CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIAL PACKAGES

1. a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. DOCKET NUMBER	d. PACKAGE IDENTIFICATION NUMBER	PAGE	PAGES
9356	6	71-9356	USA/9356/B(U)F-96	1 OF	42

2. PREAMBLE

   a. This certificate is issued to certify that the package (packaging and contents) described in Item 5 below meets the applicable safety standards set forth in Title 10, *Code of Federal Regulations*, Part 71, "Packaging and Transportation of Radioactive Material."

   b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. ISSUED TO *(Name and Address)*

NAC-International
2 Sun Court, Suite 220
Peachtree Corners, GA 30092

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION

NAC International, Inc., application dated August 13, 2025.

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.

(a) Packaging

(1) Model No.: MAGNATRAN

(2) Description:

The MAGNATRAN package is canister-based and is part of a dual-purpose system for the storage and transportation of spent nuclear fuel for transporting the MAGNASTOR® transportable storage canister (TSC). The MAGNATRAN packaging includes the package body, upper and lower impact limiters, and TSC. The package body consists of the inner and outer shells, lead and upper forging, lid, bottom plate, bottom forging and solid neutron shield.

Leakage testing of the package containment seals, in conjunction with the post-fabrication leakage testing of the entire containment boundary, assures that the containment is leaktight. The TSC may be credited for moderator exclusion, thus serving the function of being a special design feature, as required by 10 CFR 71.55(c), that prevents a single packing error from permitting leakage into the fissile material region. Regardless of credit applied to the TSC confinement boundary to prevent water in leakage, the containment function is retained by the transport package body.

The packaging body is a cylinder with multiwall construction consisting of inner and outer stainless steel shells separated by a lead gamma radiation shielding. The inner and outer stainless steel shells are 1.75 and 2.25 inches thick, respectively. The lead gamma shield is 3.2 inches thick. Welded above the inner and outer steel shells is the upper forging. The upper forging is 7.2 inches thick where it attaches to the inner and outer shells.

5.(a)(2) Description (continued)

The bottom of the package body consists of the bottom inner forging, the bottom outer forging and the bottom plate. The bottom inner forging is cup shaped and welded to the inner shell and the bottom forging. The ring-shaped bottom outer forging is welded to the outer shell and to the bottom plate. The bottom plate is welded onto the outer ring. The bottom inner forging is 5 inches thick and the bottom plate is 8.65 inches thick for a total of 13.65 inches of stainless steel shielding through the bottom.

The package lid is a 7.75-inch-thick stainless steel disk used to close the package. The lid is attached to the top forging by forty-eight, 2-8 UN-2A socket head cap screws. The socket head cap screws screw into the tapped holes in the upper forging. The package lid is sealed by two concentric O-rings, as is the coverplate for the lid port, using inner metallic and outer ethylene propylene diene monomer (EPDM) O-rings. The MAGNATRAN package contains a lid port that is closed by a bolted Type 304/304L stainless steel coverplate with dual O-rings. There are four stainless steel coverplate bolts. The lid port provides access to the port opening and the quick-disconnect fitting for backfilling and sampling the cavity gas during loading and unloading.

The neutron shield is comprised of NS-4-FR encased in stainless steel enclosures. The neutron shield material and its enclosure have two thicknesses, 5.8 inches and 6.4 inches, and is attached onto the outer shell along the length of the active fuel region around the circumference of the package cavity.

Two diametrically opposite lifting trunnions are bolted to the outside of the top forging to lift the transport package. Prior to transport, the lifting trunnions are removed and replaced with trunnion plugs. Two rotation trunnions are located on the outer shell near the bottom of the package to permit rotation between the horizontal and vertical positions and to provide longitudinal tiedown restraint in the aft direction. The rotation trunnions are located approximately 5 inches off the cask centerline to ensure that the cask rotates in the proper direction.

A cavity spacer is used for the short TSCs to locate and support the canister and to minimize excessive longitudinal movement in the transport cask cavity, which is sized to accommodate the long TSC.

The MAGNATRAN package has cup-shaped impact limiters, consisting of a combination of redwood and balsa wood encased in a stainless-steel shell. The impact limiters are bolted over each end of the package to limit the g-loads acting on the package during a package drop event. The impact limiters are attached to the lid and bottom plate via 16 tapped holes for retaining rods and nuts.

5.(a)(2) Description (continued)

The TSC is constructed of a stainless steel cylindrical shell, bottom-end plate, closure lid, closure ring, and redundant port covers. The TSC confines the fuel basket structure and the spent fuel or the Greater-Than-Class C (GTCC) waste basket liner and GTCC waste. The TSC cylindrical shell is dual certified 304/304L stainless steel with a 72-inch diameter and is ½ inch thick and either 191.8 or 184.8 inches long, depending on the contents. The bottom end plate is welded onto the lower end of the TSC shell and is 2.75 inches thick. The closure lid is 9 inches thick and is either a solid stainless steel closure lid or stainless steel/carbon steel closure lid. The closure lid is welded onto the upper end of the TSC shell. The dual port covers provide a dual-welded closure system for the vent and drain ports. The GTCC TSC is similar in design and construction to the TSC's for spent fuel, but instead of a basket, it contains a GTCC waste liner.

The PWR fuel basket design is an arrangement of 21 square, stainless steel fuel tubes held in a right-circular cylinder configuration by side and corner support weldments that are bolted to the outer fuel tubes. The 21 tubes develop 37 positions within the basket for the PWR spent fuel. Each PWR basket fuel tube has a nominal 8.86-inch square opening. Each developed cell fuel position has a nominal 8.76-inch square opening. The fuel tubes support an enclosed neutron absorber sheet on up to four interior sides of the fuel tube. Each neutron absorber sheet is covered by a thin stainless steel sheet to protect the neutron absorber during fuel loading and to keep it in position. The neutron absorber and stainless steel cover are secured to the fuel tube using weld posts distributed across the width and along the length of the fuel tube.

The PWR damaged fuel basket is designed to store up to four damaged fuel cans in the damaged fuel basket assembly in the short TSC. The damaged fuel basket assembly has a capacity of up to 37 undamaged PWR fuel assemblies, which includes the four damaged fuel can locations. A damaged fuel can may be placed in each of the four damaged fuel can basket locations. The arrangement of tubes and fuel positions is the same as in the standard fuel basket, but the design of each of the four corner support weldments is modified with additional structural support to provide an enlarged position for a damaged fuel can at the outermost corners of the fuel basket. Each damaged fuel can location has a nominal 9.80-inch square opening. A damaged fuel can, or an undamaged fuel assembly may be loaded in a damaged fuel can location.

Similar to the PWR basket, the BWR basket consists of 45 stainless steel fuel tubes that develop 87 basket locations for the BWR spent fuel. Each BWR basket fuel tube has a nominal 5.86-inch square opening. Each developed cell fuel position has a nominal 5.77-inch square opening. The BWR basket fuel tubes are held in a right-circular cylinder configuration by side and corner support weldments that are bolted to the outer fuel tubes. The fuel tubes support an enclosed neutron absorber sheet on up to four interior sides of the fuel tube for criticality control. Each neutron absorber sheet is covered by a sheet of stainless steel to protect the neutron absorber during fuel loading and to keep it in position. The neutron absorber and stainless steel cover are secured to the fuel tube using weld posts distributed across the width and along the length of the fuel tube.

5.(a)(2) Description (Continued)

The damaged fuel can confines the fuel material within the can to minimize the potential for dispersal of the fuel material into the TSC cavity. The side plates that form the upper end of the damaged fuel can are 0.15-in thick and the tube body walls are 0.048-in thick (18-gage sheet). The damaged fuel can lid plate and bottom thicknesses total 11/16 inches and the lid overall height is 2.32 inches. The damaged fuel can bottom plate thickness is 5/8 (0.625) inch. The damaged fuel can is designed in two lengths: an overall length of 166.9 inches with a nominal cavity length of 164.0 inches; or an overall length of 171.8 inches with a nominal cavity length of 169.0 inches (shorter fuel assemblies may be accommodated with a fuel assembly spacer to limit axial movement). For the shorter damaged fuel can, a spacer is used in the damaged fuel basket assembly or alternatively fixed to the damaged fuel can bottom plate to provide an overall height of 171.5 inches. The damaged fuel can (DFC) lid and bottom include screened drain holes.

The stainless steel GTCC waste basket liner is designed to hold GTCC waste and dimensionally fit in a TSC. The GTCC waste basket liner is 173 inches long with a 1-inch-thick bottom plate welded onto it. The GTCC liner stainless steel shell is 2 inches thick for structural and gamma shield functions and has lifting lugs welded on the inside diameter of the shell. The liner design also includes an outer ring and a middle support under the bottom plate and drain holes in the bottom plate to facilitate free flow drainage from the liner. The GTCC TSC includes a sump location in the bottom plate and the closure lid includes a drain tube assembly to enable draining and drying of the loaded TSC.

The package has approximate dimensions and weight as follows:

Cavity diameter	72 inches
Cavity length	193 inches
Package body outer diameter	87 inches
Impact limiter diameter	128 inches
Package length	
without impact limiters	214 inches
with impact limiters	322 inches

The maximum gross weight of the package is about 312,000 lbs.

5.(a)(3) Drawings

The MAGNATRAN package is constructed and assembled in accordance with NAC drawings:

71160-500, Rev. 6P	Shipping Configuration, Transport Cask, MAGNATRAN
71160-501, Rev. 0	Assembly, Transport Cask, MAGNATRAN
71160-502, Rev. 6P	Transport Cask Body, MAGNATRAN
71160-504, Rev. 2	Misc. Details, Transport Cask, MAGNATRAN
71160-505, Rev. 6P	Lid Assembly, Transport Cask, MAGNATRAN

5.(a)(3) Drawings (Continued)

71160-506, Rev. 1	Cask Cavity Spacer, MAGNATRAN
71160-511, Rev. 1	Personnel Barrier, Shipping Configuration, Transport Cask, MAGNATRAN
71160-512, Rev. 1	Nameplate, MAGNATRAN
71160-530, Rev. 1	Misc. Details, Impact Limiter, MAGNATRAN
71160-531, Rev. 2P	Impact Limiter, Transport Cask, MAGNATRAN
71160-551, Rev. 10P	Fuel Tube Assembly, MAGNASTOR - 37 PWR
71160-559, Rev. 0	Lifting Trunnion, Transport Cask, MAGNATRAN
71160-571, Rev. 10P	Details, Neutron Absorber, Retainer, MAGNASTOR – 37 PWR
71160-572, Rev. 9P	Details, Neutron Absorber, Retainer, MAGNASTOR – 87 BWR
71160-574, Rev. 6	Basket Support Weldments, MAGNASTOR - 37 PWR
71160-575, Rev. 11P	Basket Assembly, MAGNASTOR - 37 PWR
71160-581, Rev. 5	Shell Weldment, TSC, MAGNASTOR
71160-584, Rev. 8	Details, TSC, MAGNASTOR
71160-585, Rev. 13	TSC Assembly, MAGNASTOR
71160-591, Rev. 8P	Fuel Tube Assembly, MAGNASTOR - 87 BWR
71160-598, Rev. 7P	Basket Support Weldments, MAGNASTOR - 87 BWR
71160-599, Rev. 8P	Basket Assembly, MAGNASTOR - 87 BWR
71160-600, Rev. 5P	Basket Assembly, MAGNASTOR - 82 BWR
71160-601, Rev. 0	Damaged Fuel Can (DFC), Assembly, MAGNASTOR
71160-602, Rev. 1	Damaged Fuel Can (DFC), Details, MAGNASTOR
71160-620, Rev. 1P	Top Fuel Spacer, MAGNASTOR
71160-671, Rev. 2P	Details, Neutron Absorber, Retainer, For DF [Damaged Fuel] Corner Weldment, MAGNASTOR - 37 PWR
71160-673, Rev. 1	Damaged Fuel Can (DFC), Spacer, MAGNASTOR
71160-674, Rev. 4P	DF Corner Weldment, MAGNASTOR
71160-675, Rev. 3P	DF Basket Assembly, 37 Assembly PWR, MAGNASTOR
71160-681, Rev. 1	DF, Shell Weldment, TSC, MAGNASTOR
71160-684, Rev. 2	Details, DF Closure Lid, MAGNASTOR
71160-685, Rev. 8	DF, TSC Assembly, MAGNASTOR
71160-711, Rev. 1	GTCC Waste Basket Liner, MAGNASTOR
71160-781, Rev. 1	Shell Weldment, GTCC TSC, MAGNASTOR
71160-785, Rev. 4	GTCC TSC, Assembly, MAGNASTOR

5.(b) Contents

(1) Type and Form of Material

(i) Undamaged PWR assemblies

Undamaged PWR fuel assemblies within the 37 PWR basket assembly. Undamaged fuel is spent nuclear fuel that does not have any visible deformation other than uniform bowing that occurs in the reactor, assemblies that do not have missing rods, and assemblies with missing rods that are replaced by solid stainless steel or zirconium filler rods that displace a volume equal to or greater than the original rods and assemblies

5.(b)(1)(i) Contents - Type and Form of Material (continued)

that do not contain structural defects that adversely affect radiological and/or criticality safety and/or result in unsupported fuel rod lengths in excess of 60 inches and that can be handled by normal means. Undamaged PWR fuel is loaded into the short TSC, except for Combustion Engineering (CE) 16×16 fuel assemblies, which may be loaded into either length TSC.

The fuel assemblies consist of uranium dioxide pellets with zirconium alloy-clad fuel rods and zirconium alloy instrument and guide tubes. Empty fuel rod positions are to be filled with a solid filler rod or a solid neutron absorber rod. PWR fuel assemblies containing nonfuel hardware may be loaded in the TSC. Prior to irradiation, the fuel assemblies must be within the dimensions and specifications of the hybrid assemblies listed in Table 1. In addition, the PWR fuel must meet the fuel class assembly specifications listed in Table 2.

The burnup credit loading curve in Table 3, must be used for the 37 assembly loading profile. WE15x15 fuel may use the burnup credit loading curve in Table 4, with the 33, 35 or 36 assembly loading scheme provided the required cell locations for that profile shown in Figure 1 are left empty, at a minimum. Fuel assembly burnup, minimum initial average enrichment[1], and cool time requirements are provided in Table 9 and Table 11, for PWR baskets with Type 2 neutron absorbers and Table 12 and Table 14 for baskets with Type 1 neutron absorbers. Burnup credit curves are only applicable to systems not crediting moderator exclusion. Initial enrichment up to 5 weight percent (wt%) in the ^{235}U isotope, with no burnup requirement, is permitted when crediting moderator exclusion.

