FuelSolutions™ Spent Fuel Management System

Certificate of Compliance Renewal Application

Certificate of Compliance No. 1026 (Docket No. 72-1026)

Prepared by:

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Contents

GLOSSARY

Accident condition: The extreme level of an event or condition, which has a specified resistance, limit of response, and requirement for a given level of continuing capability, which exceeds off-normal events or conditions. Accident conditions include both design-basis accidents and conditions caused by natural and manmade phenomena.

Aging effect: The manifestation of an aging mechanism (e.g., cracking, loss of fracture toughness, loss of material).

Aging management activity (AMA): An application of either the aging management program (AMP) or time-limited aging analyses (TLAAs) to provide reasonable assurance that the intended functions of structures, systems, and components (SSCs) of independent spent fuel storage installations (ISFSIs) and dry storage systems (DSSs) are maintained during the period of extended operation.

Aging management program (AMP): A program for addressing aging effects that may include prevention, mitigation, condition monitoring, and performance monitoring. (See Title 10 of the *Code of Federal Regulations* (10 CFR) 72.3, "Definitions.")

Aging management review (AMR): An assessment conducted by the licensee or certificate of compliance (CoC) holder that addresses aging mechanisms and effects that could adversely affect the ability of SSCs from performing their intended functions during the period of extended operation.

Aging mechanism: The degradation process for a given material and environment which results in an aging effect (e.g., freeze-thaw degradation, neutron irradiation, erosion).

Amendment of a license or CoC: An application for amendment of a license or a CoC must be submitted whenever a holder of a specific license or CoC desires to amend the license or CoC (including a change to the license or CoC conditions). The application must fully describe the changes desired and the reasons for such changes and following as far as applicable, the form prescribed for original applications. See 10 CFR 72.56, "Application for Amendment of License," and 10 CFR 72.244, "Application for Amendment of a Certificate of Compliance."

Baseline inspection: The first inspection of an AMP to assess the condition of SSCs to either: (1) confirm that the results of pre-application inspections conducted at other sites are bounding of the subject site, or (2) verify the adequacy of the AMPs and the conclusions of the TLAAs when pre-application inspections were not performed.

Burnup: The measure of thermal power produced in a specific amount of nuclear fuel through fission, usually expressed in GWd/MTU (gigawatt days per metric ton uranium).

Canister (in a dry storage system for SNF): A metal cylinder that is sealed at both ends and may be used to perform the function of confinement. Typically, a separate storage cask performs the radiological shielding and physical protection function.

Certificate of compliance (CoC) (for a dry storage system for SNF): The certificate issued by the NRC that approves the design of a spent fuel storage cask in accordance with the provisions of 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 L, "Approval of Spent Fuel Storage Casks." (See 10 CFR 72.3.)

Certificate of compliance holder (CoC holder): A person who has been issued a CoC by the U.S. Nuclear Regulatory Commission (NRC) for a spent fuel storage cask design under 10 CFR Part 72. (See 10 CFR 72.3.)

Certificate of compliance user (CoC user): The general licensee that has loaded, or plans to load, a dry storage system (DSS) in accordance with a CoC issued under 10 CFR Part 72.

Confinement (in a dry storage system for spent nuclear fuel): The ability to limit or prevent the release of radioactive substances into the environment.

Confinement systems: Those systems, including ventilation, that act as barriers between areas containing radioactive substances and the environment. (See 10 CFR 72.3.)

Criticality: The condition wherein a system or medium is capable of sustaining a nuclear chain reaction.

Damaged fuel can: A metal enclosure that is sized to confine one damaged spent fuel assembly. A fuel can for damaged spent fuel with damaged spent-fuel assembly contents must satisfy fuel-specific and system-related functions for undamaged spent nuclear fuel (SNF) required by the applicable regulations.

Degradation: Any change in the properties of a material that adversely affects the performance of that material; adverse alteration.

Design bases:[4] Information that identifies the specific function(s) to be performed by SSCs (both important-to-safety and not important-to-safety) of a facility or of a spent fuel storage cask and the specific values or ranges of values chosen for controlling parameters as reference bounds for design. These values may be (1) restraints, derived from generally accepted "state-of-the-art" practices for achieving functional goals, or (2) requirements, derived from analysis (based on calculation, experiments, or both) of the effects of a postulated event under which SSCs must meet their functional goals. (See 10 CFR 72.3.)

Dry storage: The storage of spent nuclear fuel in a DSS, which typically involves drying the DSS canister and backfilling with an inert gas.

Dry storage system (DSS): A system that typically uses a canister in a storage cask as a component in which to store spent nuclear fuel in a dry environment. A DSS provides confinement, radiological shielding, sub-criticality control, structural support, and passive cooling of its spent nuclear fuel during normal, off-normal, and accident conditions.

General license: Authorizes the storage of spent fuel in an ISFSI at power reactor sites to persons (i.e., general licensee) authorized to possess or operate nuclear power reactors under 10 CFR Part 50 ("Domestic Licensing of Production and Utilization Facilities") or Part 52 ("Licenses, Certifications, and Approvals for Nuclear Power Plants"). The general license is limited to (1) that spent fuel which the general licensee is authorized to possess at the site under the specific Part 50 or Part 52 license for the site, and (2) storage of spent fuel in casks approved under the provisions of 10 CFR Part 72, Subpart L. See 10 CFR 72.210 ("General License Issued") and 72.212(a)(1)-(2).

High burnup (HBU) fuel: Spent nuclear fuel with burnups generally exceeding 45 GWd/MTU.

Important to safety (ITS): See structures, systems, and components (SSCs) important to safety.

Independent spent fuel storage installation (ISFSI): A complex designed and constructed for the interim storage of spent nuclear fuel, solid reactor-related greater-than-Class-C (GTCC) waste, and other radioactive materials associated with spent fuel and reactor-related GTCC waste storage. (See 10 CFR 72.3.)

Inspection: The examination of an SSC, using a nondestructive testing technique, to determine its current condition and if there is any damage, defect, or degradation that could have an adverse effect on the function of that SSC.

Intended function: A design-bases function defined as either (1) important to safety or (2) failure of which could impact a safety function.

Interim staff guidance (ISG): Supplemental information that clarifies important aspects of regulatory requirements. An ISG provides review guidance to NRC staff in a timely manner until standard review plans are revised accordingly.

Monitoring: Data collection (from activities performed in either the initial storage period or the period of extended operation) to determine the status of a DSS, ISFSI, or both, and to verify the continued efficacy of the system, on the basis of measurements of specified parameters, including temperature, direct radiation, radioactive effluents, functionality, and characteristics of components of the system. Monitoring could thus be described as those activities that periodically or continuously monitor performance as an indirect indicator of degradation (e.g., monitoring groundwater chemistry) or monitor the effectiveness of preventive measures. With respect to direct radiation and radioactive effluents, according to 10 CFR 20.1003, “Definitions,” monitoring means the measurement of radiation levels, concentrations, surface area concentrations or quantities of radioactive material, and the use of the results of these measurements to evaluate potential exposures and doses.

Normal events or conditions: The maximum level of an event or condition expected to routinely occur. Events and conditions that exceed the levels associated with “normal” are considered to be, and to have the response allowed for, “off-normal” or “accident-level” events and conditions.

Not Important to Safety (NITS): An item, function or condition related to the ISFSI, or its activities, that does not meet the definition of “Important to Safety.”

Off-normal events or conditions: The maximum level of an event or condition that, although not occurring regularly, can be expected to occur with moderate frequency (once per calendar year) and for which there is a corresponding maximum specified resistance, specified limit of response, or requirement for a specified level of continuing capability. Off-normal is considered to include “anticipated occurrences” as used in 10 CFR Part 72.

Pre-application inspection: An inspection performed at the discretion of the licensee or CoC holder before submittal of the renewal application to provide operating experience to support the aging management review, proposed AMP activities, or evaluation of TLAAs.

Radiation shielding: ISFSI and DSS SSCs that are designed so that dry storage operations at an ISFSI meet the requirements of 10 CFR 72.126(a)(6) and 10 CFR 72.128(a)(2) and the requirements of 10 CFR 72.104(a) and 10 CFR 72.106(b), when both direct radiation and radioactive effluents are considered.

Renewal of a license or CoC: A certificate holder may apply for renewal of the design of a spent fuel storage cask for a term not to exceed 40 years. In the event that the certificate holder does not apply for a cask design renewal, any licensee using a spent fuel storage cask, a representative of the licensee, or another certificate holder may apply for a renewal of that cask design for a term not to exceed 40 years. See 10 CFR 72.240, "Conditions for Spent Fuel Storage Cask Renewal." Specific licenses may be renewed by the Commission at the expiration of the license term upon application by the licensee for a period not to exceed 40 years. (See 10 CFR 72.42, "Duration of License; Renewal.")

Retrievability: Storage systems must be designed to allow ready retrieval of spent fuel, high-level radioactive waste, and reactor related GTCC waste for further processing or disposal. See 10 CFR 72.122(l). ISG-2 and NUREG-2215 provide guidance on the fuel retrievability, including ready retrieval.

Safety analysis report (SAR): The document that a CoC holder, specific licensee, an applicant for a CoC, or an applicant for a specific license supplies to the NRC for evaluation. For specific-license renewals, the SAR must contain information required in 10 CFR 72.24, "Contents of Application; Technical Information." For CoC renewals, the SAR must meet the requirements of 10 CFR 72.240(b). The SAR provides references and drawings of the DSS, ISFSI, or both; details of construction; materials; and standards to which the SSC has been designed or fabricated. For clarification, SAR is a general term; while FSAR indicates the document that is submitted within 90 days after the issuance of the license or CoC that is based on the SAR in the license or CoC application and reflects any changes or applicant commitments developed during the license or CoC approval and/or hearing process. Both FSAR and updated final safety analysis report (UFSAR) are terms that are used to indicate the FSAR update that is required every 2 years. A specific licensee or CoC holder shall update the FSAR in accordance with 10 CFR 72.70 ("Safety Analysis Report Updating") or 10 CFR 72.248, ("Safety Analysis Report Updating") respectively.

Safety evaluation report (SER): The document that the NRC publishes at the completion of a licensing or certification review. The SER contains all of the NRC staff findings and conclusions from the licensing or certification review.

Safety function: A function defined as ITS. The ITS functions that structures, systems, and components are designed to maintain include:

- structural integrity
- content temperature control (i.e., heat-removal capability)
- radiation shielding
- confinement
- sub-criticality control
- retrievability

Service conditions: Conditions (e.g., time of service, temperatures, environmental conditions, radiation, and loading) that a component experiences during storage.

Specific license: A license for the receipt, handling, storage, and transfer of spent fuel, high-level radioactive waste, or reactor-related GTCC waste that is issued to a named person (i.e., specific licensee) on an application filed under regulations in 10 CFR Part 72, Subpart B, "License Application, Form, and Contents."

Spent fuel storage cask system: All the components and systems associated with the container in which spent fuel, or other radioactive materials associated with spent fuel, is stored at an ISFSI. (See 10 CFR 72.3.)

Spent nuclear fuel or spent fuel: Nuclear fuel that has been withdrawn from a nuclear reactor after irradiation, has undergone at least a 1-year decay process since being used as a source of energy in a power reactor, and has not been chemically separated into its constituent elements by reprocessing. Spent fuel includes the special nuclear material, byproduct material, source material, and other radioactive materials associated with fuel assemblies. (See 10 CFR 72.3.)

Storage cask: A heavy-walled concrete, metal, or combined concrete and metal structure designed to store spent fuel canisters at an ISFSI. The storage cask provides physical protection of canisters and radiological shielding, while allowing passive cooling.

Structures, systems, and components (SSCs) important to safety: (See 10 CFR 72.3.) Those features of the ISFSI and spent fuel storage cask whose functions are at least one of the following:

- to maintain the conditions required to safely store spent fuel, high-level radioactive waste, or reactor-related GTCC waste
- to prevent damage to the spent fuel, the high-level radioactive waste, or reactor-related GTCC waste container during handling and storage
- to provide reasonable assurance that spent fuel, high-level radioactive waste, or reactor-related GTCC waste can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public

Time-limited aging analysis (TLAA): (See 10 CFR 72.3.) A licensee or CoC holder calculation or analysis that has all of the following attributes:

- involves SSCs important to safety within the scope of license or CoC renewal
- considers the effects of aging
- involves time-limited assumptions defined by the current operating term, for example, 40 years
- was determined to be relevant by the licensee or CoC holder in making a safety determination
- involves conclusions or provides the basis for conclusions related to the capability of the SSCs to perform their intended safety functions
- is contained or incorporated by reference in the design bases

Transfer cask: A shielded SSC used to transfer the fuel canister between the spent fuel handling area and the storage cask.

1. GENERAL INFORMATION

Introduction

The FuelSolutions™ Storage System Certificate of Compliance (CoC) No. 1026, Revision 0 [1.1] was approved by the U.S. Nuclear Regulatory Commission (NRC) pursuant to 10 CFR Part 72 for a term of 20 years effective February 15, 2001, for storage of spent nuclear fuel (SNF) by general licensees. The expiration date for CoC 1026 is February 15, 2021. As the certificate holder of CoC 1026, Westinghouse Electric Company, LLC. is applying for the renewal of CoC 1026 for a term of 40 years in accordance with the 10 CFR 72.240(a) [1.2].

This application for CoC 1026 renewal includes the Final Safety Analysis Report (FSAR) information required by 10 CFR 72.240(c). The FSAR content of this application is based on the guidance provided in NUREG-1927 [1.3] and covers the Model Number W150 storage cask; the W100 transfer cask; and the W21 and W74 canisters.

In accordance with NUREG-1927, this renewal application is based "on the continuation of the approved design basis throughout the period of extended operation." The identification and management of potential aging degradation mechanisms for different material/environment combinations was based on the guidance of NUREG-2214 [1.4] in support of this renewal application.

1.1 FuelSolutions Storage System Summary Description

This section provides a summary description of the FuelSolutions Storage System. A more complete description of the FuelSolutions Storage System structures, systems and components (SSC) is contained in Section 2.2.2 of this renewal application. A complete description of the FuelSolutions Storage System is contained in the FuelSolutions Storage System FSARs [2.3, 2.4, and 2.5] referenced in Chapter 2 of this renewal application.

1.1.1 General System Description

The FuelSolutions Storage System is a canister-based dry cask spent fuel storage system that is comprised of three principal components; the W21 canister for storage of PWR spent fuel assemblies, the W74 canister for storage of BWR spent fuel assemblies, and 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 SNF loading, handling, and monitoring operations, and to provide for radiological protection, criticality control, and maintenance of structural and thermal safety margins.

1.1.2 Principal Components of the FuelSolutions Storage System

1.1.2.1 FuelSolutions W21 and W74 Canisters

The FuelSolutions W21 and W74 canisters are designed for storage in the FuelSolutions W150 Storage Cask, on-site transfer and loading in the FuelSolutions W100 Transfer Cask. The W21 canister can store up to 21 PWR spent fuel assemblies and the W74 canister can store up to 64 BWR spent fuel assemblies. The major components of these canisters are a basket assembly and a shell assembly. The shell assembly is designed as the confinement boundary for on-site transfer and storage conditions. The basket assembly is sealed inside the canister shell assembly and maintains the position of the SNF assemblies and neutron absorbing materials, thus providing criticality control.

1.1.2.2 FuelSolutionsW150 Storage Cask

The FuelSolutionsW150 Storage Cask consists of a modular reinforced concrete structure with three cylindrical segments, and a concrete and steel cover at the top end. Incorporated within the cavity of the storage cask are a thick carbon steel liner, an aluminum thermal shield, carbon steel guide rails to center the canister, and carbon steel support rails with a high strength chromium-manganese-nickel austenitic stainless steel (Nitronic 60) facing to provide bearing surfaces during canister transfer operations. The W150 storage cask contains vent openings at the base and near the top. The vent openings allow air flow via natural convection to dissipate the decay heat generated by the canister. Eight high-strength steel, full length tie rods are used to secure the concrete precast segments of the storage cask together. The canister is supported vertically off the bottom of the storage cask cavity by radially arranged, austenitic stainless steel structural pipe sections. The support pipes elevate the base of the canister above the bottom of the storage cask inner cavity and facilitate air flow.

1.1.2.3 FuelSolutionsW100 Transfer Cask

The FuelSolutionsW100 Transfer Cask consists of an austenitic stainless steel inner liner and outer structural shell, with lead gamma shielding in the annular space between them. A neutron shield, consisting of an outer austenitic stainless steel jacket forming an annular cavity that is filled with clean, demineralized water, surrounds the structural shell. With the exception of the exterior surface of the neutron shield jacket, all exposed surfaces of the transfer cask (including the top and bottom covers) are austenitic stainless steel to facilitate radiological decontamination. The exterior of the neutron shield jacket has a white epoxy coating to increase its thermal transfer characteristics and to decrease the absorptivity of direct sunlight. This epoxy coating has good continuous service temperature resistance (350°F) and excellent decontamination characteristics. High strength chromium-manganese-nickel austenitic stainless steel (Nitronic 60) rails are welded to the inner liner cavity to facilitate horizontal transfer.

The ends of the transfer cask body include austenitic stainless steel forged flanges that are welded to the structural shell and inner liner. The covers at each end of the cask are bolted to the flanges, providing access to the transfer cask cavity from either end. The bottom cover consists of a thick austenitic stainless steel plate and solid neutron shielding encased in a shell. The top cover is similar to the bottom cover, except that it includes a two-piece design with a primary top cover assembly and a central ram access cover assembly which is attached to the top cover with bolts.

Two high-strength austenitic stainless steel trunnions are provided near the top end of the transfer cask and are separated by 180° for vertical cask handling operations. Two high-strength austenitic stainless steel trunnions near the bottom end of the transfer cask, separated by 180°, are provided for cask upending/downending operations onto the transfer skid and transfer cask trailer. The bearing surfaces of the trunnion shoulders are covered by austenitic stainless steel sleeves.

1.1.2.4 Other Site-Specific Structures, Systems and Components (SSCs)

Other site-specific SSCs related to the FuelSolutions Storage System are described and evaluated in Section 2.2.2 of this renewal application. These other site-specific SSCs include:

- Spent Fuel Assemblies
- Fuel Transfer and Auxiliary Equipment
- ISFSI Storage Pad
- ISFSI Security Equipment

1.2 FuelSolutions Storage System CoC 1026 Amendments

Table 1-1 lists each of the approved FuelSolutions Storage System CoC 1026 amendments. The table provides a description of the scope of the amendment, its approval time, identification of the FSAR which provides the licensing basis, and a pointer to where the AMPs for different amendments are located in this application. Note, that because the FSAR is updated for each amendment, the latest FSAR contains the full licensing basis for all previous amendments.

Table 1-1 FuelSolutions Storage System CoC 1026 Amendments

Amend No.	Description of Changes	Effective Date	FSAR(s) Revision(s)
0	Initial Issue	02/15/01	WSNF-220R0 WSNF-221R0 WSNF-223R0
1	Revised the W74 Technical Specifications to: (1) allow the storage of W74 spent fuel assemblies having MOX fuel rods, (2) allow storage of partial W74 fuel assemblies, and (3) allow storage of damaged W74 fuel assemblies.	05/14/01	WSNF-223R1
2	Revised the W74 Technical Specifications to: (1) provide an alternative to returning the W74 canister to the spent fuel building to resolve canister issues, (2) clarify the terminology for fuel to be stored in the W74 canister, and (3) revise the thermocouples called out for consistency with the Safety Analysis Report.	01/28/02	WSNF-223R2
3	Revised the W21 Technical Specifications to: (1) provide an alternative to returning the W21 canister to the spent fuel building to resolve canister issues, and, (2) make several minor editorial corrections to Technical Specification language.	05/07/03	WSNF-221R2
4	Revised the W21, W74 and W150 Technical Specifications to: (1) change the Technical Specifications requirements related to periodic monitoring during storage operations by allowing longer surveillance intervals for casks with total heat loads lower than the design-basis heat load and permitting either visual inspection of the cask vent screens or measurement of the cask liner temperature to satisfy the periodic monitoring requirement of 10 CFR 72.122(h)(4), and (2) make editorial changes to the FuelSolutions Final Safety Analysis Reports associated with the company name change.	07/03/06	WSNF-220R3 WSNF-221R4 WSNF-223R5

1.3 References

[1.1] NRC letter dated January 29, 2001 from E. William Brach, Director to Robert D. Quinn, Operations Manager, BNFL Fuel Solutions, Subject: “Certificate Of Compliance For The FuelSolutions™ Spent Fuel Management System” - ML010300164.

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

[1.3] U.S. Nuclear Regulatory Commission, NUREG-1927, “Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel,” Revision 1, June 2016.

[1.4] U.S. Nuclear Regulatory Commission, NUREG-2214, “Managing Aging Processes in Storage (MAPS) Report,” July 2019.

2. SCOPING EVALUATION

Introduction

The scoping evaluation identifies those Structures, Systems and Components (SSC) of the FuelSolutions Storage System that are within the scope of the Certificate of Compliance (CoC) 1026 renewal and require further evaluation for potential aging effects. The process and methodology used for the scoping evaluation is described in Section 2.1. The scoping evaluation results are summarized in Section 2.2.

2.1 Scoping Evaluation Process

The scoping evaluation of the FuelSolutions Storage System is based on the process described in NUREG-1927 [2.1]. The process determines which SSCs (and associated subcomponents) are within the scope of the renewal. SSCs are considered within the scope of the renewal if they satisfy either of the following criteria:

(1) They are classified as Important-To-Safety (ITS), as they are relied on to do one of the following safety functions:

i. Maintain the conditions required by the regulations or CoC to store spent fuel safely,

ii. Prevent damage to the spent fuel during handling and storage, or

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

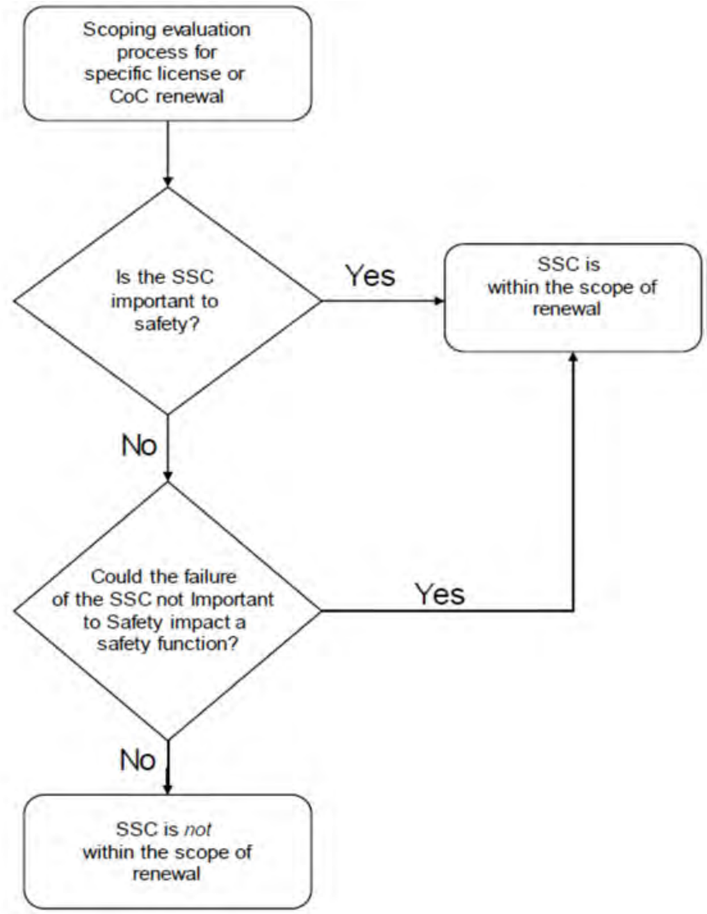
These SSCs ensure that important safety functions are met for (1) confinement, (2) radiation shielding, (3) sub-criticality control, (4) heat-removal capability, (5) structural integrity, and (6) retrievability.

