5%	4.7%	3.6%	3.8%	4.1%	4.4%	4.7%
BW15H2	3.6%	3.9%	4.2%	4.5%	4.8%	3.6%	3.8%	4.1%	4.4%	4.7%	3.5%	3.8%	4.1%	4.3%	4.6%
BW15H3	3.6%	3.9%	4.2%	4.5%	4.8%	3.5%	3.8%	4.1%	4.4%	4.6%	3.5%	3.8%	4.0%	4.3%	4.6%
BW15H4	3.8%	4.1%	4.4%	4.7%	5.0%	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	3.9%	4.2%	4.5%	4.8%
BW17H1	3.6%	3.9%	4.2%	4.5%	4.8%	3.6%	3.9%	4.1%	4.4%	4.7%	3.5%	3.8%	4.1%	4.4%	4.6%
CE14H1	4.4%	4.8%	5.0%	5.0%	5.0%	4.3%	4.7%	5.0%	5.0%	5.0%	4.3%	4.6%	4.9%	5.0%	5.0%
CE16H1	4.4%	4.7%	5.0%	5.0%	5.0%	4.2%	4.6%	5.0%	5.0%	5.0%	4.2%	4.5%	4.9%	5.0%	5.0%
WE14H1	4.6%	5.0%	5.0%	5.0%	5.0%	4.5%	5.0%	5.0%	5.0%	5.0%	4.5%	4.9%	5.0%	5.0%	5.0%
WE15H1	3.8%	4.1%	4.4%	4.7%	5.0%	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	4.0%	4.3%	4.6%	4.8%
WE15H2	3.9%	4.3%	4.6%	4.9%	5.0%	3.8%	4.2%	4.5%	4.8%	5.0%	3.8%	4.1%	4.4%	4.7%	5.0%
WE17H1	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	3.9%	4.2%	4.5%	4.8%	3.6%	3.9%	4.2%	4.5%	4.8%
WE17H2	3.9%	4.3%	4.6%	5.0%	5.0%	3.9%	4.2%	4.5%	4.9%	5.0%	3.8%	4.1%	4.5%	4.8%	5.0%

[a] Borated aluminum neutron absorber sheet effective areal ^{10}B density.

Table 6.4.3-4 BWR Fuel Basket Allowable Loading (Enrichment Limits)

	Max. Initial Enrichment[a] (wt % ^{235}U)					
	Absorber[b] 0.027 ^{10}B g/cm^2		Absorber 0.0225 ^{10}B g/cm^2		Absorber 0.02 ^{10}B g/cm^2	
	87-Assy Basket	82-Assy Basket	87-Assy Basket	82-Assy Basket	87-Assy Basket	82-Assy Basket
B7_48A	4.0%	4.5%	3.7%	4.5%	3.6%	4.4%
B7_49A	3.8%	4.5%	3.6%	4.4%	3.5%	4.3%
B7_49B	3.8%	4.5%	3.6%	4.4%	3.5%	4.2%
B8_59A	3.9%	4.5%	3.7%	4.5%	3.6%	4.3%
B8_60A	3.8%	4.5%	3.7%	4.4%	3.5%	4.2%
B8_60B	3.8%	4.5%	3.6%	4.3%	3.5%	4.2%
B8_61B	3.8%	4.5%	3.6%	4.3%	3.5%	4.2%
B8_62A	3.8%	4.5%	3.6%	4.3%	3.5%	4.1%
B8_63A	3.8%	4.5%	3.6%	4.3%	3.4%	4.2%
B8_64A	3.8%	4.5%	3.6%	4.3%	3.5%	4.2%
B8_64B	3.6%	4.3%	3.4%	4.1%	3.3%	4.0%
B9_72A	3.8%	4.5%	3.6%	4.3%	3.4%	4.1%
B9_74A	3.7%[c]	4.3%	3.4%	4.1%	3.4%	4.0%
B9_76A	3.5%	4.2%	3.4%	4.0%	3.3%	3.9%
B9_79A	3.7%	4.4%	3.4%	4.2%	3.3%	4.0%
B9_80A	3.8%	4.5%	3.6%	4.3%	3.5%	4.2%
B10_91A	3.7%	4.5%[d]	3.6%	4.3%	3.5%	4.1%
B10_92A	3.8%	4.5%[d]	3.6%	4.3%	3.5%	4.1%
B10_96A	3.7%	4.3%	3.5%	4.1%	3.4%	4.0%
B10_100A	3.6%	4.4%	3.5%	4.1%	3.4%	4.0%

[a] Maximum planar average.
[b] Borated aluminum neutron absorber sheet effective areal ^{10}B density.
[c] 3.85% in the 86-assembly basket configuration.
[d] 4.55% in the alternate 82-assembly basket configuration.

Table 6.4.3-5 Damaged Fuel Basket PWR Fuel Assembly Loading Criteria (Enrichment/Soluble Boron Limits)

	Max. Initial Enrichment (wt % ^{235}U)														
	Absorber[a] 0.036 ^{10}B g/cm^2					Absorber[a] 0.030 ^{10}B g/cm^2					Absorber[a] 0.027 ^{10}B g/cm^2				
Soluble Boron	1500 (ppm)	1750 (ppm)	2000 (ppm)	2250 (ppm)	2500 (ppm)	1500 (ppm)	1750 (ppm)	2000 (ppm)	2250 (ppm)	2500 (ppm)	1500 (ppm)	1750 (ppm)	2000 (ppm)	2250 (ppm)	2500 (ppm)
BW15H1	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	3.9%	4.2%	4.5%	4.7%	3.6%	3.8%	4.1%	4.4%	4.7%
BW15H2	3.6%	3.9%	4.2%	4.5%	4.8%	3.6%	3.8%	4.1%	4.4%	4.7%	3.5%	3.8%	4.1%	4.3%	4.6%
BW15H3	3.6%	3.9%	4.2%	4.5%	4.8%	3.5%	3.8%	4.1%	4.4%	4.6%	3.5%	3.8%	4.0%	4.3%	4.6%
BW15H4	3.8%	4.1%	4.4%	4.7%	5.0%	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	3.9%	4.2%	4.5%	4.8%
BW17H1	3.6%	3.9%	4.2%	4.5%	4.8%	3.6%	3.9%	4.1%	4.4%	4.7%	3.5%	3.8%	4.1%	4.4%	4.6%
CE14H1	4.4%	4.8%	5.0%	5.0%	5.0%	4.3%	4.7%	5.0%	5.0%	5.0%	4.3%	4.6%	4.9%	5.0%	5.0%
CE16H1	4.4%	4.7%	5.0%	5.0%	5.0%	4.2%	4.6%	5.0%	5.0%	5.0%	4.2%	4.5%	4.9%	5.0%	5.0%
WE14H1	4.6%	5.0%	5.0%	5.0%	5.0%	4.5%	5.0%	5.0%	5.0%	5.0%	4.5%	4.9%	5.0%	5.0%	5.0%
WE15H1	3.8%	4.1%	4.4%	4.7%	5.0%	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	4.0%	4.3%	4.6%	4.8%
WE15H2	3.9%	4.3%	4.6%	4.9%	5.0%	3.8%	4.2%	4.5%	4.8%	5.0%	3.8%	4.1%	4.4%	4.7%	5.0%
WE17H1	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	3.9%	4.2%	4.5%	4.8%	3.6%	3.9%	4.2%	4.5%	4.8%
WE17H2	3.9%	4.3%	4.6%	5.0%	5.0%	3.9%	4.2%	4.5%	4.9%	5.0%	3.8%	4.1%	4.5%	4.8%	5.0%

[a] Borated aluminum neutron absorber sheet effective areal ^{10}B density.

6.7.4 BWR Model Details

The BWR system payload consists of 87 fuel assemblies that are placed into 87 of 89 openings formed by a combination of 45 fuel tubes, and 4 side and corner weldments. Two of the basket opening are located on the basket periphery below the vent and drain port opening and are not designed to contain fuel assemblies. All 89-fuel assembly openings are filled in the "87-Assembly" basket model.

Additional configurations are evaluated with assemblies removed from the basket. An 86 assembly configuration is evaluated with the center basket location without a fuel assembly. An "82-Assembly" configuration is evaluated with five assemblies removed in an x-pattern from the basket center. The alternate 82-assembly configuration moves the four empty basket locations out from the center of the basket. A sketch of the basket configuration is shown in Figure 6.1.1-1. The 86 and 82-assembly configurations removes a significant quantity of fissile material from the basket center in addition to providing flux traps for neutrons from the adjacent assemblies to thermalize and be absorbed by the absorber sheets. These effects combine to allow a significant enrichment increase over the 87-assembly configuration.

The BWR basket model is similar in structure to the PWR model documented in Section 6.7.1, with differences being limited to the addition of an optional zirconium-based alloy channel and the option to model sub-channeled type assemblies. Sub-channeled assemblies are comprised of four fuel rod sub-bundles. Dimensioned fuel tubes forming the base configuration of the basket are shown in Figure 6.7.4-1. The assembled BWR basket is shown in Figure 6.7.4-2.