Unirradiated fuel and unenriched fuel are not authorized for loading, except that unenriched axial blankets are permitted, provided that the nominal length of the blanket is not greater than 6 inches. An unenriched rod may be used as a replacement rod to return a fuel assembly to an undamaged condition.

Undamaged PWR fuel assemblies may contain nonfuel hardware. Fuel assemblies with an instrument tube tie rod repair shall be loaded with fuel inserts and/or top spacers to ensure proper spacing and support of the fuel assembly. Fuel inserts and/or top spacers are not required when using the extended fuel tube basket because the top nozzle is adequately supported. The nonfuel hardware may be loaded as a complete assembly or as individual components, individual nonfuel rods may be full-length rods or partial-length rods/rodlets. Partial-length rods/rodlets are permitted in guide tubes provided guide tube plug devises are installed. Nonfuel hardware must meet the exposure and cool time or cobalt-60 activity requirements in Tables 6–8. Fuel assemblies loaded with nonfuel hardware must meet the additional cool time requirements in Table 5 (for Type 2 neutron absorbers), and Table 15 (for Type 1 neutron absorbers).

Hafnium absorber assemblies (HFRA) are only allowed for Westinghouse (WE) assemblies and may have a maximum exposure of 4.0 GWd/MTU and must have a minimum cool time of 16 years. Fuel assemblies may contain any number of unirradiated

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[1] Assembly average fuel enrichment is the enrichment value determined by averaging the ^{235}U wt% enrichment over the entire fuel region (UO_2) of an individual assembly, including axial blankets, if present.

5.(b)(1)(i) Contents - Type and Form of Material (continued)

nonfuel solid filler fuel replacement rods. Activated stainless steel fuel replacement rods are limited to 5 steel rods per assembly, 1 assembly per basket, and a maximum steel rod exposure of 32.5 GWd/MTU. Fuel assemblies with activated stainless steel rods must be cooled for either a minimum of 21 years or the loading table minimum cool time (as adjusted for additional cool times for nonfuel hardware, as applicable) plus 1 year, whichever is greater.

Fuel assemblies loaded with in-core instrument thimbles must meet the additional cool time requirements in Table 5 or Table 15, as appropriate, for burnable poison rod assemblies (BPRAs) or guide tube thimble plug devices (GTPDs), whichever is bounding, for Westinghouse and Babcock and Wilcox (B&W) fuel types and for reactor control components (RCCs) for CE fuel types. The additional cool time requirements for assemblies with nonfuel hardware are added to any additional cool time requirements due to damaged fuel also being loaded in the same TSC. RCCs are restricted to fuel storage locations 11, 12, 13, 18, 19, 20, 25, 26 and 27 in Figure 1. Only one neutron source assembly (NSA) is permitted to be loaded in a TSC in fuel storage locations 11, 12, 13, 18, 19, 20, 25, 26 or 27, as shown on Figure 1.

NSAs 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. NSAs, GTPDs, and BPRAs are not authorized for CE fuel assemblies. In addition, the following un-irradiated nonfuel hardware may be loaded with the fuel assemblies: stainless steel rods inserted to displace guide tube “dashpot” water, instrument tube tie components, and guide tube anchors or similar devices. Axial power shaping rods are not allowed contents.

Under-burned Westinghouse 15×15 assemblies (assemblies with a maximum enrichment greater than that dictated by the burnup credit loading curve) may be loaded provided that a RCCA is inserted in the assembly, the enrichment is equal to or less than 4.05 wt. % ^{235}U, and the assembly burnup is greater than or equal to 12,000 MWd/MTU. When loading under-burned fuel, the RCCAs must be full-length Ag-In-Cd RCCAs comprised of stainless steel clad rods constructed with 80% Ag, 15% In and 5% Cd absorber pellets and having an exposure equal to or less than 200,000 MWd/MTU. The basket must include absorber sheets with an effective ^{10}B areal density of 0.036 g/cm^2. Any assemblies loaded without an RCCA inserted must meet the burnup credit loading curve for the applicable assembly loading profile. Burnup credit curves, and the criticality need for RCCA insertion are only applicable to systems not crediting moderator exclusion. Initial enrichment up to 5 wt% ^{235}U, with no burnup requirement, is permitted when crediting moderator exclusion.

5.(b)(1)(i) Contents - Type and Form of Material (continued)

Table 1 — PWR Hybrid Fuel Assembly Characteristics

Vendor	Hybrid Assembly	Hybrid Group	Array	No. of Fuel Rods	No. of Guide Tubes (See Note 1)	Max Pitch (in.)	Min Clad OD (in.)	Min Clad Thick. (in.)	Max Pellet OD (in.)	Max Active Length (in.)	Max Load (MTU)
BW	BW15H1	H1	15x15	208	17	0.5680	0.4300	0.0265	0.3686	144.0	0.4807
BW	BW15H2	H2	15x15	208	17	0.5680	0.4300	0.0250	0.3735	144.0	0.4807
BW	BW15H3	H3	15x15	208	17	0.5680	0.4280	0.0230	0.3742	144.0	0.4807
BW	BW15H4	H4	15x15	208	17	0.5680	0.4140	0.0220	0.3622	144.0	0.4690
BW	BW17H1	H1	17x17	264	25	0.5020	0.3770	0.0220	0.3252	144.0	0.4681
CE	CE14H1	H1	14x14	176	5	0.5800	0.4400	0.0260	0.3805	137.0	0.4115
CE	CE16H1	H1	16x16	236	5	0.5063	0.3820	0.0250	0.3250	150.0	0.4463
WE	WE14H1	H1	14x14	179	17	0.5560	0.4000	0.0162	0.3674	145.2	0.4144
WE	WE15H1	H1	15x15	204	21	0.5630	0.4220	0.0242	0.3669	144.0	0.4671
WE	WE15H2	H2	15x15	204	21	0.5630	0.4170	0.0265	0.3570	144.0	0.4469
WE	WE17H1	H1	17x17	264	25	0.4960	0.3720	0.0205	0.3232	144.0	0.4671
WE	WE17H2	H2	17x17	264	25	0.4960	0.3600	0.0225	0.3088	144.0	0.4327

Notes:
1. Combined number of guide and instrument tubes.

5.(b)(1)(i) Contents - Type and Form of Material (continued)

Table 2 — PWR Fuel Class Assembly Characteristics

Characteristic	Fuel Class					
	14x14	14x14	15x15	15x15	16x16	17x17
Base Fuel Type[2]	CE, SPC	WE, SPC	WE, SPC	BW, FCF	CE	BW, SPC, WE, FCF
Max Initial Enrichment (wt. % ^{235}U)[3]	5.0	5.0	5.0	5.0	5.0	5.0
Min Initial Enrichment (wt. % ^{235}U)[3]	1.3	1.3	1.3	1.3	1.3	1.3
Number of Fuel Rods[4]	176	179	204	208	236	264
Max Assembly Average Burnup (MWd/MTU)[5]	60,000	60,000	60,000	60,000	60,000	60,000
Min Cool Time (years)	4	4	4	4	4	4
Max Weight per Storage Location (lbs.)	See Note 1	See Note 1	See Note 1	See Note 1	See Note 1	See Note 1
Max Decay Heat per Fuel Location (Watts)[6]	See Note 2	See Note 2	See Note 2	See Note 2	See Note 2	See Note 2

Notes:

1. Maximum weight per storage location is 1,765 lbs (weight includes spent fuel assembly, nonfuel hardware, damaged fuel cans and fuel spacers) with a maximum contents weight of 62,160 lbs for the PWR basket and 61,184 lbs for the damaged fuel basket[7]. The maximum nominal assembly length is 178.3 inches for assemblies in the long TSC and 167.0 inches for assemblies in the short TSC. The maximum nominal fuel width is 8.54 inches.
2. For PWR baskets with Type 2 thermal conductivity neutron absorbers, the maximum heat load is 622 watts per storage location (590.5 watts for maximum assembly average burnup >45,000 MWd/MTU), and for PWR baskets with Type 1 thermal conductivity neutron absorbers the maximum heat load is 595 watts per storage location (565 watts for maximum assembly average burnup >45,000 MWd/MTU). The heat load includes the contribution from the nonfuel hardware.

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[2] Indicates assembly and/or nuclear steam supply system vendor/type referenced for fuel input data. Fuel acceptability for loading is not restricted to the indicated vendor provided that the fuel assembly meets the load limits. Abbreviations are as follows: Westinghouse (WE), Combustion Engineering (CE), Siemens Power Corporation (SPC), Babcock and Wilcox (BW), and Framatome Cogema Fuels (FCF).
[3] All reported enrichment values are nominal preirradiation fabrication values.
[4] Assemblies may contain nonfuel hardware and/or fuel replacement rods (also referred to as filler rods). Filler rods are considered to be a component of spent nuclear fuel assemblies and not nonfuel hardware. Filler rods may be burnable absorber rods, stainless steel rods or zirconium alloy rods.
[5] Assembly average burnup is the burnup value determined by averaging the burnup over the entire fuel region (UO_2) of an individual assembly, including axial blankets, if present.
[6] Maximum uniform heat load per storage location.
[7] TSC and maximum contents shall not exceed 104,500 pounds.

5.(b)(1)(i) Contents - Type and Form of Material (continued)

Table 3 — Maximum Initial Enrichment – 37-Assembly Undamaged Fuel
15 Year Minimum Cool Time

Assembly ID	^{10}B Absorber (g/cm^2)	Zero (0) Burnup Maximum Enrichment (wt %)	Max Initial Enrichment (wt % ^{235}U) = C_4 × Burnup (GWd/MTU) + C_5					
			Burnup (GWd/MTU) < 18		18 ≤ Burnup (GWd/MTU) ≤ 30		Burnup (GWd/MTU) > 30	
			C_4	C_5	C_4	C_5	C_4	C_5
BW15	0.036	1.9	0.0501	1.69	0.0693	1.65	0.0748	1.60
BW17		1.9	0.0502	1.72	0.0687	1.70	0.0742	1.66
CE14		2.1	0.0473	2.04	0.0675	2.03	0.0759	1.93
CE16		2.1	0.0464	2.03	0.0657	2.06	0.0733	1.99
WE14		2.2	0.0496	2.08	0.0672	2.21	0.0725	2.29
WE15		1.9	0.0494	1.74	0.0683	1.72	0.0742	1.67
WE17		1.9	0.0494	1.71	0.0685	1.68	0.0749	1.61
BW15	0.030	1.8	0.0507	1.61	0.0687	1.59	0.0745	1.48
BW17		1.9	0.0503	1.66	0.0683	1.63	0.0733	1.59
CE14		2.1	0.0468	1.95	0.0664	1.97	0.0738	1.90
CE16		2.1	0.0470	1.95	0.0649	1.99	0.0727	1.90
WE14		2.1	0.0492	2.03	0.0680	2.10	0.0728	2.19
WE15		1.9	0.0503	1.67	0.0675	1.66	0.0747	1.54
WE17		1.9	0.0494	1.64	0.0685	1.58	0.0737	1.53
BW15	0.027	1.8	0.0508	1.58	0.0686	1.52	0.0754	1.41
BW17		1.8	0.0503	1.62	0.0683	1.59	0.0748	1.47
CE14		2.1	0.0471	1.92	0.0666	1.92	0.0729	1.87
CE16		2.1	0.0462	1.93	0.0657	1.92	0.0747	1.75
WE14		2.1	0.0499	1.98	0.0667	2.10	0.0743	2.07
WE15		1.9	0.0503	1.63	0.0677	1.60	0.0749	1.46
WE17		1.9	0.0497	1.60	0.0683	1.54	0.0749	1.41

5.(b)(1)(i) Contents - Type and Form of Material (continued)

Table 4 — Maximum Initial Enrichment – Undamaged Fuel Configuration
WE15x15 Optional Configurations - 20 Year Minimum Cool Time

Number of Assemblies Loaded	^{10}B Absorber (g/cm^2)	Zero (0) Burnup Maximum Enrichment (wt. % ^{235}U)	Max Initial Enrichment (wt % ^{235}U) = C_4 × Burnup (GWd/MTU) + C_5					
			Burnup (GWd/MTU) < 18		18 ≤ Burnup (GWd/MTU) ≤ 30		Burnup (GWd/MTU) > 30	
			C_4	C_5	C_4	C_5	C_4	C_5
36	0.036	2.0	0.0497	1.93	0.0681	1.99	0.0747	2.00
35		2.1	0.0507	1.97	0.0673	2.08	0.0730	2.12
33		2.2	0.0504	2.12	0.0664	2.29	0.0745	2.32
36	0.030	2.0	0.0494	1.87	0.0687	1.90	0.0737	1.93
35		2.0	0.0499	1.92	0.0688	1.97	0.0740	1.99
33		2.1	0.0497	2.06	0.0686	2.15	0.0724	2.29
36	0.027	2.0	0.0501	1.83	0.0677	1.87	0.0741	1.84
35		2.0	0.0494	1.89	0.0675	1.94	0.0735	1.96
33		2.1	0.0492	2.03	0.0674	2.12	0.0730	2.21

Table 5 — Additional Fuel Assembly Cool Time
Required to Load Nonfuel Hardware (23kW/Package)

Core (Assembly)	Additional Cool Time (Years)			
	BPRA/HFRA	GTPD	RCC	NSA
CE14	--	--	0.4	--
WE14	1.1	0.1	0.3	1.1
WE15	1.3	0.1	6.9	1.3
BW15	0.1	0.2	0.3	0.2
CE16	--	--	0.4	--
WE17	1.4	0.2	6.7	1.4
BW17	0.1	0.2	0.3	0.2

5.(b)(1)(i) Contents - Type and Form of Material (continued)

Table 6 — Nonfuel Hardware Max Exposure and Required Cool Times (Years)

Hardware	Maximum Exposure (GWd/MTU)	Minimum Cool Time (Years)				
		WE 14x14	WE 15x15	B&W 15x15	WE 17x17	B&W 17x17
BPRA	70	8.0	8.0	8.0	8.0	8.0
GTPD	180	8.0	8.0	8.0	8.0	8.0

Note: 1. Specified minimum cool times for BPRAs are independent of the required minimum cool times for the fuel assembly containing the BPRA
2. Specified minimum cool times for GTPDs are independent of the required minimum cool times for the fuel assembly containing the GTPD.
3. The maximum exposure and minimum cooling time limits for NSAs without absorber rods are the same as those for GTPDs while the maximum exposure and minimum cooling time limits for NSAs with absorber rods are the same as those for BPRAs.
4. Only GTPDs that do not include absorber, or poison, rods or water displacement rods are allowed contents.

