PRELIMINARY
SAFETY EVALUATION REPORT

FOR THE
FUELSOLUTIONS™ SPENT FUEL MANAGEMENT SYSTEM
CERTIFICATE OF COMPLIANCE RENEWAL

DOCKET NO. 72-1026

Office of Nuclear Material Safety and Safeguards
United States Nuclear Regulatory Commission

DATE

TABLE OF CONTENTS

TABLES

ABBREVIATIONS AND ACRONYMS

ACI	American Concrete Institute
ADAMS	Agencywide Documents Access and Management System
AMID	Aging Management Institute of Nuclear Power Operations Database
AMP	aging management program
AMR	aging management review
ASME	American Society of Mechanical Engineers
B&PV	boiler and pressure vessel
BFS	BNFL Fuel Solutions Corporation
BWR	boiling water reactor
C	Celsius
CFR	*Code of Federal Regulations*
CoC	certificate of compliance
DSS	dry storage system
EPRI	Electric Power Research Institute
F	Fahrenheit
FSAR	final safety analysis report
GWd/MTU	gigawatt-days per metric ton of uranium
HBU	high burnup
HDRP	High Burnup Dry Storage Cask Research and Development Project
ISFSI	independent spent fuel storage installation
ISG	interim staff guidance
ITS	important to safety
k_{eff}	“k” effective-neutron multiplication factor
ksi	kilopound per square inch
MAPS	managing aging processes in storage

NEI	Nuclear Energy Institute
NITS	not important to safety
NRC	U.S. Nuclear Regulatory Commission
PHSS	precipitation-hardened stainless steel
psi	pound per square inch
psig	pounds per square inch gauge
PWR	pressurized water reactor
RAI	request for additional information
RCS	reinforced concrete structure
SAR	safety analysis report
SER	safety evaluation report
SNF	spent nuclear fuel
SSC	structure, system, and component
TC	transfer cask
TLAA	time-limited aging analysis
TS	technical specifications
UFSAR	updated final safety analysis report
WEC	Westinghouse Electric Company LLC
WSSC	Welded Stainless Steel Canister

EXECUTIVE SUMMARY

In accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste," the U.S. Nuclear Regulatory Commission (NRC) issued Certificate of Compliance (CoC) No. 1026 for 20 years for the FuelSolutions™ Storage System for dry storage of spent nuclear fuel in an independent spent fuel storage installation (ISFSI) at power reactor sites to persons authorized to possess or operate nuclear power reactors under 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," and 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," in accordance with 10 CFR Part 72, Subpart K, "General License for Storage of Spent Fuel at Power Reactor Sites." The CoC was to expire on February 15, 2021.

By letter dated November 6, 2020 (WEC 2020), as supplemented on March 30, 2021 (WEC 2021), June 30, 2022 (WEC 2022a), and September 13, 2022 (WEC 2022b), Westinghouse Electric Company LLC (referred to as WEC or the applicant in this report), submitted an application to the NRC for the renewal of CoC No. 1026 for a period of 40 years beyond the initial certificate period.

The applicant submitted the renewal application in accordance with the regulatory requirements of 10 CFR 72.240, "Conditions for spent fuel storage cask renewal." Because the renewal application was submitted more than 30 days before the certificate's expiration date, pursuant to 10 CFR 72.240(b), the existing CoC is in timely renewal. The application documented the technical bases for renewal of the certificate and the applicant's commitments to manage the potential aging of the systems, structures, and components (SSCs) of the dry storage system (DSS) to ensure that these SSCs will maintain their intended functions during the time period of operation that extends beyond the term certified by the current certificate (referred to in this report as the period of extended operation or extended storage).

In the November 6, 2020 submittal (WEC 2020), the applicant requested the renewal for the initial CoC (Amendment No. 0) and Amendments No. 1 through 5. The renewal application contains two parts: the first part is the renewal application for the FuelSolutions™ Spent Fuel Management System, which includes the initial CoC and Amendments No. 1 through 4; and the second part is the renewal application for FuelSolutions™ Spent Fuel Management System SENTRY Dry Storage System Addenda, which is Amendment No. 5. By a letter dated June 27, 2022 (WEC 2022c), the applicant requested to withdraw Amendment No. 5 from the renewal application. Therefore, this safety evaluation report (SER) only evaluates the renewal for the initial CoC and Amendments No. 1 through 4.

The FuelSolutions™ Storage System is a canister-based dry cask spent fuel storage system. It is comprised of three principal components: (1) the W21 canister for storage of pressurized water reactor (PWR) spent fuel assemblies, (2) the W74 canister for storage of boiling water reactor (BWR) spent fuel assemblies, and (3) the W150 storage cask. In addition, the system includes the W100 transfer cask that is used for canister loading/unloading operations into the W150 storage cask. The system design features are intended to facilitate on-site spent nuclear fuel (SNF) loading, handling, and monitoring operations, and to provide for radiological protection, criticality control, and maintenance of structural and thermal safety margins.

In the renewal application, the applicant presented general information about the DSS design with a scoping analysis to determine the SSCs that are in scope of the renewal and subject to an aging management review (AMR). The applicant further screened the in-scope SSCs to identify and describe the subcomponents that support the in-scope SSC intended function(s). The applicant documented the technical bases for renewal of the CoC and proposed actions for managing potential aging of the SSCs of an ISFSI that are within the scope of license renewal to ensure that these SSCs will maintain their intended functions during the period of extended operation. For each in-scope SSC subcomponent, the applicant provided one of the following to assure that the SSC will maintain its intended function(s) during the period of extended operation: (1) an analysis that shows that no aging management is necessary because no aging effects are relevant for the SSC, (2) an updated time-limited aging analysis, (3) a supplemental aging analysis to justify the proposed aging management approach, or (4) an aging management program (AMP).

The NRC staff reviewed the technical bases for safe operation of the DSS for an additional 40 years beyond the current CoC term of 20 years. This safety evaluation report summarizes the results of the staff's review for compliance with 10 CFR 72.240. In its review, the staff followed the guidance in NUREG-1927, Revision 1, "Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel," issued June 2016 (NRC 2016), and NUREG-2214, "Managing Aging Processes in Storage (MAPS) Report," issued July 2019 (NRC 2019).

NUREG-2214 (NRC 2019) establishes a generic technical basis for the safety review of ISFSI licenses and DSS CoC renewal applications, in terms of the evaluation of (1) aging mechanisms and effects that could impact the ability of ISFSI and DSS SSCs to fulfill their intended functions in the period of extended operation (i.e., credible aging mechanisms and effects) and (2) AMPs to manage the aging effects, including examples of AMPs that are considered generically acceptable to address the credible aging effects to ensure that the design bases will be maintained in the period of extended operation. The staff evaluated the applicant's technical basis for its AMR and proposed AMPs and compared it to the generic technical basis in NUREG-2214. For that comparison, the staff ensured that the design features, operating environments, aging mechanisms, and operating experience for the CoC No. 1026 are bounded by those evaluated in NUREG-2214.

This safety evaluation report is organized into six sections. Section 1 provides the staff's review of the general information on the DSS design. Section 2 presents the staff's review of the scoping evaluation performed to determine which SSCs are within the scope of the CoC renewal. Section 3 provides the staff's evaluation of the applicant's AMR for assessment of aging effects and aging management activities for SSCs within the scope of renewal. Section 4 documents the additions and changes to the license that resulted from the review of the license renewal application. Section 5 presents the staff's conclusions from its review. Section 6 lists the references supporting the staff's review and technical determinations.

1 GENERAL INFORMATION

1.1 Certificate of Compliance and Certificate of Compliance Holder Information

By letter dated November 6, 2020 (WEC 2020), as supplemented on March 30, 2021 (WEC 2021), June 30, 2022 (WEC 2022a), and September 14, 2022 (WEC 2022b), the current CoC holder, Westinghouse Electric Company LLC[1] (referred to as WEC or the applicant in this report), submitted an application to the NRC to renew CoC No. 1026 for the FuelSolutions™ Storage System for a period of 40 years beyond the initial certificate period. The application is subject to the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste," Subpart K, "General License for Storage of Spent Fuel at Power Reactor Sites," and Subpart L, "Approval of Spent Fuel Storage Casks." The applicant submitted the renewal application in accordance with the regulatory requirements of 10 CFR 72.240, "Conditions for spent fuel storage cask renewal." Because the renewal application was submitted more than 30 days before the certificate's expiration date, pursuant to 10 CFR 72.240(b), the existing CoC is in timely renewal.

In the November 6, 2020 submittal (WEC 2020), the applicant requested the renewal for the initial CoC and Amendments No. 1 through 5. The renewal application contains two parts: the first part is the renewal application for the FuelSolutions™ Spent Fuel Management System, which includes the initial CoC and Amendments No. 1 through 4 and covers W150 storage cask, W100 transfer cask, and W21 and W74 canister; and the second part is the renewal application for FuelSolutions™ Spent Fuel Management System SENTRY Dry Storage System Addenda, which is Amendment No. 5. By a letter dated June 27, 2022 (WEC 2022c), the applicant requested to withdraw Amendment No. 5 from the renewal application. Therefore, this SER only evaluates the renewal for the initial CoC and Amendments No. 1 through 4.

The U.S. Nuclear Regulatory Commission (NRC) issued the initial CoC (Amendment No. 0) on February 15, 2001, for the FuelSolutions™ Storage System (NRC 2001). Subsequently, the NRC has issued four amendments to the FuelSolutions™ CoC. In its renewal application, the applicant provided a description of the licensing basis for the FuelSolutions™ initial issuance, as well as general descriptions of the changes and reasons for each amendment, including the dates of the applications and associated supplements, the date of issue of the CoC and CoC amendments, and the corresponding updated final safety analysis report (UFSAR) revisions in which the changes were incorporated. Chapter 1 of the application lists the amendments and provides a description for each amendment along with references. Chapter 2 of the application provides further details on the scope of each amendment.

---

[1] The initial certificate for CoC No. 1026 for FuelSolutions™ Storage System was issued to BNFL Fuel Solutions Corporation (BFS) in February 2001 (NRC 2001). On April 12, 2005, BFS notified the NRC that, effective on April 13, 2005, BFS changed the company name to BNG Fuel Solutions Corporation (BNLF 2005). On February 17, 2006, BNG America, the corporate parent company of BNG Fuel Solutions, notified the NRC that, effective January 30, 2006, all assets of BNG America were transferred to and held by BNG America LLC (BNG 2006). Further, BNG America LLC was in the process of being acquired by Energy*Solutions*. On January 18, 2013, Energy*Solutions* LLC notified the NRC of an indirect transfer of control of CoC No. 1026 to Rockwell Holdco, Inc. (ES LLC 2013) where Energy*Solutions* and its subsidiaries maintain responsibility for the maintenance of CoC No. 1026. On September 13. 2019, WEC notified the NRC that, effective September 13, 2019, WEC has acquired the intellectual property for FuelSolutions™ Storage System from Energy*Solutions* and assumed as the CoC holder (WEC 2019).

1.2 Safety Review

The objective of this safety review is to determine whether the DSS will continue to meet the requirements of 10 CFR Part 72 during the period of extended operation. The NRC staff safety review assesses the technical aspects of the FuelSolutions™ Spent Fuel Management System renewal application. In accordance with 10 CFR 72.240(c)(2) and (c)(3), an application for the renewal of a spent fuel storage cask CoC must be accompanied by a safety analysis report (SAR) that includes (1) time-limited aging analyses (TLAAs) that demonstrate SSCs important to safety will continue to perform their intended functions for the requested period of extended operation and (2) a description of the AMPs for management of issues associated with aging that could adversely affect SSCs important to safety.

The applicant stated that the CoC renewal application is consistent with guidance in NUREG-1927 (NRC 2016). In addition, the applicant stated that credible aging mechanisms for the material/environment combinations for the SSCs included in the scope of the renewal followed the guidance in NUREG-2214 (NRC 2019).

The applicant performed a scoping evaluation and aging management review to identify all SSCs within the scope of the renewal and pertinent aging mechanisms and effects, respectively. The applicant developed AMPs and evaluated TLAAs to ensure that the in-scope SSCs will continue to perform their intended functions during the period of extended operation. This review documents the staff's evaluation of the applicant's scoping analysis, aging management review, and supporting AMPs and TLAAs.

1.3 Application Content

The renewal application provides the following information:

- general information
- scoping evaluation
- AMRs
- aging management tollgates
- TLAAs and other supplemental evaluations
- AMPs
- changes to the CoC 1026 final safety analysis report (FSAR)
- changes to the CoC 1026 technical specifications (TS)

In appendix D of the application, the applicant also provided CoC and FSAR changes for all CoC amendments, which incorporated all changes to the FuelSolutions™ Storage System previously made in accordance with 10 CFR 72.48(c) and (d).

1.4 Interim Staff Guidance

The staff, industry, and other interested stakeholders gain experience and develop lessons learned from operating ISFSIs and DSSs, as well as each renewal review. The lessons learned address issues related to the licensing goals of maintaining safety, improving effectiveness and efficiency, reducing regulatory burden, and increasing public confidence. The staff develops interim staff guidance (ISG) to clarify or to address issues not addressed in standard review plans, such as NUREG-1927, Revision 1. The staff, industry, and other interested stakeholders are to use ISGs until they are incorporated into staff guidance documents such as regulatory guides and standard review plans. The applicant specifically referenced ISG-11, “Cladding Considerations for the Transportation and Storage of Spent Fuel,” Revision 3, issued November 2003 (NRC 2003).

1.5 Evaluation Findings

The staff reviewed the general information in chapter 1 of the renewal application. The staff performed its review by following the standard review plan for renewal applications in NUREG-1927, Revision 1. Based on its review, the staff determined that the applicant provided sufficient information with adequate details to support the renewal application, with the following findings:

F1.1 The information presented in the renewal application satisfies the requirements of 10 CFR 72.48, “Changes, tests, and experiments,” and 10 CFR 72.240, “Conditions for spent fuel storage cask renewal.”

F1.2 The applicant provided a tabulation of all supporting information and docketed material incorporated by reference, in compliance with 10 CFR 72.240.

2 SCOPING EVALUATION

As described in NUREG-1927, Revision 1 (NRC 2016), a scoping evaluation is necessary to identify the SSCs requiring an AMR. The objective of this scoping evaluation is to identify SSCs meeting one of the following criteria:

1. SSCs that are classified as important to safety (ITS), as they are relied on for one of the following functions:

   i. Maintain the conditions required by the regulations or the CoC to store spent fuel safely.
   ii. Prevent damage to the spent fuel during handling and storage.
   iii. Provide reasonable assurance that spent fuel can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public.

2. SSCs that are classified as not important to safety (NITS) but, according to the design bases, their failure could prevent fulfillment of a function that is important to safety.

After the determination of in-scope SSCs, the in-scope SSCs are screened to identify and describe the subcomponents that support the intended functions of the SSC.

2.1 Scoping and Screening Methodology

In chapter 2 of the renewal application for the FuelSolutions™ system (WEC 2020, 2021), the applicant performed a scoping and screening evaluation and provided the following information:

- a description of the scoping and screening process and method for determining the SSCs and SSC subcomponents that are included in the scope of renewal, and for determining the SSCs and SSC subcomponents that are excluded from the scope of renewal;
- descriptions of the SSCs, the SSCs' intended design functions, and their safety classifications;
- a list of the SSCs and their subcomponents that are identified to be within and not within the scope of renewal and the basis for the scoping and screening determination;
- a list of sources of information used for the scoping and screening evaluation;
- identification of the drawings and documents used to determine the scoping and screening process, the SSCs' intended design functions, and the safety classifications.

The staff reviewed the scoping and screening process and results provided in the renewal application for the FuelSolutions™ system. The following sections discuss the staff's review and findings regarding the applicant's scoping and screening evaluation.

2.1.1 Scoping Process

In section 2.1 of the renewal application for the FuelSolutions™ system, the applicant reviewed the following design bases documents to identify SSCs with safety functions meeting either scoping criterion 1 or 2, as defined above:

- FuelSolutions™ Storage System FSAR Revision 4, WSNF-220, issued April 2007 (WEC 2007a)
- FuelSolutions™ Storage System Final Safety Analysis Report Revision 5 Change Pages, WSNF-220, issued April 2015 (WEC 2015a)
- FuelSolutions™ W21 Canister Storage Final Safety Analysis Report Revision 5, WSNF-221, issued April 2007 (WEC 2007b)
- FuelSolutions™ W74 Canister Storage Final Safety Analysis Report Revision 6, WSNF-223, issued April 2007 (WEC 2007c)
- CoC 1026 and technical specifications for each amendment as follows:
  - Amendment 0, February 2001: Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML010300176, ML003762478, ML003762485, ML003762498
  - Amendment 1, May 2001: ML011210069, ML011210170
  - Amendment 2, January 2002: ML020250542, ML020250578
  - Amendment 3, May 2003: ML031320811, ML031320818
  - Amendment 4, July 2006: ML061910582, ML061910677, ML061910681, ML061910684
- NRC SERs for CoC 1026, Amendment Nos. 0 through 4: ML003762509, ML011210243, ML020250586, ML031320789, ML061910574

2.1.2 Scoping Results

SER table 2.1-1 lists the FuelSolutions™ system SSCs included and excluded from the scope of renewal and identifies the scoping criterion met by each in-scope SSC. The staff reviewed the scoping results to determine whether the applicant's conclusions regarding the out-of-scope SSCs accurately reflect the design bases documentation in the FuelSolutions™ Spent Fuel Storage System FSARs.

Table 2.1-1 FuelSolutions™ System SSCs Within and Not Within the Scope of Renewal

SSCs	Criterion 1	Criterion 2	In-Scope
Spent Nuclear Fuel Assemblies	Yes	N/A	Yes
W21 and W74 Canisters	Yes	N/A	Yes
W150 Storage Cask	Yes	N/A	Yes
W100 Transfer Cask	Yes	N/A	Yes
Fuel Transfer and Auxiliary Equipment (Important to Safety or Safety Related)[1]	Yes	N/A	Yes
Fuel Transfer and Auxiliary Equipment (Not Important to Safety)[2]	No	No	No
ISFSI Storage Pad	No	No	No
ISFSI Security Equipment[3]	No	No	No

[1] The applicant stated that certain FuelSolutions™ fuel transfer and auxiliary equipment necessary for ISFSI operations and spent fuel handling is classified as important to safety or safety related. These components include the storage cask impact limiter, canister vertical lift fixture, cask lifting yoke, cask cavity axial spacer, shielded docking collar, cask restraints, empty canister lift fixture, and standard lifting slings inside the plant facility.

[2] The applicant identified the Fuel Transfer and Auxiliary Equipment that are classified as not important to safety. These components are listed in Table 2-3 of the renewal application.

SSCs	Criterion 1	Criterion 2	In-Scope
[3] The applicant stated that ISFSI Security Equipment includes (but is not limited to) the security fences and gates, lighting, communications, and monitoring equipment.			