All fuel tubes are initially modeled as containing four neutron absorber sheets with weld post locations along the tube face for the criticality evaluations associated with maximum reactivity payload and basket configuration and optimum moderation. Final system configuration increases the number of weld posts and allows the removal of the neutron absorber sheets or replacement by aluminum sheets at up to 24 basket peripheral locations for the 87-assembly basket and up to 16 locations for the 82-assembly basket. The reduction in the number of absorber sheets does not affect system reactivity, as demonstrated in Section 6.7.6.1. Similarly, an additional column of weld posts has no significant effect on system reactivity as shown in Section 6.7.6.1. Since the combination of a reduced number of absorber sheets and an increase in the number of weld posts has the potential for increasing k_{eff} slightly above the statistically significant level threshold, the maximum enrichments and k_{eff} in Section 6.7.6.2 are calculated using a model incorporating both design attributes.

Sample input files for the BWR transfer cask 87-assembly configuration and 82-assembly configuration are shown in Figure 6.7.4-3 and Figure 6.7.4-4, respectively. Only the transfer

cask model is shown since PWR and BWR concrete cask models are identical with the exception of the TSC contents. The inputs provided represent the maximum reactivity configuration and include the minimum cell spacing, replacement of the optional peripheral absorbers by aluminum sheets, and the full number of weld posts illustrated in the licensing drawings.

6.7.5 BWR Fuel Characterization

Fuel definitions listed in Section 6.4 are the result of grouping the large range of commercial fuel types by core type, number of fuel rods, and key criticality characteristics. These characteristics are primarily associated with the assembly moderator ratio and fuel mass and include pellet diameter, active fuel length, fuel rod diameter and clad thickness, and water rod configuration. Another variable for BWR assemblies is the presence, and thickness, of the channel.

Characterization studies are based on the 87-assembly basket configuration. For assemblies exceeding the USL at the enrichment specified in the studies either the 86-assembly basket, the 82-assembly basket configurations, or reduced maximum enrichments are required. Enrichment limits for the basket configurations are provided in Section 6.7.6.

Lattice Configuration and Channel Studies

BWR fuel assemblies are typically undermoderated in the basket structure (H/U ratio below optimum levels). Therefore, initial criticality analysis extracts from each assembly type the following characteristics.

- Minimum fuel rod outer diameter
- Minimum clad thickness (only relevant to flooded pellet-to-clad gap scenarios)
- Minimum water rod outer diameter and thickness
- Maximum rod pitch (assemblies are grouped by core type and, therefore, typically have single nominal pitch)

Based on the maximum H/U set of characteristics, the reactivity of each assembly is determined under various conditions. Evaluated is a dry and flooded pellet-to-clad gap. Since relative reactivity for the assembly design and flood conditions are evaluated, the models are based on nominal basket characteristics with the assemblies centered in the tube and developed cell. Comparisons are performed at a 4 wt.% enrichment level.

Results of the analysis at various clad-to-gap conditions are shown in Table 6.7.5-1. Flooding the pellet-to-clad gap raised system reactivity across the majority of fuel types, indicating that the fuel assemblies are significantly undermoderated in the basket. No statistically significant reactivity decrease occurs as a result of flooding the gap for any of the fuel types. The channel thickness study documented in Table 6.7.5-2 demonstrates that modeling the maximum channel thickness is conservative and that it is permissible to load assemblies without channel.

The evaluation presented previously assumed that the assemblies are undermoderated and that choosing the corresponding set of parameters maximizes system reactivity. This assumption is supported by the pellet-to-clad gap flood evaluation, which clearly demonstrates that providing

additional moderator to the lattice increases reactivity. This assumption is further validated by evaluating a subset of the fuel assembly types for a variation in the lattice parameters. As typical assemblies loaded into the cask are expected to be intact (no leak), the pellet-to-clad gap is specified to be dry for these analyses. Fuel assemblies are evaluated in a nominal configuration basket with fuel assemblies centered in the tube. As this evaluation is concerned with relative reactivity differences due to lattice parameter changes, the results of this analysis may be applied to the maximum reactivity basket configuration. Each assembly hybrid is evaluated over its range of nominal lattice parameters.

Rather than evaluating individual parameter effects separately, the fuel characteristics analysis is divided into distinct regions.

Fuel rod lattice unit cell
- H/U ratio controlled by rod pitch, rod diameter, and clad thickness

Water rod unit cell (note that not all BWR assemblies contain water rods)
- H/U controlled by water rod diameter and thickness

Pellet diameter (NUREG-6716 [9] indicates the possibility of a minimum pellet diameter increasing system reactivity)

Monte Carlo evaluation results of the nominal assembly parameter ranges provided limited useful information, as the majority of reactivity changes were not resolvable within a two or three sigma uncertainty band. Statistically significant results were obtained from an additional calculation set applying increased variances to each of the parameters. The results of the increased variance evaluation for 4.0 wt.% enriched cases are shown in Table 6.7.5-3. As shown, the cases containing maximum H/U ratio in the fuel rod lattice location, maximum H/U in the water rod location (minimum water rod diameter and thickness), and maximum pellet diameter produce a maximum reactivity configuration system. The result set also demonstrates that water rod dimensions are not a crucial to system criticality control. Critical assemblies characteristics are listed below.

Number of fuel rods

Minimum fuel rod outer diameter

Minimum clad thickness

Maximum rod pitch

Maximum active fuel length (not evaluated but based on neutron leakage maximum active fuel length results in a bounding payload definition)

Homogeneous versus Heterogeneous Assembly Enrichment Evaluation

BWR fuel assemblies are typically loaded with a heterogeneous enrichment scheme of multiple fuel pin enrichments in one assembly. For the criticality analysis presented previously, an initial peak planar-average enrichment is used. The initial peak planar-average enrichment is the

6.7.6 BWR Undamaged Fuel Criticality Evaluation

6.7.6.1 Optimum System Configuration

Enrichment limits are based on a maximum reactivity configuration system. To determine the maximum reactivity system, the following system perturbations are evaluated:

TSC interior moderator elevation variations (partial flooding)
Moderator density changes from void to full density (inside and outside the TSC)
Basket fabrication tolerance
Component shift scenarios

All system perturbation analyses are based on fuel assemblies at the maximum lattice moderator (H/U) ratio. Justification for this fuel assembly configuration is provided in Section 6.7.5. Only transfer cask cases are used in these evaluations since the transfer cask is the only cask body in which TSC flooding occurs. In the dry concrete cask, the TSC has a low reactivity, $k_{eff} < 0.5$.

All elevations in this section are based on full-length rods in all assemblies. Partial length rods are addressed in the loading tables. Optimum system configuration studies are based on the 87-assembly basket configuration and a 4.0 wt % ^{235}U initial enrichment, unless otherwise stated. Certain assembly types and configurations exceed the USL at the 4.0 wt % ^{235}U in the 87-assembly basket configuration. These assemblies require the use of either the 86-assembly basket, the 82-assembly basket configurations, or reduced maximum enrichments.

Initial reactivity analysis is based on a basket and neutron absorber configuration with the following characteristics:

a.) Neutron absorbers on all four sides of each tube.

b.) A single column of weld posts connecting neutron absorber to tube.

c.) A neutron absorber thickness tolerance of ±0.005 inch.

d.) A neutron absorber width tolerance of ±0.02 inch.

e.) Neutron absorber sheet effective areal density of 0.027 ^{10}B g/cm^2.

Differences in reactivity due to system configuration and tolerance changes from these characteristics are evaluated in the subsection titled "Neutron Absorber Modifications."

Changes in neutron absorber areal density are addressed in Section 6.7.6.2.

Partial Flooding

Partial flood cases drain the TSC to the top of the active fuel region. The partial flood reactivity cases investigate reactivity difference between a water reflector over the active fuel region and reflection from the steel lid. The results of the partial flooding study, documented in Table 6.7.6-1, demonstrate that BWR system reactivity is independent of TSC moderator elevations.

Moderator Density Variations

Moderator density variation cases are based on a cask array model generated by surrounding a single cask body with a cylindrical reflecting enclosure. The reflecting body is spaced 20 cm from the cask body to allow exterior moderator density conditions to affect the results. Reactivities calculated for various moderator densities are graphically illustrated in Figure 6.7.6-1 and Figure 6.7.6-2 for the 87-assembly and 82-assembly basket configurations, respectively. Moderator density curves are based on the B9_79A assembly hybrid at an initial enrichment of 4.0 wt % ^{235}U and a flooded pellet-to-clad gap. Reactivity increases in the system as TSC interior moderator density rises. Exterior moderator conditions have no significant effect on system reactivity for a flooded TSC. The k_{eff} of the dry TSC is less than 0.5 under all exterior conditions.

Fabrication Tolerances and Component Shift

Fabrication tolerances and shift effects are evaluated using representative fuel types from the major core configurations. Nominal fuel assembly characteristics are employed in the tolerance and shifting evaluations.