Table 7 — Nonfuel Hardware Max ^{60}Co Activity (Ci)

Hardware	WE 14x14	WE 15x15	B&W 15x15	WE 17x17	B&W 17x17
BPRA	704.0	901.0	26.0	894.0	27.0
GTPD	60.5	73.1	99.2	93.3	107.8

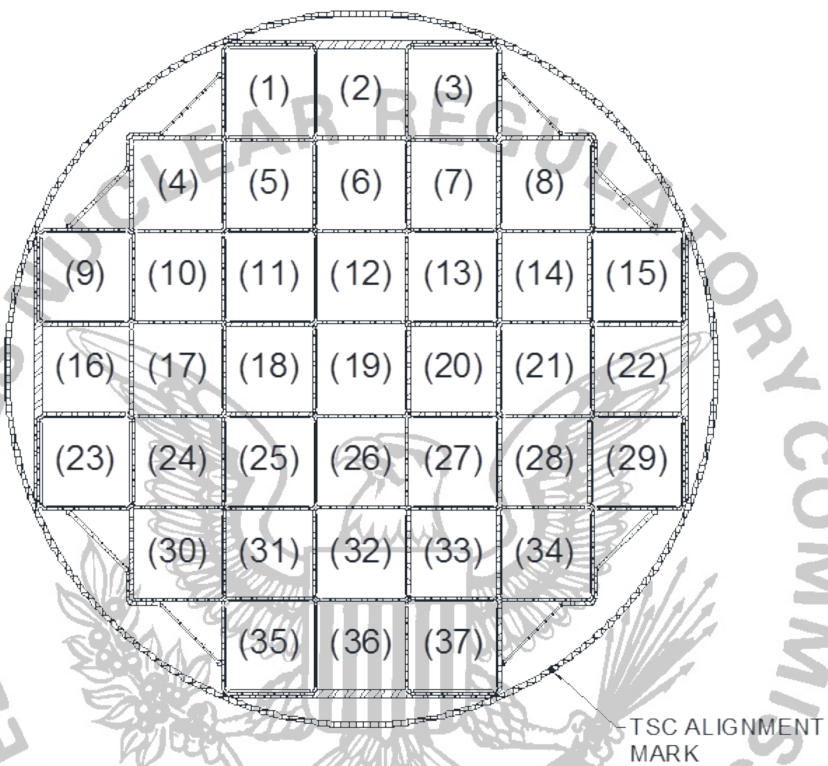
Table 8 — RCC Cool Time (Years)

Minimum Cool Time (Years)	Maximum Exposure (GWd/MTU)
10.0	180
14.0	270
20.0	360

Note: 1. Interpolation between exposure – cool time limits is not allowed.

5.(b)(1)(i) Contents - Type and Form of Material (continued)

Figure 1 — Undamaged Fuel Basket Loading Profile[8]



37 assembly loading

36 assembly loading: remove 19

35 assembly loading: remove 19, 18

33 assembly loading: remove 19, 18, 20, 12

Note: The 33, 35 and 36-Assembly patterns also apply to the damaged fuel basket.

[8] A short loaded 33, 35 or 36 assembly loading profile may still use the burnup credit curve in Table 4 provided that, at a minimum, the required cell locations for that profile shown in Figure 1 are left empty.

5.(b)(1)(i) Contents - Type and Form of Material (continued)

Table 9—Loading Table for PWR Fuel – 23 kW/Package[1]

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup ≤ 30 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	5.7	5.8	6.7	6.9	6.3	6.8	6.8
2.3 ≤ E < 2.5	5.7	5.8	6.6	6.9	6.2	6.7	6.7
2.5 ≤ E < 2.7	5.6	5.7	6.6	6.8	6.1	6.6	6.6
2.7 ≤ E < 2.9	5.5	5.6	6.5	6.7	6.0	6.6	6.6
2.9 ≤ E < 3.1	5.6	5.6	6.4	6.7	6.0	6.5	6.5
3.1 ≤ E < 3.3	5.4	5.6	6.4	6.6	6.0	6.5	6.5
3.3 ≤ E < 3.5	5.4	5.5	6.3	6.6	5.9	6.4	6.4
3.5 ≤ E < 3.7	5.3	5.5	6.3	6.5	5.9	6.4	6.4
3.7 ≤ E < 3.9	5.3	5.4	6.2	6.5	5.9	6.3	6.3
3.9 ≤ E < 4.1	5.3	5.4	6.2	6.5	5.8	6.3	6.3
4.1 ≤ E < 4.3	5.2	5.4	6.1	6.4	5.8	6.3	6.3
4.3 ≤ E < 4.5	5.2	5.3	6.1	6.4	5.8	6.2	6.2
4.5 ≤ E < 4.7	5.2	5.3	6.1	6.4	5.8	6.2	6.2
4.7 ≤ E < 4.9	5.1	5.3	6.0	6.3	5.7	6.1	6.1
E ≥ 4.9	5.1	5.2	6.0	6.3	5.7	6.1	6.1
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	30 < 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	-	-	9.2	-	-	-	-
2.3 ≤ E < 2.5	7.1	7.4	9.0	9.6	8.1	9.1	9.1
2.5 ≤ E < 2.7	7.0	7.2	8.9	9.5	8.0	9.0	9.0
2.7 ≤ E < 2.9	6.9	7.1	8.8	9.3	7.9	8.9	8.8
2.9 ≤ E < 3.1	6.8	7.0	8.7	9.2	7.8	8.8	8.7
3.1 ≤ E < 3.3	6.8	7.0	8.6	9.0	7.7	8.6	8.6
3.3 ≤ E < 3.5	6.7	6.9	8.5	9.0	7.7	8.6	8.6
3.5 ≤ E < 3.7	6.7	6.9	8.4	8.9	7.6	8.5	8.5
3.7 ≤ E < 3.9	6.6	6.8	8.3	8.9	7.5	8.4	8.4
3.9 ≤ E < 4.1	6.5	6.7	8.2	8.8	7.5	8.4	8.4
4.1 ≤ E < 4.3	6.5	6.7	8.2	8.7	7.4	8.3	8.3
4.3 ≤ E < 4.5	6.4	6.6	8.1	8.7	7.4	8.2	8.2
4.5 ≤ E < 4.7	6.4	6.6	8.1	8.6	7.3	8.2	8.2
4.7 ≤ E < 4.9	6.4	6.6	8.0	8.6	7.3	8.1	8.1
E ≥ 4.9	6.3	6.5	8.0	8.5	7.2	8.1	8.1

1. ‘-‘ means not allowed

5.(b)(1)(i) Contents - Type and Form of Material (continued)

Table 9—Loading Table for PWR Fuel – 23 kW/Package[1] (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	35 < 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	9.7	11.9	13.5	14.7	11.6	13.7	13.7
2.7 ≤ E < 2.9	9.5	10.1	13.3	14.4	11.5	13.4	13.4
2.9 ≤ E < 3.1	9.3	9.8	13.1	14.1	11.3	13.2	13.2
3.1 ≤ E < 3.3	9.1	9.7	12.8	14.0	11.1	13.0	13.0
3.3 ≤ E < 3.5	9.0	9.5	12.6	13.8	10.9	12.8	12.8
3.5 ≤ E < 3.7	8.9	9.4	12.5	13.6	10.8	12.7	12.6
3.7 ≤ E < 3.9	8.8	9.3	12.3	13.5	10.7	12.5	12.5
3.9 ≤ E < 4.1	8.7	9.1	12.1	13.3	10.5	12.3	12.3
4.1 ≤ E < 4.3	8.6	9.0	12.0	13.2	10.4	12.2	12.2
4.3 ≤ E < 4.5	8.5	9.0	11.9	13.1	10.3	12.1	12.1
4.5 ≤ E < 4.7	8.4	8.9	11.8	13.0	10.2	12.0	12.0
4.7 ≤ E < 4.9	8.4	8.8	11.7	12.8	10.2	12.0	11.9
E ≥ 4.9	8.3	8.8	11.7	12.8	10.1	11.9	11.9

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	40 < 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	14.5	19.0	20.0	21.3	17.2	20.0	20.0
2.9 ≤ E < 3.1	13.6	16.7	19.3	21.0	16.8	19.6	19.6
3.1 ≤ E < 3.3	13.4	14.6	19.0	20.7	16.5	19.4	19.3
3.3 ≤ E < 3.5	13.1	14.1	18.7	20.4	16.3	19.1	19.1
3.5 ≤ E < 3.7	12.9	13.8	18.6	20.2	16.0	18.8	18.8
3.7 ≤ E < 3.9	12.7	13.7	18.3	19.9	15.8	18.7	18.6
3.9 ≤ E < 4.1	12.5	13.5	18.1	19.7	15.6	18.4	18.4
4.1 ≤ E < 4.3	12.3	13.3	17.9	19.6	15.4	18.3	18.3
4.3 ≤ E < 4.5	12.1	13.1	17.7	19.4	15.3	18.1	18.0
4.5 ≤ E < 4.7	12.0	13.0	17.6	19.2	15.2	18.0	17.9
4.7 ≤ E < 4.9	11.9	12.8	17.4	19.0	15.0	17.7	17.8
E ≥ 4.9	11.8	12.7	17.3	19.0	14.9	17.6	17.6

1. '-' means not allowed

5.(b)(1)(i) Contents - Type and Form of Material (continued)

Table 10—Loading Table for High Burnup PWR Fuel – 21.85 kW/Package[1]

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	45 < Assembly Average Burnup ≤ 50 GWd/MTU Minimum Cooling Time (years)					
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	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	-	-	29.5	-	-	-
2.9 ≤ E < 3.1	21.7	25.2	28.4	30.3	28.9	28.8
3.1 ≤ E < 3.3	21.3	22.9	28.2	30.1	28.7	28.6
3.3 ≤ E < 3.5	21.1	22.2	28.0	29.8	28.4	28.4
3.5 ≤ E < 3.7	20.7	21.9	27.7	29.7	28.1	28.1
3.7 ≤ E < 3.9	20.5	21.7	27.5	29.4	28.0	28.0
3.9 ≤ E < 4.1	20.2	21.4	27.3	29.2	27.8	27.7
4.1 ≤ E < 4.3	20.0	21.2	27.1	29.0	27.6	27.5
4.3 ≤ E < 4.5	19.7	21.0	26.9	28.8	27.4	27.4
4.5 ≤ E < 4.7	19.6	20.7	26.7	28.7	27.3	27.2
4.7 ≤ E < 4.9	19.4	20.5	26.5	28.5	27.1	27.0
E ≥ 4.9	19.2	20.4	26.3	28.3	27.0	26.9
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**50 < Assembly Average Burnup ≤ 55 GWd/MTU Minimum Cooling Time (years)**					
	CE 14×14	**WE 14×14**	**WE 15×15**	**B&W 15×15**	**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	26.8	31.7	33.8	35.8	34.9	34.9
3.3 ≤ E < 3.5	26.4	29.4	33.5	35.5	34.7	34.6
3.5 ≤ E < 3.7	26.2	28.1	33.3	35.3	34.5	34.4
3.7 ≤ E < 3.9	25.9	27.9	33.1	35.1	34.4	34.2
3.9 ≤ E < 4.1	25.7	27.6	32.9	34.9	34.1	34.1
4.1 ≤ E < 4.3	25.4	27.4	32.8	34.8	34.0	33.9
4.3 ≤ E < 4.5	25.1	27.2	32.5	34.6	33.9	33.8
4.5 ≤ E < 4.7	25.0	26.9	32.4	34.5	33.7	33.7
4.7 ≤ E < 4.9	24.7	26.7	32.3	34.3	33.5	33.4
E ≥ 4.9	24.5	26.6	32.0	34.2	33.4	33.3

1. '-' means not allowed

5.(b)(1)(i) Contents - Type and Form of Material (continued)

Table 10—Loading Table for High Burnup PWR Fuel – 21.85 kW/Package[1] (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	55 < Assembly Average Burnup ≤ 60 GWd/MTU Minimum Cooling Time (years)					
	CE 14×14	WE 14×14	WE 15×15	B&W 15×15	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	-	-	41.3	-	-	-
3.3 ≤ E < 3.5	32.5	37.6	39.1	41.2	39.8	39.7
3.5 ≤ E < 3.7	31.7	35.4	38.9	41.0	39.6	39.5
3.7 ≤ E < 3.9	31.4	33.6	38.7	41.0	39.4	39.3
3.9 ≤ E < 4.1	31.1	33.4	38.6	40.8	39.3	39.1
4.1 ≤ E < 4.3	30.9	33.2	38.4	40.6	39.1	39.0
4.3 ≤ E < 4.5	30.7	33.0	38.3	40.4	38.9	38.9
4.5 ≤ E < 4.7	30.5	32.8	38.1	40.3	38.8	38.7
4.7 ≤ E < 4.9	30.3	32.6	38.0	40.1	38.7	38.6
E ≥ 4.9	30.0	32.4	37.9	40.1	38.6	38.5

1. '-' means not allowed

Table 11—Low Burnup PWR Fuel Loading Table – 23 kW/Package

Max. Assembly Avg. Burnup [MWd/MTU]	Min. Assembly Avg. Initial Enrichment [wt% ^{235}U]	Minimum Cool Time [Years]
10,000	1.3	4.0
15,000	1.5	4.0
20,000	1.7	4.4
25,000	1.9	5.5
30,000	2.1	6.9

5.(b)(1)(i) Contents - Type and Form of Material (continued)

Table 12—Loading Table for PWR Fuel – 22 kW/Package[1]