The applicant listed in table 2-3 of the renewal application for the FuelSolutions™ system certain fuel transfer and auxiliary equipment necessary for ISFSI operations that are classified as NITS. The applicant stated that failure of the specified NITS fuel transfer and auxiliary equipment would not prevent the FuelSolutions™ system components from fulfilling their intended safety functions. Therefore, the applicant concluded that the specified NITS fuel transfer and auxiliary equipment does not meet scoping criterion 2 and is not within the scope of renewal. The staff reviewed table 2.1-1 of the FuelSolutions™ Storage System FSAR (WEC 2007a) and confirmed that these SSCs are classified as NITS. The staff finds the applicant's determination that certain fuel transfer and auxiliary equipment identified in table 2-3 of the renewal application for the FuelSolutions™ system are not in scope to be acceptable because their failure does not prevent fulfillment of safety functions of the FuelSolutions™ system components.

The applicant stated that the ISFSI storage pad provides free-standing support of the FuelSolutions™ storage cask, and the cask components are designed such that any potential failures of the ISFSI storage pad would not prevent them from fulfilling their intended safety functions. Therefore, the applicant concluded that the ISFSI storage pad does not meet scoping criterion 2 and is not within the scope of renewal. The staff reviewed section 2.6.3.5 of the FuelSolutions™ Storage System FSAR (WEC 2007a) and confirmed that the ISFSI storage pad is classified as NITS. The staff finds the applicant's determination that the ISFSI storage pad is not in scope to be acceptable because its failure does not impact safety functions of the FuelSolutions™ storage cask.

The applicant stated that the ISFSI security equipment—including security fences and gates, lighting, communications, and monitoring equipment—are NITS components that are not part of the CoC No. 1026 storage system approved in accordance with 10 CFR Part 72, Subpart L. The applicant concluded that, consistent with the guidance provided in NUREG-1927, failure of the ISFSI security equipment would not prevent fulfilment of a safety function. The staff reviewed the applicant's description of the ISFSI security equipment and the equipment security functions and confirmed that the ISFSI security equipment does not meet either of the two scoping criteria identified in NUREG-1927 – specifically, (1) the security equipment is not relied on to perform any ITS design function, and (2) failure of the security equipment would not prevent fulfillment of an ITS function. Therefore, the staff finds the applicant's determination that the ISFSI security equipment is not within the scope of renewal to be acceptable because the ISFSI security equipment does not meet either of the scoping criteria identified in NUREG-1927.

Based on its review, the staff finds that the applicant has identified the in-scope SSCs in a manner consistent with NUREG-1927 and therefore, the staff finds the scoping results to be acceptable. The applicant screened the in-scope SSCs to identify and describe the subcomponents that support the SSC intended functions. SER sections 2.1.3 and 2.1.4 address the SSC subcomponents within and outside the scope of renewal.

2.1.3 Screening of Structures, Systems, and Components Within the Scope of Renewal

Using the scoping results discussed in section 2.2.3 of the renewal application for the FuelSolutions™ system, the applicant screened the FuelSolutions™ system SSCs that are within the scope of renewal to identify their subcomponents that are within the scope of renewal. The in-scope SSCs include the SNF assemblies, W21 and W74 canisters, W150 storage cask, W100 transfer cask, and the important-to-safety and safety-related fuel transfer and auxiliary equipment. The SNF assemblies, canisters, storage cask, and transfer cask were determined to be within the scope of renewal per criterion 1. The applicant stated that certain fuel transfer and auxiliary equipment necessary for ISFSI operations and spent fuel handling is classified as important to safety or safety related and is therefore also included in the scope of the renewal per criterion 1. SER tables 2.1-2 through 2.1-6 tabulate the subcomponents of these SSCs that were determined by the applicant to be within the scope of renewal and thus subject to an AMR. The renewal application also screens the subcomponents of the SSCs (i.e., the parent subcomponents) to determine individual constituent parts of the subcomponents that are relied upon to support the subcomponents' intended safety functions. Screening results based on detailed part listings for in-scope subcomponents are not repeated in SER tables 2.1-2 through 2.1-6.

The staff reviewed the applicant's screening of the in-scope SSCs to identify subcomponents and parts of subcomponents within the scope of renewal. The staff's review considered the intended function of the subcomponents and parts, their safety classification or basis for inclusion in the scope of renewal, and design bases information in the FuelSolutions™ Spent Fuel Storage System FSARs. Based on its review, the staff determined that the applicant screened the in-scope SSCs in a manner consistent with NUREG-1927. Therefore, the staff finds the screening results for determining the in-scope SSC subcomponents and parts of subcomponents to be acceptable.

2.1.4 Subcomponents Not Within the Scope of Renewal

The applicant reviewed the in-scope SSCs to identify any subcomponents that do not support the SSC intended functions and thus do not require an AMR. SER tables 2.1-3 through 2.1-6 tabulate the subcomponents that are not within the scope of renewal. As reflected in SER table 2.1-2, all of the parent subcomponents of the W21 and W74 canisters were determined to be within the scope of renewal. However, per the renewal application, certain parts of these subcomponents were screened as not being within the scope of renewal if the part is not relied upon to support the intended safety function of the subcomponent.

The staff reviewed the applicant's screening of the in-scope SSCs to identify subcomponents (including the individual parts of the subcomponents) that are not within the scope of renewal. The staff's review considered the intended function of the subcomponents, their safety classification or basis for exclusion from the scope of renewal, and design bases information in the FuelSolutions™ Spent Fuel Storage System FSARs. Based on its review, the staff determined that the applicant screened the in-scope SSCs to identify out-of-scope SSC subcomponents and parts of subcomponents in a manner consistent with NUREG-1927. Therefore, the staff finds the screening results for determining the out-of-scope SSC subcomponents and parts of subcomponents to be acceptable.

Table 2.1-2 FuelSolutions™ W21 and W74 Canisters and Damaged Fuel Can Subcomponents Within the Scope of Renewal

W21 Canister	W74 Canister
Shell	Shell
Bottom Closure Plate	Bottom Closure Plate
Bottom End Plate and Shell Extension	Bottom End Plate and Shell Extension
Top Outer Closure Plate	Top Outer Closure Plate
Top Inner Closure Plate	Top Inner Closure Plate
Shield Plug	Alignment Bar, Adapter
Shield Plug Support Assembly	Shield Plug
Leak Test Port Cover	Shield Plug Support Assembly
Instrument Port Cover, Vent/Drain Port Cover	Leak Test Port Cover
Vent and Drain Port	Instrument Port Cover, Vent/Drain Port Cover
Guide Tube Assembly	Vent and Drain Port
Neutron Absorber	Guide Tube Assembly
Fuel Basket Support Rod, Support Sleeve	Neutron Absorber
Fuel Basket Support Rod	Fuel Basket Support Rod, Support Sleeve
Fuel Basket Support Sleeve	Fuel Basket Spacer Assembly
Fuel Basket Spacer Assembly	Damaged Fuel Can Top Lid Assembly
	Damaged Fuel Can Top Lid Assembly Hardware
	Damaged Fuel Can Guide Tube Assembly
	Damaged Fuel Can Neutron Absorber
	Fuel Basket Bolt

Table 2.1-3 FuelSolutions™ W150 Storage Cask Subcomponents Within and Not Within the Scope of Renewal

Within the Scope	Not Within the Scope
Concrete Shell, Shear Key	Round Bar, 1-3/8" Diameter
Concrete Shell	Plate, 1/4" Thick
Steel Liner, Shield Ring	Screen, 1/2" Mesh
Thermal Shield Panel Assembly	Round Bar, 2.5" Diameter
Shear Lug, Thermal Shield Support Lug	Anchor Stud, 5/8" Diameter x 6.0"
Support Rail	Sheet, 10 GA
Guide Rail	Coupling Nut, 1/2-13 UNC
Canister Support Tube	Round Bar, 1/4" Diameter x 1-1/8"
Tie Rod, Tie Rod Plate	Round Bar, 2.0" Diameter
Tie Rod Hardware	Hex Head Bolt, 1/2-13 UNC x 3/4"
Ram Anchor	Flat Washer, 1/2"
Top Cover Assembly	Half Coupling, 1/2 NPT
Top Cover Bolt	Tube, 3/4" Outer Diameter x .035" Wall
Coating on Carbon Steel Components	Heavy Square Nut, 1/2-13 UNC
	Tie Rod Cover, Sheet, 14 GA

Within the Scope	Not Within the Scope
	Name Plate
	Tamper Seal, Wire and Crimp Type Seal
	Plate, 1/2" Thick x 3” x 8”
	Anchor Stud, 1/2" Diameter x 2”
	Reinforced Concrete Coating

Table 2.1-4 FuelSolutions™ W100 Transfer Cask Subcomponents Within and Not Within the Scope of Renewal

Within the Scope	Not Within the Scope
Structural Shell	O-Ring, 1-1/2
Inner Liner	O-Ring Gasket, Ø 77.4
Neutron Shield Jacket, Trunnion Support Plate, Thermowell	O-Ring Gasket, Ø 69.4
Neutron Shield Jacket Support Rib	
Gamma Shield	
Guide Rail	
Top Flange, Bottom Flange	
Screw Thread Insert	
Block	
Swagelok Quick Connect Body, Fitting, Cap	
Coupling, Pipe, Cap	
Upper Trunnion, Lower Trunnion	
Trunnion Retainer, Trunnion Sleeve	
Trunnion Bolt	
Bolt for Top Cover, Bottom Cover, Ram Access Cover	
Washer for Trunnion, Top Cover, Bottom Cover, Ram Access Cover	
Top Cover	
Ram Access Cover	
Bottom Cover	
Bottom Support Ring	
Neutron Shield Jacket	
Neutron Shielding	
Coating on Neutron Shield Jacket	
Pressure Relief Device	

Table 2.1-5 FuelSolutions™ Spent Fuel Assembly Subcomponents Within and Not Within the Scope of Renewal

Within the Scope	Not Within the Scope
Fuel Cladding	Fuel Pellets
Guide Tubes (PWR) or Water Channels (BWR)	Control Components
Spacer Grids	
Lower and Upper End Fittings	
Fuel Channel (BWR)	
Poison Rod Assemblies (PWR)	

Table 2.1-6 FuelSolutions™ Fuel Transfer and Auxiliary Equipment Subcomponents Within and Not Within the Scope of Renewal

Within the Scope	Not Within the Scope
Canister Vertical Lift Fixture	Annulus Seal
Cask Lifting Yoke	Shield Plug Retainers
Cask Cavity Axial Spacer	Vacuum Drying System
Shielded Docking Collar	Inner Closure Plate Strongback
Cask Restraints	Automated Welding/Opening System
Empty Canister Lift Fixture	Helium Leak Detector
Standard Lifting Slings (Inside Plant Facility)	Horizontal Transfer Trailer
Storage Cask Impact Limiter	Horizontal Transfer Skid
Coating on Steel Components	Hydraulic Ram System
	Upender/Downender (Including J-Skid)
	Horizontal Lid Handling Fixture
	Vertical Transporter
	Vertical Transport Trailer
	Air Pallet System
	Standard Lifting Slings (Inside ISFSI)

2.2 Evaluation Findings

The NRC staff reviewed the scoping and screening evaluation provided in the renewal application for the FuelSolutions™ storage system and supplemental documentation. The staff performed its review following the guidance provided in NUREG-1927. Based on its review, the staff finds:

F2.1 The applicant has identified all SSCs important to safety and all SSCs whose failure could prevent an SSC from fulfilling its safety function, in accordance with 10 CFR 72.3, “Definitions,” and 10 CFR 72.236, “Specific requirements for spent fuel storage cask approval and fabrication.”

F2.2 The applicant’s justification for any SSC determined not to be within the scope of the renewal is adequate and acceptable.

3 AGING MANAGEMENT REVIEW

3.1 Review Objective

The objective of the staff's evaluation of the applicant's AMR is to determine if the applicant has adequately reviewed applicable materials, environments, and aging mechanisms and effects and proposed adequate aging management activities for in-scope SSCs. The AMR addresses aging mechanisms and effects that could adversely affect the ability of the SSCs and associated subcomponents to perform their intended functions during the period of extended operation.

3.2 Aging Management Review Process

The applicant described its AMR process as consisting of the following steps:

1. identification of materials of construction,
2. identification of operating environments,
3. identification of aging mechanisms and effects requiring management, and
4. determination of the activities (TLAAs or AMPs) required to manage the effects of aging.

The applicant identified the materials of construction, the environments, and the potential aging effects and the associated aging mechanisms for each SSC and associated subcomponents within the scope of renewal. The applicant then determined the aging effects and associated aging mechanisms that could cause degradation resulting in a loss of intended function. Finally, for each aging effect requiring management, the applicant determined the required aging management activities—either a TLAA or an AMP—to ensure that the intended function of the SSC would be maintained during the renewed license period.

The staff reviewed the applicant's AMR process, including a description of the review process and the design bases references. Based on its review, the staff finds that the applicant's AMR process is acceptable because it is consistent with the methodology recommended in NUREG-1927 and adequate for identifying credible aging effects for the SSCs within the scope of renewal.

3.3 Aging Management Review Results: Materials, Service Environment, Aging Effects, and Aging Management Activities

The staff evaluated the applicant's technical basis for its AMR by comparing it to the generic technical basis in NUREG-2214 (NRC 2019). In this evaluation, the staff ensured that the design features, environmental conditions, and operating experience for the FuelSolutions™ system are bounded by those evaluated in NUREG-2214.

SER table 3.3-1 identifies the environments considered for SSC subcomponents, as defined in the renewal application for the FuelSolutions™ system. The staff compared these environments to determine equivalency to the environments evaluated in NUREG-2214. SER table 3.3-2 identifies the comparison results. SER tables 3.3-3 through 3.3-7 provide the results of the applicant's AMR and identify the disposition of each potential aging effect for SSC subcomponent materials within the scope of renewal. These tables identify whether the applicant's conclusion on the credibility of each aging effect is consistent with the generic technical bases and conclusions discussed in NUREG-2214. The tables also identify the disposition of the aging effect, in terms of whether: (1) an aging management activity (i.e., AMP or TLAA) is, or is not, needed to address the aging effect (consistent with NUREG-2214), or (2) there is a separate technical basis or supporting analyses that justifies either that an aging effect is not credible or that an aging management activity is not needed for the aging effect (for items either not addressed in, or inconsistent with, NUREG-2214).

Table 3.3-1 Aging Management Review—Environments

Environment	Description
Helium	The helium environment refers to the inside of the canisters. Following the canister vacuum drying process, the canisters are backfilled with high purity helium gas. As a result, the helium environment inside the canisters has negligible amounts of moisture or air. The helium environment may experience a range of temperatures, as calculated for the canisters.
Sheltered	The sheltered environment refers to environments that may include ambient air, but are shielded from sunlight, precipitation, and direct wind. This environment is the annular space created between the storage casks and the canisters. The ambient air may contain moisture, salinity, dust, or other contaminants typical of the ISFSI location. The temperature of the sheltered environment reflects the air temperature passing through the annular space. The sheltered environment also refers to the interior of a building providing protection from sunlight, rain, and wind.
Embedded	The embedded environment applies to materials in contact with or sealed inside another material. This may prevent the ingress of gases, water, or contaminants to the embedded surface, depending on the permeability of the embedding environment. Subcomponents in this environment include the shield plugs in the canisters, the rebar and internal metal subcomponents of the storage casks, and the lead and neutron shielding in the transfer casks. The embedded subcomponents are exposed to the temperatures of the subcomponents in which they are embedded.
Air-outdoor	The air-outdoor environment is used for exterior surfaces that are directly exposed to weather, including precipitation and wind, which may transport dust or moisture with dissolved salt. Subcomponents exposed to this environment include the outer surfaces of the storage casks and the transfer casks. The air-outdoor environment has temperature ranges equivalent to the site ambient temperature ranges where the ISFSI is located.

Table 3.3-2 Comparison of Environment Definitions

Environment Defined in Application	Equivalent Environment in NUREG-2214
Helium	Helium
Sheltered	Sheltered
Embedded	Embedded in concrete Embedded in metal Embedded in neutron shielding
Air-outdoor	Air-outdoor

The staff reviewed the applicant's AMR results to determine whether they are consistent with the AMR results and aging management activities recommended in NUREG-2214. If the staff determined that the applicant's AMR results are consistent with the AMR results and aging management activities recommended in NUREG-2214, the staff considered the results to be acceptable since the NUREG-2214 AMR results and recommended aging management activities are applicable to the components, materials, environmental conditions, and operating experience for the FuelSolutions™ storage system. For such cases, no additional discussion is provided in this SER. The staff identified that some of the applicant's conclusions on aging mechanisms and effects are not consistent with NUREG-2214; these inconsistencies are discussed in SER section 3.3.1, which follows the tabulated summary of the applicant's AMR results in SER tables 3.3-3 through 3.3-7.