(2) They are classified as Not-Important-To-Safety (NITS), but, according to the design basis, its failure could prevent fulfillment of a function that is ITS.

The FuelSolutions Storage System is designed to allow ready retrieval of the FuelSolutions W21 and W74 canisters in accordance with 10 CFR 72.122(l) and satisfy the requirements of 10 CFR 72.236(m). The FuelSolutions W21 and W74 canisters are designed for removal of individual or canned spent fuel assemblies and for canister removal from a storage cask for placement into a transfer cask and subsequent transport off-site in the appropriate transportation cask, thus meeting the retrievability requirements of 10 CFR 72.122(l) and 10 CFR 72.236(m). Retrievability functions are further discussed in Section 3.6 “Other Analyses - Retrievability.”

The following figure provides a flowchart of the Scoping Evaluation Process utilized.

Figure 2-1 Scoping Evaluation Process



NOTE: Figure shown is Figure 2-1 from NUREG-1927 "Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel" [2.1]

The documentation of the scoping evaluation process includes the following:

- A description of the scoping process and method for the inclusion or exclusion of SSCs (and associated subcomponents) from the renewal scope
- A list of the SSCs (and associated subcomponents) that are identified as within the scope of renewal, their intended safety function(s), and safety classification or basis for inclusion in the renewal scope
- A list of the SSCs (and associated subcomponents) that are identified as not within the scope of renewal and basis for exclusion
- A list of the sources of information used
- Identification of the drawings or documents used to clarify the process, the SSC intended functions and the safety classifications

Referenced sources used to support the scoping evaluation process include the following:

- FuelSolutions safety analysis reports (SARs)

- CoC 1026 and CoC 1026 amendments
- CoC 1026 technical specifications
- NRC Safety Evaluation Reports (SERs) for CoC 1026 and for CoC amendments
- FuelSolutions Storage System design-bases documents (e.g., calculations, specifications, design change documents)
- FuelSolutions Storage System drawings
- 10 CFR 72.48 (“Changes, Tests, and Experiments”) evaluations and screenings
- FuelSolutions Storage System vendor information
- Applicable NRC guidance

The FuelSolutions canisters, transfer cask, and storage cask are classified as ITS. Individual components, assemblies, and piece parts were designed, fabricated, and tested to the quality standards commensurate with the item’s graded quality category. The quality categories for the FuelSolutions components are based on NUREG/CR-6407, “Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety,” [2.14] as referenced in the associated SAR. The scoping evaluation ensured that SSCs identified in the design-bases documents were properly differentiated as being either within or not within the scope of the renewal. The identification of SSCs and SSC subcomponents in the scoping evaluation are applied consistently throughout the renewal application.

The SSCs within the scope of renewal are screened to identify and describe the subcomponents with intended functions. SSC subcomponents may degrade by different modes or have different criteria for evaluation from the overall component (i.e., different materials or environments).

The scoping evaluation process (1) defines the intended function of each SSC subcomponent and (2) differentiates SSC subcomponents per scoping criteria (1) and (2), as defined above. This information is tabulated and described in the scoping evaluation in a comprehensive and accurate manner (i.e., SSC subcomponents are not missing from the scoping evaluation; SSC subcomponent naming is consistent with the design bases; intended functions are properly described) by comparing the results of the scoping evaluation to appropriate SAR drawings or tables.

In accordance with NUREG-1927, the FuelSolutions Storage System CoC renewal is based on the continuation of the existing FuelSolutions Current Licensing Basis (CLB) and the intended safety functions of the SSC ITS throughout the period of extended operation and maintenance. As listed above, the sources of information reviewed in the scoping evaluation process that describe the CLB and the intended safety functions of the SSC ITS include the FuelSolutions Storage System FSARs, CoC 1026, technical specifications, and NRC SERs.

2.2 Scoping Evaluation Discussion and Results

Section 2.2 discusses the FuelSolutions Storage System CoC renewal scoping evaluation and results. Table 2-1 summarizes the results of the scoping evaluation, listing the SSC that are identified within the scope of renewal and the two safety function criteria discussed in Section 2.1 upon which they are determined to be within the scope of renewal. The subcomponents of the in-scope SSC and their intended safety functions are further identified in Tables 24 through 28.

Table 2-1
Summary of Scoping Evaluation Results

Structures, Systems and Components	Criterion 1 Performs ITS Safety Function(s)	Criterion 2 NITS But Failure Prevents ITS Function(s)	In-Scope
SNF Assemblies	Yes	N/A	Yes
W21 Canister W74 Canister	Yes	N/A	Yes
W150 Storage Cask	Yes	N/A	Yes
W100 Transfer Cask	Yes	N/A	Yes
Fuel Transfer and Auxiliary Equipment (ITS and Safety Related per FSAR Table 2.1-1 [2.3])	Yes	N/A	Yes
Fuel Transfer and Auxiliary Equipment (NITS per FSAR Table 2.1-1 [2.3])	No	No	No
ISFSI Storage Pad	No	No	No
ISFSI Security Equipment	No	No	No

2.2.1 FuelSolutions Storage System Components and Drawings

The three FSARs [2.3], [2.4] and [2.5] for the FuelSolutions Storage System identify and apply to the following components and equipment:

- FSAR WSNF-220
  - W150 Storage Cask (W150)
  - W100 Transfer Cask (W100)
  - Fuel Transfer and Auxiliary Equipment (e.g., vertical trailer, transfer trailer, upender / downender, J-skid, hydraulic ram assembly, storage cask impact limiter, lift yoke, vacuum drying system, helium leak detector, welding equipment)
  - ISFSI Storage Pad
  - ISFSI Security Equipment
- FSAR WSNF-221
  - W21 Canister (W21)
- FSAR WSNF-223
  - W74 Canister (W74)

General arrangement drawings of the FuelSolutions Storage System components and equipment are provided in the FSARs that correspond with the initial CoC and all approved CoC amendments. A listing of the general arrangement drawings included in each FSAR and FSAR revision associated with the initial CoC and all subsequent CoC amendments is provided in Tables 2-9, 2-10 and 2-11 below. Descriptions of the SSCs are provided in Section 2.2.2.

2.2.2 Description of SSC

The FuelSolutions Storage System is a canister-based dry cask spent fuel storage system that is comprised of three principal components; the W21 canister for storage and transportation of PWR spent fuel assemblies, the W74 canister for storage and transportation of BWR spent fuel assemblies, and the W150 storage cask. In addition, the system includes the W100 transfer cask that is used for canister loading/unloading operations at the ISFSI storage pad. Tables 2-4a and 4b, 2-5 and 2-6 below provide detailed listings of the W74, W21, W150, and W100 component parts and materials. Other site-specific system components include the W100 lifting yoke, on-site transfer equipment, canister closure equipment, and the ISFSI storage pad. Additional descriptions of these components are provided in Chapter 1 of the three FuelSolutions FSARs [2.3, 2.4 and 2.5] and in the following sections.

2.2.2.1 Spent Fuel Assemblies

FuelSolutions Storage System canisters are designed to safely accommodate up to twenty-one (21) intact[1], unconsolidated, zircaloy clad Pressurized Water Reactor (PWR) SNF assemblies in a FuelSolutions W21 canister or up to 64 intact Boiling Water Reactor (BWR) spent fuel assemblies in a FuelSolutions W74 canister. The intended safety functions of the SNF assembly subcomponents are identified in Table 2-12.

A wide range of PWR SNF assembly types can be accommodated by the FuelSolutions Storage System, although as of this renewal application for CoC 1026, no PWR fuel assemblies have been loaded. The fuel types allowed by the CoC include B&W 15x15 Mark B, B&W 17x17 Mark C, CE/Exxon 14x14, CE 16x16 (including System 80), Westinghouse PWR 14x14, Westinghouse PWR 15x15, and Westinghouse PWR 17x17. Exceptions to commercial PWR SNF assemblies allowed for storage are noted in Section 2.2 of the FuelSolutions W21 Canister FSAR [2.4].

PWR fuel assemblies may be stored either with or without control components. Fuel assembly classes accommodated by the FuelSolutions W21 canister, and the corresponding FuelSolutions W21 canister class and type designated for use with each fuel assembly class, are addressed in FuelSolutions W21 Canister FSAR [2.4] Section 1.2.1.3. The specific fuel assembly types and associated characteristics acceptable for storage in the FuelSolutions W21 canister are addressed Section 2.1.1 of the FuelSolutions W21 Technical Specifications [2.12] Table 2.1-1 and Table 2.1-2, and further defined in Technical Specification Tables 2.1-5 through 8. SNF assemblies stored in FuelSolutions W21 canisters must be intact zircaloy-clad fuel with no known or suspected cladding defects greater than pinhole leaks or hairline cracks. For SNF assemblies with burnup exceeding 45 GWd/MTU (up to 60 GWd/MTU), cladding oxide thickness is limited to 70 μm.

In all cases, the FuelSolutions W21 canister maximum heat load is limited to 1.05 kW per SNF assembly (i.e. 22 kW per canister), the post-irradiation time is limited as defined in W21 Technical Specification Tables 2.1-5 through 8 and the maximum initial enrichment is limited to 5.0 wt% ^{235}U. The maximum assembly average burnup level is limited to ≤60,000 MWd/MTU for the associated initial enrichments noted.

FuelSolutions W74 canisters utilize a conservative design that does not require either burnup credit or moderator exclusion and are designed to accommodate up to 64 Big Rock Point (BRP) zircaloy-clad BWR fuel assemblies without the need for fuel assembly spacers and without flow channels. The W74 canisters utilize upper and lower basket assemblies, each containing 32 SNF assemblies, stack on top of each other. The ten (10) center cell locations in the FuelSolutions W74 canister are mechanically blocked to prevent fuel assembly loading and are not used. The FuelSolutions W74 canisters can accommodate UO2 Fuel Assemblies or BRP MOX, partial, and damaged fuel assemblies.

FuelSolutions W74 Canister FSAR [2.5] Table 2.2-1 lists the specific fuel assembly types and associated characteristics acceptable for storage in the FuelSolutions W74 canister. Detailed fuel

[1] Fuel with no known or suspected gross cladding failures.

assembly characteristics for the authorized contents are given in Table 2.1-1 and Table 2.1-2 of the FuelSolutions W74 Technical Specifications [2.13].

The FuelSolutions W74 canister maximum heat load is limited to 24.8 kW per canister. Spent fuel assemblies for storage in W74 canisters must meet the limits specified in Technical Specification Tables 2.1-1 through 2.1-6. The maximum array average initial enrichment for UO2 Fuel Assemblies Acceptable for Storage in the FuelSolutions W74 Canisters is detailed in Technical Specification Table 2.1-7. Mixed-Oxide (MOX) fuel assemblies acceptable for storage in the FuelSolutions W74 canister are detailed in Technical Specification Table 2.1-8. The post-irradiation times are defined in FuelSolutions W74 Technical Specifications Table 2.1-9 and Table 2.1-10 with maximum assembly average burnup level limited to 40,000 MWd/MTU for the associated enrichments and parameters noted.

2.2.2.2 W21 Canister

The W21 canister is described in Section 1.2.1.3 of the FuelSolutions W21 Canister FSAR [2.4]. The W21 canister is the confinement system for storing up to 21 PWR spent fuel assemblies. The W21 canister performs confinement, sub-criticality control, heat-removal and radiation shielding safety functions. The W21 canister consists of a shell assembly, top and bottom inner closure plates, vent and drain port covers, internal basket assembly, top and bottom shield plugs, and top and bottom outer closure plates. All structural components are constructed of high strength carbon (electroless nickel coated) or stainless steel. The W21 canister shell, top and bottom inner closure plates, and the vent and drain port tops, port covers and the associated welds form the confinement boundary. The W21 fuel basket is a right circular cylinder configuration with 21 stainless steel guide tubes for the PWR SNF contents. The guide tubes are laterally supported by a series of spacer plates held in position by support rods that run through sleeves between the spacer plates. The guide tubes include neutron poison sheets (Boral) on all four sides.

The FuelSolutions W21 canister subsystem includes two different classes of FuelSolutions canister assemblies. The two classes are as follows:

- The FuelSolutions W21M class Multi-Purpose Canister (MPC) for storage, transportation, and disposal.
- The FuelSolutions W21T class Transportable Storage Canister (TSC) for storage and transportation.

The two W21 canister classes, W21M and W21T, differ in materials of construction used for the canister shell and basket assembly. Each class of canister has four different types differing in lengths and materials for the canister end plugs. The W21M canister include long, depleted uranium (LD); long steel (LS); short, depleted uranium (SD), and short steel (SS) designs. The W21T canister class consists of a long lead (LL), long steel (LS), short lead (SL), and short steel (SS) canister.

The pressure-retaining components of the W21 canister shell assembly, i.e., the components forming the confinement boundary for storage, are designed and fabricated as an ASME Section III, Class 1 pressure vessel in accordance with the applicable requirements of Subsection NB

[2.7], as discussed in Section 2.1.2 of the W21 Canister FSAR [2.4]. These pressure-retaining components include the canister shell, the top and bottom closure plates, the ports, and the associated welds. The non-pressure-retaining components of the W21 canister shell assembly are designed and fabricated as an ASME Section III, Class 1 component support in accordance with the applicable requirements of Subsection NF [2.7], as discussed in Section 2.1.2 of the W21 Canister FSAR [2.4]. These non-pressure-retaining components include the top and bottom shield plug assemblies, shell extension, bottom end plate, and the associated welds. The W21 basket assembly is designed and fabricated as an ASME Section III core support structure in accordance with the applicable requirements of Subsection NG [2.7], as discussed in Section 2.1.2 of the W21 Canister FSAR [2.4]. All canister shell assembly confinement boundary material and basket assembly structural materials are ASME Code approved stainless steel or carbon steel materials.

2.2.2.3 W74 Canister

The W74 canister is described in Section 1.2.1.3 of the FuelSolutions W74 Canister FSAR [2.5]. The W74 canister is the confinement system for storing up to 64 BWR spent fuel assemblies. The W74 canister performs confinement, sub-criticality control, heat-removal and radiation shielding safety functions. The W74 canister consists of a shell assembly, top and bottom inner closure plates, vent and drain port covers, internal basket assembly, top and bottom shield plugs, and top and bottom outer closure plates. All structural components are constructed of high strength carbon (electroless nickel coated) or stainless steel. The W74 canister shell, top and bottom inner closure plates, and the vent and drain port adapters, port covers and the associated welds form the confinement boundary.

The W74 fuel basket assembly consists of two right circular cylindrical baskets, with a total of 74 cell locations and a capacity of up to 64 BWR assemblies. The ten unfueled cell locations are mechanically blocked to prevent SNF loading in these positions. The guide tubes are supported by a series of spacer plates, held in position by support tubes that run through sleeves placed between the spacer plates. The guide tubes include neutron poison sheets (borated stainless steel) in an arrangement that assures there is a poison sheet between all assemblies.

The FuelSolutions W74 canister subsystem includes two different classes of FuelSolutions canister assemblies. The two classes are:

- The FuelSolutions W74M class Multi-Purpose Canister (MPC) for storage, transportation, and disposal.
- The FuelSolutions W74T class Transportable Storage Canister (TSC) for storage and transportation.

Unlike other FuelSolutions canister types, the FuelSolutions W74 canister design includes only one canister length and cavity size. Only carbon steel shield plugs are used with the top end shield plug assembly comprised of a shield plate with individual shield plugs. No fuel assembly spacers are used. The configurations of the two FuelSolutions W74 canister classes are described in FuelSolutions W74 Canister FSAR [2.5] Table 1.2-2.

The W74 canister shell assembly is designed and fabricated as an ASME Section III, Class 1 pressure vessel, in accordance with the applicable requirements of Subsection NB [2.7], as discussed in Section 2.1.2 of W74 Canister FSAR [2.5]. The basket assembly is designed and fabricated as an ASME Section III core support structure, in accordance with the applicable requirements of Subsection NG [2.7], as discussed in Section 2.1.2 of W74 Canister FSAR [2.5]. All canister shell assembly confinement boundary material and basket assembly structural materials are ASME Code-approved stainless steel or carbon steel materials.

2.2.2.4 W150 Storage Cask

The W150 storage cask is described in Section 1.2.1.1 of the FuelSolutions Storage System FSAR [2.3]. The W150 storage cask is the storage overpack for the W21 canister and the W74 canister. There is a long and a short version of the W150 storage cask, both of reinforced concrete with a steel liner. The W150 safety functions include structural integrity, radiation shielding, protection from environmental conditions, and natural convection heat-removal cooling of the canister during long-term storage. The W150 storage cask has an annular air passage to allow the natural circulation of air around the canister. The W150 storage cask is a right circular cylindrical structure that is fabricated primarily from carbon steel and steel-reinforced normal-weight concrete. The W150 storage cask is designed in accordance with the requirements of ACI 349 [2.10] and constructed in accordance with ACI 318 [2.11]. Carbon steel is used to form the inside cavity and air outlet ducts of the W150 storage cask. Carbon steel is also used for the cask lid (i.e., weather cover) and the shield ring. Carbon steel surfaces of these W150 subcomponents that are not embedded inside, or in direct contact with, the W150 concrete are coated with a high emissivity (≥ .78), corrosion resistant, temperature resistant (400 Degrees F Min) and radiation resistant coating to protect against corrosion during storage.

The W150 storage cask design consists of a modular concrete structure with three cylindrical segments and a steel and concrete cover at the top end. Incorporated within the cavity of the storage cask are a thick steel liner, a metallic thermal shield, and hardened steel guide rails to center the canister and provide bearing surfaces during canister transfer operations. The cask stores long and short canisters by varying only the length of the middle storage cask segment and tie rods.

As noted above, the safety functions of the W150 storage cask include structural integrity, radiation shielding, and heat-removal capability. The W150 storage cask protects the W21 and W74 canisters from damage due to external events, such as tornado generated winds and missiles. The radiation shielding provided by the W150 storage cask reduces occupational exposure and assures that the regulatory site-boundary dose limits are met. Air inlet and outlet ducts are cast into the body of the W150 storage cask to provide natural convection heat-removal cooling of the SNF assemblies during storage.

2.2.2.5 W100 Transfer Cask

A detailed description of the W100 transfer cask is provided in Section 1.2.1.2 of the FuelSolutions Storage System FSAR [2.3]. The W100 transfer cask is used for W21 and W74 canister loading and unloading operations. The W100 transfer cask provides shielding and heat transfer during canister movements. The W100 is a multi-wall (steel/lead/steel/water/steel) design with integral lifting trunnions at the top and bottom. Covers are bolted on each end of the W100 to allow access to the cask cavity from either end. The top cover includes a secondary central cover for ram access during horizontal loading and unloading operations. Heat removal from the W100 transfer cask is primarily by conduction through the cask wall. A thermocouple probe is included to ensure that the transfer cask system temperatures are within limits during horizontal transfer.

The W100 transfer cask is comprised of a stainless steel inner liner and an outer structural shell, with lead gamma shielding in the annular space between them. A neutron shield, consisting of an outer jacket forming an annular cavity that is filled with water, surrounds the structural shell. The structural shell of the transfer cask is sized to accommodate localized loads from the lifting trunnions and other design basis loadings. All exposed surfaces of the transfer cask are polished stainless steel to ease decontamination. Low friction, hardened-steel rails are welded to the inner shell cavity to facilitate horizontal canister transfer.

Unlike the W150 storage cask, only one cavity length design is provided for the W100 transfer cask. The transfer cask internal cavity accommodates the long and short canister designs. When a short canister is loaded, a cask cavity axial spacer is installed at the bottom of the W100 transfer cask cavity.

Two upper trunnions are provided near the top end of the W100 transfer cask and separated by 180° for vertical cask handling operations. The transfer cask upper trunnions, including their associated attachment welds to the structural shell and inner liner are designed, fabricated, and load tested as a special lifting device, in accordance with ANSI N14.6 [2.9], and NUREG-0612 [2.8]. The balance of the transfer cask is designed and fabricated as an ASME Section III, Subsection NF, Class 1 [2.7] component support rather than a special lifting device consistent with its design function. Two trunnions near the bottom end of the transfer cask, separated by 180°, are provided for cask upending/downending operations onto the transfer skid and transfer cask trailer and are not used for critical lifts. The lower trunnions are off-set from the cask centerline to assure the cask center of gravity acts to rotate the cask downward, when the cask is lowered from vertical to horizontal. The transfer cask upper and lower trunnions are fitted with replaceable hardened wearing surfaces so that the load bearing portions of the trunnion are not damaged during repeated upending/downending operations.

2.2.2.6 Fuel Transfer and Auxiliary Equipment

The fuel transfer and auxiliary equipment is depicted in Figure 1.2-1 of the FuelSolutions Storage System FSAR [2.3]. Section 2.4.2.2 of NUREG 1927 [2.1] states that transporter devices may be classified as important to safety or safety related (under 10 CFR Part 50) in the design bases of various ISFSIs or dry cask storage systems. The FSAR should be reviewed to determine how these SSCs are used in the FSAR evaluations and described in the license or CoC, to understand whether these SSCs are considered part of the design bases, and thus whether they should be considered within the scope of renewal.

Certain FuelSolutions fuel transfer and auxiliary equipment necessary for ISFSI operations and spent fuel handling is classified as Important to Safety or Safety Related in Table 2.1-1 of the FuelSolutions Storage System FSAR [2.3] (e.g., storage cask impact limiter, canister vertical lift fixture, cask lifting yoke, cask cavity axial spacer, shielded docking collar, cask restraints, and empty canister lift fixture). Other Canister Closure/Opening Equipment, Equipment for Horizontal Canister Transfer, and Equipment for Vertical Canister Transfer are classified as not important to safety in the FuelSolutions Storage System FSARs [2.3 – 2.5]. The Important to Safety and Safety Related FuelSolutions fuel transfer and auxiliary equipment which are included in this Scoping Evaluation and CoC 1026 renewal are listed in Table 2-2. Table 2-8 lists the safety functions, the FSAR drawings or figures, and the safety classifications of the fuel transfer and auxiliary equipment, including subcomponents within the scope of renewal, which have been identified in the FuelSolutions Storage System FSAR [2.3].