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup ≤ 30 GWd/MTU Minimum Cooling Time (years)						
	CE 14X14	WE 14X14	WE 15x15	B&W 15x15	CE 16X16	WE 17X17	B&W 17X17
2.1 ≤ E < 2.3	6.0	6.1	7.1	7.4	6.6	7.2	7.2
2.3 ≤ E < 2.5	5.9	6.0	7.0	7.3	6.6	7.0	7.1
2.5 ≤ E < 2.7	5.9	6.0	7.0	7.2	6.5	7.0	7.0
2.7 ≤ E < 2.9	5.8	5.9	6.9	7.2	6.4	6.9	6.9
2.9 ≤ E < 3.1	5.8	5.9	6.8	7.1	6.4	6.9	6.9
3.1 ≤ E < 3.3	5.7	5.8	6.8	7.0	6.3	6.9	6.9
3.3 ≤ E < 3.5	5.7	5.8	6.8	7.0	6.3	6.8	6.8
3.5 ≤ E < 3.7	5.6	5.7	6.7	7.0	6.2	6.8	6.8
3.7 ≤ E < 3.9	5.6	5.7	6.7	6.9	6.2	6.7	6.7
3.9 ≤ E < 4.1	5.6	5.7	6.6	6.9	6.1	6.7	6.7
4.1 ≤ E < 4.3	5.5	5.6	6.6	6.9	6.1	6.7	6.7
4.3 ≤ E < 4.5	5.5	5.6	6.6	6.8	6.0	6.6	6.6
4.5 ≤ E < 4.7	5.5	5.6	6.5	6.8	6.0	6.6	6.6
4.7 ≤ E < 4.9	5.4	5.6	6.5	6.8	6.0	6.6	6.6
E ≥ 4.9	5.4	5.5	6.5	6.7	6.0	6.6	6.6
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	30 < Assembly Average Burnup ≤ 35 GWd/MTU Minimum Cooling Time (years)						
	CE 14X14	WE 14X14	WE 15x15	B&W 15x15	CE 16X16	WE 17X17	B&W 17X17
2.1 ≤ E < 2.3	-	-	10.1	-	-	-	-
2.3 ≤ E < 2.5	7.7	7.9	9.9	10.7	8.8	10.0	10.0
2.5 ≤ E < 2.7	7.5	7.8	9.8	10.6	8.7	9.9	9.9
2.7 ≤ E < 2.9	7.4	7.7	9.7	10.4	8.6	9.7	9.7
2.9 ≤ E < 3.1	7.3	7.6	9.5	10.2	8.5	9.6	9.6
3.1 ≤ E < 3.3	7.2	7.5	9.4	10.1	8.4	9.5	9.5
3.3 ≤ E < 3.5	7.2	7.4	9.3	10.0	8.3	9.4	9.4
3.5 ≤ E < 3.7	7.1	7.4	9.2	9.9	8.2	9.3	9.3
3.7 ≤ E < 3.9	7.0	7.3	9.1	9.8	8.1	9.3	9.2
3.9 ≤ E < 4.1	7.0	7.2	9.1	9.7	8.1	9.1	9.2
4.1 ≤ E < 4.3	6.9	7.2	9.0	9.6	8.0	9.1	9.1
4.3 ≤ E < 4.5	6.9	7.1	9.0	9.6	8.0	9.0	9.0
4.5 ≤ E < 4.7	6.9	7.0	8.9	9.5	7.9	9.0	9.0
4.7 ≤ E < 4.9	6.8	7.0	8.8	9.5	7.9	9.0	9.0
E ≥ 4.9	6.8	7.0	8.8	9.4	7.9	8.9	8.9

1. '-' means not allowed

5.(b)(1)(i) Contents - Type and Form of Material (continued)

Table 12—Loading Table for PWR Fuel – 22 kW/Package[1] (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	35 < Assembly Average Burnup ≤ 40 GWd/MTU Minimum Cooling Time (years)						
	CE 14X14	WE 14X14	WE 15x15	B&W 15x15	CE 16X16	WE 17X17	B&W 17X17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	10.7	11.9	15.2	16.6	13.1	15.4	15.4
2.7 ≤ E < 2.9	10.5	11.2	14.9	16.2	12.9	15.2	15.1
2.9 ≤ E < 3.1	10.3	11.0	14.7	16.0	12.6	14.8	14.8
3.1 ≤ E < 3.3	10.1	10.8	14.4	15.8	12.4	14.7	14.7
3.3 ≤ E < 3.5	9.9	10.6	14.2	15.6	12.2	14.4	14.5
3.5 ≤ E < 3.7	9.8	10.4	14.1	15.4	12.0	14.3	14.2
3.7 ≤ E < 3.9	9.7	10.3	13.9	15.3	11.9	14.2	14.1
3.9 ≤ E < 4.1	9.6	10.1	13.7	15.1	11.8	14.0	14.0
4.1 ≤ E < 4.3	9.5	10.0	13.6	15.0	11.7	13.9	13.9
4.3 ≤ E < 4.5	9.4	10.0	13.5	14.8	11.6	13.7	13.8
4.5 ≤ E < 4.7	9.3	9.9	13.5	14.8	11.6	13.7	13.6
4.7 ≤ E < 4.9	9.2	9.8	13.3	14.6	11.5	13.6	13.6
E ≥ 4.9	9.2	9.7	13.3	14.5	11.5	13.5	13.5
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	40 < Assembly Average Burnup ≤ 45 GWd/MTU Minimum Cooling Time (years)						
	CE 14X14	WE 14X14	WE 15x15	B&W 15x15	CE 16X16	WE 17X17	B&W 17X17
2.1 ≤ E < 2.3	-	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-	-
2.7 ≤ E < 2.9	15.7	19.0	21.7	23.5	19.2	22.1	22.1
2.9 ≤ E < 3.1	15.3	16.7	21.4	23.2	18.8	21.8	21.8
3.1 ≤ E < 3.3	15.0	16.2	21.1	22.9	18.6	21.5	21.5
3.3 ≤ E < 3.5	14.8	15.9	20.9	22.6	18.3	21.3	21.3
3.5 ≤ E < 3.7	14.5	15.7	20.7	22.4	18.0	21.1	21.0
3.7 ≤ E < 3.9	14.2	15.5	20.4	22.2	17.8	20.8	20.8
3.9 ≤ E < 4.1	14.0	15.3	20.2	22.0	17.6	20.6	20.6
4.1 ≤ E < 4.3	13.9	15.0	20.0	21.8	17.5	20.5	20.4
4.3 ≤ E < 4.5	13.7	14.8	19.8	21.6	17.3	20.3	20.3
4.5 ≤ E < 4.7	13.6	14.7	19.7	21.5	17.1	20.1	20.1
4.7 ≤ E < 4.9	13.5	14.5	19.6	21.3	17.0	20.0	19.9
E ≥ 4.9	13.4	14.4	19.5	21.2	16.9	19.8	19.9

1. '-' means not allowed

5.(b)(1)(i) Contents - Type and Form of Material (continued)

Table 13—Loading Table for High Burnup PWR Fuel – 20.9 kW/Package[1]

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	45 < Assembly Average Burnup ≤ 50 GWd/MTU Minimum Cooling Time (years)					
	CE 14X14	WE 14X14	WE 15x15	B&W 15x15	WE 17X17	B&W 17X17
2.1 ≤ E < 2.3	-	-	-	-	-	-
2.3 ≤ E < 2.5	-	-	-	-	-	-
2.5 ≤ E < 2.7	-	-	-	-	-	-
2.7 ≤ E < 2.9	-	-	31.0	-	-	-
2.9 ≤ E < 3.1	23.8	25.2	30.7	32.7	31.3	31.2
3.1 ≤ E < 3.3	23.5	24.7	30.5	32.5	31.0	31.0
3.3 ≤ E < 3.5	23.2	24.4	30.2	32.2	30.8	30.8
3.5 ≤ E < 3.7	22.9	24.1	30.0	32.1	30.6	30.5
3.7 ≤ E < 3.9	22.6	23.9	29.8	31.9	30.4	30.3
3.9 ≤ E < 4.1	22.4	23.6	29.6	31.7	30.2	30.1
4.1 ≤ E < 4.3	22.2	23.4	29.4	31.5	30.0	29.9
4.3 ≤ E < 4.5	22.0	23.2	29.3	31.3	29.9	29.8
4.5 ≤ E < 4.7	21.8	23.0	29.1	31.2	29.7	29.6
4.7 ≤ E < 4.9	21.6	22.8	28.9	31.0	29.6	29.5
E ≥ 4.9	21.4	22.7	28.7	30.8	29.4	29.3
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	50 < Assembly Average Burnup ≤ 55 GWd/MTU Minimum Cooling Time (years)					
	CE 14X14	WE 14X14	WE 15x15	B&W 15x15	WE 17X17	B&W 17X17
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	28.9	31.7	36.1	38.1	37.3	37.2
3.3 ≤ E < 3.5	28.7	30.7	35.8	38.0	37.1	37.0
3.5 ≤ E < 3.7	28.3	30.4	35.7	37.8	36.9	36.8
3.7 ≤ E < 3.9	28.1	30.2	35.4	37.6	36.8	36.6
3.9 ≤ E < 4.1	27.9	29.9	35.2	37.4	36.6	36.5
4.1 ≤ E < 4.3	27.6	29.7	35.1	37.3	36.4	36.3
4.3 ≤ E < 4.5	27.4	29.5	34.8	37.1	36.3	36.2
4.5 ≤ E < 4.7	27.2	29.3	34.7	37.0	36.2	36.1
4.7 ≤ E < 4.9	27.1	29.1	34.6	36.8	36.0	35.9
E ≥ 4.9	26.9	28.9	34.4	36.7	35.8	35.7

1. '-' means not allowed

5.(b)(1)(i) Contents - Type and Form of Material (continued)

Table 13—Loading Table for High Burnup PWR Fuel – 20.9 kW/Package[1] (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	55 < Assembly Average Burnup ≤ 60 GWd/MTU Minimum Cooling Time (years)					
	CE 14X14	WE 14X14	WE 15x15	B&W 15x15	WE 17X17	B&W 17X17
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	-	-	41.6	-	-	-
3.3 ≤ E < 3.5	34.1	37.6	41.4	43.7	42.2	42.1
3.5 ≤ E < 3.7	33.8	36.1	41.3	43.5	42.0	41.9
3.7 ≤ E < 3.9	33.6	35.9	41.1	43.4	41.8	41.7
3.9 ≤ E < 4.1	33.4	35.7	41.0	43.3	41.8	41.6
4.1 ≤ E < 4.3	33.2	35.5	40.8	43.1	41.6	41.5
4.3 ≤ E < 4.5	33.0	35.3	40.7	43.0	41.4	41.3
4.5 ≤ E < 4.7	32.9	35.1	40.5	42.9	41.3	41.2
4.7 ≤ E < 4.9	32.7	35.0	40.4	42.8	41.2	41.1
E ≥ 4.9	32.5	34.8	40.3	42.7	41.1	41.0

1. '-' means not allowed

5.(b)(1)(i) Contents - Type and Form of Material (continued)

Table 14—Low Burnup PWR Fuel Loading Table – 22 kW/Package

Max. Assembly Avg. Burnup [MWd/MTU]	Min. Assembly Avg. Initial Enrichment [wt% ^{235}U]	Minimum Cool Time [Years]
10,000	1.3	4.0
15,000	1.5	4.0
20,000	1.7	4.5
25,000	1.9	5.7
30,000	2.1	7.4

Table 15—Additional Fuel Assembly Cool Time to Load Nonfuel Hardware (Reduced Heat Load – 22kW PWR - Configuration)

Assembly	BPRA/ HFRA	GTPD	RCC	NSA
CE 14x14	-	-	0.4	-
WE 14x14	1.1	0.1	0.3	1.1
WE 15x15	1.5	0.2	7.6	1.5
BW 15x15	0.1	0.2	0.3	0.2
CE 16x16	-	-	0.4	-
WE 17x17	1.5	0.2	7.3	1.5
BW 17x17	0.1	0.2	0.3	0.2

5.(b)(1) Contents - Type and Form of Material (continued)

(ii) Undamaged and damaged PWR assemblies

A combination of damaged and undamaged PWR fuel assemblies in the 37 PWR damaged fuel basket, shown in Figure 2, in a short TSC. Undamaged, low burnup fuel assemblies must meet the description for PWR fuel in 5.(b)(1)(i). Up to four damaged fuel assemblies, or fuel material that is less than, or equivalent to, one undamaged PWR fuel assembly must be placed in a damaged fuel can and must be placed in locations 4, 8, 30 and 34 in the PWR damaged fuel basket. Undamaged, low burnup fuel may also be placed in the 4 damaged fuel locations, without the use of a damaged fuel can. Prior to irradiation, the damaged and undamaged fuel assemblies must be within the dimensions and specifications of the hybrid assemblies listed in Table 1 and meet the fuel class assembly specifications listed in Table 2.

For the 33 non-damaged fuel can locations in the damaged fuel basket, the fuel must meet the class enrichment, post-irradiation cooling time, burnup credit loading curves, and the TSC neutron absorber sheet ^{10}B density in Table 16. For the loading profiles up to the 33, 35 and 36 assembly loading pattern, the PWR fuel must meet the burnup loading curves in Table 17. A short-loaded 33, 35 or 36 assembly loading profile may still use the burnup credit curve in Table 17 provided the required cell locations for that profile shown in Figure 1 are left empty, at a minimum. For a TSC with a damaged fuel basket assembly that does not contain any damaged fuel, the fuel class enrichment, post-irradiation cooling time, burnup credit loading curves, and the TSC neutron absorber sheet ^{10}B density in Tables 3 and 4 may be used for all locations (burnup credit curves are only applicable to systems not crediting moderator exclusion).

Fuel assembly burnup, minimum initial average enrichment[9], and cool time requirements are provided in Tables 9–11 for PWR baskets with Type 2 neutron absorbers and Tables 12–14 for baskets with Type 1 neutron absorbers. For TSCs containing damaged fuel, all fuel assemblies in the TSC must meet the additional cool time requirements in Table 18 for the assembly type that is loaded in the damaged fuel can. If two types of fuel assemblies are loaded in different damaged fuel cans in a single TSC, the longest additional fuel cooling time applies to all fuel assemblies in the TSC. The additional cool time requirements in Table 18 apply to assemblies loaded in TSC baskets with Type 1 or Type 2 neutron absorbers. Damaged CE 16×16 fuel assemblies are not authorized for shipment.

The fuel assemblies consist of uranium dioxide pellets with zirconium alloy-clad fuel rods and zirconium alloy instrument and guide tubes. Empty fuel rod positions for undamaged fuel assemblies are to be filled with a solid filler rod or a solid neutron absorber rod that displaces a volume equal to or greater than the original rod. PWR fuel assemblies containing nonfuel hardware may be loaded in the TSC.

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9 Assembly average fuel enrichment is the enrichment value determined by averaging the ^{235}U wt% enrichment over the entire fuel region (UO_2) of an individual assembly, including axial blankets, if present.

5.(b)(1)(ii) Contents - Type and Form of Material (continued)

Unirradiated fuel and unenriched fuel are not authorized for loading, except that unenriched axial blankets are permitted, provided that the nominal length of the blanket is not greater than 6 inches. An unenriched rod may be used as a replacement rod to return a fuel assembly to an undamaged condition. Damaged fuel located in a damaged fuel can location in the damaged fuel basket must have a minimum burnup of 5 GWd/MTU, a maximum enrichment of 4.05 wt. % ^{235}U, and a minimum cool time of 15 years. PWR fuel assemblies loaded in a damaged fuel can must not contain nonfuel hardware with the exception of instrument tube tie components, guide tube anchors or similar devices, and steel inserts. Application of moderator exclusion allows increasing the maximum initial enrichment to 5 wt% ^{235}U, with no burnup requirement.