Table 3.3-3 Aging Management Review Results—FuelSolutions™ W21 and W74 Canisters

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Stainless steel (welded)	Sheltered	Stress corrosion cracking	Cracking	Yes	Yes	AMP—See SER table 3.5-1
	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	Yes	AMP/TLAA not necessary
Stainless steel	Sheltered	Pitting and crevice corrosion	Loss of material (Precursor to stress corrosion cracking)	Yes	Yes	AMP—See SER table 3.5-1
		Microbiologically influenced corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Fatigue	Cracking	Yes	Yes	TLAA—See SER sections 3.4.3 and 3.4.4
		Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	Yes	AMP/TLAA not necessary
		Fatigue	Cracking	Yes	Yes	TLAA—See SER sections 3.4.3 and 3.4.4
		Creep	Change in dimensions	No	Yes	AMP/TLAA not necessary
		Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Stainless steel	Helium	Stress relaxation	Loss of preload	No	Yes	AMP/TLAA not necessary
	Embedded (steel, depleted uranium)	Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
Stainless steel (17-4 PH)	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	Yes	No	Technical basis—See SER section 3.3.1.1
		Fatigue	Cracking	Yes	Yes	TLAA—See SER sections 3.4.3 and 3.4.4
		Creep	Change in dimensions	No	Yes	AMP/TLAA not necessary
		Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
Steel	Helium	General corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Galvanic corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Thermal aging	Loss of fracture toughness and loss of ductility	No	Yes	AMP/TLAA not necessary
		Fatigue	Cracking	Yes	Yes	TLAA—See SER sections 3.4.3 and 3.4.4
		Creep	Change in dimensions	No	Yes	AMP/TLAA not necessary

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Steel	Helium	Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
		Stress relaxation (bolting only)	Loss of preload	Yes	No	Technical basis—See SER section 3.3.1.2
	Embedded (stainless steel)	Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
	Embedded (stainless steel, depleted uranium)	Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
Lead	Embedded (stainless steel)	None identified	None identified	No	Yes	AMP/TLAA not necessary
Depleted uranium	Embedded (stainless steel)	None identified	None identified	No	Yes	AMP/TLAA not necessary
	Embedded (stainless steel, steel)	None identified	None identified	No	Yes	AMP/TLAA not necessary
Boral®	Helium	General corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Galvanic corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Thermal aging	Loss of strength	No	Yes	AMP/TLAA not necessary

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Boral®	Helium	Wet corrosion and blistering	Change in dimensions	No	Yes	AMP/TLAA not necessary
		Creep	Change in dimensions	No	Yes	AMP/TLAA not necessary
		Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
		Boron depletion	Reduction of neutron-absorbing capacity	Yes	Yes	TLAA—See SER section 3.4.1
Borated stainless steel	Helium	Boron depletion	Reduction of neutron-absorbing capacity	Yes	Yes	TLAA—See SER section 3.4.2
		Thermal aging	Loss of fracture toughness and loss of ductility	No	Yes	AMP/TLAA not necessary
		Creep	Change in dimensions	No	Yes	AMP/TLAA not necessary
		Radiation embrittlement	Loss of fracture toughness and loss of ductility	No	Yes	AMP/TLAA not necessary

Table 3.3-4 Aging Management Review Results—FuelSolutions™ W150 Storage Cask

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Concrete, grout	Air-outdoor	Aggressive chemical attack	Cracking	Yes	Yes	AMP—See SER table 3.5-2
			Loss of strength	Yes	Yes	AMP—See SER table 3.5-2
			Loss of material (spalling, scaling)	Yes	Yes	AMP—See SER table 3.5-2
		Creep	Cracking	No	Yes	AMP/TLAA not necessary
		Dehydration at high temperature	Cracking	No	Yes	AMP/TLAA not necessary
			Loss of strength	No	Yes	AMP/TLAA not necessary
		Delayed ettringite formation	Loss of material (spalling, scaling)	No	Yes	AMP/TLAA not necessary
			Loss of strength	No	Yes	AMP/TLAA not necessary
			Cracking	No	Yes	AMP/TLAA not necessary
		Fatigue	Cracking	No	Yes	AMP/TLAA not necessary
		Freeze and thaw	Cracking	Yes	Yes	AMP—See SER table 3.5-2
			Loss of material (spalling, scaling)	Yes	Yes	AMP—See SER table 3.5-2

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Concrete, grout	Air-outdoor	Radiation damage	Cracking	No	Yes	AMP/TLAA not necessary
			Loss of strength	No	Yes	AMP/TLAA not necessary
		Reaction with aggregates	Cracking	Yes	Yes	AMP—See SER table 3.5-2
			Loss of strength	Yes	Yes	AMP—See SER table 3.5-2
		Salt scaling	Loss of material (spalling, scaling)	Yes	Yes	AMP—See SER table 3.5-2
		Shrinkage	Cracking	No	Yes	AMP/TLAA not necessary
		Leaching of calcium hydroxide	Loss of strength	Yes	Yes	AMP—See SER table 3.5-2
			Increase in porosity and permeability	Yes	Yes	AMP—See SER table 3.5-2
			Reduction of concrete pH (reducing corrosion resistance of steel embedments)	Yes	Yes	AMP—See SER table 3.5-2
	Fully encased (steel)	Delayed ettringite formation	Loss of material (spalling, scaling)	No	Yes	AMP/TLAA not necessary

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Concrete, grout	Fully encased (steel)	Delayed ettringite formation	Cracking	No	Yes	AMP/TLAA not necessary
			Loss of strength	No	Yes	AMP/TLAA not necessary
		Radiation damage	Cracking	No	Yes	AMP/TLAA not necessary
			Loss of strength	No	Yes	AMP/TLAA not necessary
		Reaction with aggregates	Cracking	No	Yes	AMP/TLAA not necessary
			Loss of strength	No	Yes	AMP/TLAA not necessary
Reinforcing steel	Air-outdoor, groundwater	Corrosion of reinforcing steel	Loss of concrete/steel bond	Yes	Yes	AMP—See SER table 3.5-2
			Loss of material (spalling, scaling)	Yes	Yes	AMP—See SER table 3.5-2
			Cracking	Yes	Yes	AMP—See SER table 3.5-2
			Loss of strength	Yes	Yes	AMP—See SER table 3.5-2
Stainless steel	Sheltered	Stress corrosion cracking	Cracking	Yes	No	AMP—See SER table 3.5-3. Technical basis—See SER section 3.3.1.3

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Stainless steel	Sheltered	Pitting and crevice corrosion	Loss of material	Yes	No	AMP—See SER table 3.5-3. Technical basis—See SER section 3.3.1.3
Stainless steel	Sheltered	Microbiologically influenced corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
		Stress relaxation	Loss of preload	No	Yes	AMP/TLAA not necessary
		Wear	Loss of material	Yes	Yes	AMP—See SER table 3.5-3
Steel	Air-outdoor	General corrosion	Loss of material	Yes	Yes	AMP—See SER table 3.5-3
		Pitting and crevice corrosion	Loss of material	Yes	Yes	AMP—See SER table 3.5-3
		Microbiologically influenced corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
	Sheltered	General corrosion	Loss of material	Yes	Yes	AMP—See SER table 3.5-3
		Galvanic corrosion	Loss of material	Yes	Yes	AMP—See SER table 3.5-3

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Steel	Sheltered	Pitting and crevice corrosion	Loss of material	Yes	Yes	AMP—See SER table 3.5-3
Steel	Sheltered	Microbiologically influenced corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
		Stress relaxation (bolting only)	Loss of preload	Yes	Yes	AMP—See SER table 3.5-3
	Embedded (concrete)	Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
Aluminum	Sheltered	General corrosion	Loss of material	Yes	Yes	AMP—See SER table 3.5-3
		Galvanic corrosion	Loss of material	Yes	Yes	AMP—See SER table 3.5-3
		Pitting and crevice corrosion	Loss of material	Yes	Yes	AMP—See SER table 3.5-3
		Microbiologically influenced corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Thermal aging	Loss of strength	No	Yes	AMP/TLAA not necessary
		Creep	Change in dimensions	No	Yes	AMP/TLAA not necessary

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Aluminum	Sheltered	Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
Coating	Air-outdoor	Radiation embrittlement	Coating degradation	Yes	Yes	AMP—See SER table 3.5-3
		Thermal aging	Coating degradation	Yes	Yes	AMP—See SER table 3.5-3
	Sheltered	Radiation embrittlement	Coating degradation	Yes	Yes	AMP—See SER table 3.5-3
		Thermal aging	Coating degradation	Yes	Yes	AMP—See SER table 3.5-3

Table 3.3-5 Aging Management Review Results—FuelSolutions™ W100 Transfer Cask

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Stainless steel (welded)	Air-indoor/ outdoor	Stress corrosion cracking	Cracking	No	Yes	AMP/TLAA not necessary
	Demineralized water	Stress corrosion cracking	Cracking	No	Yes	AMP/TLAA not necessary
Stainless steel	Air-indoor/ outdoor	Pitting and crevice corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Microbiologically influenced corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Stress corrosion cracking	Cracking	No	Yes	AMP/TLAA not necessary
		Fatigue	Cracking	Yes	Yes	TLAA—See SER section 3.4.5
		Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
		Stress relaxation	Loss of preload	No	Yes	AMP/TLAA not necessary
		Wear	Loss of material	Yes	Yes	AMP—See SER table 3.5-4
	Demineralized water	Pitting and crevice corrosion	Loss of material (Precursor to stress corrosion cracking)	No	Yes	AMP/TLAA not necessary

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Stainless steel	Demineralized water	Microbiologically influenced corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Stress corrosion cracking	Cracking	No	Yes	AMP/TLAA not necessary
		Fatigue	Cracking	Yes	Yes	TLAA—See SER section 3.4.5
		Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
		Wear	Loss of material	Yes	Yes	AMP—See SER table 3.5-4
	Embedded (stainless steel)	Fatigue	Cracking	Yes	Yes	TLAA—See SER section 3.4.5
		Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
	Embedded (stainless steel, lead)	Fatigue	Cracking	Yes	Yes	TLAA—See SER section 3.4.5
		Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
	Embedded (RX-277, NS-3)	Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
Steel	Air-indoor/ outdoor	General corrosion	Loss of material	Yes	Yes	AMP—See SER table 3.5-4

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Steel	Air-indoor/ outdoor	Pitting and crevice corrosion	Loss of material	Yes	Yes	AMP—See SER table 3.5-4
		Galvanic corrosion	Loss of material	Yes	Yes	AMP—See SER table 3.5-4
		Microbiologically influenced corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Fatigue	Cracking	Yes	Yes	TLAA—See SER section 3.4.5
		Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
		Stress relaxation	Loss of preload	No	Yes	AMP/TLAA not necessary
Lead	Embedded (stainless steel)	None identified	None identified	No	Yes	AMP/TLAA not necessary
RX-277, NS-3 Neutron Shield	Embedded (stainless steel)	Thermal aging	Loss of fracture toughness and loss of ductility	No	Yes	AMP/TLAA not necessary
		Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
		Boron depletion	Loss of shielding	Yes	Yes	AMP—See SER table 3.5-4
Coating	Air-indoor/ outdoor	Radiation embrittlement	Coating degradation	Yes	Yes	AMP—See SER table 3.5-4

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Coating	Air-indoor/ outdoor	Thermal aging	Coating degradation	Yes	Yes	AMP—See SER table 3.5-4
Brass	Air-indoor/ outdoor	General corrosion	Loss of material	Yes	Yes	AMP—See SER table 3.5-4
		Pitting and crevice corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Microbiologically influenced corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary

Table 3.3-6 Aging Management Review Results—FuelSolutions™ SNF Assemblies

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Zirconium-based alloy (Zircaloy-2, Zircaloy-4, ZIRLO™, or M5®)	Helium	Oxidation	Loss of load bearing capacity	No	Yes	AMP/TLAA not necessary
		Pitting corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Galvanic corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Stress corrosion cracking	Cracking	No	Yes	AMP/TLAA not necessary
		Hydride reorientation	Loss of ductility	Yes	Yes	AMP—See SER table 3.5-5
		Delayed hydride cracking	Cracking	No	Yes	AMP/TLAA not necessary
		Thermal creep	Change in dimensions	Yes	Yes	AMP—See SER table 3.5-5
		Low-temperature creep	Change in dimensions	No	Yes	AMP/TLAA not necessary
		Radiation embrittlement	Loss of strength	No	Yes	AMP/TLAA not necessary
		Fatigue	Cracking	No	Yes	AMP/TLAA not necessary
		Mechanical overload	Cracking	No	Yes	AMP/TLAA not necessary

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Zirconium-based alloy	Helium	Creep	Change in dimensions	No	Yes	AMP/TLAA not necessary
		Hydriding	Change in dimensions	No	Yes	AMP/TLAA not necessary
		Radiation embrittlement	Loss of strength	No	Yes	AMP/TLAA not necessary
		Fatigue	Cracking	No	Yes	AMP/TLAA not necessary
Inconel	Helium	Creep	Change in dimensions	No	Yes	AMP/TLAA not necessary
		General corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Stress corrosion cracking	Cracking	No	Yes	AMP/TLAA not necessary
		Radiation embrittlement	Loss of strength	No	Yes	AMP/TLAA not necessary
		Fatigue	Cracking	No	Yes	AMP/TLAA not necessary
Stainless steel	Helium	Creep	Change in dimensions	No	Yes	AMP/TLAA not necessary
		General corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Stress corrosion cracking	Cracking	No	Yes	AMP/TLAA not necessary

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Stainless steel	Helium	Radiation embrittlement	Loss of strength	No	Yes	AMP/TLAA not necessary
		Fatigue	Cracking	No	Yes	AMP/TLAA not necessary

Table 3.3-7 Aging Management Review Results—FuelSolutions™ Fuel Transfer and Auxiliary Equipment

Material	Environment	Aging Mechanism	Aging Effect	Applicant Defined as Credible	Consistent with Conclusion of NUREG-2214	Disposition
Steel	Sheltered	General corrosion	Loss of material	Yes	Yes	AMP—See SER table 3.5-3
		Galvanic corrosion	Loss of material	Yes	Yes	AMP—See SER table 3.5-3
		Pitting and crevice corrosion	Loss of material	Yes	Yes	AMP—See SER table 3.5-3
		Microbiologically influenced corrosion	Loss of material	No	Yes	AMP/TLAA not necessary
		Radiation embrittlement	Cracking	No	Yes	AMP/TLAA not necessary
Polyurethane	Embedded	Thermal aging	Polyurethane degradation	No	N/A	Technical basis—See SER section 3.3.1.4
		Radiation embrittlement	Alter polymer structures	No	N/A	Technical basis—See SER section 3.3.1.4
		Microbiological contamination	Polyurethane degradation	No	N/A	Technical basis—See SER section 3.3.1.4
		Humidity	Polyurethane surface degradation	No	N/A	Technical basis—See SER section 3.3.1.4
Coating	Sheltered	Thermal aging	Coating degradation	Yes	Yes	AMP—See SER table 3.5-3

3.3.1 Technical Bases/Supplemental Analyses

For those SSC subcomponents with AMR results that are not consistent with NUREG-2214, the staff reviewed the applicant's AMR results to determine whether the applicant provided adequate information to justify that an AMP or TLAA is not needed for addressing certain aging mechanisms and effects, or for ensuring adequate performance of certain SSC subcomponents considering applicable aging mechanisms and effects. The staff's assessment of the adequacy of the applicant's conclusions is discussed in the subsections below.

3.3.1.1 Thermal Aging of 17-4 Precipitation Hardened Stainless Steel Items

For the W21 and W74 canisters, the application AMR results in tables 2-4a and 2-4b identify that loss of toughness and ductility due to thermal aging of the 17-4 precipitation-hardened stainless steel (PHSS) fuel basket support rod (helium environment) is addressed by the canister fatigue TLAAs. The application cites section 3.2.2.8 of NUREG-2214 as the technical basis for this AMR result. The corresponding AMR line item for this subcomponent in table 4-21 of NUREG-2214 states that a "TLAA/AMP or a supporting analysis is required" to address loss of toughness and ductility due to thermal aging of the 17-4 PHSS fuel basket support rod in a helium environment. NUREG-2214, section 3.2.2.8, provides specific guidance for performing a case-specific evaluation of loss of toughness and ductility due to thermal aging in subcomponents fabricated from 17-4 PHSS. NUREG-2214 section 3.2.2.8 states that the degree of embrittlement of a specific subcomponent will depend on the service temperature and time duration, as well as the initial heat treatment condition of the SSC. As such, a review of the thermal aging effects should be performed on a case-by-case basis for all subcomponents constructed from Type 17-4 PHSS. Further, NUREG-2214 provides guidance that that NRC technical review staff should ensure that the application provides a bounding analysis to show that the loss of toughness and ductility due to thermal aging is not expected to compromise the SSC's intended function during the period of extended operation.

Considering the above guidance provided in NUREG-2214 section 3.2.2.8, the staff identified that the application did not provide the case-specific evaluation of the loss of toughness and ductility due to thermal aging for the 17-4 PHSS fuel basket support rod. The fatigue TLAA, as cited in the applicant's AMR results for this item, is a structural analysis of the effects of cyclic loading on the components and is unrelated to the evaluation of thermal aging and associated loss of toughness and ductility for 17-4 PHSS. Therefore, the staff issued a request for additional information (RAI) on May 6, 2022 (NRC 2022) requesting that the applicant provide a TLAA or supporting analysis to show that the loss of toughness and ductility due to thermal aging is not expected to compromise the intended function of the 17-4 PHSS fuel basket support rod during the 60-year extended storage period. The staff also requested that the applicant revise the AMR results for the 17-4 PHSS fuel basket support rod in tables 2-4a and 2-4b of the application to be consistent with the corresponding AMR line item in table 4-21 of NUREG-2214.

In its response to the RAI (WEC 2022a), the applicant stated that a supporting analysis of thermal aging of the 17-4 PHSS fuel basket support rod has been provided in section 3.3.1.2.1 in the updated renewal application (WEC 2022b). The applicant stated that the only FuelSolutions™ System components made of 17-4 PHSS are the support rod subcomponents of the W21 canister, and no 17-4 PHSS subcomponents are used in the W74 canisters. For operating temperatures between 243 degrees Celsius (°C) and 316 °C (470 to 600 degrees Fahrenheit [°F]), the applicant noted that NUREG-2214, section 3.2.2.8, cites literature that recommends an evaluation of conditions on a per-component basis to address the potential impact of loss of toughness due to thermal aging on 17-4 PHSS component functionality. The applicant referenced the FuelSolutions™ W21 Canister Storage FSAR table 4.4-2 (WEC 2007b), which shows that for normal storage conditions, the 17-4 PHSS fuel basket support rod subcomponents in the W21 canister have a maximum temperature of 472 °F (244 °C). The applicant stated that the time that the support rod subcomponents would be above the recommended lower bound temperature threshold of 470 °F (243 °C), as recommended in NUREG-2214, section 3.2.2.8 for case-specific evaluation of thermal aging for 17-4 PHSS components, is limited because of the minimal time that the ambient temperature would be at the normal maximum temperature of 100 °F (38 °C) and the continuing decay of the heat source. In addition, the applicant noted that there is conservatism in the thermal model that was used to analyze the support rod temperature as addressed in the FuelSolutions™ W21 Canister Storage FSAR. Therefore, the applicant concluded that loss of toughness due to thermal aging embrittlement is unlikely to adversely affect the functionality of the 17-4 PHSS fuel basket support rod subcomponents during the period of extended storage.

The staff reviewed the applicant's supporting analysis in section 3.3.1.2.1 of the updated renewal application (WEC 2022b) and the FuelSolutions™ W21 Canister Storage FSAR (WEC 2007b) and confirmed that the maximum FSAR-analyzed temperature for the 17-4 PHSS fuel basket support rod is only about 1 °C greater than the lower bound temperature threshold recommended in NUREG-2214, section 3.2.2.8 for evaluation of 17-4 PHSS component thermal aging on a case-specific basis. The staff also noted that the maximum temperature reported in the FSAR for the 17-4 PHSS fuel basket support rod is conservatively calculated based on the assumption that the outdoor ambient temperature for the FuelSolutions™ storage system is 100 °F (38 °C), and this analysis does not credit the continuing decay of the spent fuel heat source. Based on these considerations, the staff confirmed that the amount of time that the 17-4 PHSS fuel basket support rod would realistically be maintained at 1 °C above the lower bound temperature threshold for case-specific evaluation of 17-4 PHSS component thermal aging is not significant enough to warrant a specific evaluation of loss of toughness due to thermal aging for the fuel basket support rod. The staff also determined that thermal aging embrittlement, if any, of the 17-4 PHSS fuel basket support rod is unlikely to adversely affect the functionality of the fuel basket support rod in the W21 canister during the period of extended operation. Accordingly, the staff determined that the applicant's supporting analysis for the 17-4 PHSS fuel basket support rod is acceptable because the analysis demonstrated that thermal aging the 17-4 PHSS fuel basket support rod is not expected to be a credible aging mechanism during the period of extended storage.

3.3.1.2 Loss of Preload Due to Stress Relaxation of Steel Fuel Basket Bolting

For the W21 and W74 canisters, the application AMR results in the left half of tables 2-4a and 2-4b identify that loss of preload due to stress relaxation of steel fuel basket bolts (helium environment) is addressed by the canister fatigue TLAAs. The application cites section 3.2.1.10 of NUREG-2214 as the technical basis for this AMR result. The corresponding AMR line item for this subcomponent in table 4-21 of NUREG-2214 states that a "TLAA/AMP or a supporting analysis is required" to address loss of preload due to stress relaxation of the steel fuel basket bolt in a helium environment. NUREG-2214, section 3.2.1.10 provides guidance that aging management of steel bolting in higher temperature environments (such as the canister interior helium or storage cask interior sheltered environments) to look for evidence of loss of bolt preload due to stress relaxation.