Table 2-2
Important to Safety and Safety Related Fuel Transfer and Auxiliary Equipment

Fuel Transfer and Auxiliary Equipment	Classification
Equipment for Horizontal Canister Transfer:	-
• Storage Cask Impact Limiter	Important to Safety
Equipment for Vertical Canister Transfer:	-
• Canister Vertical Lift Fixture	Safety Related
Common Equipment for Horizontal and Vertical Canister Transfer:	-
• Cask Lifting Yoke	Safety Related
• Cask Cavity Axial Spacer	Important to Safety
• Shielded Docking Collar	Important to Safety
• Cask Restraints	Important to Safety
• Empty Canister Lift Fixture	Safety Related
• Standard Lifting Slings (inside plant facility)	Safety Related

2.2.2.7 ISFSI Storage Pad

Two typical ISFSI storage pad layouts are shown in Figures 1.4-1 and 1.4-2 of the FuelSolutions Storage System FSAR [2.3]. The ISFSI storage pad is a steel-reinforced concrete slab that supports free-standing FuelSolutions Storage System casks. As stated in Section 1.4 of the FuelSolutions Storage System FSAR [2.3], the ISFSI storage pad is classified as NITS. The ISFSI storage pad is capable of supporting the loads from the free-standing FuelSolutions Storage System casks and fuel transfer operations. The W150 storage casks and the W100 transfer cask are designed such that any potential failures of the ISFSI storage pad would not prevent them from fulfilling their intended safety functions.

The cask storage pad is designed and analyzed to limit cask deceleration during design basis drop accidents and postulated tip over events. FuelSolutions FSAR Section 2.3.3.2 Cask Drop addresses hypothetical drop accidents. Postulated cask tip-over events are addressed in WSNF-220 Storage System FSAR Sections 2.3.3.3 "Storage Cask Tip-over" and 3.7.4 Storage Cask Tip-Over and further delineated in associated W74 FSAR or W21 FSAR Sections 2.3.3.2 "Cask Drop and Tip-over" and 3.7.4 "Storage Cask Tip-Over." [2.3 – 2.5]

Some FuelSolutions Storage System users may identify their ISFSI storage pad as ITS and may perform aging management inspections on a site specific basis.

2.2.2.8 <u>ISFSI Security Equipment</u>

The ISFSI security equipment (e.g., ISFSI security fences and gates, lighting, communications, and monitoring equipment) are not part of the FuelSolutions Storage System approved by the FuelSolutions Storage System CoC [2.6], and as such, are not described in detail in the FuelSolutions Storage System FSARs [2.3]. Two typical ISFSI storage pad layouts, which identify some ISFSI security features, are shown in Figures 1.4-1 and 1.4-2 of the FuelSolutions Storage System FSAR [2.3]. Existing plant programs and procedures ensure that the ISFSI security equipment requirements are met. Potential failure of the ISFSI security equipment would not prevent the FuelSolutions Storage System casks from performing their intended safety functions.

2.2.3 SSCs Within the Scope of CoC Renewal

The FuelSolutions SSC determined to be within the scope of renewal include are the W150 storage cask, the W100 transfer cask, and the W21 and W74 canisters. The W150 storage cask, the W100 transfer cask, and the W21 and W74 canisters satisfy Criteria 1 of the scoping evaluation process. Both the in-scope ITS and in-scope NITS subcomponents and parts of these in-scope FuelSolutions SSC and their intended safety functions are identified in Tables 2-4 through 2-7.

In determining the in-scope FuelSolutions NITS subcomponents and parts, it was noted that NUREG-2214 [2.2] Table 4-21 included aging management reviews for the FuelSolutions canister NITS subcomponents and parts. NUREG-2214 Tables 4-22 and 4-23 also included aging management reviews for most of the FuelSolutions storage cask and transfer cask NITS subcomponents and parts. The FuelSolutions storage cask and transfer cask NITS subcomponents and parts not included in NUREG-2214 Tables 4-22 and 4-23 were items such as O-rings, gaskets, vent screens, vent screen retainer plates, name plates and other associated NITS hardware which are easily accessible for inspection and replacement as necessary as part of a routine maintenance program.

Westinghouse used the above described approach of classifying most FuelSolutions NITS items as being in-scope in determining if aging deterioration or failure of a NITS item internal to a cask or canister could potentially adversely affect the performance of an ITS subcomponent or part safety function. It is conservative to conclude that most FuelSolutions NITS items are in-scope for the license renewal, and aging management reviews were performed for these NITS subcomponents and parts.

The Important to Safety and Safety Related FuelSolutions fuel transfer and auxiliary equipment listed in Table 2-2, along with the subcomponents identified in Table 2-8, are included within the scope of the CoC 1026 renewal.

The SNF assemblies, which are sealed and supported inside the W21 and W74 canisters (including any damaged W74 SNF assemblies in damaged fuel cans), are also determined to be within the scope of renewal. However, as noted in NUREG-1927 [2.1], fuel pellets are not within the scope of renewal. The intended safety functions of the SNF assembly subcomponents are identified in Table 2-12.

The above identified FuelSolutions components and equipment are the ITS and safety related SSCs, along with the FuelSolutions ITS and NITS subcomponents and parts, within the scope of the CoC 1026 [2.6] renewal under 10 CFR Part 72, Subpart L.

2.2.4 SSC Not Within the Scope of CoC Renewal

As noted in Section 2.3.3 above the FuelSolutions storage cask and transfer cask NITS subcomponents and parts not included in NUREG-2214 Tables 4-22 and 4-23 were items such as O-rings, gaskets, vent screens, vent screen retainer plates, name plates and other associated NITS hardware which are easily accessible for inspection and replacement as necessary as part of a routine maintenance program. These types of FuelSolutions NITS subcomponents and parts do not meet scoping Criteria 2 as their failure does not prevent fulfillment of a function important to safety. These out of scope FuelSolutions cask NITS items are listed separately at the bottom of FuelSolutions Renewal Application Chapter 2 Tables 2-5 and 2-6 for the storage cask and transfer cask, respectively.

Other SSC that are not in the scope of renewal include certain fuel transfer and auxiliary equipment, ISFSI storage pad, ISFSI security equipment, and W100 and W150 instrumentation. These components are classified as NITS and do not meet scoping Criteria 2 as their failure does not prevent fulfillment of a function important to safety.

Fuel Transfer and Auxiliary Equipment

As listed in Table 2-3 below, certain fuel transfer and auxiliary equipment necessary for ISFSI operations (e.g., air-pallets, vertical transport trailer, horizontal transfer trailer, vacuum drying system, welding equipment, helium leak detector, etc.) are classified as NITS in Table 2.1-1 of the FuelSolutions Storage System FSAR [2.3]. These SSCs are not included as part of the FuelSolutions Storage System approved by the FuelSolutions Storage System CoC 1026 [2.6] under 10 CFR Part 72, Subpart L.

As discussed in Section 1.2 of the FuelSolutions Storage System FSAR [2.3], the FuelSolutions Storage System W150, W100, W21 and W74 components are designed to withstand potential failure of the Table 2-3 listed fuel transfer and auxiliary equipment. Failure of this equipment would not prevent the FuelSolutions Storage System components from fulfilling their intended safety functions. Therefore, the Table 2-3 fuel transfer and auxiliary equipment does not meet scoping Criteria 2 and is not in the scope of renewal. The actual fuel transfer and auxiliary equipment used at a given site is addressed by the General Licensee in the 10 CFR 72.212 Evaluation Report on a site-specific basis.

ISFSI Storage Pad

The FuelSolutions Storage System ISFSI storage pad is not part of the approved FuelSolutions Storage System CoC [2.6] under 10 CFR Part 72, Subpart L, and as such, is not described in detail in the FuelSolutions Storage System FSAR [2.3]. The ISFSI storage pad provides free-standing support of the FuelSolutions Storage System casks. The FuelSolutions Storage System

W150, W100, W21and W74 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 ISFSI storage pad does not meet scoping Criteria 2 and is not in the scope of renewal. The ISFSI Pad subcomponents are identified in Table 2-13.

Although not within the scope of the FuelSolutions Storage System CoC renewal, if required an aging management inspection of the ISFSI pad may be addressed on a site-specific basis by a General Licensee.

ISFSI Security Equipment

The ISFSI security equipment (e.g., ISFSI security fences and gates, lighting, communications, and monitoring equipment) are NITS components that are not part of the FuelSolutions Storage System approved by the FuelSolutions Storage System CoC 1026 [2.6] in accordance with 10 CFR Part 72, Subpart L. Failure of the ISFSI security equipment would not prevent fulfillment of a function that is important to safety.

Table 2-3 below lists the Structures, Systems and Components Not Within the Scope of the CoC 1026 Renewal.

Table 2-3
SSC Not Within the Scope of CoC Renewal

Structures, Systems and Components	Classification
Canister Closure/Opening Equipment:	-
• Annulus Seal	NITS
• Shield Plug Retainers	NITS
• Vacuum Drying System	NITS
• Inner Closure Plate Strongback	NITS
• Automated Welding/Opening System	NITS
• Helium Leak Detector	NITS
Equipment for Horizontal Canister Transfer:	-
• Horizontal Transfer Trailer	NITS
• Horizontal Transfer Skid	NITS
• Hydraulic Ram System	NITS
• Upender / Downender (Including J-Skid)	NITS
• Horizontal Lid Handling Fixture	NITS
Equipment for Vertical Canister Transfer:	-
• Vertical Transporter	NITS
• Vertical Transport Trailer	NITS
• Air Pallet System	NITS
Common Equipment for Horizontal and Vertical Canister Transfer:	-
• Standard Lifting Slings (inside ISFSI)	NITS
ISFSI Storage Pad	NITS
ISFSI Security Equipment	NITS
W100 and W150 Instrumentation	NITS

Notes:

NITS = Not Important to Safety

2.3 References

[2.1] U.S. Nuclear Regulatory Commission, NUREG-1927, “Standard Review Plan for Renewal of Independent Spent Fuel Storage Installation Licenses and Dry Cask Storage System Certificates of Compliance,” Revision 1, June 2016.

[2.2] U.S. Nuclear Regulatory Commission, NUREG-2214, “Managing Aging Processes In Storage (MAPS) Report,” July 2019.

[2.3] FuelSolutions Storage System Final Safety Analysis Report, Document No. WSNF-220, Docket No. 72-1026, Revision 0, February 2001; Revision 1, April 2003; Revision 2, April 2005; Revision 3, September 2006; Revision 4, April 2007; and Revision 5, April 2015.

[2.4] FuelSolutions W21 Canister Storage Final Safety Analysis Report, Document No. WSNF-221, Docket No. 72-1026, Revision 0, February 2001; Revision 1, April 2003; Revision 2, June 2003; Revision 3, April 2005; Revision 4, September 2006; and Revision 5, April 2007.

[2.5] FuelSolutions W74 Canister Storage Final Safety Analysis Report, Document No. WSNF-223, Docket No. 72-1026, Revision 0, February 2001; Revision 1, July 2001; Revision 2, February 2002; Revision 3, April 2003; Revision 4, April 2005; Revision 5, September 2006; and Revision 6, April 2007.

[2.6] U.S. Nuclear Regulatory Commission, *Certificate of Compliance for Spent Fuel Storage Casks, Model No.: FuelSolutions Storage System*, Certificate No. 1026, Docket No. 72-1026; Initial Issue (Effective February 15, 2001); Amendment No. 1 (Effective May 14, 2001); Amendment No. 2 (Effective January 28, 2002); Amendment No. 3 (Effective May 7, 2003); Amendment No. 4 (Effective July 3, 2006).

[2.7] American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section III, Division 1, *Rules for Construction of Nuclear Power Plant Components*, 1995 Edition.

[2.8] NUREG-0612, *Control of Heavy Loads at Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, 1980.

[2.9] ANSI N14.6, *Special Lifting Devices for Shipping Containers Weighing 10,000 lbs (4500 kg) or More*, American National Standards Institute, 1993.

[2.10] ACI 349-90, *Code Requirements for Nuclear Related Concrete Structures and Commentary,* American Concrete Institute.

[2.11] ACI 318-89, *Building Code Requirements for Reinforced Concrete*, American Concrete Institute.

[2.12] FuelSolutions W21 Canister Technical Specifications Docket No. 72-1026; Initial Issue through Amendment No. 4.

[2.13] FuelSolutions W74 Canister Technical Specifications Docket No. 72-1026; Initial Issue through Amendment No. 4.

[2.14] NUREG/CR-6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety," February 1996.

Table 2-4a W74 Canister and Damaged Fuel Can (6 pages)

Structure, System, or Component	Intended Safety Function*	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Shell	CO, SR*	Stainless steel (welded)	Sheltered	Stress-corrosion cracking	Cracking	Welded Stainless Steel Canister AMP	3.2.2.5		A A
		Stainless steel	Sheltered	Pitting and crevice corrosion	Loss of material (Precursor to stress corrosion cracking)	Welded Stainless Steel Canister AMP	3.2.2.2		A
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		A
				Fatigue	Cracking	W74 Canister Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
			Helium	Radiation embrittlement	Cracking	No	3.2.2.9		
Bottom closure plate	CO, SR	Stainless steel (welded)	Sheltered** *(** Bottom closure plate is extension of shell, thus same environment and effects)*	Stress-corrosion cracking	Cracking	Welded Stainless Steel Canister AMP	3.2.2.5		A
		Stainless steel	Sheltered,	Pitting and crevice corrosion	Loss of material (Precursor to stress corrosion cracking)	Welded Stainless Steel Canister AMP	3.2.2.2		A
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		A
				Fatigue	Cracking	W74 Canister Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
		Stainless steel (welded)	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		
		Stainless steel	Helium	Fatigue	Cracking	W74 Canister Fatigue TLAA	3.2.2.7		
				Creep	Change in dimensions	No	3.2.2.6		
				Radiation embrittlement	Cracking	No	3.2.2.9		
			Embedded (steel, depleted uranium)	Radiation embrittlement	Cracking	No	3.2.2.9		
Bottom end plate and Shell extension	SR	Stainless steel (welded)	Sheltered	Stress corrosion cracking	Cracking	Welded Stainless Steel Canister AMP	3.2.2.5		B
		Stainless steel	Sheltered	Pitting and crevice corrosion	Loss of material (Precursor to stress-corrosion cracking)	Welded Stainless Steel Canister AMP	3.2.2.2		B
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		B B
				Radiation embrittlement	Cracking	No	3.2.2.9		B
			Embedded (steel, depleted uranium)	Radiation embrittlement	Cracking	No	3.2.2.9		

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 2-4a W74 Canister and Damaged Fuel Can (6 pages)

Structure, System, or Component	Intended Safety Function*	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Top outer closure plate	CO, SR*	Stainless steel (welded)	Sheltered	Stress corrosion cracking	Cracking	Welded Stainless Steel Canister AMP	3.2.2.5		A
				Pitting and crevice corrosion	Loss of material (Precursor to stress corrosion cracking)	Welded Stainless Steel Canister AMP	3.2.2.2		A
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		A
				Fatigue	Cracking	W74 Canister Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
			Helium	Radiation embrittlement	Cracking	No	3.2.2.9		
Top inner closure plate	CO, SR	Stainless steel (welded)	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		A
		Stainless steel	Helium	Fatigue	Cracking	W74 Canister Fatigue TLAA	3.2.2.7		A
				Creep	Change in dimensions	No	3.2.2.6		
				Radiation embrittlement	Cracking	No	3.2.2.9		
Alignment bar, adapter	SR	Stainless steel	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		B
				Creep	Change in dimensions	No	3.2.2.6		B
				Radiation embrittlement	Cracking	No	3.2.2.9		
Shield plug	SH	Steel	Helium	General corrosion	Loss of material	No	3.2.1.1		B
				Galvanic corrosion	Loss of material	No	3.2.1.3		
				Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.1.8		
				Creep	Change in dimensions	No	3.2.1.6		
				Radiation embrittlement	Cracking	No	3.2.1.9		
			Embedded (stainless steel)	Radiation embrittlement	Cracking	No	3.2.1.9		
			Embedded (stainless steel, depleted uranium)	Radiation embrittlement	Cracking	No	3.2.1.9		
		Lead	Embedded (stainless steel)	None identified	None identified	No	3.2.6		
		Depleted uranium							

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

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Table 2-4a W74 Canister and Damaged Fuel Can (6 pages)

Structure, System, or Component	Intended Safety Function*	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Shield plug support assembly	SR	Stainless steel (welded)	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		B
		Stainless steel	Helium	Creep	Change in dimensions	No	3.2.2.6		NITS
				Radiation embrittlement	Cracking	No	3.2.2.9		NITS B
Leak test port cover	CO	Stainless steel (welded)	Sheltered	Stress corrosion cracking	Cracking	Welded Stainless Steel Canister AMP	3.2.2.5		A
		Stainless steel	Sheltered	Pitting and crevice corrosion	Loss of material (Precursor to stress corrosion cracking)	Welded Stainless Steel Canister AMP	3.2.2.2		A
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		A
				Fatigue	Cracking	W74 Canister Fatigue TLAA	3.2.2.7		A
				Radiation embrittlement	Cracking	No	3.2.2.9		
			Helium	Radiation embrittlement	Cracking	No	3.2.2.9		
Instrument port cover, vent/drain port cover	CO	Stainless steel (welded)	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		A
		Stainless steel	Helium	Fatigue	Cracking	W74 Canister Fatigue TLAA	3.2.2.7		A
				Creep	Change in dimensions	No	3.2.2.6		A
				Radiation embrittlement	Cracking	No	3.2.2.9		A
Vent and drain port	SR	Stainless steel (welded)	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		A
		Stainless steel	Helium	Creep	Change in dimensions	No	3.2.2.6		NITS
				Radiation embrittlement	Cracking	No	3.2.2.9		NITS A NITS A NITS NITS NITS NITS

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 2-4a W74 Canister and Damaged Fuel Can (6 pages)

Structure, System, or Component	Intended Safety Function*	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Guide tube assembly	CR, SR	Stainless steel (welded)	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		B
		Stainless steel	Helium	Fatigue	Cracking	W74 Canister Fatigue (Including Basket) TLAA	3.2.2.7		B
				Creep	Change in dimensions	No	3.2.2.6		B
				Radiation embrittlement	Cracking	No	3.2.2.9		B
Neutron absorber	CR	Boral							
		Borated stainless steel	Helium	Boron depletion	Reduction of neutron-absorbing capacity	W74 Canister Fatigue (Including Basket) TLAA	3.4.1.1		A
				Thermal aging	Loss of fracture toughness and loss of ductility	No	3.4.1.3		
				Creep	Change in dimensions	No	3.4.1.2		
				Radiation embrittlement	Loss of fracture toughness and loss of ductility	No	3.4.1.4		
Fuel basket support sleeve BASKET ASSEMBLY	SR	Stainless steel	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		B
				Fatigue	Cracking	W74 Canister Fatigue (Including Basket) TLAA	3.2.2.7		
				Creep	Change in dimensions	No	3.2.2.6		NITS
				Radiation embrittlement	Cracking	No	3.2.2.9		NITS
									NITS
									NITS
									NITS
									B
									B
									B
									NITS
									NITS
									NITS
									B
									NITS
Fuel basket support rod									

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

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Table 2-4a W74 Canister and Damaged Fuel Can (6 pages)

Structure, System, or Component	Intended Safety Function*	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Fuel basket support sleeve									
Fuel basket bolt	SR	Steel	Helium	General corrosion	Loss of material	No	3.2.1.1		B
				Galvanic corrosion	Loss of material	No	3.2.1.3		
				Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.1.8		
				Fatigue	Cracking	W74 Canister Fatigue (Including Basket) TLAA	3.2.1.7		
				Creep	Change in dimensions	No	3.2.1.6		
				Radiation embrittlement	Cracking	No	3.2.1.9		
				Stress relaxation	Loss of preload	Supporting Analysis in Section 3.3.1.2.2 of the FuelSolutions Renewal Application.	3.2.1.10		
Fuel basket spacer assembly	SR	Stainless steel	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		B
				Fatigue	Cracking	W74 Canister Fatigue (Including Basket) TLAA	3.2.2.7		B
				Creep	Change in dimensions	No	3.2.2.6		B
				Radiation embrittlement	Cracking	No	3.2.2.9		B
									B B
		Steel	Helium	General corrosion	Loss of material	No	3.2.1.1		B
				Galvanic corrosion	Loss of material	No	3.2.1.3		B
				Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.1.8		
				Fatigue	Cracking	W74 Canister Fatigue (Including Basket) TLAA	3.2.1.7		
				Creep	Change in dimensions	No	3.2.1.6		
				Radiation embrittlement	Cracking	No	3.2.1.9		
Damaged fuel can top lid assembly (W74 Canister)	SR	Stainless steel (welded)	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		
		Stainless steel	Helium	Fatigue	Cracking	W74 Canister Fatigue TLAA	3.2.2.7		C
				Creep	Change in dimensions	No	3.2.2.6		B
				Radiation embrittlement	Cracking	No	3.2.2.9		B
									C C C C C

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 2-4a W74 Canister and Damaged Fuel Can (6 pages)

Structure, System, or Component	Intended Safety Function*	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Damaged fuel can top lid assembly hardware (W74 Canister)	SR	Stainless steel	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		C
				Fatigue	Cracking	W74 Canister Fatigue TLAA	3.2.2.7		C
				Creep	Change in dimensions	No	3.2.2.6		C
				Radiation embrittlement	Cracking	No	3.2.2.9		B
				Stress relaxation	Loss of preload	No	3.2.2.10		B
Damaged fuel can guide tube assembly (W74 Canister)	SR	Stainless steel (welded)	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		B
		Stainless steel	Helium	Fatigue	Cracking	W74 Canister Fatigue TLAA	3.2.2.7		B
				Creep	Change in dimensions	No	3.2.2.6		B
				Radiation embrittlement	Cracking	No	3.2.2.9		
Damaged fuel can neutron absorber (W74 Canister)	CR	Borated stainless steel	Helium	Boron depletion	Reduction of neutron-absorbing capacity	W74 Neutron Absorber Boron Depletion TLAA	3.4.1.1		B
				Thermal aging	Loss of fracture toughness and loss of ductility	No	3.4.1.3		A
				Creep	Change in dimensions	No	3.4.1.2		
				Radiation embrittlement	Loss of fracture toughness and loss of ductility	No	3.4.1.4		

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Structure, System, or Component	Intended Safety Function*	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Shell	CO, SR*	Stainless steel (welded)	Sheltered	Stress-corrosion cracking	Cracking	Welded Stainless Steel Canister AMP	3.2.2.5		A NITS
		Stainless steel	Sheltered	Pitting and crevice corrosion	Loss of material (Precursor to stress corrosion cracking)	Welded Stainless Steel Canister AMP	3.2.2.2		A
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		NITS
				Fatigue	Cracking	W21 Canister Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
			Helium	Radiation embrittlement	Cracking	No	3.2.2.9		
Bottom closure plate	CO, SR	Stainless steel (welded)	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		A
		Stainless steel	Helium	Fatigue	Cracking	W21 Canister Fatigue TLAA	3.2.2.7		
				Creep	Change in dimensions	No	3.2.2.6		
				Radiation embrittlement	Cracking	No	3.2.2.9		
			Embedded (steel, depleted uranium)	Radiation embrittlement	Cracking	No	3.2.2.9		
		Stainless steel (welded)	Sheltered *(Bottom closure plate is extension of shell, thus same environment and effects)*	Stress-corrosion cracking	Cracking	Welded Stainless Steel Canister AMP	3.2.2.5		
		Stainless steel	Sheltered	Pitting and crevice corrosion	Loss of material (Precursor to stress corrosion cracking)	Welded Stainless Steel Canister AMP	3.2.2.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Fatigue	Cracking	W21 Canister Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

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Table 2-4b W21 Canister (6 pages)