Fabrication Tolerance

The basket is composed of a set of fuel tubes, pinned together in the tube corners, and located in the TSC cavity with side and corner weldments. Tube location in the basket is controlled by the diagonal dimension across the exterior face of the fuel tube corners. This value is a key dimension for tube array and developed cell size. The tube diagonal is referred to as tube "interface width" in the analysis discussions. Similar to the PWR model, neutron absorber and tube tolerances are evaluated. Neutron absorber thickness studies are based on the minimum ^{10}B areal density allowed for the design. As such, variations in absorber thickness require adjustments in the sheet composition. The results of the tolerance evaluation for centered fuel assemblies and basket components are included in Table 6.7.6-2. As indicated in the table, little statistically significant information ($>3\sigma$) is available from this study. None of the fabrication-related tolerances, with the exception of maximum tube wall thickness, produce significant reactivity increases when taken independently.

Further evaluations of the component tolerances, including combinations of tolerances, are performed in conjunction with the shifted component configuration.

Component Shift

In addition to the component tolerances, a reactivity study on component shifts is required. Based on the pinned tube arrangement, the only radial shift to be evaluated is the shift of the fuel assembly within the tubes. The tubes are restrained in the corner by pins, minimizing tube shift potential. Evaluations on tube shift are included within the Phase 3 Design Modifications subsection (pages 6.7.6-5 through 6.7.6-7). The results of shift evaluations are shown in Table 6.7.6-2, indicating that shifting the fuel assembly towards the basket center clearly increases system reactivity.

Combined Shift and Tolerance Study

This section evaluates the effect of combining various basket tolerances with the maximum reactivity shift configuration (radial in). The results for this evaluation are shown in Table 6.7.6-3. Similar to the results of the independent basket tolerance evaluation, only fuel tube thickness affects system reactivity to a statistically significant level.

While no statistically significant reactivity difference is found between the cases with and without tolerances applied, the maximum reactivity configuration chosen for the evaluations of all fuel hybrids is as follows.

Minimum tube width and interface width
Maximum tube thickness
Minimum absorber width and maximum thickness
Fuel assemblies shifted to basket center

This configuration produced reactivities within a 3σ uncertainty band of the maximum reported value for all fuel types evaluated, and provides for the minimum separation between adjacent assemblies. The minimum separation reduces the amount of moderation and the corresponding effectiveness of the absorber sheet, which depend on the ^{10}B neutron capture cross-section in the thermal energy range.

Shift and tolerance evaluations were based on a full, 87-assembly, basket loading. While fabrication tolerance impacts relate to tube and developed cell unit behavior, a limited set of evaluations is performed to verify that the radial shifting in a fuel assembly pattern remains bounding for the 82-assembly basket configuration. The results of this evaluation are shown in Table 6.7.6-4 and demonstrate that the radial shifting in a fuel assembly pattern is limiting.

Neutron Absorber Modifications

Phase I Design Modifications

Design options permit the replacement or removal of up to 24 neutron absorber sheets in the 87-assembly and 86-assembly basket peripheral fuel tubes or up to 16 neutron absorber sheets in the 82-assembly baskets. Locations for the optional absorber sheets are shown in Figure 6.7.6-3 and Figure
6.7.6-4, respectively. Replacement sheets for the neutron absorber in the peripheral basket locations are composed of unborated aluminum. Using the most reactive basket and fuel assembly shifting specified in Section 6.7.6.1, each BWR fuel type specified in Section 6.7.5 was analyzed at 4.0 wt % ^{235}U for the 87-assembly basket and 4.5 wt % ^{235}U for the 82-assembly basket. As shown in Table 6.7.6-5 and Table 6.7.6-6, no statistically significant reactivity changes are associated with the absorber sheet removal or replacement in the model. Results were calculated using unborated water in the pellet-to-clad gap. Results for the 87-assembly basket may exceed the USL at 4.0 wt% ^{235}U. For assemblies exceeding the USL, a lower enrichment or the use of either the 86 or 82-assembly basket configurations is required.

Design enhancements introduced after completion of the primary criticality evaluations replaced the single column of weld posts down the tube face centerline with a two-column weld post configuration. The weld post columns are located 1.8 in from the tube centerline. As demonstrated in Table 6.7.6-7, the increased number of weld posts does not significantly change system reactivity. Results were calculated using unborated water in the pellet-to-clad gap.

As the combined reactivity effect of a reduced number of absorber sheets and an increased number of weld posts may exceed the statistically significant threshold ($> 3\sigma$) or potentially result in a $k_{eff} + 2\sigma >$ USL if added as a Δk, the maximum allowed enrichments are calculated with a model containing the reduced number of absorber sheets and the increased number of weld posts.

Phase 2 Design Modifications

Neutron absorbers may be manufactured at an increased tolerance band. Rather than the ±0.005-inch thickness and ±0.02-inch width tolerance evaluated in the previous calculations, a thickness tolerance of ±0.006 inch and a width tolerance of ±0.08 inch may be applied. Changes in the absorber thickness tolerance do not result in changes in the areal density of the ^{10}B absorber material as it is defined at its minimum value regardless of absorber thickness. The focus of the revised analysis is maximum tolerance sheet thickness and minimum width, as the maximum thickness change displaces moderator between fuel and absorber (i.e., potentially decreases absorber efficiency) and the minimum width removes absorber from the system.

Based on the studies described in the previous section, the interface (tube grind flat-to-flat) width controls the critical tube spacing and, therefore, assembly spacing and system reactivity.

6.7.6.2 Allowable Loading Definitions and Maximum System Reactivities

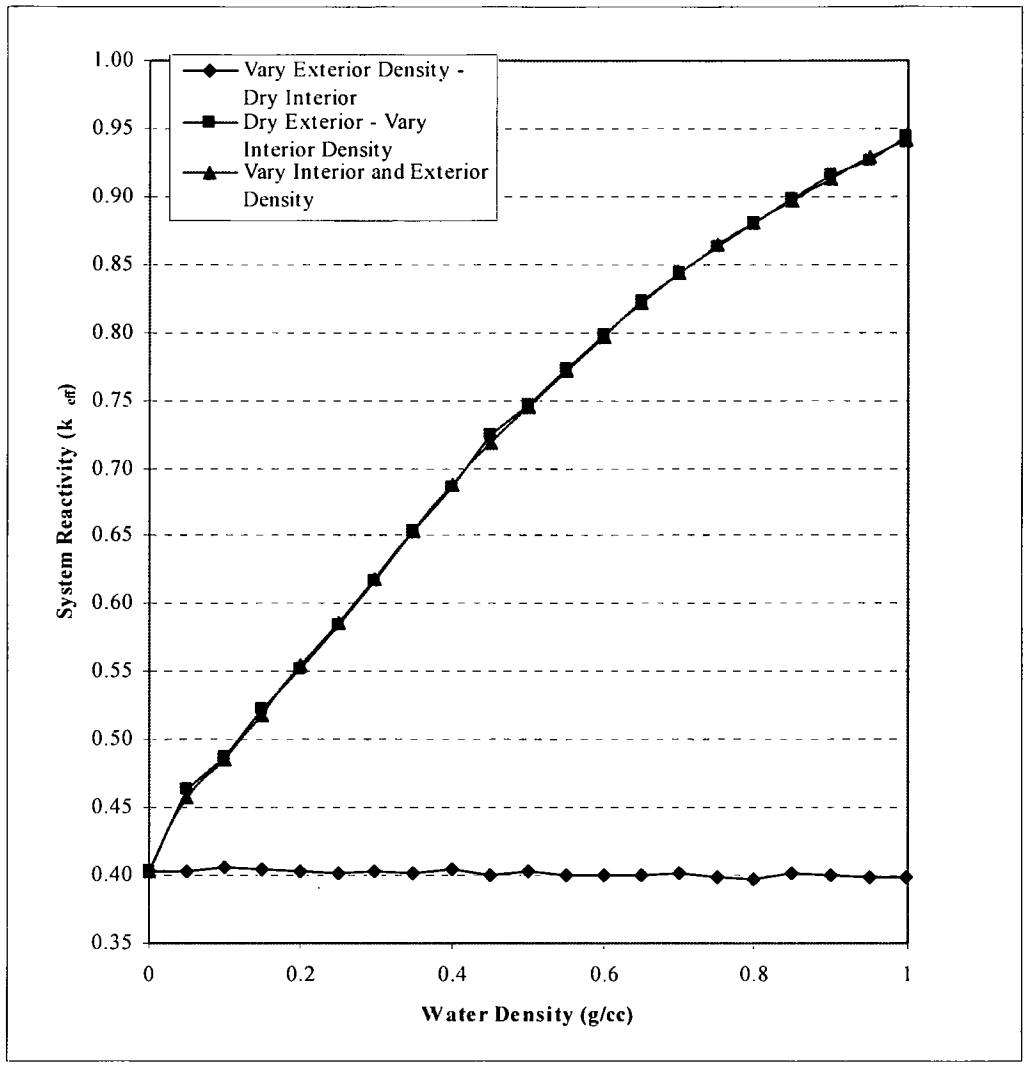
Based on the most reactive basket configuration, each of the fuel assembly types is evaluated at various enrichment levels to determine the maximum enrichment at which $k_{eff} + 2\sigma$ remains below the USL. Physical limitation on the assemblies allowed for loading are listed in Table 6.7.6-9. The maximum allowed planar average initial enrichments are listed in Table 6.7.6-10 for assemblies with and without partial length rods, where applicable, for a 0.027 ^{10}B g/cm^2 absorber basket configuration. Table 6.7.6-11 summarizes the enrichment limits for both 87-assembly and 82-assembly basket configurations at neutron absorber sheet effective areal densities of 0.027, 0.0225, and 0.020 ^{10}B g/cm^2. In all evaluations, the pellet-to-clad gap is flooded.