The staff noted that the application's subcomponent screening results in the right half of tables 2-4a and 2-4b identify that the steel fuel basket bolts are not applicable for the W21 and W74 canisters. However, the staff noted that the W74 fuel basket drawing includes steel fuel basket bolts. Further, table 4-21 of NUREG-2214 includes steel fuel basket bolts in a helium environment for the FuelSolutions™ Storage System canisters.

Considering the above guidance provided in NUREG-2214, section 3.2.1.10, the staff determined that if steel fuel basket bolts exist in any available design configuration for the W21 and/or W74 canisters, the application should include the appropriate provisions for aging management or specific analysis of the steel fuel basket bolts to address loss of bolt preload due to stress relaxation during the 60-year extended storage period. The fatigue TLAA, as cited in the applicant's AMR results for this item, is a structural analysis of the effects of cyclic loading on the components and is not related to analytical evaluation or management of loss of bolt preload due to stress relaxation.

Therefore, the staff issued an RAI on May 6, 2022 (NRC 2022) requesting that the applicant (a) provide a TLAA, AMP, or supporting analysis to address loss of bolt preload due to stress relaxation during the period of extended storage; (b) revise the fuel basket bolt subcomponent screening results in the right half of table 2-4a of the application to address the constituent parts and their quality categorizations; and (c) revise the AMR results for the steel fuel basket bolts in the left half of tables 2-4a of the application to be consistent with the corresponding AMR line item for the steel fuel basket bolt in table 4-21 of NUREG-2214.

In its response to the RAI (WEC 2022a), the applicant stated that a supporting analysis has been provided in section 3.3.1.2.2 in the updated renewal application (WEC 2022b). The applicant stated that the AMR results in table 2-4a and 2-4b have been revised to clarify that the W74 canisters do have steel fuel basket bolts, which are subject to stress relaxation, and that the W21 canisters do not have any steel fuel basket bolts and stress relaxation is not a topic of concern for the W21 canisters.

The applicant referenced the FuelSolutions™ W74 Canister Storage FSAR drawing W74-120 (WEC 2007c), which shows that 16 steel fuel basket bolts are used for each W74 canister fuel basket. The applicant stated that the 16 steel fuel basket bolts are used in conjunction with split stainless steel lock washers, and the split stainless steel lock washers will compensate for any loss of preload due to stress relaxation of the steel fuel basket bolts in a helium environment during the period of extended storage. The applicant also provided information to demonstrate that, despite their design classification as important to safety structural components for canister loading operations, these 16 steel fuel canister bolts are not important to safety during canister storage periods because they serve no structural function during storage. Therefore, the applicant concluded that loss of preload due to stress relaxation of the steel fuel basket bolts does not present a W74 canister safety concern during the period of extended storage.

The staff reviewed the applicant's supporting analysis in section 3.3.1.2.2 of the updated renewal application (WEC 2022b) and the FuelSolutions™ W74 Canister Storage FSAR (WEC 2007c) and confirmed the applicant's conclusion that loss of preload due to stress relaxation of the steel fuel basket bolts does not present a safety concern during the period of extended storage. The staff identified that the applicant appropriately classified the steel fuel basket bolts as important to safety based on the subcomponent screening results for the W74 canisters in table 2-4a of the renewal application. However, the structural safety function of the steel fuel basket bolts is relied upon to ensure adequate support of spent fuel assemblies and interfacing fuel basket components during the initial loading of spent nuclear fuel into the W74 canister. Once the W74 canister is fully loaded with spent fuel and placed inside the W150 storage cask for long-term storage, the steel fuel basket bolts are no longer relied on to perform a component support function during the initial 20-year initial storage term or the 40-year period of extended storage. Therefore, the staff determined that the applicant's analysis for the steel fuel basket bolts is acceptable because any loss of preload due to stress relaxation of the steel fuel basket bolts would not impact W74 canister safety function during the period of extended storage.

3.3.1.3 Localized Corrosion and Stress Corrosion Cracking of Stainless Steel Items

For the W150 storage cask stainless steel items in the sheltered environment, NUREG-2214 lists cracking due to SCC and loss of material due to pitting and crevice corrosion as not requiring aging management, whereas the application does list these as requiring aging management and credits the Monitoring of Metallic Surfaces AMP for aging management. Therefore, the staff reviewed the applicant's Monitoring of Metallic Surfaces AMP to ensure that it adequately addresses these two aging mechanisms and effects for stainless steel in a sheltered environment inside the storage cask. Based on its review, the staff confirmed that the applicant's Monitoring of Metallic Surfaces AMP includes provisions to ensure adequate aging management of storage cask stainless steel items in a sheltered environment, considering the potential effects of SCC, pitting, and crevice corrosion on design function performance. Accordingly, the staff determined that the applicant's AMR results for the storage cask stainless steel items are acceptable.

3.3.1.4 Thermal Aging of Rigid Polyurethane Foam Impact Limiter

The applicant included thermal aging as the aging mechanism for the rigid polyurethane foam used in the W150 storage cask impact limiter (part of the fuel transfer and auxiliary equipment) when exposed to an embedded environment. The aging effects for the coated carbon steel casing that embeds the foam are coating degradation and corrosion, which are managed by the Monitoring of Metallic Surfaces AMP. However, section 3.3.5.5 of the renewal application for the FuelSolutions™ system states that no damage or change in the properties of the embedded polyurethane foam is expected to occur over the life of the impact limiter. Therefore, the applicant concluded that no separate AMP or TLAA is required to address thermal aging of the polyurethane foam.

Polyurethane foam was not specifically discussed in NUREG-2214, but it falls in the same category of polymer material addressed in section 3.3.1 of NUREG-2214, where thermal aging and radiation embrittlement are generally identified as credible aging mechanisms for polymer-based neutron-shielding materials. The credibility of these aging mechanisms should be determined on a case-by-case basis considering the environmental, thermal, mechanical, and irradiation service conditions that the polymers experience, as recommended in NUREG-2214. Although polyurethane foams have been widely used in the construction of buildings, technical data or references relevant to the impact limiter safety function and service conditions are not provided by the applicant to support the aging management review results for the rigid polyurethane foam impact limiter. The staff issued an RAI on May 6, 2022 (NRC 2022) requesting that the applicant explain the discrepancy between the renewal application and the guidance in NUREG-2214 regarding the AMR results for the rigid polyurethane foam impact limiter, or alternatively, revise the AMR results in table 2-8 and section 3.3.5.5 of the renewal application to address how the applicable aging effects that are specific to the polyurethane foam impact limiter are managed or otherwise dispositioned for the extended storage period (60 years).

In its response to the RAI (WEC 2022a), the applicant stated that the AMR results in table 2-8 for the polyurethane foam impact limiter have been revised by removing the reference to the

Monitoring of Metallic Surfaces AMP and instead referring to the supporting analysis for the rigid polyurethane foam provided in section 3.3.5.2.1 of the updated renewal application (WEC 2022b). The applicant identified potential aging mechanisms of thermal aging, radiation embrittlement, microbiological contamination, and humidity in table 2-8 for the polyurethane foam impact limiter. The applicant referenced the FuelSolutions™ Storage System FSAR (WEC 2007a), which shows that the rigid foam is encased within a thin-plate carbon steel casing that is sufficiently strong to allow handling of the impact limiter subassemblies but has a negligible effect on the crush characteristics of the impact limiter. The carbon steel provides a sealed closure to assure foam integrity and is coated for corrosion protection. The applicant also considered a study by the General Plastics Manufacturing Company (General Plastics 2021) that provides the results of aging studies of LAST-A-FOAM® polyurethane foam across a period of 20 years. The aging testing of polyurethane foam samples held in a weather-tight, stainless steel enclosure at Portland General Electric's Trojan Spent Nuclear Fuel dry storage facility showed no apparent thermal aging or exposure-induced polyurethane foam degradation during the 20-year aging test, based on density and compressive strength data. Regarding the radiation embrittlement aging mechanism, the applicant referenced the General Plastics study (General Plastics 2021) showing that no signs of radiation embrittlement were reported for any of the polyurethane foam aging samples. In addition, the levels of radiation exposure accumulated by polymers performing a neutron radiation shielding function in NUREG-2214 section 3.3.1.3, and which could create radiation embrittlement, would far exceed the levels of radiation accumulated by the ridged polyurethane foam in an impact limiter. For the biological contamination aging mechanism, the applicant referenced the General Plastics study (General Plastics 2021) showing that the exposed polyurethane foam aging samples had moss growing on the surface of the polyurethane foam. Once the biological contamination and surface area of the foam was cleaned, there was no evidence of the biological contamination extending into the interior volume of the polyurethane foam. The surface biological contamination also did not affect the measured physical properties of the exposed rigid polyurethane foam aging samples. The enclosed polyurethane foam aging samples did not show any signs of biological contamination and had no biological related aging deterioration. The applicant referenced FuelSolutions™ Storage System FSAR section 1.2.1.4.2 (WEC 2007a), which shows that the impact limiter carbon steel casing provides a sealed closure to assure foam integrity and is coated for corrosion protection. There is no opportunity for the continuing introduction of humidity to the interior of the impact limiter. The General Plastics study (General Plastics 2021) showed that humidity effects on the polyurethane foam samples were restricted to the surface and did not affect the measured physical properties of the exposed samples. Based on the supporting analysis for the rigid polyurethane foam, the applicant concluded that the rigid polyurethane foam enclosed in FuelSolutions™ impact limiters will be able to maintain its required density and compressive strength properties during the period of extended storage.

The staff reviewed the applicant's supporting analysis in section 3.3.5.2.1 of the updated renewal application (WEC 2022b), the FuelSolutions™ Storage System FSAR (WEC 2007a), and the General Plastics study (General Plastics 2021) and agrees with the applicant's conclusion that the potential aging mechanisms (i.e., thermal aging, radiation embrittlement, microbiological contamination, and humidity) are not considered to be credible aging mechanisms for the polyurethane foam impact limiter during the period of extended operation. Therefore, the staff determined that the applicant's supporting analysis for the rigid polyurethane foam is acceptable.

3.3.2 Evaluation Findings

The staff reviewed the AMR results provided in the renewal application for the FuelSolutions™ system to verify that they adequately identify the materials, environments, aging effects, and proposed aging management activities (or TLAAs) for the in-scope SSCs. The staff performed its review following the guidance provided in NUREG-1927 and NUREG-2214. Based on its review, the staff finds:

F3.1 The applicant's AMR process is comprehensive in identifying the materials of construction and associated operating environmental conditions for those SSCs within the scope of renewal, and it has provided an adequate summary of this information in the renewal application and the FSAR supplement.

F3.2 The applicant's AMR process is comprehensive in identifying all pertinent aging mechanisms and effects applicable to the SSCs within the scope of renewal, and the applicant has provided a summary of the information in the renewal application and the FSAR supplement.

3.4 Time-Limited Aging Analyses

As discussed in appendix B to the renewal application for the FuelSolutions™ system, the applicant identified the following TLAAs for FuelSolutions™ system SSCs within the scope of the renewal review.

1. W21 canister neutron absorber boron depletion
2. W74 canister neutron absorber boron depletion
3. W21 canister fatigue (includes canister shell and basket)
4. W74 canister fatigue (includes canister shell and basket)
5. W100 transfer cask fatigue

The staff reviewed TLAAs provided by the applicant in support of conclusions regarding potential aging effects for SSCs and SSC subcomponents within the scope of renewal. The staff reviewed the analyses to determine those meeting all six criteria in 10 CFR 72.3 for valid TLAAs. The staff also reviewed the supplemental analyses provided by the applicant in support of the proposed TLAAs.

Based on its review of the design bases documents, the staff confirmed that the applicant identified all calculations and analyses meeting all six criteria in 10 CFR 72.3 and therefore concludes that the applicant adequately identified all TLAAs.

3.4.1 W21 Canister Neutron Absorber Boron Depletion

Criticality control in the FuelSolutions™ W21 canister design is based on both favorable geometry and safety function performance of the fixed Boral neutron absorber material. The applicant referenced the FuelSolutions™ W21 Canister Storage FSAR section 6.3 (WEC 2007b) to ensure that fuel assemblies are maintained in a subcritical condition with a k_{eff} less than 0.95 under all conditions of storage. The criticality safety evaluation credits 75 percent of the minimum specified boron concentration, and based on the boron concentration, the fixed Boral neutron absorber material is demonstrated to be capable of performing its function during a 100-year period. Therefore, the applicant concluded that boron depletion is not an issue for the Boral neutron absorber material, and the Boral neutron absorber material satisfies its design requirements for the extended 60-year storage period.

The staff reviewed the materials data, analysis methodology, assumptions, and conclusions of this TLAA and finds them acceptable and consistent with the technical basis in NUREG-2214.

3.4.2 W74 Canister Neutron Absorber Boron Depletion

Criticality control in the FuelSolutions™ W74 canister design is based on both favorable geometry and safety function performance of the fixed borated stainless steel neutron absorber material. The applicant referenced the FuelSolutions™ W74 Canister Storage FSAR section 6.3 (WEC 2007c) to ensure that fuel assemblies are maintained in a subcritical condition with a k_{eff} less than 0.95 under all conditions of storage. The criticality safety evaluation credits 75 percent of the minimum specified boron concentration, and based on the boron concentration, the fixed borated stainless steel neutron absorber material is demonstrated to be capable of performing its function during a 100-year period. Therefore, the applicant concluded that the effectiveness of the borated stainless steel neutron absorber material assures criticality safety in accordance with the design requirements over the extended 60-year storage period.

The staff reviewed the materials data, analysis methodology, assumptions, and conclusions of this TLAA and finds them acceptable and consistent with the technical basis in NUREG-2214.

3.4.3 W21 Canister Fatigue

3.4.3.1 W21 Canister Shell Fatigue

Appendix B.4.1 to the renewal application for the FuelSolutions™ system summarizes the results of the applicant's TLAA for the fatigue evaluation of the W21 canister shell and associated components. The applicant provided the fatigue evaluation of the W21 canister shell for the initial storage period in section 3.5.1.4.1 of the FuelSolutions™ W21 Canister Storage FSAR (WEC 2007b). This evaluation was performed in accordance with the requirements of the American Society of Mechanical Engineers (ASME) boiler and pressure vessel (B&PV) Code, Section III, NB-3222.4(d) (ASME 1995) to demonstrate that the six conditions in NB-3222.4(d) are satisfied for the initial storage period and, accordingly, that fatigue is not an aging degradation concern during the initial storage period. For the renewal application, the applicant provided information to demonstrate that the fatigue evaluation of the canister shell against the six criteria of in NB-3222.4(d) will remain valid for the extended 60-year storage period. The six conditions in NB-3222.4(d) are based on a comparison of peak stress intensities for cyclic loading with material fatigue data and include cyclic stresses generated as a result of (1) atmospheric to service pressure cycle, (2) normal service pressure fluctuation, (3) temperature difference for startup and shutdown, (4) temperature difference for normal service, (5) temperature difference for dissimilar materials, and (6) mechanical loads. Satisfaction of the six conditions of NB-3222.4(d) during the service life of an SSC constitutes an acceptable basis for assuring that the limits on peak stress intensities as governed by fatigue have been satisfied, as specified in NB-3222.4(d), and therefore fatigue is not an aging degradation concern during the service life of the SSC.

In the W21 Canister FSAR section 3.5.1.4.1, the applicant stated that for the first criterion in NB-3222.4(d), the maximum number of pressure cycles associated with startup and shutdown is below the allowable limit per the applicable ASME Code, Section III fatigue design curve. The applicant stated that canister normal service includes just one vacuum drying operation and one helium fill after closure. All other pressure fluctuations inside the canister during storage are due to changes in the outside ambient atmospheric conditions. Because the W21 canister is never cycled back to the atmospheric pressure during normal service, the applicant concluded that the first condition is satisfied. The NRC staff reviewed the applicant's evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the actual number of pressurization and depressurization cycles for the W21 canister will remain well bounded by maximum allowable number of pressure cycles, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

In the W21 Canister FSAR section 3.5.1.4.1, the applicant stated that for the second criterion in NB-3222.4(d), the total number of normal pressure fluctuation cycles for the W21 canister shell pressure boundary is less than the code allowable limit assuming the normal pressure fluctuation cycle for this criterion occurs once a day due to the maximum analyzed change in the normal outside ambient air temperature. The applicant identified that the total number of pressure fluctuation cycles is determined by conservatively assuming daily ambient temperature cycles (which cause pressure fluctuations inside the canister) over a period of 100 years, which bounds the 60-year extended storage term. The applicant calculated the maximum allowable range for the daily pressure fluctuation inside the canister per this code criterion. The applicant determined that the W21 canister shell internal pressure range, as evaluated in the FSAR, is well bounded by the allowable value of the pressure range per this code criterion. Since the range of internal pressure fluctuation for the W21 canister is bounded by the maximum allowable value per this code criterion, and the assumed number of daily pressure fluctuation cycles over 100 years exceeds the number of daily pressure fluctuation cycles for the 60-year extended storage term, the applicant concluded that the second criterion is satisfied. The NRC staff reviewed the applicant's evaluation against this second condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the W21 canister pressure fluctuation does not exceed the limits of this criterion considering the conservatively projected number of pressure fluctuation cycles over a 100-year period, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

For the third criterion in NB-3222.4(d), the applicant's FSAR calculation determined an allowable temperature difference between any two adjacent points (as defined per this code criterion) in the canister shell material based on the canister shell material properties and the allowable stress range for this code criterion assuming a conservative number of thermal startup and shutdown cycles that bound canister storage conditions. The applicant determined that the allowable temperature difference per this code criterion is much greater than the temperature difference between any two adjacent points in the W21 canister shell, as evaluated in the FuelSolutions™ W21 Canister Storage FSAR. Therefore, the applicant concluded that the third criterion is satisfied. The NRC staff reviewed the applicant's evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, the staff noted that the W21 canister shell does not undergo any significant number of thermal startup and shutdown cycles during the 60-year extended storage period. Further, even assuming a conservative value for the number of thermal startup and shutdown cycles during the extended storage period (as assumed in the application), the temperature difference between any two adjacent points of the canister shell is well bounded by maximum allowable value per this code criterion. Accordingly, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

For the fourth criterion in NB-3222.4(d), the applicant calculated the limiting value for the "significant" temperature difference fluctuation, as defined per this code criterion, based on the canister shell material properties and the maximum allowable stress range corresponding to the maximum number of temperature difference fluctuations specified for this criterion that bounds the 60-year extended storage term. The applicant stated that the temperature difference between any two adjacent points (as defined per this code criterion) in the canister shell does not change significantly from the analyzed normal cold to the analyzed normal hot condition, and temperatures at all points drop uniformly by a specified value from normal hot to normal cold conditions. The applicant determined that the maximum temperature gradient fluctuation in the canister shell based on the canister shell assembly thermal gradients for normal transfer and storage conditions, as evaluated in the W21 Canister Storage FSAR, is less than the calculated limiting value for meeting the definition of being a “significant” temperature difference fluctuation per this code criterion. Because there are no significant variations in the temperature gradient in the W21 canister shell during normal service, the applicant concluded that the fourth criterion is satisfied. The NRC staff reviewed the applicant’s evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the maximum number and range of W21 canister temperature gradient fluctuations do not exceed the limits of this criterion for the duration of the 60-year extended storage period (including the limiting value for even meeting the definition of being a “significant” temperature difference fluctuation per this code criterion), the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

The applicant’s FSAR indicated that the fifth criterion applies to components that are constructed of materials with different coefficients of thermal expansion and/or different moduli of elasticity. Because the W21 canister shell confinement boundary components are fabricated entirely of Type 304 or Type 316 stainless steel, the applicant concluded that the fifth criterion is not applicable. The staff confirmed that the fifth criterion of NB-3222.4(d) does not require specific evaluation as a TLAA since the canister shell materials are sufficiently similar, such that there is no significant cyclic loading due to the effects of temperature fluctuations on differential thermal expansion for dissimilar materials. The staff determined that the applicant’s conclusion regarding this condition remains valid for the 60-year extended storage period.