Structure, System, or Component	Intended Safety Function*	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Bottom end plate **and** **Shell extension**	SR	Stainless steel (welded)	Sheltered	Stress corrosion cracking	Cracking	Welded Stainless Steel Canister AMP	3.2.2.5		**A**
		Stainless steel	Sheltered	Pitting and crevice corrosion	Loss of material (Precursor to stress-corrosion cracking)	Welded Stainless Steel Canister AMP	3.2.2.2		A
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		A
				Radiation embrittlement	Cracking	No	3.2.2.9		A
			Embedded (steel, depleted uranium)	Radiation embrittlement	Cracking	No	3.2.2.9		A A
Top outer closure plate	CO, SR*	Stainless steel (welded)	Sheltered	Stress corrosion cracking	Cracking	Welded Stainless Steel Canister AMP	3.2.2.5		A
				Pitting and crevice corrosion	Loss of material (Precursor to stress corrosion cracking)	Welded Stainless Steel Canister AMP	3.2.2.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Fatigue	Cracking	W21 Canister Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
			Helium	Radiation embrittlement	Cracking	No	3.2.2.9		
Top inner closure plate	CO, SR	Stainless steel (welded)	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		A
		Stainless steel	Helium	Fatigue	Cracking	W21 Canister Fatigue TLAA	3.2.2.7		
				Creep	Change in dimensions	No	3.2.2.6		
				Radiation embrittlement	Cracking	No	3.2.2.9		
Alignment bar, adapter									

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 2-4b W21 Canister (6 pages)

Structure, System, or Component	Intended Safety Function*	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Shield plug	SH	Steel	Helium	General corrosion	Loss of material	No	3.2.1.1		B
				Galvanic corrosion	Loss of material	No	3.2.1.3		B
				Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.1.8		B
				Creep	Change in dimensions	No	3.2.1.6		B
				Radiation embrittlement	Cracking	No	3.2.1.9		B
			Embedded (stainless steel)	Radiation embrittlement	Cracking	No	3.2.1.9		B NITS NITS
			Embedded (stainless steel, depleted uranium)	Radiation embrittlement	Cracking	No	3.2.1.9		NITS NITS NITS NITS NITS NITS NITS B B
		Lead	Embedded	None identified	None identified	No	3.2.6		B B B
		Depleted uranium	Embedded (stainless steel)	None identified	None identified	No	3.2.7		B B B B
			Embedded (stainless steel, steel)	None identified	None identified	No	3.2.7		B B
Shield plug support assembly	SR	Stainless steel (welded)	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		B
		Stainless steel	Helium	Creep	Change in dimensions	No	3.2.2.6		
				Radiation embrittlement	Cracking	No	3.2.2.9		

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

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Table 2-4b W21 Canister (6 pages)

Structure, System, or Component	Intended Safety Function*	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Leak test port cover	CO	Stainless steel (welded)	Sheltered	Stress corrosion cracking	Cracking	Welded Stainless Steel Canister AMP	3.2.2.5		A
		Stainless steel	Sheltered	Pitting and crevice corrosion	Loss of material (Precursor to stress corrosion cracking)	Welded Stainless Steel Canister AMP	3.2.2.2		A
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Fatigue	Cracking	W21 Canister Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
			Helium	Radiation embrittlement	Cracking	No	3.2.2.9		
Instrument port cover, vent/drain port cover	CO	Stainless steel (welded)	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		
		Stainless steel	Helium	Fatigue	Cracking	W21 Canister Fatigue TLAA	3.2.2.7		
				Creep	Change in dimensions	No	3.2.2.6		
				Radiation embrittlement	Cracking	No	3.2.2.9		
Vent and drain port	SR	Stainless steel (welded)	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		NITS
		Stainless steel	Helium	Creep	Change in dimensions	No	3.2.2.6		NITS
				Radiation embrittlement	Cracking	No	3.2.2.9		NITS
									NITS
									A
									A
									A
									C
									C
									NITS
									A
									A
									A
									C
									C
									NITS
									NITS
Guide tube assembly	CR, SR	Stainless steel (welded)	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		B
		Stainless steel	Helium	Fatigue	Cracking	W21 Canister Fatigue (Including Basket) TLAA	3.2.2.7		B
				Creep	Change in dimensions	No	3.2.2.6		B
				Radiation embrittlement	Cracking	No	3.2.2.9		B
									B
									B
									B

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

FuelSolutions CoC-1026 Renewal Application
Table 2-4b W21 Canister (6 pages)

Structure, System, or Component	Intended Safety Function*	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Neutron absorber	CR	Boral	Helium	General corrosion	Loss of material	No	3.4.2.1		A
				Galvanic corrosion	Loss of material	No	3.4.2.2		A
				Thermal aging	Loss of strength	No	3.4.2.6		A
				Wet corrosion and blistering	Change in dimensions	No	3.4.2.3		A
				Creep	Change in dimensions	No	3.4.2.5		A
				Radiation embrittlement	Cracking	No	3.4.2.7		
				Boron depletion	Reduction of neutron-absorbing capacity	W21 Neutron Absorber Boron Depletion TLAA	3.4.2.4		
		Borated stainless steel							
Fuel basket support rod, support sleeve	SR	Stainless steel	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		B
				Fatigue	Cracking	W21 Canister Fatigue TLAA	3.2.2.7		B
				Creep	Change in dimensions	No	3.2.2.6		B
				Radiation embrittlement	Cracking	No	3.2.2.9		B
									B
Fuel basket support rod	SR	Stainless steel (17-4 PH)	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	Supporting Analysis in Section 3.3.1.2.1 of the FuelSolutions Renewal Application.	3.2.2.8		B
				Fatigue	Cracking	W21 Canister Fatigue (Including Basket) TLAA	3.2.2.7		B
				Creep	Change in dimensions	No	3.2.2.6		B
				Radiation embrittlement	Cracking	No	3.2.2.9		B
Fuel basket support sleeve	SR	Steel	Helium	General corrosion	Loss of material	No	3.2.1.1		B
				Galvanic corrosion	Loss of material	No	3.2.1.3		B
				Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.1.8		B
				Fatigue	Cracking	W21 Canister Fatigue (Including Basket) TLAA	3.2.1.7		B
				Creep	Change in dimensions	No	3.2.1.6		
				Radiation embrittlement	Cracking	No	3.2.1.9		

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

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Table 2-4b W21 Canister (6 pages)

Structure, System, or Component	Intended Safety Function*	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Fuel basket bolt									
Fuel basket spacer assembly	SR	Stainless steel	Helium	Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.2.8		A
				Fatigue	Cracking	W21 Canister Fatigue (Including Basket) TLAA	3.2.2.7		A
				Creep	Change in dimensions	No	3.2.2.6		A
									A
				Radiation embrittlement	Cracking	No	3.2.2.9		A
		Steel	Helium	General corrosion	Loss of material	No	3.2.1.1		A
				Galvanic corrosion	Loss of material	No	3.2.1.3		
				Thermal aging	Loss of fracture toughness and loss of ductility	No	3.2.1.8		NITS
				Fatigue	Cracking	W21 Canister Fatigue (Including Basket) TLAA	3.2.1.7		B
				Creep	Change in dimensions	No	3.2.1.6		B
				Radiation embrittlement	Cracking	No	3.2.1.9		B
									B
									B

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

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Table 2-5 Storage Cask (4 pages)

Structure, System, or Component	Intended Safety Function	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Concrete shell, shear key	SH, SR*	Shell concrete and sheer key grout	Air—outdoor	Aggressive chemical attack	Cracking	Reinforced Concrete Structures AMP	3.5.1.5		B
					Loss of strength	Reinforced Concrete Structures AMP	3.5.1.5		
					Loss of material (spalling, scaling)	Reinforced Concrete Structures AMP	3.5.1.5		
				Creep	Cracking	No	3.5.1.2		
				Dehydration at high temperature	Cracking	No	3.5.1.11		
					Loss of strength	No	3.5.1.11		
				Delayed ettringite formation	Loss of material (spalling, scaling)	No	3.5.1.13		
					Loss of strength	No	3.5.1.13		
					Cracking	No	3.5.1.13		
				Fatigue	Cracking	No	3.5.1.10		
				Freeze and thaw	Cracking	Reinforced Concrete Structures AMP	3.5.1.1		
					Loss of material (spalling, scaling)	Reinforced Concrete Structures AMP	3.5.1.1		
				Radiation damage	Cracking	No	3.5.1.9		
					Loss of strength	No	3.5.1.9		
				Reaction with aggregates	Cracking	Reinforced Concrete Structures AMP	3.5.1.3		
					Loss of strength	Reinforced Concrete Structures AMP	3.5.1.3		
				Salt scaling	Loss of material (spalling, scaling)	Reinforced Concrete Structures AMP	3.5.1.14		
				Shrinkage	Cracking	No	3.5.1.7		
				Leaching of calcium hydroxide	Loss of strength	Reinforced Concrete Structures AMP	3.5.1.8		
					Increase in porosity and permeability	Reinforced Concrete Structures AMP	3.5.1.8		
					Reduction of concrete pH (reducing corrosion resistance of steel embedments)	Reinforced Concrete Structures AMP	3.5.1.8		
Concrete shell	SH, SR	Reinforcing steel	Air—outdoor groundwater	Corrosion of reinforcing steel	Loss of concrete/steel bond	Reinforced Concrete Structures AMP	3.5.1.6		B
					Loss of material (spalling, scaling)	Reinforced Concrete Structures AMP	3.5.1.6		
					Cracking	Reinforced Concrete Structures AMP	3.5.1.6		
					Loss of strength	Reinforced Concrete Structures AMP	3.5.1.6		
Steel liner, shield ring	SH, SR	Steel	Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		B
				Galvanic corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.3		
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Radiation embrittlement	Cracking	No	3.2.1.9		
			Embedded (concrete)	Radiation embrittlement	Cracking	No	3.2.1.9		

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

FuelSolutions CoC-1026 Renewal Application
Table 2-5 Storage Cask (4 pages)

Structure, System, or Component	Intended Safety Function	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Thermal shield panel assembly	TH	Aluminum	Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.3.1		B NITS NITS NITS NITS B
				Galvanic corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.3.3		
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.3.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.3.4		
				Thermal aging	Loss of strength	No	3.2.3.7		
				Creep	Change in dimensions	No	3.2.3.5		
				Radiation embrittlement	Cracking	No	3.2.3.8		
Shear lug, thermal shield support lug	SR	Steel	Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		C B
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Radiation embrittlement	Cracking	No	3.2.1.9		
Support rail	SR, RE NOTE: Degraded NITS Items May Adversely Affect Canister Retriev-ability (RE)	Stainless steel	Sheltered	Stress corrosion cracking	Cracking	Monitoring of Metallic Surfaces AMP	3.2.2.5		B B B NITS NITS
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.2.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Radiation embrittlement	Cracking	No	3.2.2.9		
				Wear	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.2.11		
		Steel	Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		NITS NITS NITS NITS NITS NITS NITS NITS NITS
				Galvanic corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.3		
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Radiation embrittlement	Cracking	No	3.2.1.9		
				Stress relaxation	Loss of preload	Monitoring of Metallic Surfaces AMP	3.2.1.10		
Guide rail	SR, RE NOTE: Degraded NITS Items May Adversely Affect Canister Retriev-ability (RE)	Stainless steel	Sheltered	Stress corrosion cracking	Cracking	Monitoring of Metallic Surfaces AMP	3.2.2.5		NITS
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.2.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Radiation embrittlement	Cracking	No	3.2.2.9		
				Wear	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.2.11		
		Steel	Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		NITS
				Galvanic corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.3		C NITS NITS NITS NITS NITS NITS
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Radiation embrittlement	Cracking	No	3.2.1.9		
				Stress relaxation	Loss of preload	Monitoring of Metallic Surfaces AMP	3.2.1.10		

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

FuelSolutions CoC-1026 Renewal Application
Table 2-5 Storage Cask (4 pages)

Structure, System, or Component	Intended Safety Function	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Canister support tube	SR	Stainless steel	Sheltered	Stress corrosion cracking	Cracking	Monitoring of Metallic Surfaces AMP	3.2.2.5		B
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.2.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Radiation embrittlement	Cracking	No	3.2.2.9		
Tie rod, tie rod plate	SR	Stainless steel	Sheltered	Stress corrosion cracking	Cracking	Monitoring of Metallic Surfaces AMP	3.2.2.5		B C
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.2.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Radiation embrittlement	Cracking	No	3.2.2.9		
Tie rod hardware	SR	Stainless steel	Sheltered	Stress corrosion cracking	Cracking	Monitoring of Metallic Surfaces AMP	3.2.2.5		B
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.2.2		
				Microbiologically influenced	Loss of material	No	3.2.2.4		
				Radiation embrittlement	Cracking	No	3.2.2.9		
				Stress relaxation	Loss of preload	No	3.2.2.10		
		Steel	Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		C NITS
				Galvanic corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.3		NITS NITS
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		NITS
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Radiation embrittlement	Cracking	No	3.2.1.9		
				Stress relaxation	Loss of preload	Monitoring of Metallic Surfaces AMP	3.2.1.10		
Ram anchor	SR	Steel	Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		C
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		C
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Radiation embrittlement	Cracking	No	3.2.1.9		
Top cover assembly	SR	Steel	Air—outdoor	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		B
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Radiation embrittlement	Cracking	No	3.2.1.9		
			Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		NITS
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Radiation embrittlement	Cracking	No	3.2.1.9		

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 2-5 Storage Cask (4 pages)

Structure, System, or Component	Intended Safety Function	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Top cover assembly (continued)		Concrete	Fully encased (steel)	Delayed ettringite formation	Loss of material (spalling, scaling)	No	3.5.1.13		NITS
					Cracking	No	3.5.1.13		
					Loss of strength	No	3.5.1.13		
				Radiation damage	Cracking	No	3.5.1.9		
					Loss of strength	No	3.5.1.9		
				Reaction with aggregates	Cracking	No	3.5.1.3		
					Loss of strength	No	3.5.1.3		
Top cover bolt	SR	Steel	Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		C
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Radiation embrittlement	Cracking	No	3.2.1.9		
				Stress relaxation	Loss of preload	Monitoring of Metallic Surfaces AMP	3.2.1.10		
Coating on carbon steel components	SR	Coating	Air—outdoor	Radiation embrittlement	Coating degradation	Monitoring of Metallic Surfaces AMP	3.2.8		C
				Thermal aging	Coating degradation	Monitoring of Metallic Surfaces AMP	3.2.8		
			Sheltered	Radiation embrittlement	Coating degradation	Monitoring of Metallic Surfaces AMP	3.2.8		
				Thermal aging	Coating degradation	Monitoring of Metallic Surfaces AMP	3.2.8		

NOTE: The following Not Important to Safety (NITS) W150 Storage Cask items and parts do not perform any safety functions and their malfunction would not preclude Important to Safety (ITS) items and parts from performing their safey functions. The listed NITS items and parts are typically accessible for inspection and maintenance as required, and can be repaired or replaced as necessary without applying an Aging Management Program.

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*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 2-6 Transfer Cask (5 pages)

Structure, System, or Component	Intended Safety Function	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG- 2214 Section)	(a,c)	Qual CAT
Structural shell	SR*	Stainless steel (welded)	Air—indoor/outdoor	Stress corrosion cracking	Cracking	No	3.2.2.5		A
		Stainless steel	Air—indoor/outdoor	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
Inner liner	SR	Stainless steel (welded)	Air—indoor/outdoor	Stress corrosion cracking	Cracking	No	3.2.2.5		A
		Stainless steel	Air—indoor/outdoor	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
Neutron shield jacket, trunnion support plate, thermowell	SR	Stainless steel	Air—indoor/outdoor	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		B B B B
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Stress corrosion cracking	Cracking	No	3.2.2.5		
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
Neutron shield jacket support rib	SR	Stainless steel	Demineralized water	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		B
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Stress corrosion cracking	Cracking	No	3.2.2.5		
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
Gamma shield	SH	Lead	Embedded (stainless steel)	None identified	None identified	No	3.2.6		B
Guide rail	SR	Stainless steel	Air—indoor/outdoor	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		C
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Stress corrosion cracking	Cracking	No	3.2.2.5		
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
				Wear	Loss of material	Transfer Cask AMP	3.2.2.11		

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 2-6 Transfer Cask (5 pages)

Structure, System, or Component	Intended Safety Function	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG- 2214 Section)	(a,c)	Qual CAT
Top flange, bottom flange	SR	Stainless steel (welded)	Air—indoor/outdoor	Stress corrosion cracking	Cracking	No	3.2.2.5		A A
		Stainless steel	Air—indoor/outdoor	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
Screw thread insert	SR	Stainless steel	Embedded (stainless steel)	Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		A C NITS A
				Radiation embrittlement	Cracking	No	3.2.2.9		C
Block	SR	Stainless steel	Embedded (stainless steel, lead)	Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		A
				Radiation embrittlement	Cracking	No	3.2.2.9		
Swagelok quick connect body, fitting, cap	SR	Stainless steel	Air—indoor/outdoor	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		B
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		B
				Stress corrosion cracking	Cracking	No	3.2.2.5		NITS
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		B
				Radiation embrittlement	Cracking	No	3.2.2.9		
Coupling, pipe, cap	SR	Stainless steel	Air—indoor/outdoor	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		NITS
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		NITS
				Stress corrosion cracking	Cracking	No	3.2.2.5		B
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		NITS
				Radiation embrittlement	Cracking	No	3.2.2.9		
Upper trunnion, lower trunnion	SR	Stainless steel (welded)	Air—indoor/outdoor	Stress corrosion cracking	Cracking	No	3.2.2.5		A
			Demineralized water	Stress corrosion cracking	Cracking	No	3.2.2.5		A
		Stainless steel	Air—indoor/outdoor	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
			Demineralized water	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 2-6 Transfer Cask (5 pages)

Structure, System, or Component	Intended Safety Function	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG- 2214 Section)	(a,c)	Qual CAT
Trunnion retainer, trunnion sleeve	SR	Stainless steel	Air—indoor/outdoor	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		C
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		C
				Stress corrosion cracking	Cracking	No	3.2.2.5		C
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		C
				Radiation embrittlement	Cracking	No	3.2.2.9		
				Wear	Loss of material	Transfer Cask AMP	3.2.2.11		
			Demineralized water	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Stress corrosion cracking	Cracking	No	3.2.2.5		
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
				Wear	Loss of material	Transfer Cask AMP	3.2.2.11		
Trunnion bolt	SR	Stainless steel	Air—indoor/outdoor	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		C
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Stress corrosion cracking	Cracking	No	3.2.2.5		
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
				Stress relaxation	Loss of preload	No	3.2.2.10		
Bolt for top cover, bottom cover, ram access cover	SR	Steel	Air—indoor/outdoor	General corrosion	Loss of material	W100 Transfer Cask AMP	3.2.1.1		A
				Pitting and crevice corrosion	Loss of material	W100 Transfer Cask AMP	3.2.1.2		A
				Galvanic corrosion	Loss of material	W100 Transfer Cask AMP	3.2.1.3		C
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.1.9		
				Stress relaxation	Loss of preload	No	3.2.1.10		

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 2-6 Transfer Cask (5 pages)

Structure, System, or Component	Intended Safety Function	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG- 2214 Section)	(a,c)	Qual CAT
Washer for trunnion, top cover, bottom cover, ram access cover	SR	Stainless steel	Air—indoor/outdoor	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		C
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		C
				Stress corrosion cracking	Cracking	No	3.2.2.5		C
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
Top cover	SR	Stainless steel	Air—indoor/outdoor	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		C
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		NITS
				Stress corrosion cracking	Cracking	No	3.2.2.5		A
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
Ram access cover	SR	Stainless steel	Air—indoor/outdoor	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		B
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		C
				Stress corrosion cracking	Cracking	No	3.2.2.5		NITS
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		C
				Radiation embrittlement	Cracking	No	3.2.2.9		C
Bottom cover	SR	Stainless steel	Air—indoor/outdoor	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		A
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		B
				Stress corrosion cracking	Cracking	No	3.2.2.5		NITS
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		NITS
				Radiation embrittlement	Cracking	No	3.2.2.9		NITS NITS NITS NITS
~~Top lifting insert~~(NOTE: Cover lifting inserts are included with cover SS parts), Bottom support ring	SR	Stainless steel	Air—indoor/outdoor	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		B
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Stress corrosion cracking	Cracking	No	3.2.2.5		
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 2-6 Transfer Cask (5 pages)

Structure, System, or Component	Intended Safety Function	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG- 2214 Section)	(a,c)	Qual CAT
Neutron shield jacket	SR	Stainless steel	Air—indoor/outdoor	Pitting and crevice corrosion	Loss of material	No	3.2.2.2		C
				Microbiologically influenced corrosion	Loss of material	No	3.2.2.4		
				Stress corrosion cracking	Cracking	No	3.2.2.5		
				Fatigue	Cracking	W100 Transfer Cask Fatigue TLAA	3.2.2.7		
				Radiation embrittlement	Cracking	No	3.2.2.9		
			Embedded (RX-277, NS-3)	Radiation embrittlement	Cracking	No	3.2.2.9		
Neutron shielding	SH	RX-277, NS-3	Embedded (stainless steel)	Thermal aging	Loss of fracture Toughness and loss of ductility	No	3.3.1.2		B
				Radiation embrittlement	Cracking	No	3.3.1.3		B
				Boron depletion	Loss of shielding	W100 Transfer Cask AMP	3.3.1.1		
Coating on neutron shield jacket	TH	Coating	Air—indoor/outdoor	Radiation embrittlement	Coating degradation	W100 Transfer Cask AMP	3.2.8		B
				Thermal aging	Coating degradation	W100 Transfer Cask AMP	3.2.8		
Pressure relief device	SR	Brass	Air—indoor/outdoor	General corrosion	Loss of material	W100 Transfer Cask AMP	3.2.5.1		B
				Pitting and crevice corrosion	Loss of material	No	3.2.5.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.5.3		
				Radiation embrittlement	Cracking	No	3.2.5.4		

NOTE: The following Not Important to Safety (NITS) W100 Transfer Cask items and parts do not perform any safety functions and their malfunction would not preclude Important to Safety (ITS) items and parts from performing their safey functions. The listed NITS items and parts are typically accessible for inspection and maintenance as required, and can be repaired or replaced as necessary without applying an Aging Management Program.