Maximum system reactivities are summarized as follows. Analysis results represent maximum reactivity basket and fuel geometry. There are no design basis off-normal or accident transfer cask conditions affecting system reactivity. Therefore, only normal condition results are presented. An accident condition for the concrete cask represents a flooding of the concrete cask to canister annulus. Concrete cask results are based on the maximum fuel mass assembly at the highest allowed enrichment (4.5 wt % ^{235}U).

Condition	Pellet to Clad Gap Condition	Maximum Multiplication Factors ($k_{eff} + 2\sigma$)	
		Transfer Cask	Concrete Cask
Normal	Dry	0.92900	0.43685
Normal	Wet	0.93679	N/A
Accident / Off-Normal	Dry	N/A	0.42991

Note that there is no statistical difference between normal and accident condition cases, which differ only by the flooding of the pellet-to-clad gap under the "accident condition."

Figure 6.7.6-1 87-Assembly Basket BWR Water Density Variations



significantly affect system reactivity. Increased plate thickness would add parasitic absorber to the system, while further separating fissile material masses and, therefore, does not represent a criticality concern.

6.7.8.3 Sample Input Files

Three sample damaged fuel basket input files are provided. Figure 6.7.8-2 contains an input file for an undamaged assembly loaded into the four DFCs. Figure 6.7.8-3 contains an input file for an unclad rod array input file without inserts. Figure 6.7.8-4 contains a mixture input file that is also partially flooded. In this input file, the flooded mixture elevation is at the top of the active fuel in the DFC.

6.7.8.4 Damaged Fuel Characterization

Starting with the most reactive basket configuration determined for undamaged fuel, various damaged fuel configurations are evaluated. Each DFC configuration is evaluated at 0.036, 0.030 and 0.027 g ^{10}B /cm^2 effective absorber densities with and without inserts in the fuel assembly guide tubes. Use of the maximum reactivity configuration for undamaged fuel as the baseline is appropriate because it maintains the most reactive configuration of the 33 undamaged fuel assemblies and minimizes the separation between the damaged fuel assemblies and the rest of the payload.

Clad Rods – Grid Undamaged

DFC evaluations are initiated by placing undamaged fuel assemblies into the DFC to demonstrate the effect of the additional stainless steel shell and thicker corner weldment. Undamaged rods within a nominal lattice/pitch configuration are identified by the acronym "IAA" in the DFC content description.

With all 37 assemblies modeled as undamaged at their limiting enrichments (see Section 6.7.3.2), the DFC and corner weldment material has no statisically significant effect on system reactivity with average reactivity changes of 0.44, 0.55 and 0.48 $\Delta k/\sigma$ for the 0.036, 0.030 and 0.027 g ^{10}B/cm^2 absorbers, respectively. Sample results for the 0.036 g ^{10}B/cm^2 without inserts are presented in Table 6.7.8-1. Similar to results of the undamaged fuel basket evaluations, the presence or absence of the inserts has no statistically significant effect on system performance.

As the undamaged fuel basket enrichment limits resulted in reactivties (eigenvalues) within a very small margin to the USL, the statistical nature of the Monte Carlo evaluation resulted in a limited number of enrichment/soluble boron/fuel type combinations exceeding the USL. The

maximum required reduction in enrichment for all combinations to remain below the USL is 0.1 wt % ^{235}U under the undamaged fuel basket limits.

The system is designed to allow loading of undamaged fuel assemblies into the four designated DFC locations in the DF basket assembly without the use of a DFC. The difference between this configuration and undamaged fuel in the DFC evaluated previously in this section is the presence of the 0.048-inch thick DFC wall. Given that the 1.125-inch inner wall plate separates DFC content from adjoining assemblies in both models, there is no expectation of statistically resolvable reactivity differences between models with and without a DFC. Evaluating each primary array type at 0.036 and 0.027 g/cm^2 ^{10}B concentration in the absorber sheets, with minimum (1500 ppm) and maximum (2500ppm) borated water concentrations, resulted in an absolute average change in reactivity of 0.30 $\Delta k/\sigma$. All cases remain under the USL of 0.9376. Loading of undamaged fuel into the four designated DFC locations in the DF basket assembly without a DFC is, therefore, acceptable.

Unclad Rods – Loose Pellet Stack

In this stage of the DFC evaluations, damaged fuel is postulated to lose its cladding and pellets are allowed to separate. As PWR assemblies are typically undermoderated, the removal of cladding, in conjunctions with pitch variations, has the potential to increase system reactivity. Pellet array pitch is allowed to increase until it fills the DFC opening. Clad removal and pitch modification affects system reactivity by varying moderator between fuel rods, therefore, changing neutron thermalization and utilization, while simultaneously varying the neutron absorber quantity in the form of soluble boron in the moderator. These are offsetting phenomena (i.e., increasing pitch increases the borated moderator quantity between fuel rods, which improves thermalization of fast fission neutron for absorption in the fuel, while also increasing the ^{10}B absorber quantity between rods and thereby reducing thermal neutron flux). As shown in Table 6.7.8-2, a sample analysis using the 0.036 g B^{10}/cm^2 absorber at a 2250 ppm soluble boron content, the result of the offsetting phenomena is that there is no statistically resolvable trend of pellet pitch to system reactivity (pitch indicated is either the nominal, as assembly design pitch, the maximum pitch allowed by the DFC opening, or the average pitch between nominal and maximum). As lower soluble boron shifts the trend towards increasing system reactivity as a function of increasing pitch, maximum pitch is applied to the remaining pellet evaluations.

Similar to the undamaged fuel assembly in the DFC evaluation, the loose pellets study results in no statistically significant change in system reactivity, with average reactivity changes of 0.57, 0.52, and 0.49 $\Delta k/\sigma$ for the 0.036, 0.030, and 0.027 g $^{10}B/cm^2$ absorbers, respectively. Sample results for the 0.036 g $^{10}B/cm^2$ without inserts are presented in Table 6.7.8-3.

Table 6.7.8-1 Sample Results for Undamaged Fuel in DFC (Damaged Fuel Basket)

Assembly Type	Minimum 1500 ppm Max. Initial Enrichment	Reactivity			Minimum 2000 ppm Max. Initial Enrichment	Reactivity			Minimum 2500 ppm Max. Initial Enrichment	Reactivity		
	(wt% ^{235}U)	σ	k_{eff} + 2σ	Δk/σ	(wt% ^{235}U)	σ	k_{eff} + 2σ	Δk/σ	(wt% ^{235}U)	σ	k_{eff} + 2σ	Δk/σ
BW15H1	3.7%	0.00073	0.92965		4.4%	0.00073	0.93538		5.0%	0.00070	0.93416	
	3.7%	0.00073	0.93240	2.66	4.4%	0.00072	0.93503	-0.34	5.0%	0.00073	0.93594	1.76
BW15H2	3.7%	0.00068	0.93581		4.3%	0.00071	0.93498		4.9%	0.00072	0.93317	
	3.7%	0.00073	0.93607		4.3%	0.00073	0.93763	2.60	4.9%	0.00077	0.93435	
					4.2%	0.00076	0.92842					
BW15H3	3.7%	0.00071	0.93700		4.3%	0.00074	0.93514		4.9%	0.00072	0.93415	
	3.7%	0.00070	0.93818	1.18	4.3%	0.00074	0.93697	1.75	4.9%	0.00074	0.93686	2.62
	3.6%	0.00070	0.93066									
BW15H4	3.8%	0.00071	0.93146		4.5%	0.00073	0.93364		5.0%	0.00073	0.92368	
	3.8%	0.00074	0.93284		4.5%	0.00078	0.93488	1.16	5.0%	0.00075	0.92548	
BW17H1	3.7%	0.00073	0.93296		4.3%	0.00070	0.93382		5.0%	0.00072	0.93716	
	3.7%	0.00071	0.93589	2.88	4.3%	0.00072	0.93432	0.50	5.0%	0.00072	0.94043	3.21
									4.9%	0.00072	0.93171	
CE14H1	4.5%	0.00073	0.93518		5.0%	0.00078	0.91583		5.0%	0.00078	0.87766	
	4.5%	0.00081	0.93353		5.0%	0.00074	0.91808	2.09	5.0%	0.00071	0.87934	
CE16H1	4.4%	0.00075	0.93329		5.0%	0.00077	0.92515		5.0%	0.00080	0.88644	
	4.4%	0.00074	0.93299	-0.28	5.0%	0.00073	0.92359	-1.47	5.0%	0.00079	0.88529	-1.02
WE14H1	4.7%	0.00073	0.93682		5.0%	0.00073	0.90625		5.0%	0.00077	0.86657	
	4.7%	0.00077	0.93520	-1.53	5.0%	0.00075	0.90620	-0.05	5.0%	0.00074	0.86864	1.94
WE15H1	3.8%	0.00072	0.93295		4.5%	0.00078	0.93614		5.0%	0.00074	0.92470	
	3.8%	0.00079	0.93092		4.5%	0.00074	0.93534	-0.74	5.0%	0.00075	0.92747	
WE15H2	4.0%	0.00077	0.93454		4.7%	0.00072	0.93520		5.0%	0.00071	0.91355	
	4.0%	0.00071	0.93602	1.41	4.7%	0.00074	0.93494	-0.25	5.0%	0.00073	0.91313	-0.41
WE17H1	3.7%	0.00074	0.92921		4.4%	0.00076	0.93628		5.0%	0.00070	0.93402	
	3.7%	0.00070	0.93064		4.4%	0.00074	0.93712	0.79	5.0%	0.00073	0.93419	
WE17H2	4.0%	0.00073	0.93415		4.7%	0.00071	0.93342		5.0%	0.00071	0.91309	
	4.0%	0.00076	0.93355	-0.57	4.7%	0.00072	0.93507	1.63	5.0%	0.00070	0.91196	-1.13