In the W21 Canister FSAR section 3.5.1.4.1, the applicant stated that for the sixth criterion in NB-3222.4(d), the only significant mechanical load fluctuations for the W21 canister shell are those associated with lifting and transfers. Assuming a bounding value for the number of significant mechanical load cycles that bounds the 60-year extended storage term, the applicant determined that the maximum allowable value of the stress range per this code criterion is greater than the range of mechanical load stress for the W21 canister shell, as evaluated in the FSAR. Therefore, the applicant concluded that the sixth criterion is satisfied. The NRC staff reviewed the applicant’s evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the number of significant mechanical load cycles for the W21 canister shell would not exceed the assumed bounding value during the 60-year extended storage period, and the range of mechanical load stress would not exceed the associated maximum allowable value, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

As documented above, the staff independently verified the applicant’s calculations in the FuelSolutions™ W21 Canister FSAR section 3.5.1.4.1 for each of the six conditions specified in NB-3222.4(d). Based on the foregoing review, the staff determined that the requirements of NB-3222.4(d) will continue to be satisfied for the W21 canister shell during the 60-year extended storage period. Therefore, the staff finds that the applicant’s analysis for fatigue of the W21 canister shell is consistent with the technical basis in NUREG-2214 and therefore acceptable.

3.4.3.2 W21 Canister Basket Fatigue

Appendix B.4.2 to the renewal application for the FuelSolutions™ system summarizes the results of the applicant's TLAA for the fatigue evaluation of the W21 canister basket assembly and associated components. The applicant provided the fatigue evaluation of the W21 canister basket assembly for the initial storage period in section 3.5.1.4.2 of the FuelSolutions™ W21 Canister Storage FSAR (WEC 2007b). This evaluation was performed in accordance with the requirements of the ASME B&PV Code, Section III, NG-3222.4(d) (ASME 1995) to demonstrate that the four conditions in NG-3222.4(d) are satisfied for the initial storage period and, accordingly, that fatigue is not an aging degradation concern during the initial storage period. For the renewal application, the applicant provided information to demonstrate that the fatigue evaluation of the canister basket assembly against the four criteria in NG-3222.4(d) will remain valid for the extended 60-year storage period. The four conditions in NG-3222.4(d) are based on a comparison of peak stress intensities for cyclic loading with material fatigue data and include cyclic stresses generated as a result of (1) temperature difference for startup and shutdown, (2) temperature difference for normal service, (3) temperature difference for dissimilar materials, and (4) mechanical loads. Satisfaction of the four conditions of NG-3222.4(d) during the service life of an SSC constitutes an acceptable basis for assuring that the limits on peak stress intensities as governed by fatigue have been satisfied, as specified in NG-3222.4(d), and therefore fatigue is not an aging degradation concern during the service life of the SSC.

For the first criterion in NG-3222.4(d), the applicant's FSAR calculation determined an allowable value for the temperature difference between any two adjacent points (as defined per this code criterion) within any canister basket component based on component material properties and the allowable stress range for this code criterion assuming a conservative number of thermal startup and shutdown cycles that bound canister storage conditions. The applicant determined that the allowable temperature difference per this code criterion is greater than the temperature difference between any two adjacent points within any canister basket component, as evaluated in the FuelSolutions™ W21 Canister Storage FSAR. Therefore, the applicant concluded that the first criterion is satisfied. The NRC staff reviewed the applicant's evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, the staff noted that the W21 canister basket does not undergo a significant number of thermal startup and shutdown cycles during the 60-year extended storage period. Further, even assuming a conservative value for the number of thermal startup and shutdown cycles during the extended storage period (as assumed in the application), the temperature difference between any two adjacent points within any canister basket component is bounded by maximum allowable value per this code criterion. Accordingly, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

For the second criterion in NG-3222.4(d), the applicant's FSAR calculation determined the maximum allowable value of the temperature difference fluctuation per this code criterion. The applicant stated that the temperature difference between any two adjacent points in the W21 canister basket assembly does not change significantly from normal cold to normal hot conditions. The applicant also stated that the largest temperature difference fluctuation within the W21 basket assembly between normal hot storage and normal cold storage, as analyzed in the FSAR, is less than the code allowable value. Because there are no significant fluctuations in the temperature gradients within the canister basket components during normal service, the applicant concluded that the second criterion is satisfied. The NRC staff reviewed the applicant's evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the W21 canister basket temperature gradient fluctuations do not exceed the limits of this criterion for the 60-year extended storage period, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

The third criterion applies to components that are constructed of materials with different coefficients of thermal expansion and/or different moduli of elasticity. The W21 canister basket assembly structural components are fabricated from SA-240, Type 316 austenitic stainless steels, or SA-564, Grade 630 precipitation hardened stainless steel and SA-517, Grade P carbon steel. In the W21 Canister FSAR, the applicant calculated the value of the maximum allowable temperature fluctuation for the dissimilar materials per this code criterion based on the conservatively-assumed number of significant temperature fluctuation cycles for a 100-year period. The applicant determined that this maximum allowable value is higher than the maximum temperature fluctuation evaluated in the FSAR for any two dissimilar metal components in the W21 canister basket during normal service. Therefore, the applicant concluded that the third criterion is satisfied. The NRC staff reviewed the applicant’s evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the significant temperature fluctuations for dissimilar materials in the W21 canister basket do not exceed the limits of this criterion for the conservatively-assumed number of significant temperature fluctuation cycles for a 100-year period, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

In the W21 Canister FSAR, the applicant stated that for the fourth criterion in NG-3222.4(d), the only significant mechanical loads during the W21 canister service are those due to transfers. Assuming a bounding number of significant mechanical load cycles associated with transfers, the applicant determined the maximum allowable value of the stress range per this code criterion. Because the W21 basket assembly stresses due to normal transfer loads do not exceed this value, the applicant concluded that the fourth criterion is satisfied. The NRC staff reviewed the applicant’s evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the number of significant mechanical load cycles would not exceed the assumed bounding value during the 60-year extended storage period, and the range of mechanical load stress for the W21 canister basket would not exceed the associated maximum allowable value, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

As documented above, the staff independently verified the applicant’s calculations in the FuelSolutions™ W21 Canister FSAR section 3.5.1.4.2 for each of the four conditions specified in NG-3222.4(d). Based on the foregoing review, the staff determined that the requirements of NG-3222.4(d) will continue to be satisfied for the W21 canister basket assembly during the 60-year extended storage period. Therefore, the staff finds that the applicant’s analysis for fatigue of the W21 canister basket assembly is consistent with the technical basis in NUREG-2214 and therefore acceptable.

3.4.4 W74 Canister Fatigue

3.4.4.1 W74 Canister Shell Fatigue

Appendix B.5.1 to the renewal application for the FuelSolutions™ system summarizes the results of the applicant’s TLAA for the fatigue evaluation of the W74 canister shell and associated components. The applicant provided the fatigue evaluation of the W74 canister shell for the initial storage period in section 3.5.1.4.1 of the FuelSolutions™ W74 Canister Storage FSAR (WEC 2007c). This evaluation was performed in accordance with the requirements of the ASME Code, Section III, NB-3222.4(d) (ASME 1995) to demonstrate that the six conditions in

NB-3222.4(d) are satisfied for the initial storage period and, accordingly, that fatigue is not an aging degradation concern during the initial storage period. For the renewal application, the applicant provided information to demonstrate that the fatigue evaluation of the canister shell against the six criteria of in NB-3222.4(d) will remain valid for the extended 60-year storage period. The six conditions in NB-3222.4(d) are based on a comparison of peak stress intensities for cyclic loading with material fatigue data and include cyclic stresses generated as a result of: (1) atmospheric to service pressure cycle, (2) normal service pressure fluctuation, (3) temperature difference for startup and shutdown, (4) temperature difference for normal service, (5) temperature difference for dissimilar materials, and (6) mechanical loads. Satisfaction of the six conditions of NB-3222.4(d) during the service life of an SSC constitutes an acceptable basis for assuring that the limits on peak stress intensities as governed by fatigue have been satisfied, as specified in NB-3222.4(d), and therefore fatigue is not an aging degradation concern during the service life of the SSC.

In the W74 Canister FSAR section 3.5.1.4.1, the applicant stated that for the first criterion in NB-3222.4(d), the maximum number of pressure cycles associated with startup and shutdown is below the allowable limit per the applicable ASME Code, Section III fatigue design curve. The applicant stated that canister normal service includes just one vacuum drying operation and one helium fill after closure. All other pressure fluctuations inside the canister during storage are due to changes in the outside ambient atmospheric conditions. Because the W74 canister is never cycled back to the atmospheric pressure during normal service, the applicant concluded that the first condition is satisfied. The NRC staff reviewed the applicant’s evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the actual number of pressurization and depressurization cycles for the W74 canister will remain well bounded by maximum allowable number of pressure cycles, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

In the W74 Canister FSAR section 3.5.1.4.1, the applicant stated that for the second criterion in NB-3222.4(d), the total number of normal pressure fluctuation cycles for the W74 canister shell pressure boundary is less than the code allowable limit assuming the normal pressure fluctuation cycle for this criterion occurs once a day due to the maximum analyzed change in the normal outside ambient air temperature. The applicant identified that the total number of pressure fluctuation cycles is determined by conservatively assuming daily ambient temperature cycles (which cause pressure fluctuations inside the canister) over a period of 100 years, which bounds the 60-year extended storage term. The applicant calculated the maximum allowable range for the daily pressure fluctuation inside the canister per this code criterion. The applicant determined that the W74 canister shell internal pressure range, as evaluated in the FSAR, is well bounded by the allowable value of the pressure range per this code criterion. Since the range of internal pressure fluctuation for the W74 canister is bounded by the maximum allowable value per this code criterion, and the assumed number of daily pressure fluctuation cycles over 100 years exceeds the projected number of daily pressure fluctuation cycles for the 60-year extended storage term, the applicant concluded that the second criterion is satisfied. The NRC staff reviewed the applicant’s evaluation against this second condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the W74 canister pressure fluctuation does not exceed the limits of this criterion considering the conservatively projected number of pressure fluctuation cycles over a 100-year period, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

For the third criterion in NB-3222.4(d), the applicant’s FSAR calculation determined an allowable temperature difference between any two adjacent points (as defined per this code criterion) in the canister shell material based on the canister shell material properties and the allowable stress range for this code criterion assuming a conservative number thermal startup and shutdown cycles that bound canister storage conditions. The applicant determined that the allowable temperature difference per this code criterion is much greater than the temperature difference between any two adjacent points in the W74 canister shell, as evaluated in the FuelSolutions™ W74 Canister Storage FSAR. Therefore, the applicant concluded that the third criterion is satisfied. The NRC staff reviewed the applicant's evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, the staff noted that the W74 canister shell does not undergo any significant number of thermal startup and shutdown cycles during the 60-year extended storage period. Further, even assuming a conservative value for the number of thermal startup and shutdown cycles during the extended storage period (as assumed in the application), the temperature difference between any two adjacent points of the canister shell is well bounded by maximum allowable value per this code criterion. Accordingly, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

For the fourth criterion in NB-3222.4(d), the applicant calculated the limiting value for the "significant" temperature difference fluctuation, as defined per this code criterion, based on the canister shell material properties and the maximum allowable stress range corresponding to the maximum number of temperature difference fluctuations specified for this criterion that bounds the 60-year extended storage term. The applicant stated that the temperature difference between any two adjacent points (as defined per this code criterion) in the canister shell does not change significantly from the analyzed normal cold to the analyzed normal hot condition, and temperatures at all points drop uniformly by a specified value from normal hot to normal cold conditions. The applicant determined that the maximum temperature gradient fluctuation in the canister shell based on the canister shell assembly thermal gradients for normal transfer and storage conditions, as evaluated in the W74 Canister Storage FSAR, is less than the calculated limiting value for meeting the definition of being a "significant" temperature difference fluctuation per this code criterion. Because there are no significant variations in the temperature gradient in the W74 canister shell during normal service, the applicant concluded that the fourth criterion is satisfied. The NRC staff reviewed the applicant's evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the maximum number and range of W74 canister temperature gradient fluctuations do not exceed the limits of this criterion for the duration of the 60-year extended storage period (including the limiting value for meeting the definition of being a "significant" temperature difference fluctuation per this code criterion), the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

The applicant's FSAR indicated that the fifth criterion applies to components that are constructed of materials with different coefficients of thermal expansion and/or different moduli of elasticity. Because the W74 canister shell confinement boundary components are fabricated entirely of Type 304 or Type 316 stainless steel, the applicant concluded that the fifth criterion is not applicable. The staff confirmed that the fifth criterion of NB-3222.4(d) does not require specific evaluation as a TLAA since the canister shell materials are sufficiently similar, such that there is no significant cyclic loading due to the effects of temperature fluctuations on differential thermal expansion for dissimilar materials. The staff determined that the applicant's conclusion regarding this condition remains valid for the 60-year extended storage period.

In the W74 Canister FSAR section 3.5.1.4.1, the applicant stated that for the sixth criterion in NB-3222.4(d), the only significant mechanical load fluctuations for the W74 canister shell are those associated with lifting and transfers. Assuming a bounding value for the number of significant mechanical load cycles that bounds the 60-year extended storage term, the applicant determined that the maximum allowable value of the stress range per this code criterion is greater than the range of mechanical load stress for the W74 canister shell, as evaluated in the FSAR. Therefore, the applicant concluded that the sixth criterion is satisfied. The NRC staff reviewed the applicant's evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the number of significant mechanical load cycles for the W74 canister shell would not exceed the assumed bounding value during the 60-year extended storage period, and the range of mechanical load stress would not exceed the associated maximum allowable value, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

As documented above, the staff independently verified the applicant's calculations in the FuelSolutions™ W74 Canister FSAR section 3.5.1.4.1 for each of the six conditions specified in NB-3222.4(d). Based on the foregoing review, the staff determined that the requirements of NB-3222.4(d) will continue to be satisfied for the W74 canister shell during the 60-year extended storage period. Therefore, the staff finds that the applicant's analysis for fatigue of the W74 canister shell is consistent with the technical basis in NUREG-2214 and therefore acceptable.

3.4.4.2 W74 Canister Basket Fatigue

Appendix B.5.2 to the renewal application for the FuelSolutions™ system summarizes the results of the applicant's TLAA for the fatigue evaluation of the W74 canister basket assembly and associated components. The applicant provided the fatigue evaluation of the W74 canister basket assembly for the initial storage period in section 3.5.1.4.2 of the FuelSolutions™ W74 Canister Storage FSAR (WEC 2007c). This evaluation was performed in accordance with the requirements of ASME B&PV Code, Section III, NG-3222.4(d) (ASME 1995) to demonstrate that the four conditions in NG-3222.4(d) are satisfied for the initial storage period and, accordingly, that fatigue is not an aging degradation concern during the initial storage period. For the renewal application, the applicant provided information to demonstrate that fatigue evaluation of the canister basket assembly against the four criteria in NG-3222.4(d) will remain valid for the extended 60-year storage period. The four conditions in NG-3222.4(d) are based on a comparison of peak stress intensities for cyclic loading with material fatigue data and include cyclic stresses generated as a result of: (1) temperature difference for startup and shutdown, (2) temperature difference for normal service, (3) temperature difference for dissimilar materials, and (4) mechanical loads. Satisfaction of the four conditions of NG-3222.4(d) during the service life of an SSC constitutes an acceptable basis for assuring that the limits on peak stress intensities as governed by fatigue have been satisfied, as specified in NG-3222.4(d), and therefore fatigue is not an aging degradation concern during the service life of the SSC.

For the first criterion in NG-3222.4(d), the applicant's FSAR calculation determined an allowable value for the temperature difference between any two adjacent points (as defined per this code criterion) within any canister basket component based on component material properties and the allowable stress range for this code criterion assuming a conservative number of thermal startup and shutdown cycles that bound canister storage conditions. The applicant determined that the allowable temperature difference per this code criterion is greater than the temperature difference between any two adjacent points within any canister basket component, as evaluated in the FuelSolutions™ W74 Canister Storage FSAR. Therefore, the applicant concluded that the first criterion is satisfied. The NRC staff reviewed the applicant's evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, the staff noted that the W74 canister basket does not undergo a significant number of thermal startup and shutdown cycles during the 60-year extended storage period. Further, even assuming a conservative value for the number of thermal startup and shutdown cycles during the extended storage period (as assumed in the application), the temperature difference between any two adjacent points within any canister basket component is bounded by maximum allowable value per this code criterion. Accordingly, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

For the second criterion in NG-3222.4(d), the applicant's FSAR calculation determined the maximum allowable value of the temperature difference fluctuation per this code criterion. The applicant stated that the temperature difference between any two adjacent points in the W74 canister basket assembly does not change significantly from normal cold to normal hot conditions. The applicant also stated that the largest temperature difference fluctuation within the W74 basket assembly between normal hot storage and normal cold storage, as analyzed in the FSAR, is less than the code allowable value. Because there are no significant fluctuations in the temperature gradients within the canister basket components during normal service, the applicant concluded that the second criterion is satisfied. The NRC staff reviewed the applicant's evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the W74 canister basket temperature gradient fluctuations do not exceed the limits of this criterion for the 60-year extended storage period, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

The third criterion applies to components that are constructed of materials with different coefficients of thermal expansion and/or different moduli of elasticity. The W74 canister basket assembly structural components are fabricated from SA-240, Type 316, Type 304, and Type XM-19 austenitic stainless steels and SA-517 or A514, Grade P or Grade F carbon steels. In the W74 Canister FSAR, the applicant calculated the value of the maximum allowable temperature fluctuation for the dissimilar materials per this code criterion based on the conservatively-assumed number of significant temperature fluctuation cycles for a 100-year period. The applicant determined that this maximum allowable value is higher than the maximum temperature fluctuation evaluated in the FSAR for any two dissimilar metal components in the W74 canister basket during normal service. Therefore, the applicant concluded that the third criterion is satisfied. The NRC staff reviewed the applicant's evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the significant temperature fluctuations for dissimilar materials in the W74 canister basket do not exceed the limits of this criterion for the conservatively-assumed number of significant temperature fluctuation cycles for a 100-year period, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

In the W74 Canister FSAR, the applicant stated that for the fourth criterion in NG-3222.4(d), the only significant mechanical loads during the W74 canister service are those due to transfers. Assuming a bounding number of significant mechanical load cycles associated with transfers, the applicant determined the maximum allowable value of the stress range per this code criterion. Because the W74 basket assembly stresses due to normal transfer loads do not exceed this value, the applicant concluded that the fourth criterion is satisfied. The NRC staff reviewed the applicant's evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the number of significant mechanical load cycles would not exceed the assumed bounding value during the 60-year extended storage period, and the range of mechanical load stress for the W74 canister basket would not exceed the associated maximum allowable value, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

As documented above, the staff independently verified the applicant's calculations in the FuelSolutions™ W74 Canister FSAR section 3.5.1.4.2 for each of the four conditions specified in NG-3222.4(d). Based on the foregoing review, the staff determined that the requirements of NG-3222.4(d) will continue to be satisfied for the W74 canister basket assembly during the 60-year extended storage period. Therefore, the staff finds that the applicant's analysis for fatigue of the W74 canister basket assembly is consistent with the technical basis in NUREG-2214 and therefore acceptable.