(a.c)

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 2-7 Spent Fuel Assemblies (2 pages)

Structure, System, or Component	Intended Safety Function	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	Reference	Qual CAT
Fuel rod cladding	CO, CR, RE, SH, SR, TH*	Zirconium-based alloy (Zircaloy-2, Zircaloy-4, ZIRLO™, or M5®)	Helium	Oxidation	Loss of load bearing capacity	No	3.6.1.6		A
				Pitting corrosion	Loss of material	No	3.6.1.7		
				Galvanic corrosion	Loss of material	No	3.6.1.8		
				Stress corrosion cracking	Cracking	No	3.6.1.9		
				Hydride reorientation	Loss of ductility	W21 High-Burnup Fuel Monitoring and Assessment AMP	3.6.1.1	** Refer to the W21 Technical Specifications Section 5.3.6 "Vacuum Drying Program" regarding fuel cladding temperature limits of 400 C to assure cladding integrity	
				Delayed hydride cracking	Cracking	No	3.6.1.2		
				Thermal Creep	Changes in dimensions	W21 High-Burnup Fuel Monitoring and Assessment AMP	3.6.1.3	** Refer to the W21 Technical Specifications Section 5.3.6 "Vacuum Drying Program" regarding fuel cladding temperature limits of 400 C to assure cladding integrity	
				Low-temperature creep	Changes in dimensions	No	3.6.1.4		
				Radiation embrittlement	Loss of strength	No	3.6.1.10		
				Fatigue	Cracking	No	3.6.1.11		
				Mechanical overload	Cracking	No	3.6.1.5		
Guide tubes (PWR) or water channels (BWR)	CR, RE, SR	Zirconium-based alloy	Helium	Creep	Changes in dimensions	No	3.6.2.1		A
				Hydriding	Changes in dimensions	No	3.6.2.2		
				Radiation embrittlement	Loss of strength	No	3.6.1.10		
				Fatigue	Cracking	No	3.6.1.11		
Spacer grids	CR, RE, SR, TH	Zirconium-based alloy	Helium	Creep	Changes in dimensions	No	3.6.2.1		A
				Hydriding	Changes in dimensions	No	3.6.2.2		
				Radiation embrittlement	Loss of strength	No	3.6.1.10		
				Fatigue	Cracking	No	3.6.1.11		

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 2-7 Spent Fuel Assemblies (2 pages)

Structure, System, or Component	Intended Safety Function	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	Reference	Qual CAT
Spacer grids (continued)		Inconel	Helium	Creep	Change in dimensions	No	3.6.2.1		
				General corrosion	Loss of material	No	3.6.2.3		
				Stress corrosion cracking	Cracking	No	3.6.2.4		
				Radiation embrittlement	Loss of strength	No	3.6.1.10		
				Fatigue	Cracking	No	3.6.1.11		
Lower and upper end fittings	CR, RE, SR	Stainless steel	Helium	Creep	Change in dimensions	No	3.6.2.1		A
				General corrosion	Loss of material	No	3.6.2.3		
				Stress corrosion cracking	Cracking	No	3.6.2.4		
				Radiation embrittlement	Loss of strength	No	3.6.1.10		
				Fatigue	Cracking	No	3.6.1.11		
		Inconel	Helium	Creep	Change in dimensions	No	3.6.2.1		
				General corrosion	Loss of material	No	3.6.2.3		
				Stress corrosion cracking	Cracking	No	3.6.2.4		
				Radiation embrittlement	Loss of strength	No	3.6.1.10		
				Fatigue	Cracking	No	3.6.1.11		
Fuel channel (BWR)	CR, TH	Zirconium-based alloy	Helium	Creep	Change in dimensions	No	3.6.2.1		A
				Hydriding	Change in dimensions	No	3.6.2.2		
				Radiation embrittlement	Loss of strength	No	3.6.1.10		
				Fatigue	Cracking	No	3.6.1.11		
Poison rod assemblies (PWR)	CR	Stainless steel	Helium	Creep	Change in dimensions	No	3.6.2.1		A
				General corrosion	Loss of material	No	3.6.2.3		
				Stress corrosion cracking	Cracking	No	3.6.2.4		
				Radiation embrittlement	Loss of strength	No	3.6.1.10		
				Fatigue	Cracking	No	3.6.1.11		

** W74 canisters for BWR fuel can accomodate a maximum assembly burnup limited to 40,000 MWd/MTU as noted in the W74 Technical Specifications..

W21 canisters for PWR fuel can accomadate a maximum assembly burnup limited to < 60,000 MWd/MTU as noted in approved W21 Technical Specification Table 2.1-1. For the W21 canisters loading PWR fuel assemblies, the exposure (burnup) of any inserted control component must not exceed that of the host assembly. For burnups exceeding 45,000 MWd/MTU, cladding oxide layer thickness is limited to 70µm, to be determined in accordance with W21 Technical Specification 5.3.7. Burnups greater than 60,000 MWD/MTU are not qualified for storage in the W21 canisters as noted in the W21 Technical Specification Table 2.1-5 through Table 2.1-8 notes.
It should be noted that no W21 fuel canisters have been loaded as of this CoC renewal.

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 2-8 Fuel Transfer and Auxiliary Equipment (2 pages)

Structure, System, or Component	Intended Safety Function	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Canister Vertical Lift Fixture	SR	Steel	Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		Safety Related
				Galvanic corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.3		
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Radiation embrittlement	Cracking	No	3.2.1.9		
Cask Lifting Yoke	SR	Steel	Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		Safety Related
				Galvanic corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.3		
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Radiation embrittlement	Cracking	No	3.2.1.9		
Cask Cavity Axial Spacer	SR	Steel	Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		ITS
				Galvanic corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.3		
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Radiation embrittlement	Cracking	No	3.2.1.9		
Shielded Docking Collar	SR, SH	Steel	Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		ITS
				Galvanic corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.3		
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Radiation embrittlement	Cracking	No	3.2.1.9		
Cask Restraints	SR	Steel	Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		ITS
				Galvanic corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.3		
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Radiation embrittlement	Cracking	No	3.2.1.9		

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

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Table 2-8 Fuel Transfer and Auxiliary Equipment (2 pages)

Structure, System, or Component	Intended Safety Function	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual CAT
Empty Canister Lift Fixture	SR	Steel	Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		Safety Related
				Galvanic corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.3		
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Radiation embrittlement	Cracking	No	3.2.1.9		
Standard Lifting Slings (inside plant facility)	SR	Steel	Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		Safety Related
				Galvanic corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.3		
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		
				Radiation embrittlement	Cracking	No	3.2.1.9		
Storage Cask Impact Limiter	SR	Steel	Sheltered	General corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.1		NITS
				Galvanic corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.3		NITS
				Pitting and crevice corrosion	Loss of material	Monitoring of Metallic Surfaces AMP	3.2.1.2		NITS
				Microbiologically influenced corrosion	Loss of material	No	3.2.1.4		NITS
				Radiation embrittlement	Cracking	No	3.2.1.9		
		Poly-urethane	Embedded	Thermal aging	Polymer degradation	No	Supporting Analysis in Section 3.3.5.2.1 of the FuelSolutions Renewal Application.		B
				Radiation embrittlement	Alter polymer structures	No			B
				Microbiological contamination	Polyurethane degradation	No			B
				Humidity	Polyurethane surface degradation	No			NITS
Coating on steel components	SR	Coating	Sheltered	Thermal aging	Coating degradation	Monitoring of Metallic Surfaces AMP	3.2.8		NITS

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 2-9 - FuelSolutions Storage System FSAR Drawings

(a,c)

Notes:

(1) Initial Storage System FSAR [2.3] associated with CoC 1026 initial issue.

(2) FSAR Revision 1 [2.3] incorporated biennial changes in accordance with 10 CFR 72.48

(3) FSAR Revision 2 [2.3] incorporated biennial changes in accordance with 10 CFR 72.48
No drawing revisions have been made after Storage System FSAR Revision 2.

Table 2-10 - FuelSolutions W21 Canister FSAR Drawings (2 Pages)

(a,c)

Table 2-10 - FuelSolutions W21 Canister FSAR Drawings (2 Pages)

(a,c)

Notes:
Initial W21 Canister FSAR [2.4] associated with CoC 1026 initial issue.
FSAR Revision 1 [2.4] incorporated biennial changes in accordance with 10 CFR 72.48.
No drawing revisions have been made after W21 Canister FSAR Revision 1.

Table 2-11 - FuelSolutions W74 Canister FSAR Drawings

(a,c)

Notes:
(1) Initial W74 Canister FSAR [2.5] associated with CoC 1026 initial issue.
(2) FSAR Revision 1 [2.5] incorporated changes from CoC 1026 Amendment 1. Added Drawing 3319.
(3) FSAR Revision 2 [2.5] incorporated changes from CoC 1026 Amendment 2. No drawing revisions.
(4) FSAR Revision 3 [2.5] incorporated biennial changes in accordance with 10 CFR 72.48. No drawing revisions have been made after W74 Canister FSAR Revision 3.

Table 2-12 - Intended Safety Functions of SNF Assembly Subcomponents

Subcomponent	Intended Safety Functions[(1)]
Fuel Pellets	---
Fuel Cladding	CO, CR, RE, SH, SR, TH
Spacer Grid Assemblies	CR, RE, SR, TH
Upper and Upper End Fitting	CR, RE, SR
Guide Tubes (PWR) or water channels (BWR)	CR, RE, SR
Control Components	---[(2)]

Notes:

(1) Intended safety functions are abbreviated as follows: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

(2) The FuelSolutions criticality analysis does not credit negative reactivity effects of control components. Therefore, the control components do not have a criticality control function.

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Table 2-13 ISFSI Pad (2 pages)

Structure, System, or Component	Intended Safety Function	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual Cat
Reinforced concrete: ISFSI pad	SR*	Concrete	Air—outdoor	Aggressive chemical attack	Cracking	Not Applicable for Renewal **	3.5.1.5		NITS
					Loss of strength	Not Applicable for Renewal **	3.5.1.5		
					Loss of material (spalling, scaling)	Not Applicable for Renewal **	3.5.1.5		
					Reduction of concrete pH (reducing corrosion resistance of steel embedments)	Not Applicable for Renewal **	3.5.1.5		
				Creep	Cracking	No	3.5.1.2		
				Dehydration at high temperatures	Cracking	No	3.5.1.11		
					Loss of strength	No	3.5.1.11		
				Delayed ettringite formation	Loss of material (spalling, scaling)	No	3.5.1.13		
					Loss of strength	No	3.5.1.13		
					Cracking	No	3.5.1.13		
				Differential settlement	Cracking	No	3.5.1.4		
				Fatigue	Cracking	No	3.5.1.10		
				Freeze and thaw	Cracking	Not Applicable for Renewal **	3.5.1.1		
					Loss of material (spalling, scaling)	Not Applicable for Renewal **	3.5.1.1		
				Radiation damage	Cracking	No	3.5.1.9		
					Loss of strength	No	3.5.1.9		
				Reaction with aggregates	Cracking	Not Applicable for Renewal **	3.5.1.3		
					Loss of strength	Not Applicable for Renewal **	3.5.1.3		
				Salt scaling	Loss of material (spalling, scaling)	Not Applicable for Renewal **	3.5.1.14		
				Shrinkage	Cracking	No	3.5.1.7		
				Leaching of calcium hydroxide	Loss of strength	Not Applicable for Renewal **	3.5.1.8		
					Increase in porosity and permeability	Not Applicable for Renewal **	3.5.1.8		
					Reduction of concrete pH (reducing corrosion resistance of steel embedments)	Not Applicable for Renewal **	3.5.1.8		
			Groundwater/soil	Aggressive chemical attack	Cracking	Not Applicable for Renewal **	3.5.1.5		
					Loss of strength	Not Applicable for Renewal **	3.5.1.5		
					Loss of material (spalling, scaling)	Not Applicable for Renewal **	3.5.1.5		
					Reduction of concrete pH (reducing corrosion resistance of steel embedments)	Not Applicable for Renewal **	3.5.1.5		
				Creep	Cracking	No	3.5.1.2		
				Dehydration at high temperatures	Cracking	No	3.5.1.11		
					Loss of strength	No	3.5.1.11		
				Delayed ettringite formation	Loss of material (spalling, scaling)	No	3.5.1.13		
					Loss of strength	No	3.5.1.13		
					Cracking	No	3.5.1.13		
				Differential settlement	Cracking	Not Applicable for Renewal **	3.5.1.4		
				Fatigue	Cracking	No	3.5.1.10		

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

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Table 2-13 ISFSI Pad (2 pages)

Structure, System, or Component	Intended Safety Function	Material	Environment	Aging Mechanism	Aging Effect	Aging Management Activity	Technical Basis (NUREG-2214 Section)	(a,c)	Qual Cat
				Freeze and thaw	Cracking	Not Applicable for Renewal **	3.5.1.1		
					Loss of material (spalling, scaling)	Not Applicable for Renewal **	3.5.1.1		
				Microbiological degradation	Loss of strength	Not Applicable for Renewal **	3.5.1.12		
					Loss of material (spalling, scaling)	Not Applicable for Renewal **	3.5.1.12		
					Increase in porosity and permeability	Not Applicable for Renewal **	3.5.1.12		
					Reduction of concrete pH (reducing corrosion resistance of steel embedments)	Not Applicable for Renewal **	3.5.1.12		
				Radiation damage	Cracking	No	3.5.1.9		
					Loss of strength	No	3.5.1.9		
				Reaction with aggregates	Cracking	Not Applicable for Renewal **	3.5.1.3		
					Loss of strength	Not Applicable for Renewal **	3.5.1.3		
				Salt scaling	Loss of material (spalling, scaling)	Not Applicable for Renewal **	3.5.1.14		
				Shrinkage	Cracking	No	3.5.1.7		
				Leaching of calcium hydroxide	Loss of strength	Not Applicable for Renewal **	3.5.1.8		
					Increase in porosity and permeability	Not Applicable for Renewal **	3.5.1.8		
					Reduction of concrete pH (reducing corrosion resistance of steel embedments)	Not Applicable for Renewal **	3.5.1.8		
		Reinforcing steel	Air—outdoor; groundwater	Corrosion of reinforcing steel	Loss of concrete/steel bond	Not Applicable for Renewal **	3.5.1.6		NITS
					Loss of material (spalling, scaling)	Not Applicable for Renewal **	3.5.1.6		
					Cracking	Not Applicable for Renewal **	3.5.1.6		
					Loss of strength	Not Applicable for Renewal **	3.5.1.6		

****** The ISFSI pad for the FuelSolutions Storage System is classified as not important to safety. Potential ISFSI pad degradation would not adversely affect important to safety cask functions.
To assure that degradation of the ISFSI pad resulting in large differential settlements does not occur, minimum design and construction requirements are identified for the ISFSI pad.
Refer to FSAR WSNF-220 [2.3], Section 2.6.3.5 "ISFSI Pad Requirements."
ISFSI concrete pad is to be graded for effective drainage.
Per NUREG-1536, ACI 349 was used for the design of the ISFSI pad at BRP (Ref: UFHSR 09-15-2006 Consumers Ltr - ML062610419.
FuelSolutions Calculation Package CMP 1504.005, Rev 2, *"Determination of G-loads for the Storage Cask End Drop and Transfer Cask Side Drop"* provided confirmation that the BRP ISFSI design basis deceleration loads for the storage cask and canister are not exceeded.

*Safety Functions: Confinement (CO), Subcriticality (CR), Retrievability (RE), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

3. AGING MANAGEMENT REVIEW

Introduction

The purpose of the aging management review (AMR) for the FuelSolutions Storage System Certificate of Compliance (CoC) 1026 is to assess the need for aging management activities (AMAs) of structures, systems, and components (SSCs) determined to be within the scope of renewal for CoC 1026. The AMR addresses aging mechanisms and effects that could adversely affect the ability of the SSCs, including their associated subcomponents, to perform their intended safety functions during the requested 40 year period of extended operation. The initial design life for the W21 canisters, W74 canisters and W150 storage casks is 100 years. The W100 transfer cask has been engineered to perform its design functions for 40 years.

Utilizing the guidance of NUREG-1927 [2.1] along with that provided by NUREG-2214 [2.2], this section addresses the technical bases and considerations used in conducting the FuelSolutions Storage System AMR. The areas considered include:

- identification of materials and environments of SSCs and associated subcomponents within the scope of renewal
- identification of aging mechanisms and the effects requiring management
- identification of time-limited aging analyses (TLAAs), if applicable, and aging management programs (AMPs) for managing the effects of aging for SSCs within scope

The W150 Storage Cask (W150) and W100 Transfer Cask (W100) FSAR [2.3], the W21 Canister (W21) FSAR [2.4] and the W74 Canister (W74) FSAR [2.5] including the associated design drawings were utilized as the primary documents to identify the safety classifications, intended functions, materials, and service environments of the SSCs and subcomponents.

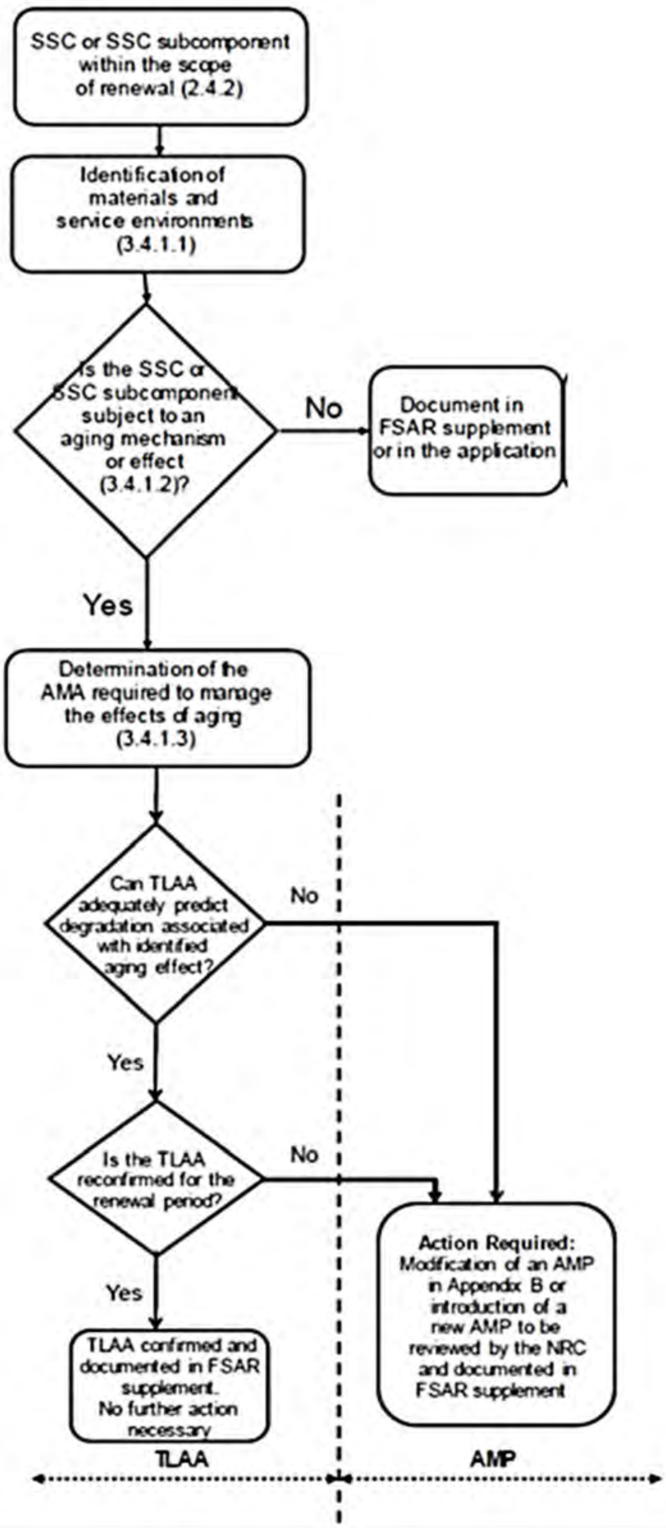
The AMR decision process utilized the flowchart obtained from NUREG-1927 as shown in Figure 3-1.

Section 3.1 describes the direct operating experience of the FuelSolutions Storage System casks in service as of this AMR date.

Section 3.2 describes the Aging Management Review Methodology utilized following the guidance of NUREG-1927 and the identification of in-scope SSC's requiring Aging Management Review. Section 3.2.2 describes AMR Materials and Environments. Section 3.2.3 describes the identification of Aging Effects Requiring Management. Section 3.2.4 describes the aging management activity (TLAA or AMP) to manage the effects of aging.

Section 3.3 presents the results of the Aging Management Review along with a description of the FuelSolutions Storage System SSCs. Section 3.4 identifies the Time-Limited Aging Analyses (TLAAs) needed and Section 3.5 identifies the Aging Management Programs (AMPs) required.

Figure 3-1 Aging Management Review Process



NOTE: Figure shown is the AMR Process Flowchart per NUREG-1927 [2.1] Figure 3-1

3.1 Operating Experience Review

3.1.1 FuelSolutions Storage System Operating Experience

A total of seven FuelSolutions Storage System casks have been loaded with spent nuclear fuel and are currently in service at the Big Rock Point ISFSI site which is located in Michigan north of the town of Charlevoix, on the shore of Lake Michigan. The Big Rock Point W150 Dry Fuel Storage Casks with W74 Canisters were loaded in 2002 and 2003 and continue to be stored in accordance with Amendment 2 of the FuelSolutions Storage System CoC 1026.

3.1.2 User Operating Experience

A review of user operating experience for the FuelSolutions Storage System was performed to evaluate if there was any operating experience or inspection results that would impact the aging of the system. As of 2020, the FuelSolutions system is only in use at the Big Rock Point ISFSI located in Michigan. Therefore, the review only includes items at that site. This review found the following items:

- W150 Storage Cask Concrete and Grout Degradation
  - ➢ A few concrete "bug holes" [Ref 2.2, Table 6-3] and pits were found and repaired on the seven W150 storage casks.
  - ➢ Degraded grout in some cask seam locations was found and repaired.
  - ➢ No deterioration of cask coatings was identified in periodic inspections.
  - ➢ Concrete hairline cracks, which occurred during the initial cask loading time frame, near some of the W150 storage cask tie rod locations have not propagated.
  - ➢ Concrete handling damage, which occurred in a small area on one W150 storage cask was found and repaired during the canister loading campaign.
- W100 Transfer Cask
  - ➢ No deleterious coating degradation noted during periodic inspections.
  - ➢ No neutron shield tank leakage identified during periodic pressure test using air at approximately 5 psi.
  - ➢ Neutron shield tank relief valve found to be correctly set between 40 and 45 psig during periodic inspections.
- W74 Canister
  - ➢ No W74 canister degradation found during each five year borescope visual inspection of W150 Storage Cask #7 interior.

- Impact Limiters
  - Some deteriorated paint on impact limiter steel sheeting was noted during periodic inspections. No degradation of the steel sheeting encasing the impact limiter rigid polyurethane foam was noted.
- J-Skid and Other Auxiliary Equipment
  - Operable components have been exercised periodically with no degradation identified.

The conditions noted are proposed to be monitored by the aging management programs described in Appendix A for the applicable components. The types of degradation previously seen were utilized in determining the criteria for future inspections. Trending of these conditions and corrective actions, as necessary, are also part of the proposed aging management programs. The reviewed operating experience evaluations covered the in scope subcomponents. Out of scope components listed in Chapter 2 were not evaluated for this renewal application. In addition, relevant operating experience was gathered from the inspections of other dry fuel storage systems as described in Appendix C.

The aging management programs in Appendix A were developed considering this operating experience.

3.1.3 User Exemption Requests

No exemption requests have been identified at the time of writing this renewal application that have implications regarding aging management involving the design basis requirements for the structures, systems and components (SSCs) at the Big Rock Point ISFSI. If exemption requests are made in the future, they should be evaluated for impact on aging management.