Table 6.7.8-2 DFC Unclad Rod Array Pitch Study Results

Assembly	Enrichment	Reactivity with Maximum Pitch		Reactivity with Average Pitch			Reactivity with Nominal Pitch		
	(wt% ^{235}U)	σ	k_{eff} + 2σ	σ	k_{eff} + 2σ	Δk/σ	σ	k_{eff} + 2σ	Δk/σ
BW15H1	4.7%	0.00071	0.93472	0.00072	0.93607	1.34	0.00075	0.93646	1.68
BW15H2	4.6%	0.00073	0.93589	0.00075	0.93641	0.50	0.00076	0.93473	-1.10
BW15H3	4.6%	0.00066	0.93711	0.00073	0.93765	0.55	0.00078	0.93778	0.66
BW15H4	4.8%	0.00071	0.93398	0.00077	0.93390	-0.08	0.00075	0.93433	0.34
BW17H1	4.6%	0.00073	0.93383	0.00072	0.93446	0.61	0.00073	0.93466	0.80
CE14H1	5.0%	0.00079	0.89735	0.00077	0.89484	-2.28	0.00074	0.89522	-1.97
CE16H1	5.0%	0.00075	0.90438	0.00074	0.90395	-0.41	0.00077	0.90557	1.11
WE14H1	5.0%	0.00077	0.88574	0.00078	0.88600	0.24	0.00079	0.88591	0.15
WE15H1	4.8%	0.00074	0.93410	0.00075	0.93307	-0.98	0.00075	0.93368	-0.40
WE15H2	5.0%	0.00079	0.93251	0.00075	0.93201	-0.46	0.00073	0.93239	-0.11
WE17H1	4.7%	0.00073	0.93349	0.00075	0.93626	2.65	0.00074	0.93546	1.90
WE17H2	5.0%	0.00073	0.93227	0.00071	0.93048	-1.76	0.00077	0.93145	-0.77

Table 6.7.8-3 Sample Results for Unclad Rod/Loose Pellet Fuel in DFC (Damaged Fuel Basket)

Assembly Type	Minimum 1500 ppm Max. Initial Enrichment	Reactivity			Minimum 2000 ppm Max. Initial Enrichment	Reactivity			Minimum 2500 ppm Max. Initial Enrichment	Reactivity		
	(wt% ^{235}U)	σ	k_{eff} + 2σ	Δk/σ	(wt% ^{235}U)	σ	k_{eff} + 2σ	Δk/σ	(wt% ^{235}U)	σ	k_{eff} + 2σ	Δk/σ
BW15H1	3.7%	0.00073	0.92965		4.4%	0.00073	0.93538		5.0%	0.00070	0.93416	
	3.7%	0.00072	0.93127	1.58	4.4%	0.00073	0.93700	1.57	5.0%	0.00075	0.93608	1.87
BW15H2	3.7%	0.00068	0.93581		4.3%	0.00071	0.93498		4.9%	0.00072	0.93317	
	3.7%	0.00070	0.93704	1.26	4.3%	0.00075	0.93589	0.88	4.9%	0.00073	0.93554	2.31
BW15H3	3.7%	0.00071	0.93700		4.3%	0.00074	0.93514		4.9%	0.00072	0.93415	
	3.7%	0.00069	0.93818	1.19	4.3%	0.00069	0.93668	1.52	4.9%	0.00071	0.93579	1.62
	3.6%	0.00072	0.93134									
BW15H4	3.8%	0.00071	0.93146		4.5%	0.00073	0.93364		5.0%	0.00073	0.92368	
	3.8%	0.00072	0.93393	2.44	4.5%	0.00073	0.93438	0.72	5.0%	0.00074	0.92418	0.48
BW17H1	3.7%	0.00073	0.93296		4.3%	0.00070	0.93382		5.0%	0.00072	0.93716	
	3.7%	0.00072	0.93545	2.43	4.3%	0.00071	0.93443	0.61	5.0%	0.00069	0.93818	1.02
									4.9%	0.00072	0.93174	
CE14H1	4.5%	0.00073	0.93518		5.0%	0.00078	0.91583		5.0%	0.00078	0.87766	
	4.5%	0.00077	0.93387	-1.23	5.0%	0.00079	0.91801	1.96	5.0%	0.00081	0.87926	1.42
CE16H1	4.4%	0.00075	0.93329		5.0%	0.00077	0.92515		5.0%	0.00080	0.88644	
	4.4%	0.00076	0.93404	0.70	5.0%	0.00076	0.92362	-1.41	5.0%	0.00073	0.88414	-2.12
WE14H1	4.7%	0.00073	0.93682		5.0%	0.00073	0.90625		5.0%	0.00077	0.86657	
	4.7%	0.00074	0.93777	0.91	5.0%	0.00077	0.90693	0.64	5.0%	0.00074	0.86736	0.74
	4.6%	0.00074	0.93090									
WE15H1	3.8%	0.00072	0.93295		4.5%	0.00078	0.93614		5.0%	0.00074	0.92470	
	3.8%	0.00070	0.93213	-0.82	4.5%	0.00075	0.93689	0.69	5.0%	0.00072	0.92569	0.96
WE15H2	4.0%	0.00077	0.93454		4.7%	0.00072	0.93520		5.0%	0.00071	0.91355	
	4.0%	0.00074	0.93465	0.10	4.7%	0.00070	0.93439	-0.81	5.0%	0.00076	0.91163	-1.85
WE17H1	3.7%	0.00074	0.92921		4.4%	0.00076	0.93628		5.0%	0.00070	0.93402	
	3.7%	0.00075	0.92991	0.66	4.4%	0.00070	0.93500	-1.24	5.0%	0.00072	0.93484	0.82
WE17H2	4.0%	0.00073	0.93415		4.7%	0.00071	0.93342		5.0%	0.00071	0.91309	
	4.0%	0.00072	0.93379	-0.35	4.7%	0.00074	0.93522	1.76	5.0%	0.00072	0.91258	-0.50

Table 6.7.8-4 DFC Missing Rod Study

# Missing Rods	Reactivity			
	k_{eff}	σ	$k_{eff} + 2\sigma$	$\Delta k/\sigma$
0	0.93574	0.00072	0.93718	-
1	0.9357	0.0007	0.93710	-0.08
4	0.93565	0.00075	0.93715	-0.03
8	0.93526	0.00072	0.93670	-0.47
12	0.93574	0.00071	0.93716	-0.02
16	0.93492	0.00075	0.93642	-0.73
20	0.93544	0.0007	0.93684	-0.34
32	0.93535	0.00075	0.93685	-0.32
50	0.93334	0.00067	0.93468	-2.54