3.4.5 W100 Transfer Cask Fatigue

Appendix B.6 to the renewal application for the FuelSolutions™ storage system summarizes the results of the applicant's TLAA for the fatigue evaluation of the W100 transfer cask. The applicant provided the fatigue evaluation of the W100 transfer cask for the initial storage period in section 3.5.3.3.5 of the FuelSolutions™ Storage System FSAR (WEC 2007a). This evaluation was performed in accordance with the requirements of ASME Code, Section III, NC-3219.2, Condition B (ASME 1995) to demonstrate that the six conditions in NC-3219.2, Condition B, are satisfied for the initial storage period and, accordingly, that fatigue is not an aging degradation concern during the initial storage period. For the renewal application, the applicant provided updated information in its TLAA evaluation and corresponding FSAR section 3.5.3.3.5 change pages to demonstrate that the fatigue evaluation of the transfer cask satisfies the six criteria of NC-3219.2, Condition B, for the extended 60-year storage period. The six conditions in NC-3219.2, Condition B, are based on a comparison of peak stress intensities for cyclic loading with material fatigue data and include cyclic stresses generated as a result of: (1) the expected design number of full range pressure cycles, (2) the expected design range of pressure cycles during normal service, (3) the temperature difference between any two adjacent points, (4) the range of temperature difference between any two adjacent points, (5) temperature difference for dissimilar materials, and (6) mechanical loads. Satisfaction of the six conditions of NC-3219.2, Condition B, during the service life of an SSC constitutes an acceptable basis for assuring that the limits on peak stress intensities as governed by fatigue have been satisfied and therefore fatigue is not an aging degradation concern during the service life of the SSC.

For the first criterion in NC-3219.2, Condition B, the applicant determined a maximum allowable number of full range pressure cycles for the W100 transfer cask based on the calculated stress range per this code criterion. The applicant identified a bounding value for the maximum number of canister transfers per year, for which only the liquid neutron shield jacket is designed to withstand internal pressure. Based on the bounding value for the maximum number of canister transfers per year, the applicant calculated a total number of full range pressure cycles for the neutron shield jacket over the 60-year extended storage term, which is much less than the maximum allowable value per this code criterion. Therefore, the applicant concluded that the first condition is satisfied. The NRC staff reviewed the applicant's evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the actual number of full range pressure cycles for the liquid neutron shield jacket of the W100 transfer cask will remain well bounded by the maximum allowable number of pressure cycles, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

For the second criterion in NC-3219.2, Condition B, the applicant determined a maximum design range of pressure cycles for the liquid neutron shield jacket during canister transfer operations based on a negative pressure for an empty neutron shield jacket with the transfer cask submerged in the pool water ranging up to the maximum internal design pressure for the shield jacket filled with neutron shielding liquid. Conservatively assuming a specified number of significant pressure fluctuations for the liquid neutron shield jacket during each canister transfer operation, the applicant determined the total number of significant pressure fluctuation cycles for the shield jacket over 60 years, based on the total number of canister transfer operations over 60 years, as discussed above for the first criterion. In accordance with second criterion, the applicant calculated the maximum allowable range of pressure during normal service based on the maximum internal design pressure for the shield jacket, the design stress intensity for the shield jacket material, and an allowable stress range for the total number of significant pressure fluctuation cycles for the shield jacket over 60 years based on the design fatigue curve. Because the maximum design range of the pressure cycles for the shield jacket is less than the maximum allowable pressure range, the applicant concluded that the second criterion is satisfied. The NRC staff reviewed the applicant's evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the maximum design range of pressure cycles during normal service for the liquid neutron shield jacket of the W100 transfer cask will remain less than the maximum allowable pressure range, as determined based on the conservatively projected number of significant pressure fluctuation cycles for the 60-year extended storage period, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

For the third criterion in NC-3219.2, Condition B, the applicant calculated the maximum allowable value of the temperature difference between any two adjacent points (as defined per this code criterion) of the transfer cask based on the projected total number of canister transfer operations over 60 years, as discussed above for the first criterion, and the W100 transfer cask material property data. The applicant demonstrated that under no condition does the temperature difference between any two adjacent points of the transfer cask approach this value. Therefore, the applicant concluded that the third criterion is satisfied. The NRC staff reviewed the applicant's evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the maximum temperature difference between any two adjacent points of the transfer cask will remain well bounded by the maximum allowable value, based on the projected total number of canister transfer operations over 60 years, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

For the fourth criterion in NC-3219.2, Condition B, the applicant determined that the range of temperature difference between any two adjacent points of the transfer cask does not change during normal service by more than the maximum allowable value per this code criterion. The applicant also stated that any changes in the W100 transfer cask temperature are relatively slow and gradual due to its large thermal capacity and the absence of rapid changes in external temperature conditions. Therefore, the applicant concluded that the fourth criterion is satisfied. The NRC staff reviewed the applicant's evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the range of temperature difference between any two adjacent points of the transfer cask does not change during normal service by more than the maximum allowable value, based on the projected total number of canister transfer operations over 60 years, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

The fifth criterion in NC-3219.2, Condition B, applies to components that are constructed of materials with different coefficients of thermal expansion and/or different moduli of elasticity. Because the W100 transfer cask components are fabricated entirely of Type 304, F304, or F304N stainless steel, the applicant concluded that the fifth criterion is not applicable. The NRC staff confirmed that there are no significant differences in the thermoelastic properties of the stainless steel types for the W100 transfer cask components that would necessitate a specific evaluation of the effect of temperature fluctuation on differential thermal expansion for dissimilar materials. Therefore, the staff determined that this condition is not applicable.

For the sixth criterion in NC-3219.2, Condition B, the applicant identified that the transfer cask maximum stress condition for mechanical load fluctuations occurs for a fully loaded transfer cask and canister. The applicant determined the total number of mechanical load fluctuation cycles for any given canister fuel loading and transfer campaign. The applicant calculated the projected total number of significant mechanical load fluctuation cycles for the extended 60-year storage period based on the bounding value for the maximum number of canister transfers per year. The applicant determined the maximum allowable value of the stress range per this criterion for the projected total number of significant mechanical load fluctuation cycles. The applicant determined that the peak stress intensity at any point of the transfer cask considering all required load combinations, as evaluated in the FuelSolutions™ Storage System FSAR (WEC 2007a), is lower than the maximum allowable value of the stress range per this criterion. Therefore, the applicant concluded that the sixth criterion is satisfied. The NRC staff reviewed the applicant’s evaluation against this condition and confirmed that this condition is satisfied for the renewal period. Specifically, since the full range of mechanical loads does not result in stress intensities whose range exceeds that maximum allowable value per this code criterion, based on the projected total number of significant mechanical load fluctuation cycles over 60 years, the NRC staff determined that this condition will remain satisfied for the 60-year extended storage period.

As documented above, the staff independently verified the applicant’s calculations in the FuelSolutions™ Storage System FSAR section 3.5.3.3.5, as updated in the renewal application for the 60-year storage term, for each of the six conditions specified in NC-3219.2, Condition B. Based on the foregoing review, the staff determined that the requirements of NC-3219.2, Condition B, will be satisfied for the W100 transfer cask during the 60-year extended storage period. Therefore, the staff finds that the applicant’s analysis for fatigue of the W100 transfer cask is consistent with the technical basis in NUREG-2214 and therefore acceptable.

3.4.6 Evaluation Findings

The staff reviewed the TLAAs provided in the renewal application for the FuelSolutions™ system. The staff performed its review following the guidance provided in NUREG-1927, Revision 1, and NUREG-2214. The staff verified that the TLAA inputs, assumptions, calculations, and analyses are adequate and bound the environments, service conditions, aging mechanisms, and aging effects for the pertinent SSCs. Based on its review, the staff finds:

F3.3 The applicant identified all aging mechanisms and effects pertinent to SSCs within the scope of renewal that are subject to TLAAs. The methods and values of the input parameters for the applicant’s TLAAs are adequate. Therefore, the applicant’s TLAAs provide reasonable assurance that the SSCs will maintain their intended functions for the period of extended operation, require no further aging management activities, and meet the requirements in 10 CFR 72.240(c)(2).

3.5 Aging Management Programs

Under 10 CFR 72.240(c)(3) requirements, the applicant must provide a description of AMPs for management of issues associated with aging that could adversely affect the design functions of SSCs important to safety. The applicant proposed the following AMPs in appendix A of the renewal application and in the proposed FSAR change pages provided in appendix D of the renewal application for the FuelSolutions™ system:

1. FuelSolutions™ Welded Stainless Steel Canister AMP
2. FuelSolutions™ Reinforced Concrete Structures AMP
3. FuelSolutions™ Monitoring of Metallic Surfaces AMP
4. FuelSolutions™ W100 Transfer Cask AMP
5. FuelSolutions™ W21 Canister High-Burnup Fuel Monitoring and Assessment AMP

The staff conducted a safety review of the proposed AMPs in the renewal application for the FuelSolutions™ system in accordance with NUREG-1927, Revision 1. The staff evaluated the proposed AMPs by comparing them to the generically acceptable example AMPs in NUREG-2214, as follows:

- The FuelSolutions™ Welded Stainless Steel Canister AMP was compared to the NUREG-2214 example AMP for localized corrosion and stress corrosion cracking of welded stainless steel dry storage canisters (see SER table 3.5-1).
- The FuelSolutions™ Reinforced Concrete Structures AMP was compared to the NUREG-2214 example AMP for reinforced concrete structures (see SER table 3.5-2).
- The FuelSolutions™ Monitoring of Metallic Surfaces AMP was compared to the NUREG-2214 example AMP for monitoring of metallic surfaces (see SER table 3.5-3).
- The FuelSolutions™ W100 Transfer Cask AMP was compared to the NUREG-2214 example AMP for transfer casks (see SER table 3.5-4).
- The FuelSolutions™ W21 Canister High-Burnup Fuel Monitoring and Assessment AMP was compared to the NUREG-2214 example AMP for high-burnup fuel monitoring and assessment (see SER table 3.5-5).

SER tables 3.5-1 through 3.5-5 provide the staff's findings and conclusions on the consistency of the proposed AMPs in the application with the corresponding example AMPs in NUREG-2214. The staff's review is documented on an element-by-element basis, consistent with standard 10-element AMP format for the example AMPs provided in NUREG-2214. For those application AMP elements that the staff found to be completely consistent with corresponding example AMP elements described in NUREG-2214, the staff confirmed that the consistency of the application AMP elements with the corresponding example AMP elements in NUREG-2214 is appropriate for the FuelSolutions™ Storage System, and the staff identified these AMP elements as "consistent" in SER table 3.5-1 through 3.5-5 with no further review explanation needed. For AMP Element 10, "Operating Experience," the staff also included a brief summary of the relevant operating experience associated with the AMP. More detailed explanation is provided in SER table 3.5-1 through 3.5-5 to address the staff's evaluation for those application AMP elements for which the staff identified potential inconsistencies that necessitated resolution through the issuance of an RAI and associated updates to the renewal application.

**Table 3.5-1 Aging Management Program Review Results—
FuelSolutions™ Welded Stainless Steel Canister AMP**

AMP Element	Staff's Assessment of Consistency with the NUREG-2214 Example AMP for Localized Corrosion and Stress Corrosion Cracking of Welded Stainless Steel Dry Storage Canisters
1. Scope of Program	Consistent
2. Preventive Actions	Consistent
3. Parameters Monitored or Inspected	Consistent
4. Detection of Aging Effects	Consistent
5. Monitoring and Trending	Consistent
6. Acceptance Criteria	Consistent
7. Corrective Actions	Consistent
8. Confirmation Process	Consistent
9. Administrative Controls	Consistent
10. Operating Experience	Consistent The applicant provided previous operating experience and relevant industry operating experience in section 3.1 and appendix C to the renewal application for the FuelSolutions™ system. The applicant stated that the periodic visual inspections and pre-application inspections conducted to date have not identified any structural deficiencies due to aging-related degradation of the W74 canister system. As discussed in SER section 3.5.1, the applicant also stated that it will use the industry's Aging Management Institute of Nuclear Power Operations Database (AMID) to share operating experience with others and inform the assessment of AMP effectiveness.

Table 3.5-2 Aging Management Program Review Results—
FuelSolutions™ Reinforced Concrete Structures AMP

AMP Element	Staff's Assessment of Consistency with the NUREG-2214 Example AMP for Reinforced Concrete Structures
1. Scope of Program	Section 6.6 of NUREG-2214 states that, if supported by a technical justification, visual inspections of the concrete per American Concrete Institute (ACI) 349.3R-02 (ACI 2002) may be an acceptable alternative approach to the performance of radiation surveys for managing loss of shielding due to concrete degradation. However, no technical justification was originally provided in the Reinforced Concrete Structures (RCS) AMP for the use of visual inspections of the concrete per ACI 349.3R-02 as an acceptable alternative approach to performing radiation surveys for managing loss of shielding due to concrete degradation. In its response to an NRC RAI (WEC 2022a), the applicant stated that it will implement periodic radiation surveys (in addition to visual inspections) for managing loss of shielding due to concrete degradation during the period of extended storage. The applicant also provided supplemental information for its RAI response (WEC 2022c) that justifies the applicability of the radiation survey operating experience at the Big Rock Point ISFSI for supporting its proposed 5-year concrete radiation survey frequency. The staff's detailed review of the applicant's criteria for performing radiation surveys during the period of extended storage and associated supplemental information is addressed below for AMP Element 4, "Detection of Aging Effects." The staff's review determined that the applicant's criteria implementation of periodic radiation surveys (in addition to visual inspections) for managing loss of shielding due to concrete degradation is acceptable because it is consistent with the guidance in the NUREG-2214 example RCS AMP. Based on its review of the revisions to the RCS AMP in the updated renewal application, the staff finds this AMP element consistent with NUREG-2214.
2. Preventive Actions	Consistent
3. Parameters Monitored or Inspected	The RCS AMP did not originally justify that the visual inspections of the concrete per ACI 349.3R-02 are an acceptable alternative approach to the performance of radiation surveys for managing loss of shielding due to concrete degradation. In its response to an NRC RAI (WEC 2022a), the applicant stated that it will implement periodic radiation surveys (in addition to visual inspections) for managing loss of shielding due to concrete degradation during the period of extended storage. The radiation surveys will be conducted on each cask every 5 years during the period of extended storage using the methods and acceptance criteria in

	FuelSolutions™ Storage System Technical Specification 5.3.5, “Cask Surface Dose Rate Evaluation Program” (WEC 2007a). The staff reviewed the applicant’s FuelSolutions™ Storage System Technical Specification 5.3.5, “Cask Surface Dose Rate Evaluation Program” (WEC 2007a), and determined that the applicant’s planned radiation surveys for managing loss of shielding due to concrete degradation are acceptable because the cask surface dose rate limits established in Technical Specification 5.3.5 shall include gamma-ray and neutron dose rates, and this approach is consistent with the guidance in the NUREG-2214 example RCS AMP. Based on its review of the revisions to the RCS AMP in the updated renewal application, the staff finds this AMP element consistent with NUREG-2214.
4. Detection of Aging Effects	The RCS AMP did not originally justify that the visual inspections of the concrete per ACI 349.3R-02 are an acceptable alternative approach to the performance of radiation surveys for managing loss of shielding due to concrete degradation. In its response to an NRC RAI (WEC 2022a), the applicant stated that it will implement periodic radiation surveys (in addition to visual inspections) for managing loss of shielding due to concrete degradation during the period of extended storage. The radiation survey requirements have been added to Element 4 of the RCS AMP in the updated renewal application (WEC 2022b). The radiation surveys will be conducted on each cask every 5 years during the period of extended storage using the methods and acceptance criteria in FuelSolutions™ Storage System Technical Specification 5.3.5, “Cask Surface Dose Rate Evaluation Program” (WEC 2007a). The applicant also stated that the 5-year concrete radiation survey frequency is based on 20 years of cask concrete operating experience with no detected decrease in concrete shielding effectiveness at the Big Rock Point ISFSI. The staff reviewed the updated renewal application (WEC 2022b) and the FuelSolutions™ Storage System Technical Specification 5.3.5, “Cask Surface Dose Rate Evaluation Program” (WEC 2007a) and determined that the applicant’s planned radiation surveys for managing loss of shielding due to concrete degradation are acceptable because the radiation surveys are conducted at the cask side wall and inlet vent position using calibrated gamma ray and neutron detection equipment and qualified radiation protection program personnel, consistent with the guidance in the NUREG-2214 example RCS AMP. The applicant also provided supplemental information (WEC 2022c) to support its RAI response that justifies the application of the radiation survey operating experience at the Big Rock