Undamaged PWR fuel assemblies may contain nonfuel hardware, while damaged PWR fuel assemblies shall not, with the exception of the following unirradiated nonfuel hardware: instrument tube tie components, guide tube anchors or similar devices, and steel inserts. The nonfuel hardware may be loaded as a complete assembly or as individual components, individual nonfuel rods may be full-length rods or partial-length rods/rodlets. Partial-length rods/rodlets are permitted in guide tubes provided guide tube plug devises are installed. Fuel assemblies with an instrument tube tie rod repair shall be loaded with fuel inserts and/or top spacers to ensure proper spacing and support of the fuel assembly. Fuel inserts and/or top spacers are not required when using the extended fuel tube basket because the top nozzle is adequately supported. Nonfuel hardware must meet the exposure and cool time or cobalt-60 activity requirements listed in Tables 6–8.

HFRAs are only allowed for Westinghouse assemblies and may have a maximum exposure of 4.0 GWd/MTU and must have a minimum cool time of 16 years. Fuel assemblies loaded with nonfuel hardware must meet the additional cool time requirements of Table 5 (for Type 2 neutron absorbers), and Table 15 (for Type 1 neutron absorbers). Fuel assemblies may contain any number of unirradiated nonfuel solid filler fuel replacement rods. Activated stainless steel fuel replacement rods are limited to 5 steel rods per assembly, 1 assembly per basket, and a maximum steel rod exposure of 32.5 GWd/MTU. Fuel assemblies with activated stainless steel rods must be cooled for either a minimum of 21 years or the loading table minimum cool time (as adjusted for additional cool times for nonfuel hardware and the presence of damaged fuel in the TSC, as applicable) plus 1 year, whichever is greater.

Fuel assemblies loaded with in-core instrument thimbles must meet the additional cool time requirements in Table 5 or Table 15, as appropriate, for BPRAs or GTPDs, whichever is bounding, for Westinghouse and B&W fuel types and for RCCs for CE fuel types. The additional cool time requirements for assemblies with nonfuel hardware are added to any additional cool time requirements due to damaged fuel also being loaded in the same TSC. RCCs are restricted to fuel storage locations 11, 12, 13, 18, 19, 20, 25, 26 and 27 in Figure 1.

5.(b)(1)(ii) Contents - Type and Form of Material (continued)

One NSA is permitted to be loaded in a TSC in fuel storage locations 11, 12, 13, 18, 19, 20, 25, 26 or 27 in Figure1. NSAs 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. NSAs, GTPDs, and BPRAs for CE fuel types are not allowed contents. In addition, the following unirradiated, nonfuel hardware may be loaded with the fuel assemblies: stainless steel rods inserted to displace guide tube “dashpot” water, instrument tube tie components, and guide tube anchors or similar devices. Axial power shaping rods are not allowed contents.

Under-burned Westinghouse 15x15 assemblies (assemblies with a maximum enrichment greater than that dictated by the burnup credit loading curve) may be loaded provided that an RCCA is inserted in the assembly, the enrichment is equal to or less than 4.05 wt. % ^{235}U, and the assembly burnup is greater than or equal to 12,000 MWd/MTU. When loading under-burned fuel, the RCCAs must be full length Ag-In-Cd RCCAs comprised of stainless steel clad rods constructed with 80% Ag, 15% In and 5% Cd absorber pellets and having an exposure equal to or less than 200,000 MWd/MTU. The basket must include absorber sheets with an effective ^{10}B areal density of 0.036 g/cm^2. Any assemblies loaded without an RCCA inserted must meet the burnup credit loading curve for the applicable assembly loading profile. Burnup credit curves, and the criticality requirement for RCCA insertion, are only applicable to systems not crediting moderator exclusion. Initial enrichment up to 5 wt% ^{235}U, with no burnup or RCCA requirement, is permitted when crediting moderator exclusion.

5.(b)(1)(ii) Contents - Type and Form of Material (continued)

Table 16—Maximum Initial Enrichment - 37 Assembly Damaged Fuel Configuration
20 Year Minimum Cool Time

Assembly ID	^{10}B Absorber (g/cm^2)	Zero (0) Burnup Max. Enr. (wt %)	Max Initial Enrichment (wt % ^{235}U) = C_4 × Burnup (GWd/MTU) + C_5							
			Burnup (GWd/MTU) < 18		18 ≤ Burnup (GWd/MTU) ≤ 30		30 < Burnup (GWd/MTU) ≤ 50		50 < Burnup (GWd/MTU)	
			C_4	C_5	C_4	C_5	C_4	C_5	C_4	C_5
BW15	0.036	1.6	0.0453	1.42	0.0681	1.29	0.0750	1.03	0.0750	0.736
BW17		1.6	0.0476	1.45	0.0668	1.37	0.0712	1.17	0.0712	0.891
CE14		1.9	0.0504	1.79	0.0696	1.75	0.0751	1.60	0.0751	1.60
CE16		1.9	0.0484	1.79	0.0679	1.74	0.0758	1.52	0.0758	1.52
WE14		1.9	0.0542	1.85	0.0729	1.85	0.0794	1.75	0.0794	1.75
WE15		1.6	0.0482	1.43	0.0692	1.27	0.0738	1.08	0.0738	0.767
WE17		1.6	0.0439	1.45	0.0657	1.35	0.0732	1.00	0.0732	0.700
BW15	0.030	1.5	0.0487	1.31	0.0660	1.26	0.0740	0.896	0.0740	0.614
BW17		1.5	0.0470	1.37	0.0673	1.29	0.0745	0.937	0.0745	0.655
CE14		1.8	0.0494	1.71	0.0705	1.64	0.0781	1.37	0.0781	1.37
CE16		1.8	0.0489	1.71	0.0679	1.68	0.0724	1.52	0.0724	1.52
WE14		1.9	0.0533	1.82	0.0725	1.76	0.0821	1.50	0.0821	1.50
WE15		1.6	0.0475	1.35	0.0661	1.29	0.0746	0.859	0.0746	0.575
WE17		1.6	0.0448	1.38	0.0646	1.26	0.0710	0.968	0.0710	0.691
BW15	0.027	1.5	0.0471	1.30	0.0666	1.19	0.0725	0.857	0.0725	0.581
BW17		1.5	0.0474	1.36	0.0652	1.27	0.0724	0.918	0.0724	0.639
CE14		1.8	0.0486	1.68	0.0696	1.61	0.0778	1.32	0.0778	1.32
CE16		1.8	0.0493	1.66	0.0660	1.64	0.0761	1.33	0.0761	1.33
WE14		1.8	0.0535	1.71	0.0694	1.75	0.0805	1.52	0.0805	1.52
WE15		1.5	0.0465	1.33	0.0664	1.24	0.0710	0.968	0.0710	0.685
WE17		1.5	0.0447	1.31	0.0647	1.25	0.0714	0.846	0.0714	0.564

5.(b)(1)(ii) Contents - Type and Form of Material (continued)

Table 17—Maximum Initial Enrichment – WE 15x15 Assembly Damaged Fuel Configuration 20 Year Minimum Cool Time

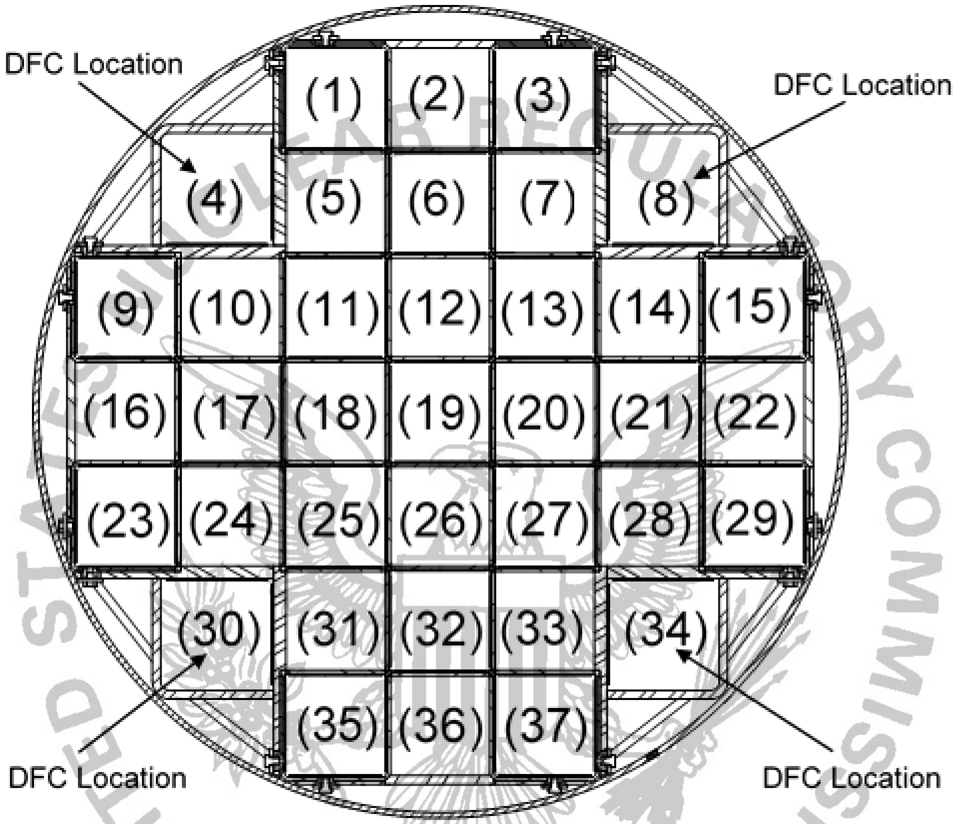
Number of Assemblies	^{10}B Absorber (g/cm^2)	Zero (0) Burnup Max. Enr. (wt %)	Max Initial Enrichment (wt % ^{235}U) = C_4 × Burnup (GWd/MTU) + C_5							
			Burnup (GWd/MTU) < 18		18 ≤ Burnup (GWd/MTU) ≤ 30		30 < Burnup (GWd/MTU) ≤ 50		50 < Burnup (GWd/MTU)	
			C_4	C_5	C_4	C_5	C_4	C_5	C_4	C_5
36	0.036	1.6	0.0483	1.53	0.0721	1.35	0.0750	1.17	0.0750	0.851
35		1.7	0.0532	1.51	0.0722	1.45	0.0778	1.14	0.0778	1.14
33		1.7	0.0524	1.60	0.0734	1.52	0.0791	1.22	0.0791	1.22
36	0.030	1.6	0.0483	1.48	0.0707	1.32	0.0739	1.15	0.0739	0.811
35		1.6	0.0499	1.48	0.0722	1.34	0.0733	1.20	0.0733	0.847
33		1.7	0.0523	1.52	0.0728	1.40	0.0780	1.19	0.0780	1.19
36	0.027	1.6	0.0473	1.42	0.0668	1.33	0.0731	1.02	0.0731	0.693
35		1.6	0.0477	1.46	0.0736	1.27	0.0738	1.13	0.0738	0.775
33		1.7	0.0491	1.51	0.0718	1.41	0.0784	1.09	0.0784	1.09

Table 18—Additional Cool Time Required for Damaged PWR Fuel Contents

Max Assembly Average Burnup (GWd/MTU)	Min. Initial Assembly Average Enrichment (wt% ^{235}U)	CE 14x14 Δ Cool Time (years)	WE 14x14 Δ Cool Time (years)	WE 15x15 Δ Cool Time (years)	WE 17x17 Δ Cool Time (years)
35	2.1	N/A	N/A	2.5	N/A
	2.3	0.0	0.6	0.8	0.3
40	2.5	1.9	2.4	3.3	2.8
	2.7	0.3	2.1	1.2	0.8
	2.9	0.0	0.6	0.0	0.0
45	2.7	3.9	2.6	4.5	4.2
	2.9	2.5	2.6	2.7	2.2
	3.1	0.6	2.5	0.7	0.1
	3.3	0.0	1.0	0.0	0.0
50	2.7	N/A	N/A	4.8	N/A
	2.9	3.6	2.8	3.5	2.8
	3.1	1.7	2.8	1.2	0.5
	3.3	0.0	1.2	0.0	0.0
55	3.1	4.2	2.9	4.0	3.6
	3.3	2.2	3.0	1.9	1.5
	3.5	0.2	2.0	0.0	0.0
60	3.1	N/A	N/A	5.0	N/A
	3.3	4.6	3.0	4.9	4.1
	3.5	3.1	3.1	2.9	2.1
	3.7	1.3	2.8	0.8	0.0
	3.9	0.0	0.9	0.0	0.0

5.(b)(1)(ii) Contents - Type and Form of Material (continued)

Figure 2—Damaged Fuel Basket Loading Profile



DFC designated locations may contain a loaded DFC or an undamaged PWR fuel assembly.

5.(b)(1) Type and Form of Material (continued)

(iii) Undamaged BWR assemblies

Undamaged BWR fuel assemblies within the 87 BWR basket assembly shown in Figure 3. Undamaged fuel is spent nuclear fuel that does not have any visible deformation other than uniform bowing that occurs in the reactor, assemblies that do not have missing rods, and assemblies with missing rods that are replaced by solid stainless steel or zirconium filler rods that displace a volume equal to or greater than the original rods and assemblies that do not contain structural defects that adversely affect radiological and/or criticality safety and/or result in unsupported fuel rod lengths in excess of 60 inches and that can be handled by normal means. BWR/2-3 assemblies are to be loaded into short TSCs, and BWR/4-6 assemblies are to be loaded into long TSCs.

The fuel assemblies consist of uranium dioxide pellets with zirconium alloy-clad fuel rods and zirconium alloy-clad water rods or holes. Empty rod positions must be filled with solid, unirradiated, nonfuel filler rods that displace a volume equal to, or greater than, that of the fuel rod that the filler rod replaces. Prior to irradiation, the fuel assemblies must be within the dimensions and specifications of the hybrid assemblies listed in Table 19. In addition, the BWR fuel must meet the fuel class assembly specifications listed in Table 20. Fuel assembly burnup, minimum initial average enrichment[10], and cool time requirements are provided in Table 23, Table 24, and Table 25.