Table 6.7.8-5 Sample DFC Fuel Mixture Height Study Results

Assembly Type	Mixture Height Percent DFC Cavity	Minimum 1500 ppm B Max. Initial Enrichment (wt% ^{235}U)	Reactivity $k_{eff} + 2\sigma$	Minimum 2000 ppm B Max. Initial Enrichment (wt% ^{235}U)	Reactivity $k_{eff} + 2\sigma$	Minimum 2500 ppm B Max. Initial Enrichment (wt% ^{235}U)	Reactivity $k_{eff} + 2\sigma$
BW15H1	50	3.7%	0.93203	4.4%	0.93744	5.0%	0.93465
	60	3.7%	0.93267	4.3%	0.93287	4.9%	0.93410
	70	3.7%	0.93273	4.3%	0.93553	4.9%	0.93356
	80	3.7%	0.93300	4.3%	0.93461	4.9%	0.93303
	90	3.7%	0.93323	4.3%	0.93335	4.9%	0.93382
	100	3.7%	0.93212	4.3%	0.93387	4.9%	0.93372
BW17H1	50	3.7%	0.93527	4.3%	0.93451	4.9%	0.93511
	60	3.7%	0.93596	4.3%	0.93658	4.9%	0.93623
	70	3.6%	0.92912	4.3%	0.93688	4.9%	0.93675
	80	3.7%	0.93683	4.2%	0.93055	4.9%	0.93691
	90	3.7%	0.93517	4.2%	0.92919	4.9%	0.93694
	100	3.7%	0.93737	4.3%	0.93706	4.9%	0.93686
CE14H1	50	4.5%	0.93318	5.0%	0.91737	5.0%	0.88014
	60	4.5%	0.93691	5.0%	0.91876	5.0%	0.88041
	70	4.5%	0.93728	5.0%	0.91941	5.0%	0.88169
	80	4.5%	0.93586	5.0%	0.91827	5.0%	0.88088
	90	4.5%	0.93320	5.0%	0.91968	5.0%	0.88176
	100	4.5%	0.93383	5.0%	0.91738	5.0%	0.88101
CE16H1	50	4.4%	0.93480	5.0%	0.92518	5.0%	0.88682
	60	4.4%	0.93399	5.0%	0.92902	5.0%	0.88868
	70	4.4%	0.93472	5.0%	0.92689	5.0%	0.88974
	80	4.4%	0.93575	5.0%	0.92611	5.0%	0.88962
	90	4.4%	0.93515	5.0%	0.92598	5.0%	0.88946
	100	4.4%	0.93395	5.0%	0.92705	5.0%	0.89002
WE14H1	50	4.7%	0.93751	5.0%	0.90583	5.0%	0.86685
	60	4.7%	0.93750	5.0%	0.90787	5.0%	0.87013
	70	4.7%	0.93733	5.0%	0.90738	5.0%	0.87007
	80	4.7%	0.93717	5.0%	0.90915	5.0%	0.86996
	90	4.7%	0.93660	5.0%	0.90841	5.0%	0.86892
	100	4.7%	0.93717	5.0%	0.90721	5.0%	0.86698
WE15H1	50	3.8%	0.93095	4.5%	0.93691	5.0%	0.92753
	60	3.8%	0.93313	4.5%	0.93737	5.0%	0.93028
	70	3.8%	0.93436	4.5%	0.93735	5.0%	0.93016
	80	3.8%	0.93408	4.4%	0.93060	5.0%	0.92991
	90	3.8%	0.93436	4.4%	0.93150	5.0%	0.92964
	100	3.8%	0.93538	4.5%	0.93697	5.0%	0.92849
WE17H2	50	4.0%	0.93462	4.7%	0.93661	5.0%	0.91502
	60	3.9%	0.92899	4.6%	0.93299	5.0%	0.91658
	70	3.9%	0.92934	4.6%	0.93247	5.0%	0.91559
	80	4.0%	0.93563	4.6%	0.93343	5.0%	0.91805
	90	4.0%	0.93669	4.6%	0.93159	5.0%	0.91537
	100	3.9%	0.92870	4.7%	0.93653	5.0%	0.91664

Table 6.7.8-6 DFC Fuel Mixture Maximum Reactivity Height for 0.036 g/cm^2 ^{10}B – No Inserts

Assembly	Parameter	Minimum 1500 ppm	Minimum 1750 ppm	Minimum 2000 ppm	Minimum 2250 ppm	Minimum 2500 ppm
BW15H1	Enrichment	3.7%	4.0%	4.3%	4.6%	4.9%
	$k_{eff}+2\sigma$	0.93323	0.93439	0.93553	0.93571	0.93410
	Configuration	MIX90	MIX70	MIX70	MIX70	MIX60
BW15H2	Enrichment	3.6%	3.9%	4.2%	4.5%	4.8%
	$k_{eff}+2\sigma$	0.93147	0.93234	0.93312	0.93368	0.93355
	Configuration	MIX80	MIX80	MIX90	MIX80	MIX70
BW15H3	Enrichment	3.6%	3.9%	4.2%	4.5%	4.8%
	$k_{eff}+2\sigma$	0.93380	0.93398	0.93450	0.93518	0.93674
	Configuration	MIX80	MIX100	MIX90	MIX80	MIX80
BW15H4	Enrichment	3.8%	4.1%	4.4%	4.7%	5.0%
	$k_{eff}+2\sigma$	0.93650	0.93692	0.93368	0.93302	0.93165
	Configuration	MIX80	MIX90	MIX70	MIX70	MIX70
BW17H1	Enrichment	3.6%	3.9%	4.2%	4.5%	4.9%
	$k_{eff}+2\sigma$	0.92912	0.92805	0.93055	0.93166	0.93694
	Configuration	MIX70	MIX60	MIX80	MIX90	MIX90
CE14H1	Enrichment	4.5%	4.9%	5.0%	5.0%	5.0%
	$k_{eff}+2\sigma$	0.93728	0.93616	0.91968	0.90123	0.88176
	Configuration	MIX70	MIX70	MIX90	MIX60	MIX90
CE16H1	Enrichment	4.4%	4.7%	5.0%	5.0%	5.0%
	$k_{eff}+2\sigma$	0.93575	0.93022	0.92902	0.90938	0.89002
	Configuration	MIX80	MIX70	MIX60	MIX80	MIX100
WE14H1	Enrichment	4.7%	5.0%	5.0%	5.0%	5.0%
	$k_{eff}+2\sigma$	0.93751	0.92989	0.90915	0.88872	0.87013
	Configuration	MIX50	MIX60	MIX80	MIX80	MIX60
WE15H1	Enrichment	3.8%	4.1%	4.4%	4.7%	5.0%
	$k_{eff}+2\sigma$	0.93538	0.93541	0.93150	0.93075	0.93028
	Configuration	MIX100	MIX70	MIX90	MIX80	MIX60
WE15H2	Enrichment	3.9%	4.3%	4.6%	5.0%	5.0%
	$k_{eff}+2\sigma$	0.93365	0.93581	0.93464	0.93720	0.91729
	Configuration	MIX70	MIX70	MIX70	MIX60	MIX70
WE17H1	Enrichment	3.7%	4.0%	4.3%	4.6%	4.9%
	$k_{eff}+2\sigma$	0.93327	0.93385	0.93517	0.93304	0.93417
	Configuration	MIX80	MIX90	MIX70	MIX90	MIX90
WE17H2	Enrichment	3.9%	4.3%	4.6%	5.0%	5.0%
	$k_{eff}+2\sigma$	0.92934	0.93490	0.93343	0.93722	0.91805
	Configuration	MIX70	MIX70	MIX80	MIX70	MIX80

Table 6.7.8-7 DFC Fuel Mixture Maximum Reactivity Height for 0.036 g/cm^2 ^{10}B – Inserts