3.2 Aging Management Review Methodology

The aging effects that may adversely affect the ability of SSC to perform intended safety functions during the extended period of operations have been assessed in this AMR. This AMR utilizes the recommended methodology provided in NUREG-1927 [2.1]. The aging management review process involves three major steps. This AMR utilizes the decision flowchart shown on Figure 3-1. The major steps are outlined as follows:

- Identify materials and service environments
- Identify aging mechanism or effects requiring management
- Identify the TLAAs or AMPs to manage the aging effects

3.2.1 Identification of In-Scope SSC's Requiring Aging Management Review

As discussed in Chapter 2, the SSC and subcomponents involving potential aging effects were identified as being in-scope for license renewal and aging management review. These SSCs / subcomponents are presented in Table 2-4 through Table 2-8 in Chapter 2.

SSC or subcomponents that are not in scope for renewal are excluded from evaluation in this AMR.

3.2.2 Identification of Materials and Environments

The FuelSolutions FSARs [2.3, 2.4, 2.5] provide a detailed description of the FuelSolutions Storage System and the materials used in the SSCs. Each in-scope SSC / subcomponent for aging management, with its intended function, material, and service environment is listed on Table 2-4 through Table 2-8. SSCs or subcomponents that do not have a safety function or support a safety function are not required to undergo aging management. A summary of the materials used in the aging management review is provided in Table 3-1.

Table 3-1 Summary of Materials

Term	Usage in this Document
Aluminum	Includes pure aluminum and alloys
Boral	A laminate composite that is used as a neutron absorber material. It consists of a core of aluminum and boron-carbide powder sandwiched between sheets of aluminum.
Borated stainless steel	Boron embedded in stainless steel with boron concentrations ranging from 1.0 to 1.25 weight percent natural boron for neutron absorption.
Coating	Coating on carbon steel components for corrosion protection. Thermal coatings on some components.
Concrete	A mixture of hydraulic cement, aggregates, and water, with or without admixtures, fibers, or other cementitious materials.
Depleted Uranium	Uranium metal reduced in the isotope U-235 used for canister top and bottom shielding.
Grout	Used for filling the FuelSolutions storage cask segment seams.
Lead	Used for canister shield plug and transfer cask shielding.
Neutron Shielding	RX-277 and NS-3 are castable solid materials used for neutron shielding in the transfer cask top and bottom covers.
Nickel Alloy	Includes Inconel, which is a family of austenitic nickel-chromium-based super alloys.
Stainless Steel	Stainless steel austenitic and martensitic alloys of various types such as 304, 304L, 316, 316L and 17-4 PH
Zirconium-based alloys	Materials of construction of fuel cladding and fuel assembly hardware. Various zirconium- based materials have been used in commercial reactor applications because of their low neutron cross section and excellent corrosion resistance to a variety of environmental conditions. This category includes (but is not limited to) Zircaloy-2, Zircaloy-4, ZIRLO, and M5.
Carbon Steel	Various carbon steels including ASTM A36, ASTM A320, SA193-Gr. B7, SA516-Gr. 70 and reinforcing steel.

A generic description of the four basic environments is provided below.

3.2.2.1 Helium

Helium environment refers to the inside of the W21 and W74 canisters. Following the canister drying process, the canisters are backfilled with high purity helium gas. As a result, the canister's internal environment has negligible, if any, amounts of moisture or air. The canister's helium environment may experience a range of temperatures as calculated for the W21 and W74 canisters.

3.2.2.2 Sheltered Environment

Sheltered environment refers to environments that may include ambient air, but are shielded from sunlight, precipitation and direct wind. The sheltered environment in the FuelSolutions Storage System design is the annular space created between the W150 storage cask and the W21 or W74 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.

Sheltered environment may also refer to the interior of a building providing protection from elements including sunlight, rain, and wind.

3.2.2.3 Embedded Environment

Embedded environment applies to materials that are in contact with or sealed inside another component or material. This may prevent ingress of gases, water or contaminants to the embedded surface, depending on the permeability of the embedding environment. Items in this environment include the shield plugs in the W21 and W74 canisters as well as the rebar and internal metal items of the W150 storage cask. The embedded item is subject to the temperature of the component in which it is embedded.

3.2.2.4 Air-Outdoor Environment

"Air-outdoor environment" is used for exterior surfaces that are directly exposed to weather, including precipitation and wind and which may transport dust or moisture with dissolved salt. The in-scope components in an air-outdoor environment in the FuelSolutions Storage System are the W150 storage casks and, depending on the licensee ISFSI, the W100 transfer cask. The air-outdoor environment has temperature ranges equivalent to the site ambient temperature ranges where the ISFSI is located.

3.2.3 Identifying Effects Requiring Aging Management

After the materials and environments were identified, the next step involves determining the aging effects requiring management. Aging effects requiring management during the renewed license period are those that could cause a loss of SSC intended function. If degradation of a subcomponent would be insufficient to cause a loss of function or the relevant conditions do not exist for the aging effect to occur and propagate, then no aging management is required. These aging effects were determined based on a review of NRC MAPS report (NUREG-2214) [2.2], related industry technical literature and the combination of SSC materials and environments, industry operating experience, and maintenance and inspection records from general licensees (such as condition reports and inspection reports). Both potential aging effects that could theoretically occur, as well as aging effects that have occurred based upon industry operating experience were considered.

Aging effects occur as a result of various mechanisms. To manage the effects of aging, the mechanisms that may affect the material need to be considered. The AMR process identifies both aging effects and the aging mechanism causing that effect. The aging effects and mechanisms for each SSC are broken down by subcomponent in Table 2-4 through Table 2-8. The tables in Chapter 2 note which subcomponents have ITS related functions during the extended storage period.

3.2.4 Determination of Aging Management Activities

Aging management activities are established to manage the effect of aging of SSC during the extended license period. ISFSI programs and activities are credited to manage these aging effects that have the potential to cause a loss of intended function during the renewed license period.

As described in Section 3.4.1.3 of NUREG-1927 [2.1], there are two methods to address potential aging mechanisms and effects on components; consisting of a time-limited aging analysis (TLAA) or an aging management program (AMP).

3.2.4.1 Time-Limited Aging Analysis (TLAA)

As required by 10 CFR 72.240(c)(2), the CoC application for renewal must include Time-Limited Aging Analyses (TLAA) that demonstrates that structures, systems, and components important to safety will continue to perform their intended function for the requested period of extended operation. Per 10 CFR 72.3, a Time-Limited Aging Analysis (TLAA) refers to a calculation or analysis that meets all of the following attributes:

- Involves SSCs important to safety within the scope of the license or CoC renewal,
- Considers the effects of aging,
- Involves time-limited assumptions defined by the current operating term,
- Was determined to be relevant in making a safety determination,
- Involves conclusions or provides the basis for conclusions related to the capability of the SSCs to perform their intended safety functions, and
- Is contained or incorporated by reference in the design bases.

3.2.4.2 Aging Management Program (AMP)

An Aging Management Program (AMP) monitors and controls the degradation of SSCs within the scope of renewal so that aging effects will not result in a loss of intended functions during the period of extended operation. in accordance with NUREG-1927. An AMP includes activities that are credited for managing aging mechanisms or effects for specific SSCs, including activities conducted during the initial storage period. The AMP may include preventive, mitigation, or condition / performance monitoring activities. An AMP is to be started as the FuelSolutions Storage System reaches the end of the initially licensed period and serves to support the

FuelSolutions Storage System during the renewed license period. The information gained from an AMP will provide reasonable assurance that the subcomponent maintains it's function.

3.3 Aging Management Review Results

3.3.1 Aging Management Review Results – W21 and W74 Canisters

Table 2-4a and Table 2-4b summarize the results of the aging management review for the W21 and W74 canister subcomponents determined to be in the scope of the license renewal.

Additional description of the W21 and W74 canister subcomponents is provided in Section 3.3.1.1, while Sections 3.3.1.2 and 3.3.1.3 present the materials and environments for the specified subcomponents. The aging effects requiring management and the proposed activities required to manage these effects are discussed in Sections 3.3.1.4 and 3.3.1.5, respectively.

3.3.1.1 Description of W21 and W74 Canister Subcomponents

W21 and W74 Canisters

The W21 and W74 canisters are welded cylindrical structures with flat ends that provide confinement of the spent nuclear fuel during storage operations. The confinement boundary, comprised of the bottom closure plate, the shell, the top inner closure plate, vent and drain port tops or adapters, port covers, and associated welds, is constructed entirely of stainless steel. The W21 and W74 top outer closure plate, with welded port covers, is a circular plate edge-welded to the canister shell providing a redundant welded closure. Access to the canister cavity for the purposes of water and moisture removal and subsequent backfilling with a high purity helium is achieved via the vent and drain ports. Additional details regarding the W21 and W74 canister descriptions are included in sections 2.2.2.2 and 2.2.2.3 of this renewal application.

W21 and W74 Canister Fuel Baskets

The FuelSolutions W21 canister basket assemblies consist of a series of spacer plates, support rod assemblies, and poisoned guide tube assemblies. The guide tube assemblies provide lateral support for the fuel assemblies and maintain the position of the neutron absorbing material. The spacer plates maintain the relative spacing between guide tubes and provide structural support in the lateral direction for the basket assembly and SNF payload. The spacer plates are positioned and supported longitudinally by eight support rod assemblies.

FuelSolutions W74 canister includes an upper and lower basket assembly which are similar in construction. Each assembly consists of a series of spacer plates, support tube assemblies, and guide tube assemblies. The upper basket assembly includes an engagement spacer plate which supports the SNF assemblies in the upper basket assembly for normal vertical transfer and storage. The guide tube assemblies provide lateral support for the SNF assemblies and maintain the position of the neutron absorbing material. The spacer plates maintain the relative spacing between guide tubes and provide structural support for the basket assembly and SNF assemblies in the lateral direction. The spacer plates are positioned and supported longitudinally by four support tube assemblies.

Damaged Fuel Cans

Spent nuclear fuel assemblies to be stored in the FuelSolutions W21 canister must be intact zircaloy-clad fuel with no known or suspected cladding defects greater than pinhole leaks or hairline cracks. For SNF assemblies with burnup exceeding 45 GWd/MTU (up to 60 GWd/MTU), the cladding oxide thickness is limited to 70 µm. Fuel assemblies that do not meet these criteria are considered damaged fuel, and are not acceptable for storage in the FuelSolutions W21 canister at this time. Missing or damaged fuel rods may be replaced with dummy rods that displace an equal amount of water as the original rods to permit storage in the FuelSolutions W21 canister.

MOX and UO2 fuel can be stored in the FuelSolutions W74 canister inside of specially designed FuelSolutions W74 damaged fuel can assemblies. The FuelSolutions W74 canister is designed to accommodate up to eight damaged fuel assemblies. Each damaged fuel assembly is placed inside a FuelSolutions W74 damaged fuel can within the upper or lower basket assembly support tubes. The FuelSolutions W74 damaged fuel can is designed to contain damaged or undamaged fuel assemblies during all normal, off-normal, and accident conditions for on-site storage and transfer operations. The FuelSolutions W74 damaged fuel can, containing a damaged fuel assembly, is designed to be handled vertically. The bottom end of the damaged fuel can incorporates screened holes to allow for water drainage. The damaged fuel can utilizes borated stainless steel neutron absorber sheets on all four faces of the tube. Material details for the W74 canister subcomponents are provided in Table 2-4a. Rod fragments and/or loose pellets (i.e., fuel debris) are not qualified for loading into the damaged fuel cans in the W74 canister.

3.3.1.2 W21 and W74 Canister Materials

Depending on the canister type, the baskets in the W21 and W74 canisters are constructed of stainless steel or high-strength carbon steel materials. Carbon steel basket subcomponents are coated with electroless nickel for corrosion protection following canister fabrication and during the brief immersion period during fuel loading in the spent fuel pool. The basket neutron absorbers are made from either Boral® for the W21 canisters or borated stainless steel for the W74 canisters. The Boral® used in the W21 canisters is encased and seal welded in stainless steel to alleviate water immersion of the neutron absorber panel material and possible aluminum corrosion and hydrogen generation while immersed.

Other W21 and W74 canister subcomponents in the scope of the license renewal are stainless steel, except for the embedded shield plugs which may consist of either depleted uranium, lead or carbon steel depending on the canister class. The bottom end shield plugs are embedded in stainless steel consisting of the canister bottom closure plate, the shell extension and the bottom end plate. Depending on the canister class, the top end depleted uranium or lead shield plugs are embedded in stainless steel, while top end carbon steel shield plugs are coated with electroless nickel for corrosion resistance.

The W74 canister damaged fuel cans, including the top lid assemblies, are fabricated from stainless steel with a borated stainless steel neutron absorber plate attached to the exterior surface of each of the four sides of a damaged fuel can.

Additional material details for the W21 and W74 canister subcomponents are provided in Tables 2-4a and 2-4b.

3.3.1.2.1 *Precipitation-hardened martensitic stainless steel subcomponents*

Type 17-4 precipitation-hardened (17-4PH) martensitic stainless steel operating at high temperatures may be susceptible to thermal embrittlement depending on several factors including the alloy composition within the allowable specifications, the initial heat treatment, and the operating temperature. For operating temperatures between 243 °C and 316 °C (470 to 600 °F), Section 3.2.2.8 of NUREG-2214 [1.4] recommends an evaluation of conditions on a per-component basis considering operating temperature, exposure time, operating environment, stress levels, and material composition.

The only FuelSolutions System components made of 17-4PH martensitic stainless steel are the support rod subcomponents of the W21T canister. No 17-4PH martensitic stainless steel subcomponents are used in the W21M, W74T or W74M canisters. For normal storage conditions, the W21T support rod subcomponents have a maximum temperature of 472 °F (Table 4.4-2 of the W21 Canister FSAR [2.4]). This and other W21 Canister FSAR storage case evaluations determined that the maximum support rod subcomponent temperatures were below the reported threshold temperature for 17-4PH thermal embrittlement of 500 °F in Appendix E.3 of Electrical Power Research Institute (EPRI) Report TR-1012081 [3.3]. In addition, there is conservatism in the thermal model used to estimate the support rod temperature as noted in the W21 Canister FSAR (e.g., modeling 25.1 kW for the W21 canister thermal rating instead of the allowed fuel thermal rating of 22 kW).

The time that the support rod subcomponents would be above the recommended 470 °F is limited because of the minimal time that the ambient temperature would be at the normal maximum temperature of 100 °F and the continuing decay of the heat source. Therefore, it is concluded that thermal aging embrittlement is unlikely to affect the mechanical properties of the 17-4PH steel support rod subcomponents during the period of extended storage.

It should be noted that Chapter 4 of the W21 Canister FSAR [2.4] evaluates a number of other non-storage thermal analysis cases involving canister loading, handling and transfer in which these one-time temperature evolutions only last from several hours to a few days. These one-time short-term evolutions involve worst case W21T canister support rod temperatures which never exceed the ASME Code maximum allowable temperature of 650 °F for 17 4PH martensitic stainless steel. Given the one-time, short-term time periods that the support rod subcomponents may exceed 500 °F [3.3], it is concluded that thermal aging is not an issue for these W21 Canister FSAR non-storage cases.

Therefore, thermal aging of the precipitation-hardened martensitic stainless steel is not considered a credible aging mechanism during the period of extended storage.

3.3.1.2.2 *Fuel basket bolt*

Section 3.2.1.10 of NUREG-2214 [1.4] provides guidance for aging management of steel bolting in higher temperature environments (such as the canister interior helium environment) to look for evidence of loss of bolt preload due to stress relaxation. W74 canister drawing W74-120 lists a subcomponent which shows that sixteen steel fuel basket bolts are used for each W74 canister fuel basket. The corresponding NUREG-2214 MAPS Report aging management review line item for this subcomponent in Table 4-21 of the MAPS report states that a "TLAA/AMP or a supporting analysis is required" to address loss of preload due to stress relaxation of these steel fuel basket bolts in a helium environment.

The sixteen W74 canister 7/16"-14 UNC-2A x 1" long steel fuel canister bolts are all used in conjunction with 7/16" split stainless steel lock washers. As stated in Sections 3.2.2.6, *Creep*, and 3.2.2.8, *Thermal Aging*, of NUREG-2214 creep and thermal aging of austenitic stainless steel is negligible at canister internal temperatures which may range up to 752 °F. During a 60-year period of extended of storage 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.

The actual structural functions of these sixteen steel fuel canister bolts are not important to safety during canister storage periods. Eight of the bolts attach the engagement spacer plate to the bottom of the top fuel basket during installation of the top fuel basket into the W74 canister after the bottom fuel basket has been loaded with spent fuel assemblies. The eight bolts prevent the engagement spacer plate from falling on the loaded bottom fuel basket. During storage the engagement spacer plate and loaded upper basket is supported by the four lower basket support tubes, and the eight fuel basket bolts serve no structural function. In the unlikely event the spent fuel assemblies were ever to be unloaded from a W74 canister, the eight fuel basket bolts would again function to prevent the engagement spacer plate installed on the bottom of the upper fuel basket from falling on the loaded bottom fuel basket as the unloaded upper fuel basket is removed from the W74 canister.

Four of the other eight fuel basket bolts attach two stainless steel straps to the center of the top spacer plate on the bottom fuel basket, and the other four fuel basket bolts attach a cruciform plate to the center of the top spacer plate on the top fuel basket. The straps prevent spent fuel assemblies from being loaded into the five center guide tubes in the lower fuel basket, and the cruciform plate prevents spent fuel assemblies from being loaded into the five center guide tubes in the top fuel basket. Both the two straps and the cruciform plate are classified as not important to safety and serve no structural or safety function after spent fuel assemblies are loaded into the W74 canister.

Based on the above evaluation, any loss of preload due to stress relaxation of the steel fuel basket bolts during the 60-year period of extended storage does not present a W74 canister safety concern.

3.3.1.3 W21 and W74 Canister Environments

The environments that affect the W21 and W74 canister subcomponents, both externally and internally, are described below.

3.3.1.3.1 *External*

Each W21 and W74 canister is stored in a vertical, ventilated W150 storage cask. Based on this design, the external surface of each canister is exposed to the same environment as the inside of the W150 storage cask (described in Subsection 3.3.2), which is a sheltered environment that includes ambient air but is protected from precipitation, direct wind and sunlight. The ambient air may contain moisture, dust and atmospheric contaminants. The normal operating temperature of the outside of the W21 or W74 vertical canister surface is typically highest towards the top. Refer to the respective FSAR Figure 3.5-1 for canister shell axial temperature profiles Maximum surface temperature limits are unchanged. The variations in canister external temperature does not change potential aging mechanisms and does not change the programs needed to manage them.

3.3.1.3.2 *Internal*

The W21 and W74 canisters are filled with the inert helium gas. The canister fuel basket assembly subcomponents and the W74 damaged fuel can subcomponents are exposed to this helium gas environment. The currently licensed maximum temperature limits remain the same for the license renewal period. Changes in canister temperatures do not change potential aging mechanisms and does not change their management.

3.3.1.4 Aging Effects Requiring Management (W21 and W74 Canisters)

Based on the materials of construction and the environments experienced during the period of extended storage for W21 and W74 canister the aging effects that require management are cracking (due to corrosion and stress corrosion cracking on the external canister surfaces), the loss of material, and radiation effects on the neutron absorber and steel components.

3.3.1.5 Aging Management Activities (W21 and W74 Canisters)

Based on the aging management review of the W21 and W74 canister subcomponents documented in Tables 2-4a and 2-4b, including the basket assembly subcomponents and the W74 damaged fuel can subcomponents, an AMP is required for the aging management activities of the W21 and W74 canisters and a TLAA is required specifically for the effects of radiation on the neutron absorbers. These aging management activities are discussed in detail in Sections 3.4 and 3.5.

3.3.2 Aging Management Review Results – W150 Storage Cask

Table 2-5 summarizes the results of the aging management review for the W150 storage cask subcomponents determined to be in the scope of the license renewal.

Additional description of the W150 storage cask subcomponents is provided in Section 3.3.2.1, while Sections 3.3.2.2 and 3.3.2.3 present the materials and environments for the specified subcomponents. The aging effects requiring management and the proposed activities required to manage these effects are discussed in Sections 3.3.2.4 and 3.3.2.5, respectively.

3.3.2.1 Description of W150 Storage Cask Subcomponents

The W150 storage cask provides structural support, shielding, and supports natural circulation cooling for the W21 and W74 canisters. The W150 storage cask is ventilated by internal air flow paths which allow the decay heat to be removed by natural circulation around the metal W21 and W74 canister wall. Natural convection air enters the system horizontally through the four inlet vents and channels located at the bottom of the storage cask, converges vertically into the central inlet plenum, flows upward into the storage cask cavity, flows radially outward under the canister and through/between the canister support tubes, flows upward through the dual annuli formed by the cask liner, thermal shield, and canister shell, and finally flows outward to ambient through the outlet vents at the top of the cask. The internal cavity of the W150 storage cask has a coated steel liner and bottom plate. The steel and concrete walls of the W150 storage cask are designed to minimize side surface radiation dose rates. The steel liner is coated to promote radiant heat dissipation and to minimize corrosion. An aluminum thermal shield is located between the canister exterior wall and the W150 storage cask interior wall. The W150 storage cask lid is fabricated from steel and concrete and provides additional gamma attenuation in the upward direction, reducing both direct radiation and skyshine. The W150 storage cask top cover is bolted in place and protects the W21 and W74 canisters from the environment and postulated tornado missiles. A more detailed description is included in paragraph 2.2.2.4 of this renewal application.

3.3.2.2 W150 Storage Cask Materials

The W150 storage cask is fabricated from three reinforced concrete segments with a carbon steel inner liner and bottom plate. The three segments are held together with eight alloy steel tie rods, nuts and washers, with grout used between the keyed concrete segment joints to form a weather tight vertical cylinder. The W150 storage cask reinforced concrete is in contact with the carbon steel inner liner and bottom plate. External concrete surface degradation is mitigated by using a weather-resistant protective coating.

Storage cask materials which come into contact with the canister, such as the canister support pipes and support rails, are coated or fabricated from corrosion resistant stainless steel. The carbon steel components of the storage cask, i.e., the liner, top cover, non-load bearing guide rails, tie rod tubes, and air inlet and outlet liners, are all protected with long lasting temperature- and radiation-resistant coatings. Exposed carbon steel components, such as the storage cask cover, are coated and accessible for re-coating if necessary. Exposed carbon steel components, such as the storage cask liner, which are not readily accessible are coated and not relied upon structurally. The surfaces of the storage cask support rails which contact the canister (during horizontal loading) are faced with Nitronic-60.

Additional material details for the W150 storage cask subcomponents are provided in Table 2-5.

3.3.2.3 W150 Storage Cask Environments

The W150 storage casks are located outdoors at their storage site. The W150 storage casks are designed for exposure to the following environmental temperatures as stated in Sections 2.3.1.1 and 2.3.2.1 of the FuelSolutions Storage System W150 FSAR [2.3]:

- Normal, long-term annual average design temperature of 77°F is selected as bounding for locations in the contiguous United States. Ambient temperature in the range of 0°F to 100°F are considered in the design of the storage cask; and

- Temperature cases of –40°F and 125°F (average daily temperature) are used for W150 storage cask off-normal conditions for the structural evaluation of the FuelSolutions canisters, storage cask, and transfer cask.

The interior components of the W150 storage casks are exposed to a sheltered environment. This environment includes ambient air through the air passages, but does not include precipitation, direct sun, or wind exposure. The ambient air may contain dust, moisture, salinity, or other contaminants.