Undamaged BWR fuel must meet the hybrid fuel assembly enrichment and the TSC neutron absorber sheet ^{10}B density for loading up to the 87 and 82 assembly loading patterns for fuel with axial blankets in Table 21 and fuel without axial blankets in Table 22. Spacers may be used to axially position fuel assemblies to limit their axial movement in the TSC. Unenriched and unirradiated fuel is not authorized for loading, except that unenriched axial blankets are permitted, provided that the nominal length of the blanket is not greater than 6 inches.

For a TSC that is less than fully loaded, empty fuel storage locations shall begin with location 44, followed by locations 43, 45, 33, 55, 32, 56, 34, 54 and continuing outward, as required, in an approximately symmetric pattern as shown in Figure 3. Allowable fuel assembly locations for the 82 assembly BWR fuel assembly basket configuration are shown in Figure 4. Prior to use of the 82 assembly configuration, the center cell weldment and upper weldments of nonfuel locations must be physically blocked (fuel storage locations 44, 32, 34, 54, 56 shown as in Figure 4).

BWR fuel assemblies may be unchanneled, or channeled with zirconium-based alloy channels. BWR fuel assemblies with stainless steel channels are not authorized.

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[10] Assembly average fuel enrichment is the enrichment value determined by averaging the ^{235}U wt% enrichment over the entire fuel region (UO_2) of an individual assembly, including axial blankets, if present.

5.(b)(1)(iii) Contents - Type and Form of Material (continued)

The 82-Assembly configuration is the result of criticality constraints on maximum enrichment. When crediting moderator exclusion, the 82-Assembly configuration is not required, as full capacity (87-Assembly) is permitted at an initial enrichment up to 5 wt% ^{235}U.

Table 19—BWR Hybrid Fuel Assembly Characteristics

Geometry[2,3]

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	0.2037
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	0.1996
B8_64B[4]	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[1]	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	0.1979
B9_80A	80	N/A	0.5720	0.4230	0.02950	0.3565	150.0	0.1821
B10_91A	91[1]	8	0.5100	0.3957	0.02385	0.3420	150.0	0.1906
B10_92A	92[1]	14	0.5100	0.4040	0.02600	0.3455	150.0	0.1946
B10_96A[4]	96[1]	12	0.4880	0.3780	0.02430	0.3224	150.0	0.1787
B10_100A[4]	100	N/A	0.4880	0.3780	0.02430	0.3224	150.0	0.1861

Notes:

[1] Assemblies may contain partial-length fuel rods.
[2] Assembly characteristics represent cold, unirradiated, nominal configurations.
[3] Maximum channel thickness allowed is 120 mils (nominal).
[4] Composed of four subchannel clusters.

5.(b)(1)(iii) Contents - Type and Form of Material (continued)

Table 20—BWR Fuel Class Assembly Characteristics				
Characteristic	**Fuel Class**			
	7x7	**8x8**	**9x9**	**10x10**
Base Fuel Type[11]	SPC, GE	SPC, GE	SPC, GE	SPC, GE, ABB
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[12]	72 74[13] 76 79 80	91[13] 92[13] 96[13, 14] 100[14]
Max Assembly Average Burnup (MWd/MTU)	60,000	60,000	60,000	60,000
Min Cool Time (years)	4	4	4	4
Min Average Enrichment (wt% ^{235}U)[15]	1.3	1.3	1.3	1.3
Max Weight (lb) per Storage Location	See Note 1	See Note 1	See Note 1	See Note 1
Max Decay Heat (Watts) per Fuel Location	253	253	253	253

Notes:

1. Maximum weight per storage location is 739 lbs (including fuel spacers and channel) with a maximum contents weight of 62,656 lbs. The maximum nominal assembly length is 176.2 inches for BWR/4-6 assemblies and 171 inches for the BWR/2-3 assemblies, and the maximum nominal assembly width is 5.52 inches.
2. Fuel assembly weight includes the weight of the channel.
3. Maximum initial enrichment is the peak planar-average enrichment.
4. Water rods may occupy more than one fuel lattice location. Fuel assembly to contain nominal number of water rods for the specific assembly design.
5. All enrichment values are nominal pre-irradiation fabrication values.
6. Spacers may be used to axially position fuel assemblies to facilitate handling.
7. Each BWR fuel assembly may have a zirconium-based alloy channel ≤ 0.120 inches thick.

[11] Indicates assembly vendor/type referenced for fuel input data. Fuel acceptability for loading is not restricted to the indicated vendor/type provided that the fuel assembly meets the limits listed in Table 6.2.1-1. Table 6.2.1-2 contains vendor information by fuel rod array. Abbreviations are as follows: General Electric/Global Nuclear Fuels (GE), Exxon/Advanced Nuclear Fuels/Siemens Power Corporation (SPC).
[12] May be composed of four subchannel clusters.
[13] Assemblies may contain partial-length fuel rods.
[14] Composed of four subchannel clusters
[15] Assembly average burnup is the burnup value determined by averaging the burnup over the entire fuel region (UO_2) of an individual assembly, including axial blankets, if present.

5.(b)(1)(iii) Contents - Type and Form of Material (continued)

Table 21—Undamaged BWR Fuel Assembly Loading Criteria (Enrichment Limits for Fuel With Axial Blankets)

Fuel Type	Max. Initial Enrichment[16] (wt % ^{235}U)					
	Absorber[17] 0.027 ^{10}B g/cm^2		Absorber[17] 0.0225 ^{10}B g/cm^2		Absorber[17] 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%	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%	3.6%	4.3%	3.5%	4.1%
B10_92A	3.8%	4.5%	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%

Note: When crediting moderator exclusion, the maximum allowed initial enrichment is 5 wt% ^{235}U for all basket/absorber combinations.

16 Maximum planar average.
17 Borated aluminum neutron absorber sheet effective areal ^{10}B density.

5.(b)(1)(iii) Contents - Type and Form of Material (continued)

Table 22—Undamaged BWR Fuel Assembly Loading Criteria (Enrichment Limits for Fuel Without Axial Blankets)

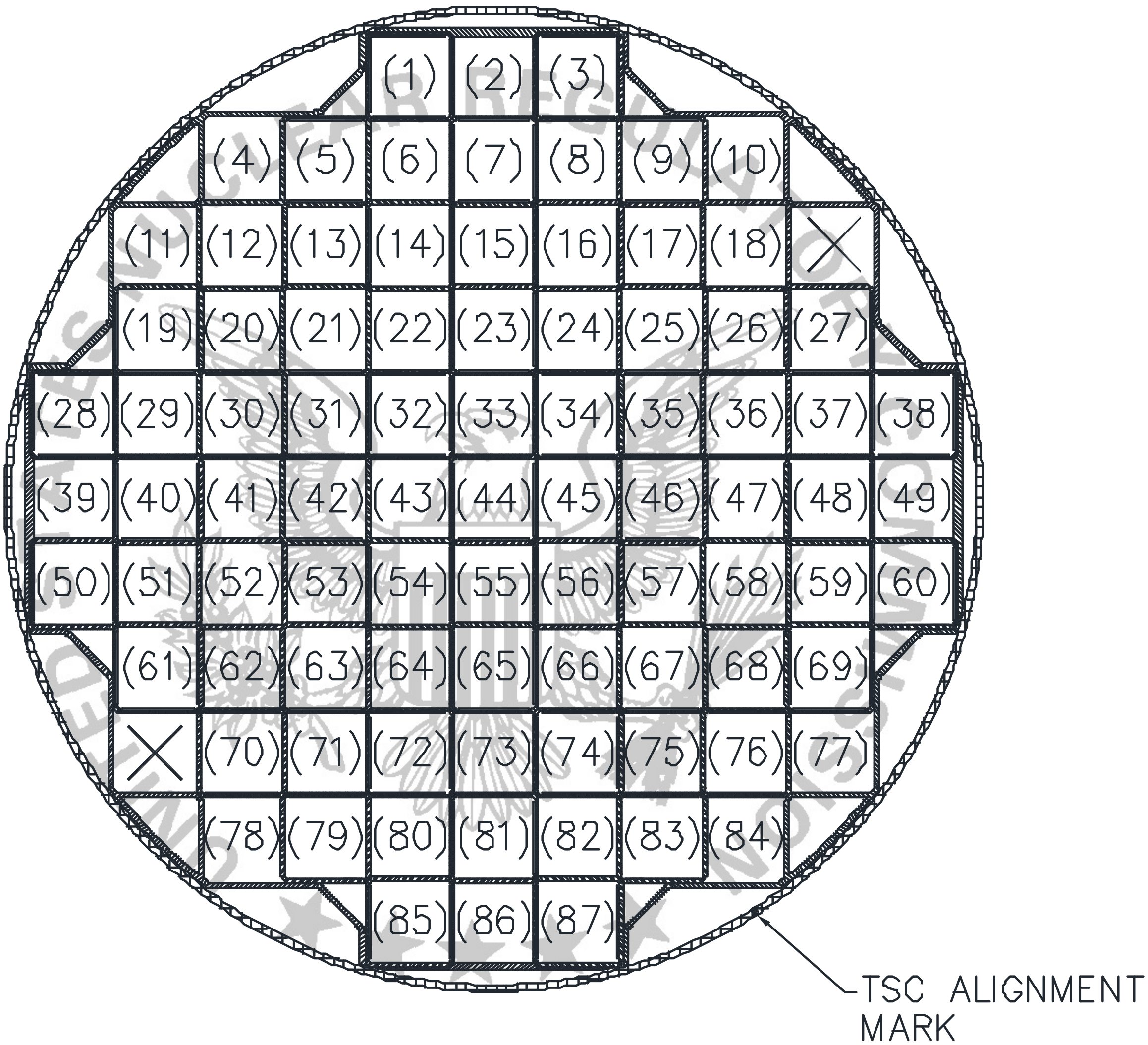
Fuel Type	Max. Initial Enrichment[18] (wt % ^{235}U)					
	Absorber[19] 0.027 ^{10}B g/cm^2		Absorber[19] 0.0225 ^{10}B g/cm^2		Absorber[19] 0.02 ^{10}B g/cm^2	
	87-Assy Basket	82-Assy Basket	87-Assy Basket	82-Assy Basket	87-Assy Basket	82-Assy Basket
B7_48A	3.9%	4.5%	3.7%	4.5%	3.6%	4.3%
B7_49A	3.7%	4.5%	3.6%	4.3%	3.4%	4.1%
B7_49B	3.7%	4.5%	3.6%	4.3%	3.5%	4.2%
B8_59A	3.8%	4.5%	3.7%	4.4%	3.5%	4.3%
B8_60A	3.7%	4.5%	3.6%	4.3%	3.5%	4.1%
B8_60B	3.7%	4.4%	3.5%	4.2%	3.4%	4.1%
B8_61B	3.7%	4.5%	3.6%	4.3%	3.5%	4.1%
B8_62A	3.6%	4.4%	3.5%	4.2%	3.4%	4.1%
B8_63A	3.7%	4.4%	3.5%	4.2%	3.4%	4.1%
B8_64A	3.7%	4.5%	3.5%	4.3%	3.4%	4.1%
B8_64B	3.6%	4.2%	3.4%	4.1%	3.3%	4.0%
B9_72A	3.7%	4.4%	3.5%	4.2%	3.4%	4.1%
B9_74A	3.6%	4.2%	3.4%	4.1%	3.3%	4.0%
B9_76A	3.5%	4.1%	3.3%	4.0%	3.2%	3.8%
B9_79A	3.5%	4.2%	3.4%	4.1%	3.2%	3.9%
B9_80A	3.7%	4.5%	3.6%	4.3%	3.5%	4.1%
B10_91A	3.7%	4.4%	3.5%	4.2%	3.4%	4.1%
B10_92A	3.7%	4.4%	3.6%	4.2%	3.4%	4.1%
B10_96A	3.6%	4.2%	3.4%	4.1%	3.4%	4.0%
B10_100A	3.6%	4.3%	3.4%	4.0%	3.3%	3.9%

Note: When crediting moderator exclusion, the maximum allowed initial enrichment is 5 wt% ^{235}U for all basket/absorber combinations.

18 Maximum planar average.
19 Borated aluminum neutron absorber sheet effective areal ^{10}B density.

5.(b)(1)(iii) Contents - Type and Form of Material (continued)

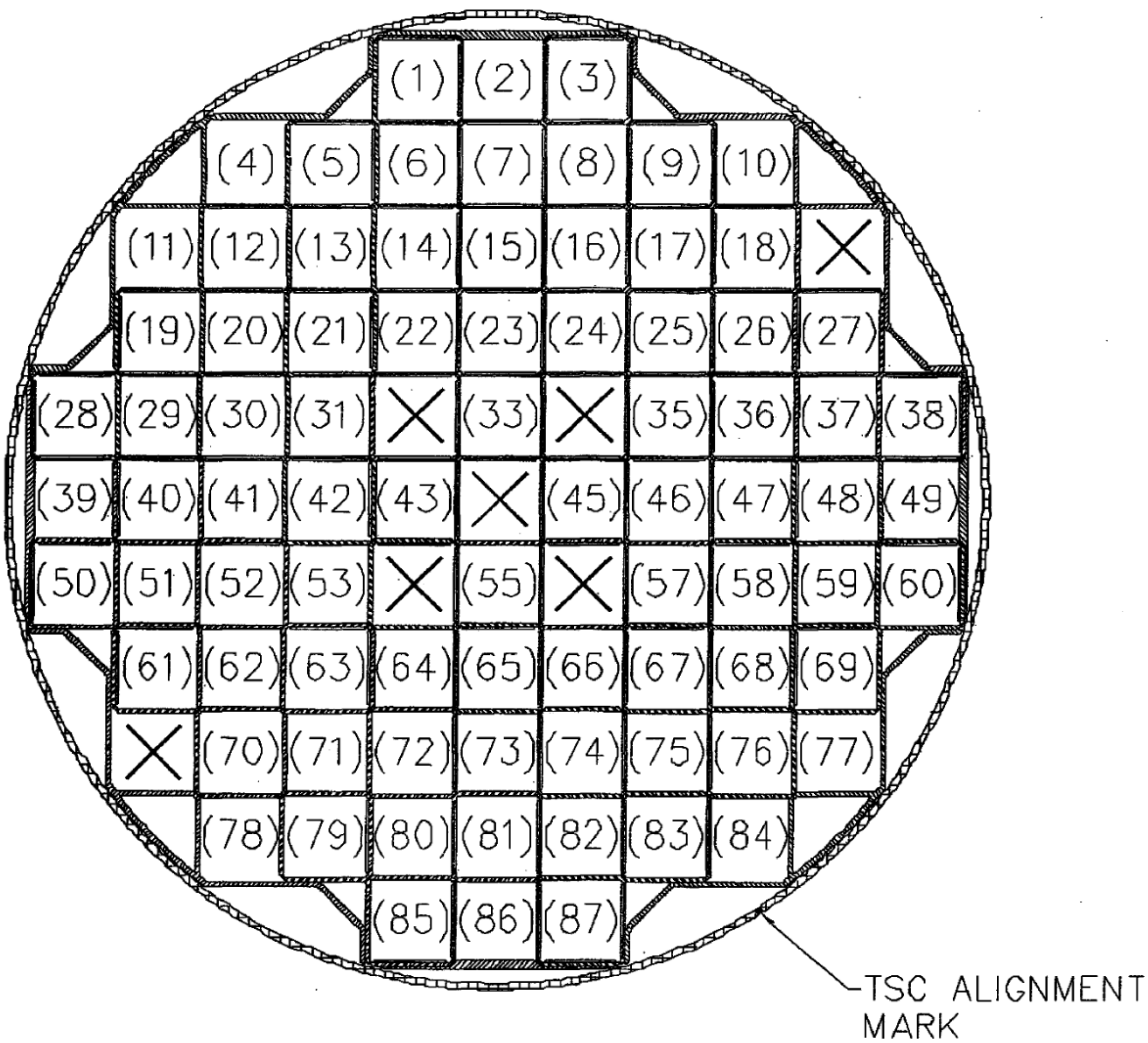
Figure 3—Undamaged Fuel Basket 87 Assembly Loading Profile