Assembly	Parameter	Minimum 1500 ppm	Minimum 1750 ppm	Minimum 2000 ppm	Minimum 2250 ppm	Minimum 2500 ppm
BW15H1	Enrichment	3.7%	4.0%	4.3%	4.6%	4.9%
	$k_{eff}+2\sigma$	0.93185	0.93353	0.93536	0.93570	0.93666
	Configuration	MIX70	MIX90	MIX80	MIX70	MIX100
BW15H2	Enrichment	3.7%	3.9%	4.2%	4.5%	4.8%
	$k_{eff}+2\sigma$	0.93732	0.92857	0.93295	0.93446	0.93579
	Configuration	MIX80	MIX100	MIX80	MIX80	MIX70
BW15H3	Enrichment	3.6%	3.9%	4.2%	4.5%	4.8%
	$k_{eff}+2\sigma$	0.92862	0.93150	0.93343	0.93497	0.93723
	Configuration	MIX80	MIX70	MIX80	MIX100	MIX80
BW15H4	Enrichment	3.8%	4.1%	4.4%	4.7%	5.0%
	$k_{eff}+2\sigma$	0.93574	0.93435	0.93620	0.93567	0.93522
	Configuration	MIX70	MIX70	MIX80	MIX70	MIX70
BW17H1	Enrichment	3.7%	4.0%	4.3%	4.5%	4.8%
	$k_{eff}+2\sigma$	0.93562	0.93574	0.93608	0.93184	0.93432
	Configuration	MIX70	MIX70	MIX80	MIX80	MIX70
CE14H1	Enrichment	4.4%	4.8%	5.0%	5.0%	5.0%
	$k_{eff}+2\sigma$	0.93160	0.93612	0.92831	0.91230	0.89638
	Configuration	MIX80	MIX70	MIX70	MIX60	MIX80
CE16H1	Enrichment	4.4%	4.7%	5.0%	5.0%	5.0%
	$k_{eff}+2\sigma$	0.93572	0.93177	0.93160	0.91441	0.89748
	Configuration	MIX80	MIX80	MIX70	MIX70	MIX90
WE14H1	Enrichment	4.8%	5.0%	5.0%	5.0%	5.0%
	$k_{eff}+2\sigma$	0.93667	0.92601	0.90543	0.88775	0.86940
	Configuration	MIX90	MIX60	MIX80	MIX70	MIX70
WE15H1	Enrichment	3.8%	4.1%	4.4%	4.7%	5.0%
	$k_{eff}+2\sigma$	0.93169	0.93364	0.93274	0.93291	0.93317
	Configuration	MIX70	MIX80	MIX70	MIX70	MIX100
WE15H2	Enrichment	4.0%	4.3%	4.6%	4.9%	5.0%
	$k_{eff}+2\sigma$	0.93503	0.93522	0.93350	0.93434	0.92239
	Configuration	MIX90	MIX80	MIX90	MIX80	MIX90
WE17H1	Enrichment	3.8%	4.1%	4.4%	4.7%	4.9%
	$k_{eff}+2\sigma$	0.93430	0.93452	0.93541	0.93710	0.93099
	Configuration	MIX90	MIX70	MIX70	MIX80	MIX90
WE17H2	Enrichment	4.0%	4.3%	4.7%	5.0%	5.0%
	$k_{eff}+2\sigma$	0.93202	0.93278	0.93680	0.93721	0.91961
	Configuration	MIX60	MIX80	MIX80	MIX90	MIX70

Table 6.7.8-8 DFC Partial Flooding Mixture Moderator Density Study (BW Fuel 3.7 wt % ^{235}U, 1500 ppm B)

Mixture Fraction of DFC Cavity	Water Density in Fuel/Water Mixture							
	0.9982 g/cm³		0.9 g/cm³		Δ to 0.9982 g/cm³	0.8 g/cm³		Δ to 0.9982 g/cm³
	$k_{eff}+2\sigma$	σ	$k_{eff}+2\sigma$	σ	$\Delta k/\sigma$	$k_{eff}+2\sigma$	σ	$\Delta k/\sigma$
25%	0.92697	0.00071	0.92642	0.00070	-0.6	0.92611	0.00072	-0.9
30%	0.92726	0.00070	0.92584	0.00074	-1.4	0.92685	0.00071	-0.4
40%	0.92924	0.00074	0.92973	0.00075	0.5	0.92986	0.00074	0.6
50%	0.93155	0.00072	0.93056	0.00070	-1.0	0.92967	0.00071	-1.9
60%	0.93286	0.00073	0.93171	0.00069	-1.1	0.93009	0.00072	-2.7
70%	0.93492	0.00074	0.93173	0.00072	-3.1	0.93192	0.00069	-3.0
80%	0.93351	0.00074	0.93300	0.00072	-0.5	0.93167	0.00073	-1.8
90%	0.93485	0.00071	0.93417	0.00073	-0.7	0.93347	0.00071	-1.4
100%	0.93212	0.00075	0.93181	0.00073	-0.3	0.93161	0.00075	-0.5

Table 6.7.8-9 PWR Damaged Fuel Storage Cask Analyses Results (BW Fuel 5.0 wt % ^{235}U)

Water Density (g/cm³)				0 ppm B	Reactivity
			DFC	Max. Initial	
Interior	Exterior	Inside DFC	Configuration	Enrichment	
				(wt% ^{235}U)	$k_{eff} + 2\sigma$
0.0001	0.0001	0.0001	IAA	5.0%	0.48727
0.0001	0.0001	0.0001	URA	5.0%	0.48578
0.0001	0.0001	0.0001	MIX50	5.0%	0.49142
0.0001	0.0001	0.0001	MIX60	5.0%	0.49042
0.0001	0.0001	0.0001	MIX70	5.0%	0.48882
0.0001	0.0001	0.0001	MIX80	5.0%	0.48578
0.0001	0.0001	0.0001	MIX90	5.0%	0.48614
0.0001	0.0001	0.0001	MIX100	5.0%	0.48210
0.0001	0.9982	0.0001	IAA	5.0%	0.48064
0.0001	0.9982	0.0001	URA	5.0%	0.48140
0.0001	0.9982	0.0001	MIX50	5.0%	0.48211
0.0001	0.9982	0.0001	MIX60	5.0%	0.48014
0.0001	0.9982	0.0001	MIX70	5.0%	0.48015
0.0001	0.9982	0.0001	MIX80	5.0%	0.48030
0.0001	0.9982	0.0001	MIX90	5.0%	0.47815
0.0001	0.9982	0.0001	MIX100	5.0%	0.47796

Notes:
IAA - undamaged assembly
URA - unclad rod array
MIX - fuel mixture cases (in the context of storage analysis various fissle material heights; no moderator)

Table 6.7.8-10 PWR Damaged Fuel Assembly Allowable Loading (Enrichment/Soluble Boron Limits)

	Max. Initial Enrichment (wt % ^{235}U)														
	Absorber[a] 0.036 ^{10}B g/cm^2					Absorber[a] 0.030 ^{10}B g/cm^2					Absorber[a] 0.027 ^{10}B g/cm^2				
Soluble Boron	1500 (ppm)	1750 (ppm)	2000 (ppm)	2250 (ppm)	2500 (ppm)	1500 (ppm)	1750 (ppm)	2000 (ppm)	2250 (ppm)	2500 (ppm)	1500 (ppm)	1750 (ppm)	2000 (ppm)	2250 (ppm)	2500 (ppm)
BW15H1	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	3.9%	4.2%	4.5%	4.7%	3.6%	3.8%	4.1%	4.4%	4.7%
BW15H2	3.6%	3.9%	4.2%	4.5%	4.8%	3.6%	3.8%	4.1%	4.4%	4.7%	3.5%	3.8%	4.1%	4.3%	4.6%
BW15H3	3.6%	3.9%	4.2%	4.5%	4.8%	3.5%	3.8%	4.1%	4.4%	4.6%	3.5%	3.8%	4.0%	4.3%	4.6%
BW15H4	3.8%	4.1%	4.4%	4.7%	5.0%	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	3.9%	4.2%	4.5%	4.8%
BW17H1	3.6%	3.9%	4.2%	4.5%	4.8%	3.6%	3.9%	4.1%	4.4%	4.7%	3.5%	3.8%	4.1%	4.4%	4.6%
CE14H1	4.4%	4.8%	5.0%	5.0%	5.0%	4.3%	4.7%	5.0%	5.0%	5.0%	4.3%	4.6%	4.9%	5.0%	5.0%
CE16H1	4.4%	4.7%	5.0%	5.0%	5.0%	4.2%	4.6%	5.0%	5.0%	5.0%	4.2%	4.5%	4.9%	5.0%	5.0%
WE14H1	4.6%	5.0%	5.0%	5.0%	5.0%	4.5%	5.0%	5.0%	5.0%	5.0%	4.5%	4.9%	5.0%	5.0%	5.0%
WE15H1	3.8%	4.1%	4.4%	4.7%	5.0%	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	4.0%	4.3%	4.6%	4.8%
WE15H2	3.9%	4.3%	4.6%	4.9%	5.0%	3.8%	4.2%	4.5%	4.8%	5.0%	3.8%	4.1%	4.4%	4.7%	5.0%
WE17H1	3.7%	4.0%	4.3%	4.6%	4.9%	3.6%	3.9%	4.2%	4.5%	4.8%	3.6%	3.9%	4.2%	4.5%	4.8%
WE17H2	3.9%	4.3%	4.6%	5.0%	5.0%	3.9%	4.2%	4.5%	4.9%	5.0%	3.8%	4.1%	4.5%	4.8%	5.0%

[a] Borated aluminum neutron absorber sheet effective areal ^{10}B density.