The metal components of the W150 storage cask that are in contact with concrete, such as the outer surface of the inner shell, are considered to be in an embedded environment. The primary concern for embedded environments is the potential chemical reaction between the two materials. The interactions between materials of the W150 storage cask subcomponents are described in Section 3.3.2.2 and are not considered to be of concern for the extended storage period.

The exterior surfaces of the W150 storage casks are designed to be exposed to the weather-related effects, including insolation, wind, rain, snow, ice, ambient air, and other environmental phenomena at their associated storage sites as an air-outdoor environment. Additionally, the W150 storage casks are exposed to radiation effects from the W21 and W74 stored canisters.

3.3.2.4 Aging Effects Requiring Management (W150 Storage Cask)

Based on a review of the W150 storage cask materials of construction and the environments experienced during the period of extended storage at the ISFSI sites the main aging effects requiring management are loss of material due to corrosion, loss of fracture toughness (due to radiation impacts) for the metal components, and concrete aging issues caused by freeze thaw cycles, alkali-silica reaction, and/or calcium hydroxide leaching.

3.3.2.5 Aging Management Activities (W150 Storage Cask)

Based on the aging management review of the W150 storage cask subcomponents documented in Table 2-5, it has been determined that the aging management activities required for the W150 storage cask are the Reinforced Concrete Structures AMP (for the W150 storage cask concrete) and the Monitoring of Metallic Surfaces AMP (for W150 metallic materials). These aging management activities are discussed in the AMPs identified in Section 3.4. For those components potentially impacted by radiation, the radiation impacts have been evaluated and determined that no additional aging management activities beyond those in the W150 storage cask AMPs are needed. A W150 TLAA is not required since no W150 analysis was incorporated or referenced in the initial W150 design basis.

3.3.3 Aging Management Review Results – Fuel Assembly

Table 2-7 summarizes the results of the aging management review for the Fuel Assembly subcomponents determined to be in the scope of the license renewal.

Additional description of the fuel assembly subcomponents is provided in Section 3.3.3.1, while Sections 3.3.3.2 and 3.3.3.3 present the materials and environments for the specified subcomponents. The aging effects requiring management and the proposed activities required to manage these effects are discussed in Sections 3.3.3.4 and 3.3.3.5, respectively.

3.3.3.1 Description of Fuel Assembly

Fuel contained within the W21 or W74 canister consists of up to 21 PWR or 64 BWR fuel assemblies respectively. Maximum heat loads, and burnups times, along with required cooling times for the subject canister is addressed in the respective Technical Specification. This renewal application evaluates the bounding information as necessary.

Fuel rod cladding provides the primary confinement barrier, while the fuel assembly maintains the axial distribution of the radiological source and its position within the fuel basket. As noted in NUREG-2214 [2.2] fuel assembly hardware includes guide tubes, spacer grids, and lower and upper end fittings. The guide tubes may be fabricated using from zirconium-based alloys. The other components are usually fabricated using various nickel alloys and stainless steels. In the helium environment most of these components are considered to not be subject to credible degradation (creep, fatigue, hydriding, general corrosion, stress corrosion cracking, and radiation embrittlement) and thus, aging management during the 60-year timeframe is not required. However, W21 high-burnup fuel rod cladding may be subject to hydride reorientation and thermal creep and a W21 High-Burnup Fuel Monitoring and Assessment AMP is required.

3.3.3.2 Fuel Assembly Materials

The fuel assembly subcomponents included in the aging management review are made from zircaloy, stainless steel, and/or Inconel. Additional material details for the Fuel Assembly subcomponents are provided in Table 2-7.

3.3.3.3 Fuel Assembly Environments

The FuelSolutions Storage System storage systems is designed to store a wide range of spent fuel assemblies in a dried and inert (helium) atmosphere. After fuel loading, draining and drying, the canister is backfilled with helium to provide an inert environment. The fuel temperatures range from the maximum value corresponding to the short term limit for a maximum canister heat load to the minimum ambient air temperature as the heat load reduces over time.

3.3.3.4 Aging Effects Requiring Management (Fuel Assembly)

Fuel assemblies authorized to be stored in the FuelSolutions Storage System are classified as either moderate-burnup fuel (≤45,000 MWd/MTU) for the W74 canisters or high-burnup fuel (>45,000 MWd/MTU) for the W21 canisters.

For BWR fuel loaded in FuelSolutions W74 canisters, post-irradiation times are defined in FuelSolutions W74 Technical Specifications Table 2.1-9 and Table 2.1-10 with maximum assembly average burnup level limited to 40,000 MWd/MTU for the associated enrichments and parameters noted. For the moderate-burnup fuel, cladding embrittlement due to irradiation damage or hydride formation is not a concern. A report prepared by Pacific Northwest National Laboratory (PNNL-14390 [3.1]), documenting research conducted by EPRI and the US Department of Energy, confirms that similar, non-high-burnup fuel assemblies stored in a helium environment, like the one present inside the W21 and W74 canisters, do not exhibit detectable degradation of the cladding or more than negligible release of gaseous fission products during storage. Therefore, no aging effects requiring management are identified for the moderate-burnup fuel assemblies.

PWR fuel loaded in FuelSolutions W21 canisters must be intact zircaloy-clad fuel with no known or suspected cladding defects greater than pinhole leaks or hairline cracks. For fuel assemblies with burnup exceeding 45 GWd/MTU (up to 60 GWd/MTU), the cladding oxide thickness is limited to 70 μm as prescribed in FuelSolutions W21 Technical Specification [2.12] Section 2.1.1. FuelSolutions W21 Canister Storage System FSAR [2.4] Section 4.3.2 "Fuel Cladding Allowable Temperatures," and associated Westinghouse calculation WCAP-15168, "Dry Storage of High Burnup Spent Nuclear Fuel," [3.6] address fuel cladding temperatures and fuel cladding thermal creep differences between 45 GWd/MTU fuel assemblies and 60 GWd/MTU) high burnup fuel assemblies for post irradiation fuel assembly storage times from 0 to 100 years.

To supplement W21 FSAR Section 4.3.2 and WCAP-15168, a FuelSolutions W21 Canister High-Burnup Fuel Monitoring and Assessment AMP has been developed to use the DOE/EPRI High Burnup Dry Storage Cask Research and Development Project (HDRP) surrogate demonstration program to justify storage of high burnup fuel assemblies up to 55 GWd/MTU, and monitor current and future industry experience involving storage of high burnup fuel applicable to the FuelSolutions W21 Canister Storage system up to 60 GWd/MTU. Since there are no high burnup fuel assemblies currently loaded in a W21 canister, industry high burnup fuel storage experience will lead any W21 canister high-burnup fuel storage efforts.

3.3.3.5 Aging Management Activities (Fuel Assembly)

Based on the above review, it is determined that an AMP is needed for high burnup fuel. NUREG-2215 [3.2] Section 8.5.15.2.7 "*High Burnup Fuel Monitoring and Assessment (dry storage periods beyond 20 years)*" provides guidance for the storage of high burnup fuel for periods greater than 20 years, and specifies that the applicant may use a maintenance plan to obtain confirmatory data as an acceptable means for confirming that the canister contents satisfy the applicable regulations. NUREG-2215 in turn refers to NUREG-1927, Rev 1, for evaluation of plans. The high burnup fuel AMP should be periodically reviewed and updated whenever new data from the demonstration program or other short term tests or modeling indicate potential degradation of the fuel or deviation from the assumptions of the AMP.

Consistent with the guidance of NUREG-2215 the aging management plan will obtain data to confirm the stored spent nuclear fuel configurations will remain as analyzed. The W21 High-Burnup Fuel Monitoring and Assessment AMP is described in Appendix A. Consistent with the guidance provided in NUREG-1927 [2.1], the AMP takes credit for the DOE/EPRI High Burnup Dry Storage Cask Research and Development Project (HDRP) [3.5].

3.3.4 Aging Management Review Results – W100 Transfer Cask

Table 2-6 summarizes the results of the aging management review for the W100 transfer cask subcomponents determined to be in the scope of the license renewal.

Additional description of the W100 transfer cask is provided in Section 3.3.4.1, while Sections 3.3.4.2 and 3.3.4.3 present the materials and environments. The aging effects requiring management and the proposed activities required to manage these effects are discussed in Sections 3.3.4.4 and 3.3.4.5, respectively.

3.3.4.1 Description of W100 Transfer Cask

The FuelSolutions W100 Transfer Cask is comprised of a stainless steel inner liner and an outer structural shell, with lead gamma shielding in the annular space between them. Primary biological shielding and structural protection for the canister is provided by the composite stainless steel and lead of the transfer cask. The transfer cask uses a liquid neutron shield that envelops its cylindrical body and solid neutron absorbing material in its top and bottom covers. The transfer cask is capable of containing either a W21 or W74 canister and can utilize a cask cavity axial spacer to accommodate short-length FuelSolutions canisters.

To avoid contamination of the canister external surface and the inner surface of the transfer cask cavity, the annulus between the canister shell and inner liner of the transfer cask is filled with clean demineralized water and an inflatable seal is placed in the top of the annulus prior to submergence of the transfer cask into the spent fuel pool. The top end of the transfer cask cavity includes a recess to accommodate the inflatable seal. The W100 transfer cask is equipped with upper and lower lifting trunnions to allow rotation of the W100 transfer cask (see Section 2.2.2.5 for additional W100 transfer cask description details).

3.3.4.2 W100 Transfer Cask Materials

The W100 transfer cask structure, top and bottom covers, and lifting trunnions are fabricated from stainless steel. Other materials included in the W100 transfer cask design are lead (for gamma shielding), RX-277 or NS-3 solid neutron shielding (for the transfer cask covers), alloy steels for bolting, and ethylene propylene elastomer (for the bottom cover seals). The solid neutron shielding and lead shielding materials are completely enclosed, and therefore there are no significant galvanic or chemical reactions between these materials and the air or borated water. As identified in the FuelSolutions Storage System FSAR [2.3], the neutron shield jacket is coated with a high emissivity (> .875), low absorptivity < .25), temperature resistant (>325 degrees f) coating. This coating enhances radiation heat transfer from the W100 transfer cask while minimizing the effects of insolation.

The material of each W100 transfer cask subcomponent is identified in Table 2-6.

3.3.4.3 W100 Transfer Cask Environments

The exterior of the W100 transfer cask is exposed to water or borated water (PWR) during fuel loading (while the W100 transfer cask was in a spent fuel pool), and to demineralized water in the annulus. Following fuel loading of the W21 and W74 canisters, the W100 transfer cask is removed from the spent fuel pool.

The W100 transfer cask is exposed to either a sheltered environment, if stack-up is performed in the building, or an air-outdoor environment if stack-up is performed outside. The relatively brief exposure of the W100 transfer cask to borated and demineralized water while in the spent fuel pool and the outside environment during transfer and loading operations (if applicable), does not significantly contribute to the aging of the W100 transfer cask during the renewal period. It is the prolonged or frequently recurring exposure to environmental conditions and stresses that must be evaluated for aging effects, such as those encountered during idle storage of the cask.

The environment to which the W100 transfer cask is exposed between W21 and W74 canister loading campaigns may be the sheltered atmosphere within a building. To be conservative and bound sites which store the W100 transfer cask outside, the W100 transfer cask storage environment is considered to be ambient air.

3.3.4.4 Aging Effects Requiring Management for W100 Transfer Cask

Based on a review of the W100 transfer cask materials of construction and the environments experienced during the period of extended storage, the main aging effects requiring management are loss of material due to corrosion and decreased effectiveness of the solid neutron shielding material in the W100 transfer cask covers.

3.3.4.5 Aging Management Activities for W100 Transfer Cask

Based on the aging management review of the W100 transfer cask subcomponents documented in Table 2-6, the aging management activities required for the W100 transfer cask are an AMP for the W100 transfer cask, and a TLAA for W100 transfer cask fatigue.

The solid neutron shielding material used in the W100 transfer cask covers is in an enclosed environment and while no exterior damage or change in the properties of the material is expected to occur over the service life of the W100 transfer cask, to verify the continued effectiveness of the RX-277 or NS-3 solid neutron shielding material a radiological surveillance inspection of the covers is included in the W100 Transfer Cask AMP listed in Section 3.4 and further described in Appendix A of this renewal application.

3.3.5 Aging Management Review Results – Fuel Transfer/Auxiliary Equipment

Table 2-8 summarizes the results of the aging management review for the fuel transfer and auxiliary equipment and subcomponents identified in the FuelSolutions Storage System FSAR [2.3] and determined to be within the scope of the CoC 1026 renewal.

Additional description of the fuel transfer and auxiliary equipment is provided in Section 3.3.5.1, while Sections 3.3.5.2 and 3.3.5.3 present the materials and environments. The aging effects requiring management and the proposed activities required to manage these effects are discussed in Sections 3.3.5.4 and 3.3.5.5, respectively.

3.3.5.1 Description of Fuel Transfer and Auxiliary Equipment

The in-scope FuelSolutions fuel transfer and auxiliary equipment necessary for ISFSI operations and spent fuel handling includes the cask lifting yoke, canister vertical lift fixture, cask cavity axial spacer, shielded docking collar, cask restraints, empty canister lift fixture, the standard lifting slings used inside the plant facility, and the storage cask impact limiter. The actual fuel transfer and auxiliary equipment used at a given site is identified and addressed by the General Licensee in the 10 CFR 72.212 Evaluation Report on a site-specific basis.

The cask lifting yoke assembly includes a steel A-frame and two lifting arms which interface with the W100 transfer cask upper trunnions. Shackles and low stretch slings are used to secure the lifting yoke to the crane hook. The canister vertical lift fixture is a steel frame which is slung below the cask lifting yoke A-frame and attaches to the W21 or W74 canister, that is used to lift or lower the canister into and out of the W100 transfer cask.

The cask cavity axial spacer is a circular steel frame used in the bottom end of the W100 transfer cask when a short canister is placed inside the cask, to take up the axial space in the cask cavity and provide positive support for the canister. The cask spacer is mounted to the inside of the transfer cask bottom cover to simplify removal during horizontal transfer operations.

A shielded docking collar is a large shielded ring placed on the top end of a W150 storage cask cavity for canister transfer operations to or from the storage cask. The inside diameter of a docking collar allows close fit up with a transfer cask or a transportation cask, while allowing the transfer cask or transportation cask to dock directly to the storage cask upper shield ring. Cask restraints attach the transfer cask lower trunnions or transportation cask upper trunnions to the shielded docking collar on both sides of the cask. A separate set of cask restraints are also used to secure the transfer cask to the transportation cask.

The empty canister lift fixture is used to lift an empty canister, including the shell and basket assembly, vertically using the top shield plug support ring and place the empty canister into the transfer cask prior to fuel loading. The empty canister lift fixture engages the bottom of the shield plug support ring in four locations and is connected to the plant's crane by four cable assemblies.

Standard lifting slings are used for the handling of various items associated with the FuelSolutions canisters, storage cask, transfer cask, and auxiliary equipment. The slings consist of standard wire rope, chains, or straps and the associated standard lifting hardware such as shackles, clevises, lifting eyes, hooks, and turn buckles.

A storage cask impact limiter is installed in a recessed area of an ISFSI pad, prior to upending or downending a loaded storage cask. The impact limiter provides an effective means to mitigate deceleration loads on the storage cask and canister resulting from a postulated tip-over accident of the storage cask during upending or downending operations. The 10-foot wide by 30-foot long by 2-foot thick impact limiter consists of modular steel encased rigid polyurethane foam in four subassemblies to facilitate subassembly handling and installation, and to facilitate uniform crush of the rigid foam during a postulated storage cask impact.

3.3.5.2 Fuel Transfer and Auxiliary Equipment Materials

The in-scope fuel transfer and auxiliary equipment are mostly fabricated from carbon and alloy steel which has been coated to mitigate corrosion. The handling slings, wire ropes and chains use standard handling component materials which are inspected and controlled using applicable industry standards to assure their qualifications during their useful life and are replaced when necessary.

~~The rigid polyurethane foam material used for the storage cask impact limiter is widely used in licensed spent fuel transportation packages and is well characterized. The rigid foam is encased with thin-plate carbon steel, which 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 materials of the in-scope fuel transfer and auxiliary equipment and subcomponents are identified in Table 2-8.

3.3.5.2.1 *Rigid polyurethane foam*

Polyurethane is a polymer. NUREG-2214 does not address or mention polyurethane and addresses polymers primarily in the context of a neutron shielding material and the associated environments in which neutron shielding materials function.

As stated in Section 1.2.1.4.2, *Equipment for Horizontal Canister Transfer*, of the FuelSolutions FSAR WSNF-220 [2.3], the polyurethane foam material used for the storage cask impact limiter is widely used in licensed spent fuel transportation packages and is well characterized. The rigid foam is encased within a thin-plate carbon steel casing, which 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 FuelSolutions FSAR WSNF-220 [2.3] Section 1.5.2.1, *Storage Cask Impact Limiter Polyurethane Foam*, refers to manufacturer's literature describing the rigid polyurethane foam material used for the storage cask impact limiter (13 pages). The manufacturer, General Plastics Manufacturing Company, refers to the FuelSolutions impact limiter polyurethane foam as LAST-A-FOAM® FR-3700 Series. The literature contains a variety of design data (e.g., polyurethane foam density in pounds per cubic foot and compressive strength in pounds per square) and fire resistance data but does not include any aging related data. (This manufacturer's literature is mentioned in Section 1.5.2.1 of each FuelSolutions FSAR WSNF-220 revision, but while the literature appears in FSAR Revisions 0 and 1, it does not appear in later electronic revisions of FSAR WSNF-220.) The manufacturer's literature states that the last two digits of the FR-3700 Series product numbers represent density. For example, the FuelSolutions impact limiter drawing identifies that the polyurethane foam has a density of 10 pounds per cubic foot which means the foam product number is FR-3710.

An internet search found a report on a General Plastics Manufacturing aging study entitled: *Long-Term Aging of LAST-A-FOAM® FR-3700 Series*, dated May 10, 2021 [3.4]. This 20-year study evaluates the characteristics of both wood and LAST-A-FOAM (product numbers FR-3704, FR-3708, and FR-3718) polyurethane foam material for aging and the fitness-for-use in long-term applications. The LAST-A-FOAM samples used in this long-term aging study bracket the 10 pound per cubic foot density and the FR-3710 compressive strength of 360 psi used for the FuelSolutions impact limiter polyurethane foam.

FuelSolutions FSAR WSNF-220 [2.3] Section 3.5.3.2 states that the FuelSolutions storage cask impact limiter must be adequate to support the normal dead and live loads of the cask and J-skid without crushing. The bounding storage cask and J-skid weights are 335,000 pounds and 17,000 pounds, respectively. Section 3.5.3.2 states that the required compressive strength to support this load was "determined to be 99 psi, which is significantly lower than the selected polyurethane foam lower bound strength of 300 psi." The manufacturer's literature states that the FuelSolutions FR-3710 polyurethane foam compressive strength is 360 psi which therefore has some margin for deterioration while maintaining the stated FSAR strength margin.

To simulate the foam embedded conditions in an impact limiter, some of the long-term aging wood and polyurethane foam samples were held in a weather-tight, stainless steel enclosure kept at Portland General Electric's Trojan Spent Nuclear Fuel dry storage facility. Additionally, each of these enclosed samples was packaged with polyvinyl film. LAST-A-FOAM FR-3708 polyurethane foam was used for these enclosed samples which have density and compressive strength properties and environmental exposures close to the FuelSolutions FR-3710 polyurethane foam. During the 20-year aging test the specified 8 pounds per cubic foot (pcf) density was measured six times ranging from 7.99 pcf to 8.11 pcf with the highest density being measured at the end of 20 years. The compressive strength measurements started at 227.3 psi and finished at 221.0 psi, with compressive strength measurements both above and below these psi numbers measured during the 20-years [3.4]. The conclusion is that the density and compressive strength remained basically flat during the twenty years and no discernable polyurethane foam degradation or aging trends were detected.

Other long-term aging wood and polyurethane foam materials were exposed year-round to the extreme environmental elements of the Pacific Northwest in uncovered storage conditions. These specimens were stored in a subterranean concrete vault which had an open grate at the top. The foam and wood were proportionately exposed to dust, dirt, insects, seasonal Pacific Northwest weather, and organic debris from plant life in the surrounding area. After cleaning up the surfaces of these exposed aging samples and measuring the polyurethane foam properties, there were also no discernable polyurethane foam degradation or aging trends detected [3.4]. The results of the long-term aging study are discussed below with respect to each of the potential polyurethane foam aging mechanisms.

This Rigid Polyurethane Foam supporting analysis accesses the three environments for polymers listed in Section 3.3.1 of NUREG- 2214 [1.4] (i.e., Boron Depletion, Thermal Aging, and Radiation Embrittlement). This supporting analysis also accesses the three environments often listed regarding deterioration of polyurethane foam in industry literature (i.e., Ultraviolet Light, Humidity, and Microbiological Contamination). These environments are evaluated below in the order of least relevant to most relevant for an impact limiter containing ridged polyurethane foam embedded in a coated carbon steel casing.

Boron Depletion – The ridged polyurethane foam in the impact limiter does not function as a neutron shielding material and contains no boron. Therefore, Boron Depletion is not an issue.

Ultraviolet Light – The ridged polyurethane foam embedded in a coated carbon steel casing is not exposed to any light including ultraviolet light. The LAST-A-FOAM samples exposed to the elements exhibited the yellowing typically expected of polyurethane products due to UV light exposure. The yellowing condition was restricted to the surface and did not affect the measured physical properties of the rigid polyurethane foam [3.4].

Radiation Embrittlement – The ridged polyurethane foam in the impact limiter does not function as a neutron shielding material. However, the ridged polyurethane foam is exposed to background levels of radiation and will be briefly exposed to slightly elevated levels of radiation during cask handling periods where the impact limiter serves its function. The FuelSolutions FSAR WSNF-220 [2.3] requires the impact limiters to be stored indoors during periods of non-use, primarily to prevent deterioration of the coated carbon steel casing. Any accumulated levels of radiation during periods of use would be minimal compared to the background levels of radiation accumulated during the long periods of storage. The levels of radiation exposure accumulated by polymers performing a neutron radiation shielding function in Section 3.3.1.3 of NUREG-2214 [1.4], and which could create Radiation Embrittlement, would far exceed the levels of radiation accumulated by the ridged polyurethane foam in an impact limiter. No signs of Radiation Embrittlement were reported for any of the LAST-A-FOAM aging samples [3.4].

Humidity -- FuelSolutions FSAR WSNF-220 [2.3] Section 1.2.1.4.2 states 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 LAST-A-FOAM samples exposed to the elements did not exhibit any in depth humidity effects. The humidity effects were restricted to the surface and did not affect the measured physical properties of the exposed rigid polyurethane foam aging samples [3.4].

Microbiological Contamination – The enclosed LAST-A-FOAM (product number FR 3708) polyurethane foam aging samples did not show any signs of biological contamination and had no biological related aging deterioration. The exposed LAST-A-FOAM (product numbers FR 3704 and FR-3718) polyurethane foam aging samples had extreme biological surface contamination (e.g., moss growing on the samples). 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. When cut, the exposed 21-year-old specimens showed virgin material typical of newly produced material. Any moss found to be growing on the LAST-A-FOAM material was a result of organic matter of leaves, dust and dirt, and not the foam material itself. The exposed LAST-A-FOAM samples did not support fungal growth conditions and the results were consistent with previously conducted independent fungal tests. The surface biological contamination did not affect the measured physical properties of the exposed rigid polyurethane foam aging samples [3.4].