X = Designated NonFuel Location

5.(b)(1)(iii) Contents - Type and Form of Material (continued)

Figure 4—Undamaged Fuel Basket 82 Assembly Loading Profile



X = Designated Nonfuel Location

5.(b)(1)(iii) Contents - Type and Form of Material (continued)

Table 23—Loading Table for BWR Fuel – 22kW/Package[1]

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	Assembly Average Burnup ≤30 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	6.5	12.3	5.8	13.7	5.3	13.0	13.5
2.3 ≤ E < 2.5	6.3	11.6	5.7	13.0	5.2	12.3	12.8
2.5 ≤ E < 2.7	6.3	11.0	5.7	12.3	5.1	11.7	12.2
2.7 ≤ E < 2.9	6.2	10.3	5.6	11.8	5.1	11.1	11.6
2.9 ≤ E < 3.1	6.1	9.8	5.6	11.2	5.0	10.5	11.1
3.1 ≤ E < 3.3	6.0	9.3	5.5	10.7	5.0	10.0	10.6
3.3 ≤ E < 3.5	6.0	8.8	5.5	10.2	4.9	9.6	10.0
3.5 ≤ E < 3.7	6.0	8.4	5.4	9.8	4.9	9.1	9.6
3.7 ≤ E < 3.9	5.9	8.0	5.4	9.4	4.9	8.8	9.2
3.9 ≤ E < 4.1	5.9	7.7	5.3	9.0	4.8	8.4	8.9
4.1 ≤ E < 4.3	5.9	7.4	5.3	8.7	4.8	8.0	8.5
4.3 ≤ E < 4.5	5.8	7.0	5.3	8.4	4.8	7.7	8.2
4.5 ≤ E < 4.7	5.8	6.8	5.2	8.1	4.7	7.5	7.9
4.7 ≤ E < 4.9	5.8	6.5	5.2	7.8	4.7	7.2	7.6
E ≥ 4.9	5.7	6.3	5.2	7.6	4.7	6.9	7.4
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	30 < 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	8.9	14.3	7.6	15.6	6.6	15.0	15.5
2.5 ≤ E < 2.7	8.8	13.5	7.5	14.8	6.5	14.1	14.6
2.7 ≤ E < 2.9	8.6	12.7	7.3	14.0	6.4	13.4	13.9
2.9 ≤ E < 3.1	8.5	12.0	7.2	13.4	6.3	12.7	13.2
3.1 ≤ E < 3.3	8.4	11.4	7.2	12.8	6.3	12.1	12.6
3.3 ≤ E < 3.5	8.3	10.8	7.1	12.2	6.2	11.5	12.0
3.5 ≤ E < 3.7	8.2	10.3	7.0	11.7	6.1	11.0	11.5
3.7 ≤ E < 3.9	8.1	9.8	6.9	11.2	6.0	10.6	11.0
3.9 ≤ E < 4.1	8.0	9.3	6.9	10.8	6.0	10.1	10.6
4.1 ≤ E < 4.3	8.0	8.9	6.9	10.4	6.0	9.7	10.1
4.3 ≤ E < 4.5	8.0	8.7	6.8	10.0	6.0	9.3	9.8
4.5 ≤ E < 4.7	7.9	8.6	6.8	9.6	5.9	8.9	9.4
4.7 ≤ E < 4.9	7.8	8.6	6.7	9.3	5.9	8.6	9.1
E ≥ 4.9	7.8	8.6	6.7	9.0	5.9	8.3	8.8

1. '-' means not allowed

5.(b)(1)(iii) Contents - Type and Form of Material (continued)

Table 23—Loading Table for BWR Fuel – 22kW/Package[1] (continued)

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	35 < 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	14.6	16.9	12.2	18.0	10.0	17.3	17.7
2.7 ≤ E < 2.9	13.3	15.8	10.7	17.0	8.7	16.3	16.7
2.9 ≤ E < 3.1	13.1	14.9	10.5	16.0	8.5	15.4	15.8
3.1 ≤ E < 3.3	12.9	14.1	10.3	15.2	8.4	14.6	15.0
3.3 ≤ E < 3.5	12.6	13.9	10.1	14.5	8.3	13.8	14.3
3.5 ≤ E < 3.7	12.5	13.7	10.0	13.8	8.2	13.2	13.6
3.7 ≤ E < 3.9	12.4	13.6	9.9	13.3	8.0	12.6	13.0
3.9 ≤ E < 4.1	12.2	13.5	9.8	12.7	8.0	12.1	12.5
4.1 ≤ E < 4.3	12.0	13.4	9.7	12.3	7.9	12.0	11.9
4.3 ≤ E < 4.5	11.9	13.3	9.6	12.2	7.9	12.0	11.5
4.5 ≤ E < 4.7	11.9	13.1	9.6	12.1	7.8	11.9	11.2
4.7 ≤ E < 4.9	11.8	13.0	9.5	12.0	7.8	11.8	11.2
E ≥ 4.9	11.8	13.0	9.4	12.0	7.7	11.8	11.1
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	40 < 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	22.3	24.0	19.9	22.9	17.4	22.7	21.5
2.9 ≤ E < 3.1	19.7	21.4	17.2	20.3	14.8	20.0	19.4
3.1 ≤ E < 3.3	18.9	20.5	15.4	19.1	12.3	18.8	18.2
3.3 ≤ E < 3.5	18.7	20.2	15.2	18.8	11.9	18.6	17.4
3.5 ≤ E < 3.7	18.5	20.0	15.0	18.7	11.7	18.3	17.2
3.7 ≤ E < 3.9	18.2	19.9	14.7	18.5	11.5	18.0	17.1
3.9 ≤ E < 4.1	18.1	19.6	14.6	18.2	11.4	17.9	16.9
4.1 ≤ E < 4.3	17.8	19.5	14.3	18.1	11.3	17.7	16.7
4.3 ≤ E < 4.5	17.8	19.4	14.3	18.0	11.2	17.7	16.5
4.5 ≤ E < 4.7	17.6	19.2	14.1	17.8	11.1	17.5	16.5
4.7 ≤ E < 4.9	17.4	19.0	14.0	17.8	11.0	17.4	16.3
E ≥ 4.9	17.3	18.9	13.8	17.7	10.9	17.3	16.2

1. '-' means not allowed

5.(b)(1)(iii) Contents - Type and Form of Material (continued)

Table 24—Loading Table for BWR Fuel – 20.9kW/Package[1]

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	45 < 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	29.6	31.5	27.3	30.2	24.9	30.2	29.0
3.1 ≤ E < 3.3	27.8	29.6	24.7	27.9	22.2	27.6	26.3
3.3 ≤ E < 3.5	27.6	29.3	23.6	27.7	19.6	27.4	26.1
3.5 ≤ E < 3.7	27.4	29.0	23.2	27.4	19.0	27.1	25.9
3.7 ≤ E < 3.9	27.2	28.9	23.0	27.3	18.7	26.9	25.6
3.9 ≤ E < 4.1	26.9	28.6	22.8	27.0	18.5	26.7	25.5
4.1 ≤ E < 4.3	26.8	28.6	22.6	27.0	18.4	26.5	25.2
4.3 ≤ E < 4.5	26.6	28.3	22.3	26.8	18.2	26.5	25.1
4.5 ≤ E < 4.7	26.4	28.1	22.3	26.6	17.9	26.3	25.0
4.7 ≤ E < 4.9	26.2	28.0	22.1	26.4	17.9	26.1	24.8
E ≥ 4.9	26.0	27.8	22.0	26.4	17.9	25.9	24.7
Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	**50 < 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	36.4	38.4	34.1	37.2	31.8	37.2	35.9
3.3 ≤ E < 3.5	34.0	358	31.7	34.6	29.2	34.6	33.4
3.5 ≤ E < 3.7	33.3	35.0	29.1	33.4	26.6	33.1	31.8
3.7 ≤ E < 3.9	33.1	34.8	28.8	33.3	24.3	32.8	31.4
3.9 ≤ E < 4.1	32.9	34.6	28.6	33.1	24.0	32.7	31.4
4.1 ≤ E < 4.3	32.7	34.5	28.5	32.9	23.9	32.5	31.1
4.3 ≤ E < 4.5	32.5	34.3	28.2	32.7	23.6	32.4	30.9
4.5 ≤ E < 4.7	32.5	34.2	28.0	32.6	23.5	32.2	30.8
4.7 ≤ E < 4.9	32.3	34.0	27.8	32.4	23.3	32.0	30.6
E ≥ 4.9	32.1	33.9	27.6	32.4	23.2	31.8	30.5

1. '-' means not allowed

5.(b)(1)(iii) Contents - Type and Form of Material (continued)

Table 24—Loading Table for BWR Fuel – 20.9kW/Package[1]

Minimum Initial Assembly Avg. Enrichment wt % ^{235}U (E)	55 < 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	42.3	44.6	40.0	43.4	38.2	43.5	42.3
3.5 ≤ E < 3.7	39.8	42.3	37.7	41.0	357	41.1	39.8
3.7 ≤ E < 3.9	38.3	40.0	35.3	38.7	33.3	38.7	37.5
3.9 ≤ E < 4.1	38.1	40.2	33.7	38.3	30.9	38.0	36.5
4.1 ≤ E < 4.3	37.8	40.0	33.6	38.2	29.0	37.8	36.4
4.3 ≤ E < 4.5	37.8	39.8	33.4	38.2	28.9	37.8	36.4
4.5 ≤ E < 4.7	37.7	39.6	33.2	38.0	28.7	37.7	36.2
4.7 ≤ E < 4.9	37.6	39.5	33.1	37.9	28.4	37.5	36.0
E ≥ 4.9	37.4	39.4	32.9	37.8	28.4	37.4	35.8

1. '-' means not allowed

Table 25—Low Burnup BWR Fuel Loading Table – 22 kW/Package

Max. Assembly Avg. Burnup [MWd/MTU]	Min. Assembly Avg. Initial Enrichment [wt% ^{235}U]	Minimum Cool Time [Years]
10,000	1.3	6.3
15,000	1.5	8.6
20,000	1.7	10.3
25,000	1.9	11.9
30,000	2.1	13.7

(iv) Greater Than Class C Waste

GTCC waste consisting of solid, irradiated, and contaminated hardware, provided the quantity of fissile material does not exceed a Type A quantity and does not exceed the mass limits of 10 CFR 71.15, within a GTCC waste basket liner transported in a GTCC TSC with a welded closure lid. The specific Curie content source of the GTCC waste shall be limited to a maximum specific activity of 2.7 Ci ^{60}Co/lb averaged over the GTCC waste, with a maximum localized peak specific activity of 16.1 Ci ^{60}Co/lb and a total ^{60}Co activity of 85,760 Ci at transport. The maximum allowed weight of this waste is 55,000 lbs.

5.(b)(2) Maximum quantity of material per package

(i) For the contents described in Item 5.(b)(1)(i): Up to 37 undamaged PWR fuel assemblies, including nonfuel hardware and spacers, with a maximum weight of 62,160 pounds and a maximum decay heat limit per fuel location not to exceed the values in Table 2.

(ii) For the contents described in Item 5.(b)(1)(ii): Up to 37 undamaged PWR fuel assemblies, which may include up to 4 damaged fuel assemblies in damaged fuel cans, nonfuel hardware and spacers, with a maximum weight of 61,184 pounds (TSC and maximum contents shall not exceed 104,500 pounds) and a maximum decay heat limit per fuel location not to exceed the values in Table 2.

(iii) For the contents described in Item 5.(b)(1)(iii): 87 undamaged BWR fuel assemblies, including channels and spacers, with a maximum weight of 62,656 pounds and a maximum decay heat limit not to exceed the values in Table 20.

(iv) For the contents described in item 5.(b)(1)(iv): GTCC waste with a maximum weight per package of 55,000 pounds in total. The maximum decay heat for the GTCC waste is 1.7 kW per package.

5.(c) Criticality Safety Index

Undamaged PWR and BWR Fuel	0.00
Damaged PWR Fuel	100.00

6. In addition to the requirements of Subpart G of 10 CFR Part 71:

   (a) The package must be prepared for shipment and operated in accordance with the Operating Procedures in Chapter 7 of the application, as supplemented.

   (b) Each packaging must be acceptance tested and maintained in accordance with the Acceptance Tests and Maintenance Program in Chapter 8 of the application, as supplemented, except that the minimum component thicknesses for the mockup in Section 8.1.6.1 and the minimum shielding effectiveness configuration for calculating the dose rates used as acceptance criteria for the tests in Sections 8.1.6.3 and 8.2.3 are defined by the component dimensions and tolerances in the drawings listed in Condition 5.(a)(3).

   (c) Only TSCs that are within their initial term for storage (i.e., in storage up to 20 years) or are new and haven't been loaded and placed into storage are authorized for shipment using the moderator exclusion option of this certificate.

7. Prior to transport by rail, the Association of American Railroads must have evaluated and approved the railcar and the system used to support and secure the package during transport.