	Point ISFSI for supporting a 5-year concrete radiation survey frequency during the period of extended storage. The supplemental response includes radiation survey data collected during the initial 20-year storage term for the Big Rock Point ISFSI. The data includes survey results conducted at several specified times during the initial 20-year storage term and is intended to show that a 5-year concrete radiation survey frequency in conjunction with the radiation survey methods and acceptance criteria in FuelSolutions™ Storage System Technical Specification 5.3.5, "Cask Surface Dose Rate Evaluation Program" is sufficient to ensure that concrete shielding performance is adequately monitored during the period of extended storage. The staff reviewed the supplemental information and confirmed that the Big Rock Point ISFSI radiation survey data show that a 5-year concrete radiation survey frequency, in conjunction with the radiation survey methods and acceptance criteria in FuelSolutions™ Storage System Technical Specification 5.3.5, is sufficient to ensure that concrete shielding performance is adequately monitored during the period of extended storage. The RCS AMP states that a visual inspection of lower vent interior concrete areas (normally inaccessible) is to be performed for one storage cask at each ISFSI site at least once every 5 years, using video camera, boroscope, or other remote visual inspection equipment. The example RCS AMP provided in section 6.6 of NUREG-2214 states that cask selection criteria should be predefined and/or justified. The original RCS AMP did not include criteria for selection of the one storage cask per ISFSI site for visual inspection of the lower vent interior concrete areas. In its response to an NRC RAI (WEC 2022a), the applicant stated that the criteria for selection of the one storage cask per ISFSI site for visual inspection of the concrete in the lower vent interior areas have been added to Element 4 of the RCS AMP. The cask selection criteria in the updated RCS AMP are based on the FuelSolutions™ Storage System FSAR section 9.2.2 requirement that the interior surface of the first cask placed in service at an ISFSI site be inspected for damage every 5 years. Alternatively, the site may conduct the 5-year lower vent interior concrete inspection on the storage cask that contains the stainless steel canister selected for visual inspection under the applicant's Welded Stainless Steel Canister (WSSC) AMP. The staff reviewed the updated renewal application (WEC 2022b) and the FuelSolutions™ Storage System FSAR section 9.2.2 and verified that that the single cask selection criteria for the lower vent interior concrete inspection are appropriately incorporated into Element 4 of the RCS AMP. The staff determined that these selection criteria are acceptable because the cask selected for lower vent interior concrete

	inspection would be either the cask with the longest time in service at the ISFSI site, or the cask selected would be the one containing the stainless steel canister selected for visual inspection under the WSSC AMP. The staff verified that that the selection criteria for the canister visual inspection under the WSSC AMP are also suitable for cask selection for performance of the lower vent interior concrete inspection. The staff also determined that in both cases, the selection criteria are consistent with the recommended criteria in the NUREG-2214 example RCS AMP. Therefore, the selection criteria are acceptable. Based on its review of the revisions to the RCS AMP in the updated renewal application, the staff finds this AMP element consistent with NUREG-2214.
5. Monitoring and Trending	The RCS AMP did not originally justify that the visual inspections of the concrete per ACI 349.3R-02 are an acceptable alternative approach to the performance of radiation surveys for managing loss of shielding due to concrete degradation. In its response to an NRC RAI (WEC 2022a), the applicant stated that it will implement periodic radiation surveys (in addition to visual inspections) for managing loss of shielding due to concrete degradation during the period of extended storage. The radiation surveys will be conducted on each cask every 5 years during the period of extended storage using the methods and acceptance criteria in FuelSolutions™ Storage System Technical Specification 5.3.5, “Cask Surface Dose Rate Evaluation Program” (WEC 2007a). The staff reviewed the applicant’s FuelSolutions™ Storage System Technical Specification 5.3.5, “Cask Surface Dose Rate Evaluation Program” (WEC 2007a), and determined that the applicant’s planned radiation surveys for managing loss of shielding due to concrete degradation are acceptable because the measured cask surface dose rates shall be compared to the limits established in Technical Specification 5.3.5 and this approach is consistent with the guidance in the NUREG-2214 example RCS AMP. Based on its review of the revisions to the RCS AMP in the updated renewal application, the staff finds this AMP element consistent with NUREG-2214.
6. Acceptance Criteria	The RCS AMP did not originally justify that the visual inspections of the concrete per ACI 349.3R-02 are an acceptable alternative approach to the performance of radiation surveys for managing loss of shielding due to concrete degradation. In its response to an NRC RAI (WEC 2022a), the applicant stated that it will implement periodic radiation surveys (in addition to visual inspections) for managing loss of shielding due to concrete degradation during the period of extended storage. The applicant added the

	acceptance criteria for the radiation surveys into Element 6 of the RCS AMP in the updated renewal application (WEC 2022b). The radiation survey acceptance criteria in the FuelSolutions™ Storage System Technical Specifications 5.3.5.2 and 5.3.5.3 for the cask side wall and inlet vent positions shall be used to determine cask concrete shielding effectiveness. The staff reviewed the updated renewal application (WEC 2022b) and the FuelSolutions™ Storage System Technical Specifications (WEC 2007a) and determined that the applicant's planned radiation surveys for managing loss of shielding due to concrete degradation are acceptable because the measured cask surface dose rates at the cask side wall and inlet vent positions shall be compared to the acceptance criteria established in the FuelSolutions™ Storage System Technical Specifications 5.3.5.2 and 5.3.5.3 to ensure compliance with 10 CFR 72.104, and this approach is consistent with the guidance in the NUREG-2214 example RCS AMP. Based on its review of the revisions to the RCS AMP in the updated renewal application, the staff finds this AMP element consistent with NUREG-2214.
7. Corrective Actions	Consistent
8. Confirmation Process	Consistent
9. Administrative Controls	Consistent
10. Operating Experience	Consistent The applicant provided previous operating experience and relevant industry operating experience in section 3.1 and appendix C to the renewal application for the FuelSolutions™ system. The applicant stated that the periodic visual inspections and pre-application inspections conducted to date revealed minor concrete and grout degradation on the W150 storage cask that was found and repaired. As discussed in SER section 3.5.1, the applicant also stated that it will use the AMID to share operating experience with others and inform the assessment of AMP effectiveness.

**Table 3.5-3 Aging Management Program Review Results—
FuelSolutions™ Monitoring of Metallic Surfaces AMP**

AMP Element	Staff's Assessment of Consistency with the NUREG-2214 Example AMP for Monitoring of Metallic Surfaces
1. Scope of Program	Consistent
2. Preventive Actions	Consistent
3. Parameters Monitored or Inspected	Consistent
4. Detection of Aging Effects	Consistent
5. Monitoring and Trending	Consistent
6. Acceptance Criteria	Consistent
7. Corrective Actions	Consistent
8. Confirmation Process	Consistent
9. Administrative Controls	Consistent
10. Operating Experience	Consistent The applicant provided previous operating experience and relevant industry operating experience in section 3.1 and appendix C to the renewal application for the FuelSolutions™ system. The applicant stated that the periodic visual inspections and pre-application inspections conducted to date revealed some deteriorated paint on the impact limiter steel casing and very minimal degradation on the W150 storage cask. As discussed in SER section 3.5.1, the applicant also stated that it will use the AMID to share operating experience with others and inform the assessment of AMP effectiveness.

**Table 3.5-4 Aging Management Program Review Results—
FuelSolutions™ W100 Transfer Cask AMP**

AMP Element	Staff's Assessment of Consistency with the NUREG-2214 Example AMP for Transfer Casks
1. Scope of Program	Element 1 of the Transfer Cask (TC) AMP did not originally address aging management of the liquid neutron shielding jacket. In its response to an NRC RAI (WEC 2022a), the applicant stated that there are no liquid neutron shield jacket aging mechanisms or effects that require aging management except for the inspection of the jacket coating for coating degradation. The staff reviewed the updated renewal application (WEC 2022b) and determined that the applicant has updated Element 1 of the TC AMP to adequately clarify the scope of the AMP to include the liquid neutron shielding jacket coating. Therefore, the staff finds the applicant's response to be acceptable. Based on its review of the revisions to the TC AMP in the updated renewal application, the staff finds this AMP element consistent with NUREG-2214.
2. Preventive Actions	Consistent
3. Parameters Monitored or Inspected	Element 3 of the TC AMP did not originally address aging management of the liquid neutron shielding jacket. In its response to an NRC RAI (WEC, 2022a), the applicant stated that there are no liquid neutron shield jacket aging mechanisms or effects that require aging management except for the inspection of the jacket coating for coating degradation. The staff reviewed the updated renewal application (WEC, 2022b) and determined that the applicant has updated Element 3 of the TC AMP to adequately clarify the parameters monitored and inspected for the liquid neutron shielding jacket coating. Therefore, the staff finds the applicant's response to be acceptable. Based on its review of the revisions to the TC AMP in the updated renewal application, the staff finds this AMP element consistent with NUREG-2214.
4. Detection of Aging Effects	Element 4 of the TC AMP did not originally address aging management of the liquid neutron shielding jacket. In its response to an NRC RAI (WEC 2022a), the applicant stated that there are no liquid neutron shield jacket aging mechanisms or effects that require aging management except for the inspection of the jacket coating for coating degradation. The staff reviewed the updated renewal application (WEC 2022b) and determined that the applicant has updated Element 4 of the TC AMP to adequately clarify activities for detection of aging effects for the liquid neutron shielding jacket

	coating. Therefore, the staff finds the applicant’s response to be acceptable. Based on its review of the revisions to the TC AMP in the updated renewal application, the staff finds this AMP element consistent with NUREG-2214.
5. Monitoring and Trending	In its response to an NRC RAI (WEC 2022a), the applicant stated that there are no liquid neutron shield jacket aging mechanisms or effects that require aging management except for the inspection of the jacket coating for coating degradation. The staff reviewed the updated renewal application (WEC 2022b) and determined that the applicant has updated the TC AMP to adequately clarify activities for monitoring and trending of inspection results and aging effects for the liquid neutron shielding jacket coating. Therefore, the staff finds the applicant’s response to be acceptable. Based on its review of the revisions to the TC AMP in the updated renewal application, the staff finds this AMP element consistent with NUREG-2214.
6. Acceptance Criteria	Element 6 of the TC AMP originally stated that for inaccessible internal surfaces, the acceptance criteria are no evidence of leakage from the neutron shield jacket or loss of wall thickness beyond a predetermined limit established by system-specific design standards or industry codes and standards. However, the other TC AMP elements did not originally address aging management of the liquid neutron shielding jacket. In its response to an NRC RAI (WEC 2022a), the applicant stated that there are no liquid neutron shield jacket aging mechanisms or effects that require aging management except for the inspection of the jacket coating for coating degradation. The staff reviewed the updated renewal application (WEC 2022b) and determined that the applicant has updated Element 6 of the TC AMP to adequately clarify the acceptance criteria for inspection results and aging effects for the liquid neutron shielding jacket coating. Therefore, the staff finds the applicant’s response to be acceptable. Based on its review of the revisions to the TC AMP in the updated renewal application, the staff finds this AMP element consistent with NUREG-2214.
7. Corrective Actions	Consistent
8. Confirmation Process	Consistent
9. Administrative Controls	Consistent
10. Operating Experience	Consistent The applicant provided previous operating experience and relevant industry operating experience in section 3.1 and appendix C to the renewal application for the FuelSolutions™

	system. The applicant stated that the periodic visual inspections conducted to date revealed very minimal degradation on the W100 transfer cask. As discussed in SER section 3.5.1, the applicant also stated that it will use the AMID to share operating experience with others and inform the assessment of AMP effectiveness.

Table 3.5-5 Aging Management Program Review Results—
FuelSolutions™ W21 Canister High-Burnup Fuel Monitoring and Assessment AMP

AMP Element	Staff's Assessment of Consistency with the NUREG-2214 Example AMP for High-Burnup Fuel Monitoring and Assessment
1. Scope of Program	The W21 Canister High-Burnup (HBU) Fuel Monitoring and Assessment AMP states that the AMP relies on the Electric Power Research Institute (EPRI) "High Burnup Dry Storage Cask Research and Development Project (HDRP)" (EPRI 2014) as a surrogate demonstration program that monitors the performance of HBU fuel in a representative dry storage cask. However, the AMP did not originally justify the applicability of the EPRI HDRP surrogate demonstration program to the W21 canister HBU fuel considering that the maximum allowable burnup limit for the HBU fuel stored in the W21 canister is 60 gigawatt-days per metric ton of uranium (GWd/MTU), which is 5 to 10 GWd/MTU greater than the specified nominal burnup of the HBU fuel stored in the HDRP cask. In its response to an NRC RAI (WEC 2022a), the applicant provided information showing that the EPRI HDRP results will be valid to support storage of HBU fuel with burnups up to 55 GWd/MTU. In addition to the HDRP, the applicant identified that there are casks that are currently licensed for storage of HBU fuel that encompass the 60 GWd/MTU upper burnup limit for the W21 canister. The applicant identified that the combination of the HDRP and the current and future industry experience with storage of HBU fuel will encompass the storage of HBU fuel at the 60 GWd/MTU upper burnup limit for the FuelSolutions™ W21 canister. The applicant also noted that since there are no HBU fuel assemblies currently loaded in a W21 canister, industry HBU fuel storage experience will lead any W21 canister HBU fuel storage efforts. The applicant further stated that the W21 Canister HBU Fuel Monitoring and Assessment AMP will rely on current and future industry HBU fuel storage experience, as monitored by the AMP tollgate assessments required in FuelSolutions™ Storage System FSAR appendix 9.A (included with the renewal application), to ensure safe storage of HBU fuel for the maximum allowable burnup limit of 60 GWd/MTU applicable to the W21 canister. The foregoing justification has been added to Element 1 of the W21 Canister HBU Fuel Monitoring and Assessment AMP in the updated renewal application. The staff reviewed the updated renewal application (WEC 2022b) and the associated FuelSolutions™ Storage System FSAR appendix 9.A AMP tollgates. The staff determined that the applicant's justification for the applicability of the EPRI HDRP surrogate demonstration program to the W21 canister HBU fuel is acceptable considering the additional data supporting the validity of the HDRP results for HBU fuel

	burnups up to 55 GWd/MTU and the applicant's commitment to use their AMP tollgates to support the incorporation of industry experience with storage of HBU fuel for the 60 GWd/MTU burnup limit. The staff also noted that since the applicant's AMP tollgates are included in the FuelSolutions™ Storage System FSAR appendix 9.A, there is assurance that current and future industry experience with storage of HBU fuel for the 60 GWd/MTU burnup condition will be incorporated into this AMP during the period of extended storage to ensure safe storage of HBU fuel in the W21 canister for the maximum allowable burnup limit of 60 GWd/MTU. Therefore, the staff determined that the applicant's approach is consistent with the guidance in the NUREG-2214 example AMP for HBU Fuel Monitoring and Assessment. Based on its review of the revisions to the W21 Canister HBU Fuel Monitoring and Assessment AMP in the updated renewal application, the staff finds this AMP element consistent with NUREG-2214.
2. Preventive Actions	Consistent
3. Parameters Monitored or Inspected	Section 6.10 of NUREG-2214 states that the applicant should identify the parameters monitored and inspected in a surrogate demonstration program that are applicable to its particular design-bases HBU fuel and should describe how this meets the guidance in appendix D of NUREG-1927. Element 3 of the W21 Canister HBU Fuel Monitoring and Assessment AMP did not originally identify the parameters monitored and inspected in the HDRP that are applicable to the W21 canister HBU fuel and describe how they meet the guidance in appendix D of NUREG-1927. In its response to an NRC RAI (WEC 2022a), the applicant stated that Element 3 of the W21 Canister HBU Fuel Monitoring and Assessment AMP has been revised to include the specific parameters monitored and inspected in the HDRP that are applicable to the W21 canister HBU fuel. The parameters monitored and inspected in the AMP are the cladding temperatures during storage, which will provide data on HBU fuel cladding temperatures for input to hydride reorientation, ductility, and creep evaluations. The applicant stated that given that the HDRP HBU fuel assembly burnups, cladding materials, temperatures, pressure, and helium environment are similar to those specified by the Technical Specifications for W21 canister fuel assemblies, the use of HDRP temperature monitoring data meets the guidance in appendix D of NUREG-1927. The staff reviewed the updated renewal application (WEC 2022b) and the W21 Canister Technical Specifications (WEC 2007b) and determined that the applicant's use of cladding temperature monitoring data from the EPRI HDRP surrogate

	demonstration program is acceptable and consistent with the guidance provided in appendix D of NUREG-1927. Based on its review of the revisions to the W21 Canister HBU Fuel Monitoring and Assessment AMP in the updated renewal application, the staff finds this AMP element consistent with NUREG-2214.
4. Detection of Aging Effects	Section 6.10 of NUREG-2214 states that the applicant should identify the detection of aging effects in a surrogate demonstration program that are applicable to its particular design-bases HBU fuel and should describe how this meets the guidance in appendix D of NUREG-1927. Element 4 of the W21 Canister HBU Fuel Monitoring and Assessment AMP did not originally identify the methods for detecting aging effects in the HDRP that are applicable to the W21 canister HBU fuel and describe how they meet the guidance in appendix D of NUREG-1927. In its response to an NRC RAI (WEC 2022a), the applicant stated that Element 4 of the W21 Canister HBU Fuel Monitoring and Assessment AMP has been revised to include the methods for detecting aging effects in the HDRP that are applicable to the W21 canister HBU fuel. The information from the HDRP will provide temperature measurements that will be used to address loss of ductility due to hydride reorientation and changes in dimensions due to thermal creep. The applicant stated that given that the HDRP HBU fuel assembly burnups and temperatures are similar to those specified by the Technical Specifications for the W21 canister fuel assemblies, the use of HDRP thermocouple temperature data for detecting aging effects meets the guidance in appendix D of NUREG-1927. The staff reviewed the updated renewal application (WEC 2022b) and the W21 Canister Technical Specifications (WEC 2007b) and determined that the applicant’s use of thermocouple temperature data from the EPRI HDRP surrogate demonstration program for detecting aging effects is acceptable and consistent with the guidance provided in appendix D of NUREG-1927. Based on its review of the revisions to the W21 Canister HBU Fuel Monitoring and Assessment AMP in the updated renewal application, the staff finds this AMP element consistent with NUREG-2214.
5. Monitoring and Trending	Consistent
6. Acceptance Criteria	Consistent
7. Corrective Actions	Consistent
8. Confirmation Process	Consistent

9. Administrative Controls	Consistent
10. Operating Experience	Consistent The applicant stated that no high-burnup fuel assemblies have been loaded in a FuelSolutions™ W21 canister to date. The program relies on the "High Burnup Dry Storage Cask Research and Development Project" (EPRI, 2014) as a surrogate demonstration program that monitors the performance of high-burnup fuel in dry storage. As discussed in SER section 3.5.1, the applicant also stated that it will use the AMID, the aggregate information from the HDRP, available operating experience, and NRC-generated communications to inform the assessment of AMP effectiveness.

3.5.1 Aging Management Tollgates

The applicant included periodic tollgate assessments in the renewal application, as recommended in Nuclear Energy Institute (NEI) 14-03, Revision 1 (NEI 2015). The applicant included the schedule for these tollgate assessments in table 4-1 of the renewal application for the FuelSolutions™ system and in the proposed FSAR supplement as the FuelSolutions™ Storage System FSAR table 9.A.2-1.

The applicant's tollgate assessments will evaluate information from the following sources:

- results of research and development programs focused specifically on aging-related degradation mechanisms identified as potentially affecting the FuelSolutions™ system and the ISFSI sites;
- relevant results of other domestic and international research;
- relevant domestic and international operating experience;
- relevant results of domestic and international ISFSI and dry storage system performance monitoring.

The applicant's tollgate process will continue on a routine 5-year basis throughout the period of extended operation to ensure that the AMPs continue to effectively manage the identified aging effects. The applicant stated that a written assessment of the aggregate impact of the information obtained from periodic tollgate assessments will be performed, including trends, corrective actions required, and the effectiveness of the associated AMPs.

To prepare the tollgate assessments effectively, the applicant stated that the licensees will have access to the industry's ISFSI AMID to facilitate the completion of these tollgate assessments. The applicant also stated that the implementation of these tollgates does not limit the licensees' ability to evaluate information in a timely fashion through their corrective action programs and other programs.