6. Fill the TSC with clean or pool water. For PWR spent fuel contents, the soluble boron concentration in the TSC shall be verified and monitored in accordance with the LCO 3.2.1.
7. Attach the lift yoke to a crane suitable for handling the loaded TSC, transfer cask and yoke. Position the lift yoke over the transfer cask and engage it with the two transfer cask trunnions.
   Note: The temperature of the transfer cask (surrounding ambient air temperature) must be verified to be at or above the minimum operating temperature of 0°F, per Section 4.3.1.f. of the Technical Specifications (not applicable to the stainless steel MTC2 design).
8. Lift the transfer cask containing the empty TSC and move it to the spent fuel pool following the prescribed load path.
   Note: An optional protective cover, attached to the bottom of the transfer cask, may be used to prevent imbedding contaminated particles in the shield doors and door rails.
9. Connect the clean water lines to the lower annulus fill ports of the transfer cask. Ensure that the unused ports are closed or capped to prevent pool water in-leakage.
10. Lower the transfer cask to the pool surface and turn on the clean water supply lines to the lower annulus fill ports to fill the transfer cask/TSC annulus.
    Note: Sequence on connection and filling/draining transfer cask/TSC annulus is at the discretion of the user based on approved site-specific procedures.
11. Spray the transfer cask and lift yoke with clean water to wet the exposed surfaces.
    Note: Wetting the components that enter the spent fuel pool and spraying the components leaving the pool will reduce the effort required to decontaminate the components.
12. Lower the transfer cask as the annulus fills with clean water until the upper annulus fill ports are accessible. Hold this position and connect the clean water annulus fill lines to the upper fill ports. Ensure the unused ports are closed or capped to prevent pool water in-leakage.
13. Lower the transfer cask to the bottom of the pool in the cask loading area.
14. Disengage the lift yoke and visually verify that the lift yoke is fully disengaged. Remove the lift yoke from the spent fuel pool while spraying the yoke and crane cables with clean water.
15. Load the previously selected fuel assemblies into the TSC basket.
    Note: The fuel assemblies shall be selected in compliance with the requirements of the approved contents specified in Appendix B of the Technical Specifications and the boron concentration limits of the Technical Specifications, including limitations on fuel assembly positions within the basket. Specific fuel assembly positions for preferential and zoned loading patterns shall be in full compliance with the requirements of Appendix B of the Technical Specifications. Assembly selection, placement and compliance with preferential zone loading patterns within the basket shall be independently verified.

Note: Up to four DFCs containing authorized PWR contents may be loaded in a TSC with a DF Basket Assembly. A DFC spacer is required to be positioned in the Designated DF Basket Assembly corner locations for the shorter length DFCs. Independently, visually verify proper placement and correct orientation of each required DFC spacer.

Note: At the option of the user, install fuel assembly spacers for the axial positioning of the PWR fuel assembly types to be loaded. Verify spacer identification and install fuel spacers in each intended fuel loading location based on the fuel spacer plan prepared, which is based on the fuel assembly inventory and nonfuel hardware to be loaded. Independently, visually verify proper placement and correct orientation of each required fuel spacer.

16. Visually verify the fuel assembly (and DFC, as applicable) identifications to confirm the serial numbers match the approved fuel-loading pattern.
17. Install three swivel hoist rings hand tight in the three closure lid lifting holes or in three of the six TSC lift holes. Install a three-legged sling set to the hoist rings and connect the sling set to the crane hook or the attachment point on the lift yoke.

    Note: At the discretion of the user, the closure lid can be attached to the lift yoke and the lid installed during the lowering of the lift yoke.
18. Raise the closure lid. Adjust closure lid rigging to level the closure lid.
19. Move the closure lid over the spent fuel pool and align the lift yoke (if used) to the transfer cask trunnions and align the closure lid to the match marks of the TSC.
20. Lower the closure lid until it enters the TSC and seats in the top of the TSC. Visually verify closure lid alignment using the match marks (± ½ inch).

    Caution: Following closure lid installation, there is a thermal time limit of 18 hours to begin the Annulus Circulating Water System (ACWS), or approved alternative annulus flow system operation, and to begin temperature measurement of the MTC annulus outlet flow to verify MTC outlet temperature is maintained < 113°F. If ACWS flow cannot be initiated in the time allowed, return the MTC to the spent fuel pool and remove the closure lid to allow cooling by the spent fuel pool water.
21. Allow sling cables to go slack and move the lift yoke into position to engage the transfer cask trunnions. Engage the lift yoke to the trunnions, apply a slight tension, and visually verify engagement.
22. Raise the transfer cask until its top clears the pool surface. Visually verify that the closure lid is properly seated. If necessary, lower the transfer cask and reinstall the closure lid. Rinse the lift yoke and transfer cask with clean water as the equipment is removed from the pool.
23. Rinse and flush the top of the transfer cask and TSC with clean water as necessary to remove any radioactive particles. Survey the top of the TSC closure lid and the top of the transfer cask to check for radioactive particles.

10.1.2.3 Pressure Testing of the TSC

Following completion of the closure lid-to-TSC shell weld during the TSC preparation operations after fuel loading, the TSC shall be hydrostatically pressure tested at not less than 125% of the design pressure of 110 psig in accordance with ASME Code, Section III, Subsection NB, NB-6200 requirements as described and defined in Section 9.1.1. A bounding minimum test pressure of 150 psig shall be applied to the drain port connection for a minimum 10-minute hold period. There shall be no visible water leakage from the closure lid-to-TSC shell weld based on visual examination of the weld after a minimum 10-minute hold period, while maintaining the test pressure. Test pressure shall be maintained until the completion of the visual weld examination. The design pressure and minimum test pressure are identical for both PWR and BWR TSCs. The minimum test pressure conservatively exceeds the hydrostatic test pressure commitment stated in Table 2.1-2 (125% of MNOP).

10.1.2.4 Load Testing of Damaged Fuel Can (DFC)

To qualify the design of the MAGNASTOR DFC, the first DFC to be provided to a user shall be load tested to 150% of the total weight of the DFC plus the heaviest contents to be loaded in the DFC. The test load on the DFC shall be applied and held for a minimum of 10 minutes. Following completion of the load test, all load bearing welds and surfaces shall be visually inspected for permanent deformation, galling or cracking. Load bearing welds shall be inspected using liquid penetrant examination in accordance with ASME Code, Section V, Article 6. Acceptance criteria shall be in accordance with ASME Code, Section III, NG-5350.

Any evidence of permanent deformation, cracking or galling of load bearing surfaces, or unacceptable liquid penetrant examination results shall be cause for rejection, repair, reperformance of the load test and reexamination of the DFC.

10.1.3 Leakage Tests

The confinement boundary is defined as the TSC shell weldment, closure lid assembly, and vent and drain port covers. As described in Section 10.1.1, the confinement boundary is designed, fabricated, examined, and tested in accordance with the requirements of the ASME Code, Section III, Subsection NB, except for the code alternatives listed in Table 2.1-2.

At the completion of the TSC shell weldment confinement boundary welds (e.g., TSC shell seam and shell to bottom plate), the TSC shell weldment shall be leakage tested. The leakage test shall be performed in accordance with the requirements and approved methods of ASME Code, Section V, Article 10, and ANSI N14.5-1997 [20] to confirm the total leakage rate is less than, or equal to, 1×10^{-7} ref. cm^3/s (i.e., leaktight). The sensitivity of the test shall be one-half of the acceptance test criteria as specified in ANSI N14.5-1997.

The TSC shell weldment will be closed using a test lid installed over the top of the shell and the cavity evacuated. A test envelope will be installed around the TSC enclosing all of the TSC shell confinement welds and base metal plates, and filled with 99.995% (minimum) pure helium to an acceptable test concentration. The percentage of helium gas in the test envelope shall be accounted for in the determination of the test sensitivity. A mass spectrometer leak detector (MSLD) will be used to sample the evacuated volume for helium.

If helium leakage is detected, the area of leakage shall be identified, repaired and re-examined in accordance with the ASME Code, Section III, Subsection NB, NB-4450 or NB-4130, as appropriate. Following repair, the complete helium leakage test shall be re-performed to the original test acceptance criteria.

Leakage testing of the TSC shell weldment shall be performed in accordance with written and approved procedures, and the test results documented.

Based on the confinement system materials, welding requirements and inspection methods, shop helium leakage testing of the 9-inch thick closure lid is not required. However, due to the reduced thickness of the stainless steel closure lid (4-inch thick base material) of the composite closure lid assembly, and the presence of extended bolt holes for attachment of the shield plate assembly, a shop helium leakage test of the composite closure lid stainless steel plate shall be performed following fabrication. The leakage test shall be performed in accordance with the requirements and approved methods of ASME Code, Section V, Article 10, and ANSI N14.5-1997 to confirm the total leakage rate is less than, or equal to, 1 ± 10^{-7} cm^3/s (i.e., leaktight).. The sensitivity of the test shall be one-half of the acceptance test criteria as specified in ANSI N14.5-1997.

If leakage is detected, the area of leakage shall be identified, repaired and re-examined in accordance with ASME Code, Section III, Subsection NB, NB-4130. Following repair and completion of required NDE, the helium leak test shall be re-performed to the original test acceptance criteria.

Leakage testing of the composite closure lid shall be performed in accordance with written and approved procedures, and the test results documented.

In order to ensure the integrity of the vent and drain inner port cover welds, a helium leakage test of each weld is performed following welding of the inner port covers to the closure lid assembly using the evacuated envelope method, as described in ASME Code, Section V, Article 10, and ANSI N14.5. The leakage test is to confirm that the leakage rate for each port cover is $\leq 2\times10^{-7}$ cm^3/s helium. Following inner port cover welding, a test bell is installed over the top of the port cover and the test bell volume is evacuated to a low pressure by a helium MSLD system. The