8. Prior to marine or barge transport, the National Cargo Bureau, Inc., must have evaluated and approved the system used to support and secure the package to the barge or vessel, and must have certified that package stowage is in accordance with the regulations of the Commandant, United States Coast Guard.

9. Transport by air is not authorized.

10. Transport of fuel assemblies, as described in Drawing No. 71160-685 Revision 8, Assembly No. 99, is not authorized.

11. Zion TSC basket assemblies with serial numbers TSC-21, TSC-22, TSC-24, TSC-25, and TSC-26, are authorized to not have weldment shims installed as required by license drawing 71160-575, Note 4.

12. The American Society of Mechanical Engineers Boiler and Pressure Vessel Code alternative in Table 2.1.4-1, "ASME Code Alternatives for MAGNATRAN Components", page 2.1.4-6 for the "Fuel Basket Assembly" the description for "Alternative, Justification and Compensatory Measures" is revised to: "Fuel basket materials fabricated from Carbon Steel with a thickness >5/8 inch, may optionally have impact tests performed on specimens oriented in a direction parallel to the principal rolling direction of the plate, provided that the results from the tests are scaled down to 67% of the measured values before comparing to acceptance criteria in The American Society of Mechanical Engineers Boiler and Pressure Vessel Code Table NG-2331(a)(1) at the Lowest Service Temperature (LST) of -40°F."

13. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR 71.17.

14. Revision No. 5 of this certificate may be used until August 31, 2026.

15. Expiration date: April 30, 2029.

REFERENCES

NAC International, Inc., Application dated August 13, 2025.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Signed by Diaz-Sanabria, Yoira on 09/15/25

Yoira K. Diaz-Sanabria, Chief
Storage and Transportation Licensing Branch
Division of Fuel Management
Office of Nuclear Material Safety and Safeguards

Date: September 15, 2025

SAFETY EVALUATION REPORT

Docket No. 71-9356
Model No. MAGNATRAN
Certificate of Compliance No. 71-9356
Revision 6

SUMMARY

By application dated December 19, 2024 (Agencywide Documents Access and Management System [ADAMS] Accession No. ML24355A131), as supplemented on June 26, 2025 (ML25177D088), NAC International (NAC or the applicant) applied for an amendment to Certificate of Compliance No. 9356 for the Model No. MAGNATRAN package. NAC requested an amendment to correct a licensing basis deficiency initially reported to the NRC on March 10, 2023 (ML23069A215). The report identified that a parameter used in the computation of bending stress in the finite element model used to structurally evaluate a fuel rod under the non-mechanistic tip-over accident condition was incorrectly specified resulting in the non-conservative calculation of stresses. MAGNATRAN safety analysis report (SAR) sections 2.11.1, 2.11.4, 2.11.6, and 2.12.1 have been revised to correct this error and provide additional clarification to the fuel rod evaluations. Also, by application dated August 13, 2025 (ML25225A114), NAC submitted a consolidated SAR.

Following staff review of the associated SAR, the staff finds that the changes do not affect the ability of the package to meet the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 71.

EVALUATION

2.0 STRUCTURAL EVALUATION

The objective of the structural evaluation is to verify that the applicant has adequately evaluated the structural performance of the proposed transport package and demonstrated that it satisfies the regulations in 10 CFR Part 71, “Packaging and Transportation of Radioactive Material.”

The staff evaluated the proposed changes in the SAR, revision 25A, in accordance with the guidance of NUREG-2216, *Standard Review Plan for Transportation Packages for Spent Fuel and Radioactive Material,* US NRC, 2020 (ML20234A651). This section documents the staff’s review, evaluation, and conclusions with respect to the structural safety aspects of the proposed transport package, as well as specific material property definitions.

2.1. Description of Structural Design

In this amendment, the applicant proposed the following design changes:

a. the addition of the fuel rod evaluation for a 30-foot transport cask side drop event,
b. a revision to the fuel rod fatigue evaluation, and
c. a revision to the fuel rod evaluation for the 30-foot transport cask end drop event.

The following documents were submitted in support of this application amendment and were included with the application:

1. 71160-2139, “PWR and BWR Fuel Assembly Fatigue Evaluation for MAGNATRAN,” Revision 1.
2. 71160-2140, “Fuel Rod Evaluation for the MAGNATRAN 30-ft Side Drop Accident,” Revision 1.

3. 71160-2126, “Fuel Assembly Structural Evaluation for the MAGNATRAN End Drop Condition,” Revision 7.

2.1.1 Fuel Rod Evaluation for 30-foot Side Drop

The applicant documented the analyses of fuel rods for the Hypothetical Accident Condition (HAC) 30-foot transport cask side drop in calculation 71160-2140 and described it in SAR section 2.11.4. The applicant performed a number of evaluations to represent the effects of this HAC event on 33 PWR and 27 BWR high burnup fuel assemblies, each comprised of 7 fuel types, at a bounding fuel temperature of 400 °C (752 °F), the maximum permitted cladding temperature during normal transport conditions. The applicant employed the finite element program ANSYS for these analyses.

Each evaluation considered a single, empty fuel rod with the cladding weight adjusted for the mass of the missing fuel and applied a cladding flexural rigidity factor of 1.25 to adjust for the absence of the fuel pellet, as recommended by section 2.3.4 of NUREG-2224, *Dry Storage and Transportation of High Burnup Spent Nuclear Fuel,* USNRC, November 2020 (ML21091A321). Cladding thicknesses for both PWR and BWR rods are also reduced to account for oxide layers for the various cladding materials, as recommended by figure 2-5 of NUREG-2224. For the PWR fuel rod analyses, the applicant considers PWR fuel rods with and without grid damage. For the PWR fuel rod without grid damage, the applicant considers the nominal as-built spacing between grids, while for the PWR fuel rod with grid damage, a maximum unsupported length of 60 inches is considered to account for fuel rods with missing, slipped, or damaged grids, which the applicant determines to be bounding over a configuration with no missing/damaged grids. For the BWR fuel rod analyses, the applicant considers the unsupported lengths to be the nominal, as-built configuration. For both PWR and BWR fuel rods, the applicant limits deflections in the analyses by the space between adjacent fuel rods as well as that between the fuel tube wall. The staff finds the applicant’s choice of analysis parameters and method of evaluation to be acceptable as they are either conservative or follow the guidance provided.

For the PWR rod analyses, the applicant considered high burnup conditions and cladding alloys that are typical for PWR fuel. Similarly, the applicant considered high burnup conditions and cladding alloys that are typically used for BWR fuel. The fuel rod and fuel pellet material properties of elastic modulus, density and yield strength, as applicable, are taken from various references.

The staff reviewed the applicant’s selection of material properties for the cladding alloys to support the analyses. In addition, the staff reviewed information on cladding material properties not cited by the applicant including:

- Shimskey, R., et al. “FY2014 PNNL Zr Cladding Testing Status Report,” PNNL-23594, August 30, 2014.
- Wells, B.E., et al. “Evaluation of Increased Peak Temperatures for Spent Fuel Cladding Performance during Dry Storage,” PNNL-30430, Rev. 1, September 2020.

The staff determined that the material properties for the BWR fuel cladding alloys used by the applicant in their side drop evaluation were acceptable because the values were obtained by measurements on irradiated cladding alloys at temperatures consistent with the applicant’s analyses. Similarly, the staff determined that the material properties for most of the PWR fuel cladding alloys used by the applicant were obtained by measurements on the irradiated cladding samples at elevated temperatures and were therefore acceptable.

The staff noted that the data used by the applicant for one of the PWR cladding alloys was obtained using tensile tests under non-quasi-static testing conditions. Zirconium-based fuel cladding alloys are known to strain harden as a function of strain rate which, in turn, increases the measured yield strength. Based on the information provided in Shimskey et al. (2014) and Wells et al., (2020), the staff determined that the yield strength of the cladding alloy would be increased by approximately 6 percent under the testing conditions in the reference cited by the applicant. The staff also determined that publicly available data for irradiated cladding material properties at elevated temperatures is limited and alternative references for properties for the alloy under quasi-static testing conditions are not available. After reviewing the available data and the applicant's analysis, the staff determined that the cited material properties for the cladding alloy were acceptable because: (1) the measurements were conducted using irradiated materials over a range of temperatures that bound the applicant's analyzed maximum temperature for the cladding alloy under transportation conditions, (2) the strain rates under drop accident conditions would be greater than quasi-static strain rates typically used to determine material properties, and (3) use of yield strength as an acceptance criteria is conservative because all zirconium-based cladding alloys strain harden above the yield stress and retain measurable ductility after irradiation.

The acceleration values applied to each fuel rod in the analyses were determined through the use of a dynamic load factor based on the modal analysis of each fuel rod, following the general principles presented in section 2.3.5.2 of NUREG-2224. The applicant created a broadened and enveloped response spectra from the acceleration time histories of the LS-DYNA finite element analyses of the 30-foot cask drops. The resulting acceleration values, applied uniformly along the entire length of the fuel rods in the analyses, were 28 g for the damaged PWR rods with grid damage, 48 g for the PWR rods without grid damage, and 48 g for the BWR rods. The staff finds this method of acceleration determination to be acceptable as it follows guidance and the resulting applied acceleration values to be acceptable as they are conservative.

For the final analysis, one PWR fuel rod with grid damage and one BWR fuel rod are chosen by the applicant based on the associated cladding section properties and inertia loading that are expected to produce bounding cladding stresses during the 30-foot transport cask side drop event. For both the PWR and BWR rod analyses, the factor of safety for all cladding yield stress versus actual stresses were greater than a value of one for all material types, indicating that the fuel rod cladding material meets the acceptance criteria during the HAC 30-foot cask side drop event. Based on these results, the staff finds the fuel rods to be structurally adequate for the HAC event required by 10 CFR 71.73(c)(1).

2.1.2 Fuel Rod Evaluation for 30-foot End Drop

The applicant documented the reduced factors of safety for the HAC 30-foot transport cask end drop fuel rod analyses in revisions to calculation 71160-2126 and tables in SAR sections 2.11.1 and 2.11.1.2 resulting from the reduced M5 fuel clad yield strengths at 400 °C (752 °F), the maximum permitted cladding temperature during normal transport conditions. The applicant previously determined that the PWR fuel rod analyses, both intact and damaged grids, bounded those of the BWR rod analyses, and the M5 cladding material also bounded the Zirlo and Zirc-4 materials. The resulting revised factors of safety for the PWR cladding yield stress versus actual stress were greater than one for the M5 material type with or without grid damage, indicating that the fuel rod cladding material meets the acceptance criteria during the HAC 30-foot cask end drop event. Based on these results, the staff finds the fuel rods to be structurally adequate for the HAC event required by 10 CFR 71.73(c)(1).

2.1.3 Fatigue Evaluation of Fuel Rods

The applicant documented this Normal Conditions of Transport (NCT) analysis in calculation 71160-2139 and revised SAR section 2.11.6 to describe this evaluation. The applicant performed a number of evaluations to represent the effects of this NCT on 33 PWR and 27 BWR high burnup fuel assemblies, each comprised of 7 fuel types, at a bounding fuel temperature of 400 °C (752 °F), the maximum permitted cladding temperature during normal transport conditions. The applicant employed the finite element program ANSYS for these analyses.

Each evaluation considered a single, empty fuel rod with the cladding weight adjusted for the mass of the missing fuel and applied a cladding flexural rigidity factor of 1.25 to adjust for the absence of the fuel pellet, as recommended by section 2.3.4 of NUREG-2224. The applicant conservatively reduces the cladding thicknesses for the PWR rods by 125 microns and by 120 microns for the BWR rods to account for oxide layers, as recommended by figure 2-5 of NUREG-2224. For the PWR fuel rod analyses, the applicant considers PWR fuel rods with and without grid damage. For the PWR fuel rod without grid damage, the applicant considers the nominal as-built spacing between grids, while for the PWR fuel rod with grid damage, a maximum unsupported length of 60 inches is considered to account for fuel rods with missing, slipped, or damaged grids, which the applicant determines to be bounding over a configuration with no missing/damaged grids. For the BWR fuel rod analyses, the applicant considers the unsupported lengths to be the nominal, as-built configuration. Both PWR and BWR fuel rods, deflections are limited in the analyses by the space between adjacent fuel rods as well as that between the fuel tube wall. The staff finds the applicant's choice of analysis parameters and method of evaluation to be acceptable as they are either conservative or follow the guidance provided.

The applicant performed response spectra analyses for the fuel rods employing five test cases from the ENSA/DOE rail cask test documented in SAND2018-13268R, *"Data Analysis of ENSA/DOE Rail Cask Tests, Spent Fuel and Waste Disposition,"* US Department of Energy, Spent Fuel and Waste Science and Technology, November, 2018, which include acceleration data in three orthogonal directions up to a frequency of 1,000 Hz. The applicant reported the resulting maximum fuel rod cladding stress and strain for the analyzed rods and compares the strain values to table 2-6 and figure 2-12 of NUREG-2224, both of which indicate lower-bound fatigue limits for high burnup Zirc-4 fuel cladding. For both the PWR and BWR rod analyses, the resulting strain values were lower than the 0.060% limits for cycles beyond 2.74×10^5 in NUREG-2224, indicating that the fuel rod cladding material meets the acceptance criteria during fatigue conditions under NCT. Based on these results, staff finds the fuel rods to be structurally adequate for the NCT event required by 10 CFR 71.71(c)(5).

2.2. Evaluation Findings

The staff reviewed the amendment package for the revised NCT and additional HAC analyses and concludes that it satisfies the requirements of 10 CFR 71.71(c)(5) and 71.73(c)(1).

The staff reviewed the structural and material performance of the package under the NCT required by 10 CFR 71.71 and the HAC required by 10 CFR Part 71.73 and concludes that it satisfies the requirements of 10 CFR 71.51(a)(1) and 71.51(a)(2) for a Type B package and 10 CFR 71.55(d)(2) and 71.55(e) for a fissile package.

Based on review of the statements and representations in the application amendment request, the NRC staff concludes that the MAGNATRAN package has been adequately described and evaluated to demonstrate that it satisfies the structural integrity and material performance requirements of 10 CFR Part 71.

CONDITIONS

In addition to small editorial changes, the following changes have been made to the certificate:

Condition 3(b) has been revised to reflect the date of the consolidated application.

Condition No. 14 has been edited to read “Revision No. 5 of this certificate may be used until August 31, 2026.”

The references section has been updated to reflect the date of the consolidated application.

CONCLUSION

Based on the statements and representations in the application, as supplemented, and the conditions listed above, the staff concludes that the Model No. MAGNATRAN package design has been adequately described and evaluated, and that these changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9356, Revision No. 6.