The staff reviewed the applicant's description of actions to ensure that the AMPs remain adequate during the period of extended operation upon review of new operating experience and research results. The staff considers that the implementation of periodic tollgate assessments and the use of ISFSI AMID, in addition to other periodic operating experience reviews consistent with the site quality assurance program, provide assurance the AMPs will remain adequate during the period of extended operation.

3.5.2 Evaluation Findings

The staff reviewed the AMPs provided in the renewal application for the FuelSolutions™ system. The staff performed its review following the guidance in NUREG-1927 and NUREG-2214. The staff evaluated the 10 elements of the proposed AMPs that address aging mechanisms and effects of potential aging that could adversely affect the ability of the SSCs and the associated subcomponents to perform their intended functions. For each program element, the staff either confirmed consistency with the example AMPs in NUREG-2214 or confirmed that the applicant's alternative approach is adequate to manage all credible aging effects. Based on its review, the staff finds:

F3.4 The applicant has identified programs that provide reasonable assurance that aging mechanisms and effects will be managed effectively during the period of extended operation, in accordance with 10 CFR 72.240(c)(3).

4 CHANGES TO CERTIFICATE OF COMPLIANCE AND TECHNICAL SPECIFICATIONS

This section provides a consolidated list of the changes to the CoC conditions and TS resulting from the review of the renewal application. Previous sections of this SER have described some of these changes. This section also describes the different amendments to which the changes apply, since some changes do not apply to all of the CoC amendments. The basis of the changes is provided for those changes that are not described elsewhere in this SER.

4.1 Changes to Certificate of Compliance

4.1.1 The NRC is updating the certificate holder name and address on the initial CoC (Amendment No. 0) and Amendments No. 1 through 4, as following:

Westinghouse Electric Company LLC
1000 Westinghouse Drive
Cranberry Township, PA 16066

4.1.2 The NRC is adding the following condition to the initial CoC (Amendment No. 0) and Amendments No. 1 through 4:

FSAR UPDATES FOR RENEWED CoC

The CoC holder shall submit updated FSARs to the Commission, in accordance with 10 CFR 72.4, within 90 days after the effective date of the CoC renewal. The updated FSARs shall reflect the changes and CoC holder commitments resulting from the review and approval of the CoC renewal. The CoC holder shall continue to update the FSARs pursuant to the requirements of 10 CFR 72.248.

The CoC holder has indicated that changes will be made to the updated FSARs to address aging management activities resulting from the renewal of the CoC. This condition ensures that the FSAR changes are made in a timely fashion to enable general licensees using the storage system during the period of extended operation to develop and implement necessary procedures.

4.1.3 The NRC is adding the following condition to the initial CoC (Amendment No. 0) and Amendments No. 1 through 4:

10 CFR 72.212 EVALUATIONS FOR RENEWED CoC USE DURING THE PERIOD OF EXTENDED OPERATION

Any general licensee that initiates spent fuel dry storage operations with the FuelSolutions™ Storage System after the effective date of the CoC renewal and any general licensee operating a FuelSolutions™ Storage System as of the effective date of the CoC renewal, including those that put additional storage systems into service after that date, shall:

a. As part of the evaluations required by 10 CFR 72.212(b)(5), include evaluations related to the terms, conditions, and specifications of this CoC amendment as modified (i.e., changed or added) as a result of the CoC renewal.

b. As part of the document review required by 10 CFR 72.212(b)(6), include a review of the FSAR changes resulting from the CoC renewal and the NRC Safety Evaluation Report related to the CoC renewal.

c. Ensure that the evaluations required by 10 CFR 72.212(b)(7) and determinations required by 10 CFR 72.212(b)(8) capture the evaluations and review described in (a.) and (b.) of this CoC condition.

d. Complete this condition prior to entering the period of extended operation or no later than 365 days after the effective date of the CoC renewal, whichever is later.

The staff considers it important to ensure that a general licensee's report prepared under 10 CFR 72.212, "Conditions of general license issued under § 72.210," evaluates the appropriate considerations for the period of extended operation. These considerations arise from the analyses and assumptions in the renewal application regarding operations during the period of extended operation. This includes potential use by general licensees that may use a new FuelSolutions™ Storage System after the CoC has been renewed, whether at a new or at an existing general-licensed ISFSI. The renewal of the CoC is based on assumptions and analyses regarding the dry storage system and the sites where it is used. Licensees considering the use of the FuelSolutions™ Storage System must evaluate it for use at their respective sites. This condition also makes it clear that to meet the requirements in 10 CFR 72.212(b)(11), general licensees that currently use a FuelSolutions™ Storage System will need to update their 10 CFR 72.212 reports, even if they do not put additional dry storage systems into service after the renewal's effective date.

4.1.4 The NRC is adding the following condition to the initial CoC (Amendment No. 0) and Amendments No. 1 through 4:

AMENDMENTS AND REVISIONS FOR RENEWED CoC

All future amendments and revisions to this CoC shall include evaluations of the impacts to aging management activities (i.e., time-limited aging analyses and aging management programs) to ensure they remain adequate for any changes to structures, systems, and components within the scope of renewal.

The CoC holder has indicated that future amendments will evaluate impacts to aging management program. The CoC may continue to be amended after it has been renewed. This condition ensures that future amendments to the CoC address the renewed design bases for the CoC, including aging management impacts that may arise from the changes to the system in proposed future amendments.

4.1.5 References to Regulations

The NRC is revising the initial CoC (Amendment No. 0) and Amendments No. 1 through 4 to address the language change in 10 CFR 72.210, “General license issued,” and other updates to the regulations. The NRC is updating the regulation citations referenced in the applicable CoCs to reflect citations currently in the regulations. The NRC is also modifying the authorization statements in the CoCs to refer to the general license issued under 10 CFR 72.210, rather than repeat the language currently in the 10 CFR 72.210 regulation regarding licensees under 10 CFR Part 50, “Domestic licensing of production and utilization facilities” and 10 CFR Part 52, “Licenses, certifications, and approvals for nuclear power plants.” These changes are not pertinent to the safety review conducted for the renewal application. The CoC authorization statements will be revised, as follows:

9. AUTHORIZATION

The FuelSolutions™ Storage System, which is authorized by this certificate, is hereby approved for use under the general license issued pursuant to 10 CFR 72.210, subject to the conditions specified by 10 CFR 72.212, this certificate, and the attached Appendices A, B, and C.

4.2 Changes to Technical Specifications

4.2.1 The NRC is updating the certificate holder’s information in all TS (i.e., TS for the FuelSolutions™ Storage System, W21 canister, and W74 canister) for the initial CoC (Amendment No. 0) and Amendments No. 1 through 4. References to “BNFL Fuel Solutions” or “BFS” are updated to “Westinghouse Electric Company LLC” or “WEC.”

The NRC also updated the name of the storage system from “Wesflex” to “FuelSolutions” in the TS for W21 canister to Amendment No. 3.

4.2.2 The NRC is adding the following section, “Aging Management Program,” to the initial CoC (Amendment No. 0) and Amendments No. 1 through 4 as section 5.3.9 in appendix A, FuelSolutions™ Storage System Technical Specifications:

Aging Management Program

Each general licensee shall have a program to establish, implement, and maintain written procedures for each applicable aging management program (AMP) described in the final safety analysis report (FSAR). The program shall include provisions for changing AMP elements, as necessary, and within the limitations of the approved licensing bases to address new information on aging effects based on inspection findings and/or industry operating experience provided to the general licensee during the renewal period. Each procedure shall contain a reference to the specific aspect of the AMP element implemented by that procedure, and that reference shall be maintained even if the procedure is modified.

The general licensee shall establish and implement these written procedures prior to entering the period of extended operation or no later than 365 days after the effective date of the renewal of the CoC, whichever is later. The general licensee shall maintain these written procedures for as long as the general licensee continues to operate FuelSolutions™ Storage Systems in service for longer than 20 years.

Each general licensee shall perform tollgate assessments as described in Appendix 9.A of the FuelSolutions™ Storage System FSAR WSNF-220.

This technical specification addition is similar to the current CoC conditions and technical specifications related to operating procedures for loading and operating dry storage systems under this CoC and extends the requirement for operating procedures to address AMP activities. This technical specification ensures that procedures address AMP activities required in the period of extended operation. The timeframe (1 year) in the condition is to ensure operating procedures are developed in a timely manner; this timeframe is consistent with the guidance in NUREG-1927. The tollgate assessments in the AMPs provide assurance that the results of those assessments will inform AMP procedures. The staff notes that the applicant proposed this technical specification, which the staff modified to state that procedures shall include AMP references and procedures should be maintained as long as the general licensee operates the FuelSolutions™ Storage System.

4.2.3 The NRC is adding the following section, “Aging Management Program,” to the initial CoC (Amendment No. 0) and Amendments No. 1 through 4 as section 5.3.9 in appendix B, FuelSolutions™ W21 Canister Technical Specifications, and in appendix C, FuelSolutions™ W74 Canister Technical Specifications.

Aging Management Program

See the Storage System Technical specification for the applicable information.

The CoC holder proposed a condition to revise or create programs or procedures for implementing the AMPs in the supplement to the final safety analysis report. This specification ensures that programs or procedures address AMP activities required for extended storage operations.

4.3 Corrections and Editorial Changes to Technical Specifications

4.3.1 The NRC made multiple changes to the TS for W21 to Amendment No. 3 as follows:

i. Add the definition of INTACT FUEL to section 1.1
ii. Add examples 1.3-2 and 1.3-3 to section 1.3.
iii. In tables 2.1-1 and 2.1-2, add “Maximum Weight per Assembly” and “Heat Load Limit per Assembly” and remove “≥ 3.1 years” from “Cooling Time.”
iv. Revise tables 2.1-3 and 2.1-4 by adding number of fuel rods, minimum clad outside diameter (OD) in inches, minimum clad thickness in inches, minimum pellet OD in inches, rod pitch size in inches, minimum bottom nozzle size in inches, and maximum active fuel length in inches. Update the associated notes to the tables.
v. Revise tables 2.1-5, 2.1-6, 2.1-7, and 2.1-8.
vi. Add sections 4.1.1.3, 4.1.2.3, and 4.3.
vii. Add two paragraphs to section 4.1.3.2.
viii. Add a paragraph to item 28 of table 4.1-1.
ix. Add sections 5.3 and 5.4.

The purpose of the above changes is to ensure that the TS for W21 to Amendment No. 3 is consistent with the previous version, i.e., TS for W21 for Amendment No. 0 (no change was made to TS of W21 for Amendments No. 1 and 2). These changes are also necessary to ensure the TS is accurate.

According to WEC (ML23296A135), no general licensees have purchased the FuelSolutions™ system under CoC No. 1026, Amendment No. 3. Therefore, these corrections to CoC No. 1026, Amendment No. 3, do no fall within the definition of backfitting under 10 CFR 72.62 or 10 CFR 50.109(a)(1). The NRC has determined that the backfit rule (10 CFR 72.62) does not apply to this direct final rule and a backfit analysis is not required.

4.3.2 Change “SAR” to “FSAR” in several places in section 5 of the TS for the FuelSolutions™ storage system to Amendments No. 0 through 4. This is to be consistent with the title of the documents.

4.3.3 Correct scientific and mathematic symbols throughout the TS for W21 canister to Amendment No. 4. Many scientific and mathematic symbols (e.g., ≤, ≥, μ, and °) appeared differently in the official document in ADAMS. The staff has verified that the situation was caused when the document was converted to the PDF file. Therefore, the staff is making the correction during the renewal.

4.3.4 Correct typos.

i. In TS for W74 canister to Amendments No. 2 and 3, LCO 3.3.3, condition C, correct the reference to “B.2.1.”
ii. In the TS for W21 canister to Amendment No. 4, LCO 3.3.2, required action B.2.1, correct the spelling for “cover.”

4.3.5 Correct item #30 in table 4.1-1 of the TS for W74 canister to Amendments 0 through 4. In Amendment No. 0, the quoted statement from ASME code is incomplete; while in Amendments No. 1 through 4, the same quoted statement is missing the last word. It appears that, in all instances, the missing texts were due to the formatting of the word processors used at the time and the author’s oversight. Since the missing texts are direct quote from ASME code, the staff considers this change a correction and editorial nature. Now the last part of item #30 in table 4.1-1 will read as follows:

“(b) A pneumatic test at a pressure not to exceed 25% of the Design Pressure may be applied, prior to either a hydrostatic or a pneumatic test, as a means of locating leaks.”

4.4 Changes to Issuance of Technical Specifications

4.4.1 The NRC is issuing the complete set of TS for each amendment when issuing the renewal.

For the initial CoC (Amendment No. 0), the NRC issued the complete set of TS as appendix A which includes TS for the FuelSolutions™ Storage System, W21 canister, and W74 canister.

For Amendments No. 1 and 2, the applicant did not make changes to the storage system and W21 canister, and the NRC only issued TS for the FuelSolutions™ W74 canister.

For Amendment No. 3, the applicant did not make changes to the storage system and W74 canister, and the NRC only issued TS for the FuelSolutions™ W21 canister.

For Amendment No. 4, the NRC issued the complete set of TS as appendix A which includes TS for the FuelSolutions™ Storage System, W21 canister, and W74 canister.

For clarity and consistency with other storage system CoCs, the NRC is issuing the complete set of TS (TS for FuelSolutions™ storage system, W21 canister, and W74 canister) for Amendments No. 0 through 4. In addition, the TS will be labeled as appendix A for FuelSolutions™ Storage System, appendix B for W21 canister, and appendix C for W74 canister.

5 CONCLUSIONS

Pursuant to 10 CFR 72.240(d), the design of a spent fuel storage cask will be renewed if: (1) the quality assurance requirements in 10 CFR Part 72, Subpart G, “Quality Assurance,” are met, (2) the requirements of 10 CFR 72.236(a) through (i) are met, and (3) the application includes a demonstration that the storage of spent fuel has not, in a significant manner, adversely affected SSCs important to safety. Additionally, 10 CFR 72.240(c) requires that the safety analysis report accompanying the application contain TLAAs and AMPs demonstrating that the DSS SSCs will continue to perform their intended functions for the requested period of extended operation.

The NRC staff reviewed the renewal application for the FuelSolutions™ Storage System, in accordance with 10 CFR Part 72. The staff followed the guidance in NUREG 1927, Revision 1. Based on its review of the renewal application and the CoC conditions, the staff determines that the DSS meets the requirements of 10 CFR 72.240.

6 REFERENCES

U.S. Code of Federal Regulations, “Domestic Licensing of Production and Utilization Facilities,” Part 50, Chapter I, Title 10, “Energy.”

U.S. Code of Federal Regulations, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” Part 52, Chapter I, Title 10, “Energy.”

U.S. Code of Federal Regulations, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste,” Part 72, Chapter I, Title 10, “Energy.”

ACI 2002. ACI 349.3R-02, “Evaluation of Existing Nuclear Safety Related Concrete Structures.” ACI Committee 349. 2002.

ASME 1995. Boiler and Pressure Vessel Code, Section III, Division 1, “Rules for Construction of Nuclear Power Plant Components,” Subsection NB, “Class 1 Components,” Subsection NC, “Class 2 Components,” and Subsection NG, “Core Support Structures.” New York, New York: American Society of Mechanical Engineers. 1995.

BNG 2006. “Notice of New Corporate Entity - BNG America LLC.” BNG America. February 17, 2006. ML060740212.

BNLF 2005. “Notice of Company Name Change.” BNFL Fuel Solutions Corporation. April 12, 2005. ML051090361.

ES LLC 2013. “Notification of Indirect Transfer of Control.” Energy*Solutions* Spent Fuel Division. January 18, 2013. ML13022A410.

EPRI 2014. “High Burnup Dry Storage Cask Research and Development Project: Final Test Plan.” Revision 0. Palo Alto, CA: Electric Power Research Institute. DOE Contract No. DE-NE-0000593. 2014.

General Plastics 2021. “Long-Term Aging of LAST-A-FOAM® FR-3700 Series.” Tacoma, WA: General Plastics Manufacturing Company. 2021. Retrieved from https://www.azom.com/article.aspx?ArticleID=20406

NEI 2015. “Format, Content and Implementation Guidance for Dry Cask Storage Operations Based Aging Management.” NEI 14-03, Revision 1. Washington, DC: Nuclear Energy Institute. ADAMS Accession No. ML15272A329. 2015.

NRC 2001. “Certificate of Compliance No. 1026, Amendment No. 0, for FuelSolutions™.” Effective date, February 15, 2001. ML010300176.

NRC 2003. ISG-11, “Cladding Considerations for the Transportation and Storage of Spent Fuel,” Revision 3, issued November 2003. ML033230335.

NRC 2016. NUREG-1927, "Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel." Revision 1. Washington, DC: U.S. Nuclear Regulatory Commission. June 2016. ML16179A148.

NRC 2019. NUREG-2214, "Managing Aging Processes in Storage (MAPS) Report," Final Report. Washington, DC: U.S. Nuclear Regulatory Commission. July 2019. ML19214A111.

NRC 2022. NRC. "Request for Additional Information for the Technical Review of the FuelSolutions™ Spent Fuel Management System—CoC 1026 Renewal Application." Washington, DC: U.S. Nuclear Regulatory Commission. May 6, 2022. ML22026A113.

WEC 2007a. "FuelSolutions™ Storage System Final Safety Analysis Report." WSNF-220, Revision 4. Westinghouse Electric Company. ML071510207.

WEC 2007b. "FuelSolutions™ W21 Canister Storage Final Safety Analysis Report." WSNF-221, Revision 5. Westinghouse Electric Company. ML071510213.

WEC 2007c. "FuelSolutions™ W74 Canister Storage Final Safety Analysis Report." WSNF-223, Revision 6. Westinghouse Electric Company. ML071510215.

WEC 2015a. "FuelSolutions™ Storage System Final Safety Analysis Report," Revision 5, Change Pages, WSNF-220, issued April 2015. ML15110A363.

WEC 2019. "Request for Transfer of Certificates of Compliance (CoC) for Dockets 71-9276, 72-1007 and 72-1026." Westinghouse Electric Company. September 13, 2019. ML19260C962.

WEC 2020. "Submittal of FuelSolutions™ Spent Fuel Management System Certificate of Compliance (CoC) Renewal Application," Westinghouse Electric Company. November 6, 2020. Package ML20315A012.

WEC 2021. "Reponses to Requests for Supplemental Information for the Application for the FuelSolutions™ Spent Fuel Management System Certificate of Compliance (CoC) Renewal Application," Westinghouse Electric Company. March 30, 2021. Package ML21090A201.

WEC 2022a. "Submittal of FuelSolutions™ Spent Fuel Management System Certificate of Compliance (CoC) Renewal Application," Westinghouse Electric Company. June 30, 2022. Package ML22186A053.

WEC 2022b. "Submittal of Supplemental Response to NRC RAI A-RCS1," Westinghouse Electric Company. September 13, 2022. Package ML22256A285.

WEC 2022c. "Request for Withdrawal from Review for Amendment 5 from CoC 72-1026 Renewal Application," Westinghouse Electric Company. June 27, 2022. ML22180A152.