Thermal Aging – During prolonged impact limiter storage conditions the LAST-A-FOAM polyurethane foam is exposed to normal ambient indoor temperature variations which have a daily range of less than 10 °F. During periods of active impact limiter use the LAST-A-FOAM polyurethane foam is exposed to normal outdoor ambient temperature variations which may have a daily temperature range of 20 to 40 °F and an annual range of about 100 °F. The FuelSolutions impact limiters are not exposed to any non-ambient heat sources and do not function as thermal insulation. LAST-A-FOAM rigid polyurethane has physical properties design data for thermal applications up to 250 °F. In tests performed over a period of 20 years, the density and compressive strength for the two densities of the exposed LAST-A-FOAM samples under evaluation were consistent with typical new product testing variations, with no apparent thermal aging exposure-induced degradations in performance [3.4].

In conclusion, whether within an enclosed steel casing or exposed to the elements, the LAST-A-FOAM rigid polyurethane samples did not decay, rot, or lose mechanical properties during the 20-year test period [3.4]. The evidence indicates that the rigid polyurethane foam enclosed in FuelSolutions impact limiters will be able to maintain its required density and compressive strength properties during the extended 40-year period of intermittent use and prolonged storage.

3.3.5.3 Fuel Transfer and Auxiliary Equipment Environments

The cask lifting yoke and canister vertical lift fixture are exposed to water or borated water (PWR) during fuel loading while the W100 transfer cask is in a spent fuel pool. While being used, the fuel transfer and auxiliary equipment is typically exposed to either an air-outdoor environment or a sheltered environment.

When not in use the fuel transfer and auxiliary equipment is exposed to a sheltered environment. Following completion of storage cask loading or unloading operations, the impact limiter is removed and placed in a storage area, where it is protected from degradation due to exposure to the air-outdoor environment.

The relatively brief exposure of the fuel transfer and auxiliary equipment to borated and demineralized water while in the spent fuel pool and the air-outdoor environment during transfer and loading operations (if applicable), does not significantly contribute to the aging of the fuel transfer and auxiliary equipment during the renewal period. It is the prolonged or frequently recurring exposure to sheltered environmental conditions, such as those encountered during storage of the equipment, that must be evaluated for aging effects.

3.3.5.4 Aging Effects Requiring Management for Fuel Transfer and Auxiliary Equipment

Based on a review of the fuel transfer and auxiliary equipment materials of construction and the environments experienced during the period of extended storage, the main aging effect requiring management is loss of material due to corrosion.

3.3.5.5 Aging Management Activities for Fuel Transfer and Auxiliary Equipment

Based on the aging management review of the fuel transfer and auxiliary equipment and subcomponents documented in Table 2-8, the aging management activities required for the fuel transfer and auxiliary equipment are the Monitoring of Metallic Surfaces AMP.

~~The rigid polyurethane foam material used for the storage cask impact limiter is widely used in the construction of buildings with an expected life of 50 to 100 years that is well recognized.~~ The impact limiter rigid polyurethane foam is encased within a thin-plate carbon steel casing and spends most of its life being stored in a sheltered environment which would prolong it lifetime. This material is in an enclosed environment and no damage or change in the properties of the material is expected to occur over the extended life of the impact limiter as evaluated in Section 3.3.5.2.1 of this renewal application. Therefore, no AMP or TLAA is required.

3.4 Aging Management Programs (AMP)

Based on the results of the aging management reviews for systems, structures, and components (SSC) previously determined to be within the scope of the license renewal, presented above, the following AMP's are required:

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 full details of these AMPs are presented in Appendix A.

3.5 Time-Limited Aging Analyses (TLAA)

Using the TLAA-identification criteria discussed in Section 3.2.4.1, the CoC, SER, Technical Specifications were reviewed and the following TLAA's were identified for further evaluation and disposition:

1. W21 Neutron Absorber Boron Depletion
2. W74 Neutron Absorber Boron Depletion
3. W21 Canister Fatigue (Including Basket)
4. W74 Canister Fatigue (Including Basket)
5. W100 Transfer Cask Fatigue

3.6 Other Analyses - Retrievability

The FuelSolutions W21 and W74 canisters are designed for removal of individual or canned spent fuel assemblies and for canister removal from a storage cask for placement into a transfer cask in accordance with 10 CFR 72.122(l) and satisfy the requirements of 10 CFR 72.236(m). "NUREG-2215 Section 3.4.3.8 addresses 10 CFR 72.122(l) in that the "storage systems must be designed to allow ready retrieval of spent fuel, high-level radioactive waste, and reactor-related GTCC waste for further processing or disposal." In addition, NUREG-2215 notes the requirements of 10 CFR 72.236(m) state that CoC holders should design for retrievability "[t]o the extent practicable in the design of spent fuel storage casks, consideration should be given to compatibility with removal of the stored spent fuel from a reactor site, transportation, and ultimate disposition by the Department of Energy." The FuelSolutions Dry Storage System has the ability to support options A and B identified in NUREG-2215:

A. remove individual or canned spent fuel assemblies from wet or dry storage,

B. remove a canister loaded with spent fuel assemblies from a storage cask/overpack,

<u>Option A:</u>

The results of the AMR show that there are no credible aging effects in the SNF assemblies that require management during the extended storage period that would prohibit retrievability of an assembly from a canister. Individual or canned spent fuel assemblies remain retrievable. Moderate-burnup (< 45 GWd/MTU), intact, zircaloy-clad SNF assemblies can be stored in the both the W21 and W74 canisters. In addition, high burnup (>45 GWd/MTU), intact, zircaloy-clad SNF assemblies can be accommodate in the W21 canisters.

Corrosion of the canister cover and closure weld are managed by the Welded Stainless Steel Canister AMP and Canister Fatigue TLAAs during the extended storage period to ensure that no aging effects result in the loss of intended functions (primarily confinement and structural support). This provides reasonable assurance that the SNF assemblies will be able to be retrieved from the canister and transferred to a spent fuel pool if required.

Degradation of the cladding of the SNF does not occur during the initial storage period or during extended storage since the inert atmosphere inside the canister is maintained. Evaluation of canister Off-Normal conditions, including retrieval, is addressed in Section 3.6 of the associated FSAR. Conditions During Canister Reflooding are discussed in Section 4.4.2.3 of the associated FSAR.

<u>Option B</u>

Corrosion and degradation of the W21 and W74 canister shell, cover and closure welds are managed by the Welded Stainless Steel Canister AMP and Canister Fatigue TLAAs during the extended storage period to ensure that no aging effect result in the loss of intended functions (primarily confinement and structural support) including canister retrievability.

Corrosion and degradation of the W100 transfer cask and W150 storage cask are managed by their applicable AMP(s) and TLAAs during the extended storage period to ensure that no aging effect result in the loss of intended functions (e.g. structural support) that may affect retrievability of the canister from either cask. The W100 transfer cask is maintained and is inspected prior to use to ensure proper condition and safe operation. This provides reasonable assurance that loaded W21 and W74 canisters can be transferred from a storage cask to the transfer cask and then to a transportation cask for removal offsite.

In addition, there are a number of FuelSolutions Storage Systems Technical Specifications which facilitate retrievability. Several of these are Design Feature (DF) Technical Specifications which state that the principal objective of the DF category of Technical Specifications is to “describe the design envelope which might constrain any physical changes to essential equipment.” By constraining physical changes to essential equipment these DF Technical Specifications facilitate retrievability of spent fuel assemblies from canisters, and retrievability of canisters from storage casks and transfer casks. These retrievability related FuelSolutions Storage Systems Technical Specifications:

- Establish administrative controls and procedures to assure that the spent fuel cladding does not exceed specified temperature limits during loading operations.
- Monitor storage cask and transfer cask liner temperatures
- Specify and monitor storage cask temperature limits during horizontal transfers
- Specify canister helium backfill density requirements
- Specify canister spent fuel loading requirements
- Specify maximum storage cask and transfer cask drop heights and g loadings

The respective retrievability related Technical Specifications continue to be applicable during the extended storage period.

Thus, FuelSolutions W21 and W74 canisters are designed for removal of individual or canned spent fuel from storage, and canister retrieval from a W150 storage cask for placement into a W100 transfer cask for subsequent transport off-site in the appropriate transportation cask. These retrievability functions support and meet the guidance of “Option A and “Option B” as noted above.

3.7 References

[3.1] PNNL-14390, “Dry Storage Demonstration for High-Burnup Spent Nuclear Fuel – Feasibility Study,” August 2003.

[3.2] NUREG-2215, Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities," U.S. Nuclear Regulatory Commission, November 2017.

[3.3] Electrical Power Research Institute, “Materials Reliability Program: PWR Internals Material Aging Degradation Mechanism Screening and Threshold Values (MRP-175),” EPRI-TR-1012081, December 2005.

[3.4] General Plastics Manufacturing Company, “Long-Term Aging of LAST-A-FOAM® FR-3700 Series” May 10, 2021.

[3.5] Electrical Power Research Institute, “High Burnup Dry Cask Research Project Cask Loading and Initial Results,” EPRI TR-3002015076, Final Report, October 2019.

[3.6] WCAP-15168, Dry Storage of High Burnup Spent Nuclear Fuel, Westinghouse Electric Company, March 1999.

4. AGING MANAGEMENT TOLLGATES

Introduction

As noted in NUREG-1927 "Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel," Revision 1, the NRC in collaboration with the Nuclear Energy Institute (NEI), developed guidance for the nuclear industry use when preparing CoC renewal applications. NEI 14-03, Revision 1, "Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management," includes guidance based on the continued evaluation of operating experience. One of the principles introduced in NEI 14-03 is the use of "tollgates" as a structured approach for incorporating operating experience and data from applicable research and industry initiatives into the aging evaluation process. NUREG-1927, Revision 1, Section 3.6.1.10, provides the associated guidance that may be used for CoC renewals.

NEI 14-03 provides a proposed framework for learning AMPs through the use of "tollgates" and defines "tollgates" as periodic points within the period of extended operation when licensees would be required to evaluate aggregate feedback from storage operations and perform and document a safety assessment that confirms the safe storage of spent fuel. Tollgates are described as an additional set of in-service assessments beyond the normal continual assessment of operating experience, research, monitoring, and inspections on DSS component and ISFSI SSC performance that is part of normal ISFSI operations for licensees during the initial storage period as well as the period of extended operation.
In addition, NEI 14-03, Revision 1, also describes a framework for the aggregation and dissemination of operating experience across the industry through the use of an aging-related operating experience "clearinghouse," titled the ISFSI Aging Management Institute of Nuclear Power Operations Database (ISFSI AMID). Aggregate feedback will be assessed by each licensee regarding ISFSI components. and if necessary, take actions to:

- Modify monitoring and inspection programs in AMPs described in Appendix A
- Modify TLAAs described in Appendix B
- Perform mitigation

Per the guidance of NEI 14-03 the tollgate assessments address the following elements as applicable:

Frequency:

- established from technical basis
- reflects aging mechanism initiation and rate of progression
- reflects risk significance

- considers findings from prior tollgate assessments

Content of tollgate assessments:

- Summary of research findings, operating experience, monitoring data, and inspection results
- Aggregate impact of findings (including trends)
- Consistency with the assumptions and inputs in TLAAs
- Effectiveness of AMPs
- Corrective actions, including changes to AMPs
- Summary and conclusions

Licensees have access to the ISFSI AMID to facilitate the completion of these tollgate assessments. Generic tollgates are shown in Table 4-1. Implementation of the tollgates does not limit licensee's ability to evaluate information in a timely fashion through the use of the corrective action programs and other licensee programs. The tollgates identify points where information is evaluated based on the collection of findings.

Table 4-1: Tollgate Assessments for General Licensees

Tollgate	Year	Assessment
1	Year of first canister loading plus 25 years	Evaluate information from the following sources (as available) and perform a written assessment of the aggregate impact of the information, including but not limited to trends, corrective actions required, and the effectiveness of the AMPs with which they are associated: • Results, if any, of research and development programs focused specifically on aging-related degradation mechanisms identified as potentially affecting the storage system and ISFSI site. One example of such research and development would be EPRI Chloride-Induced Stress Corrosion Cracking (CISCC) research. • Relevant results of other domestic and international research, which may include non-nuclear research • Relevant domestic and international operating experience, which may include non-nuclear operating experience • Relevant results of domestic and international ISFSI and dry storage system performance monitoring Much of this information can be gathered from the Aging Management INPO Database (AMID).
2	Year of first canister loading plus 30 years	Evaluate additional information gained from the sources listed in Tollgate 1 along with any new relevant sources and perform a written assessment of the aggregate impact of the information. This evaluation should be informed by the results of Tollgate 1. The aging effects and mechanisms evaluated at this tollgate and the time at which it is conducted may be adjusted based on the results of the Tollgate 1 assessment.
3	Year of first canister loading plus 35 years	Same as Tollgate 2 as informed by the results of Tollgates 1 and 2
4	Year of first canister loading plus 40 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, and 3
5	Year of first canister loading plus 45 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, 3, and 4
6	Year of first canister loading plus 50 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, 3, 4, and 5
7	Year of first canister loading plus 55 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, 3, 4, 5, and 6
8	Year of first canister loading plus 60 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, 3, 4, 5, 6, and 7

APPENDIX A: FUELSOLUTIONS AGING MANAGEMENT PROGRAMS

A.0 Introduction

Section 3.4 identifies the following needed AMPs:

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

This appendix contains the 10 elements of the AMPs, following the guidance of NUREG-1927 Revision 1.

FuelSolutions Welded Stainless Steel Canister AMP

(4 pages)

Element	Description
1 Scope of Program	This program manages the effects of aging for the surfaces of welded stainless steel canisters that are directly exposed to the sheltered environment within the W150 Storage Cask. The scope of the program includes the following canister sub-components: • Shell • Bottom closure plate • Shell extension • Bottom end plate • Top outer closure plate • Leak test port cover The following aging effects are addressed in this program: • Cracking due to stress corrosion cracking • Loss of material (precursor to stress corrosion cracking) due to pitting and crevice corrosion Examinations are performed on the accessible portions of the welded stainless steel dry storage canister confinement boundary external surfaces for atmospheric deposits, localized corrosion, and Stress Corrosion Cracking (SCC). In particular, examinations focus on accessible canister welds, weld heat-affected-zone areas, and known areas of the canister to which temporary supports or attachments were attached by welding and subsequently removed (based on available fabrication records) with the following attributes: • Locations where a crevice is formed on the canister surface • Horizontal (±30-degree) surfaces where deposits may accumulate at a faster rate compared to vertical surfaces • Canister surfaces that are cold relative to the average surface temperature • Canister surfaces with higher amounts of atmospheric deposits Examinations can be performed in coordination of the ASME Section XI code inspections provided in Code Case N860, "Examination Requirements and Acceptance Standards for Spent Nuclear Fuel Storage and Transportation Containment Systems."
2 Preventive Actions	Condition monitoring is utilized to manage aging effects. During fabrication of the canisters, however, preventative actions were used to minimize corrosion and stress corrosion cracking by selection of stainless steel materials. In addition, fabrication controls were in place during canister fabrication to support improved canister corrosion resistance. Although these preventative actions minimize the likelihood of aging effects, they cannot replace condition monitoring during the storage period. As this AMP is based on condition monitoring, new preventative actions are not included.

FuelSolutions Welded Stainless Steel Canister AMP

(4 pages)

Element	Description
3 Parameters Monitored / Inspected	The parameters monitored and/or inspected under this AMP include: • Visual inspections to look for evidence of discontinuities and imperfections, such as localized corrosion, including pitting corrosion and stress corrosion cracking of the accessible canister welds and weld heat affected zones. • The size and location of localized corrosion or stress corrosion cracks • The inspections also look for the appearance and location of deposits on the canister surfaces.
4 Detection of Aging Effects	Visual inspection of the canister surface is to be performed per ASME Code Section XI, Article IWA-2200 for VT-3 examinations utilizing a video camera, fiber-optic scope or other remote inspection device for the accessible areas of the canister surface since direct visual examination may not be possible due to neutron and gamma radiation fields near canister surfaces within the storage cask. Additional assessments are to be performed as necessary for suspected areas of localized corrosion and SCC. VT-1 visual examinations are performed per acceptance criteria when indicated by the assessment of the VT-3 results. Indications of corrosion within 2 inches of a weld are to receive an augmented surface examination for the presence of cracking. Volumetric examination consistent with the requirements of ASME Code Section XI, IWB-2500, for category B-J components may also be utilized to assess the presence of cracking. Inspection of selected areas on the canister may be upgraded to the VT-1 standard. The inspection is to be performed on a minimum of one canister at each ISFSI based on the following criteria: • EPRI Susceptibility Criteria {Ref: Technical Report 3002005371} • Age of the Canister (First canister placed in service) • Canister loaded with Lowest Heat Load • Canisters with the greatest potential for the accumulation and deliquescence of deposited salts that may promote localized corrosion and greatest potential for the accumulation and deliquescence of deposited salts that may promote localized corrosion and SCC • Where applicable, canister with previously identified manufacturing deviations which may affect the surface. Inspections are to be performed by qualified individual(s) every 5 years starting with the first inspection performed within either the later of one (1) year after the initial canister's 20th year loading anniversary or within one year after the issuance of first renewal of the CoC. If possible, examinations should occur on the same canister to support trending.
5 Monitoring and Trending	Monitoring and trending of the results from documented inspection should support the ability to evaluate the results against acceptance criteria. Inspection records, including photos and /or videos, are to be retained for comparison in subsequent

FuelSolutions Welded Stainless Steel Canister AMP

(4 pages)

Element	Description
	examinations. Changes to the size or location of discolored areas (e.g., rust), localized corrosion, pitting and crevice corrosion, and/or stress corrosion cracking should be identified and assessed for further evaluation or subsequent inspections. Trending of parameters or effects include the locations and size of any areas of localized corrosion or SCC, disposition of canisters with identified aging effects and the results of any supplemental canister inspections.
6 Acceptance Criteria	No indications of localized corrosion pits, etching, crevice corrosion, stress corrosion cracking, red-orange-colored corrosion products emanating from crevice locations, or red-orange-colored corrosion products in the vicinity of canister fabrication welds, closure welds, and welds associated with temporary attachments during canister fabrication. Minor surface corrosion is acceptable. Identified flaws may be assessed in accordance with the acceptance standards identified in ASME Code Section XI, IWB-3514. <u>Results of Inspections Requiring Additional Evaluation</u> Indications of interest (locations on the canister surface susceptible to SCC including areas adjacent to fabrication welds, closure welds, locations where temporary attachments may have been welded to and subsequently removed from the canister and the weld heat-affected zones) that are subject to additional examination and disposition through the corrective action program include: • Localized corrosion pits, crevice corrosion, stress corrosion cracking, and etching; deposits or corrosion products • Red-orange colored corrosion products or red-orange colored corrosion tubercles with deposit accumulations especially when adjacent to welds or weld heat affected zones of these areas and locations where temporary attachments were welded to and subsequently removed from the canister • Appearance of any color of liner corrosion products of any size parallel to or traversing fabrication welds, closure welds, and the weld heat affected zones. • Red-orange colored corrosion products greater than 1 mm in diameter combined with deposit accumulations on any location of the canister • Red-orange colored corrosion tubercles of any size
7 Corrective Actions	Indications not meeting the acceptance criteria above (AMP Element 6) require additional evaluation after being entered into the site's corrective action program. An evaluation is to be performed to determine the extent and impact of the corrosion on the canister's ability to perform its intended function. The site's Quality Assurance (QA) program ensures that corrective actions are completed within the Corrective Action Program (CAP) and include any necessary functionality assessments, cause evaluations, extent of condition, actions, identify any modifications to the existing AMP (e.g., increased frequency), and determine if the condition is reportable per 10 CFR 72.75.

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(4 pages)

Element	Description
8 Confirmation Process	The confirmation process is to be commensurate with the site's QA program. The QA program ensures that the confirmation process includes provisions to preclude repetition of significant conditions adverse to quality and the completion of inspections, evaluations, and corrective actions.
9 Administrative Controls	The site QA program ensures that administrative controls include provisions that address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control. Administrative controls also address the frequency for updating the AMP based on inspection results along with industry operating experience. This AMP will be updated as necessary based on tollgate assessments.
10 Operating Experience	Previous operating experience for the W74 Canister indicates very minimal corrosion detected to date. That operating experience has been incorporated into the guidance on inspections and acceptance criteria contained in this AMP. A renewal application re-submittal inspection was performed on the W74 system at Big Rock Point in July 2019.[2] Three separate tasks were completed consisting of a video inspection of the accessible area in the annulus between the cask and canister; a visual inspection of the cask interior and visual inspection of the cask storage pad. A representative canister and storage cask were selected by Entergy based on increased susceptibility for moisture intrusion and corrosion. Heat loads at the time of loading all of the canisters at Big Rock Point were within 0.5 kW of each other, and all storage casks were placed into service within months of each other (between November 2002 and May 2003). The inspection revealed some minor observations; however, no structural deficiencies were identified, and all parts continue to perform their design function. Surface rust was observed (Cask Serial Number W150-610-NMC) on washers under the nut on the tie rods (minimal depth) causing discoloration in the bearing plate and nut. Both these components are stainless steel and are not in danger of corroding. NRC Region III Inspectors[3] reviewed the previous five-year cask inspection documentation for Big Rock Point storage cask number 7 that included both pictures and video of the interior of the cask and did not identify any findings of significance. As canister inspections are performed in the future, inspection results will be uploaded into the ISFSI Aging Management Institute of Nuclear Power Operations Database (ISFSI AMID) to be shared with other users.

[2] Report 4T002-RPT-001, Rev 0 "FuelSolutions Renewal Application Pre-Submittal Inspection," August 29, 2019

[3] Errata to Big Rock Point Independent Spent Fuel Storage Installation - Inspection Reports 07200043-12-001 and 05000155-12-007 (ADAMS Accession ML13071A379) dated 03/11/13.

FuelSolutions Reinforced Concrete Structures AMP

(5 pages)

Element	Description
1 Scope of Program	The AMP addresses reinforced concrete structures such as the concrete portions of the W150 Storage Cask. The associated SSCs include the concrete shell, shear key, and reinforcing steel in air-outdoor or sheltered environments. The following aging effects are addressed in this program: • Cracking or loss of material (spalling, scaling) due to freeze-thaw degradation • Cracking, loss of strength, and loss of material (spalling, scaling) due to aggressive chemical attack • Cracking, and loss of strength due to reaction with aggregates • Loss of material (spalling, scaling) due to salt scaling • Loss of strength, increase in porosity and permeability and reduction of concrete pH (reducing corrosion resistance of steel embedments) due to leaching of calcium hydroxide • Cracking, loss of strength, loss of material (spalling, scaling), and loss of concrete/steel bond due to corrosion for reinforcing steel. Although the ISFSI Storage Pad is not considered Important to Safety, as noted in FuelSolutions Storage System FSAR Section 1.2, the pad should be inspected as may be required elsewhere.
2 Preventive Actions	Condition monitoring is utilized to manage aging effects including continuance of inspections of air inlet/outlet vents to confirm they are not blocked which also ensures design temperature limits are not exceeded and thermal dehydration of the concrete remains noncredible during the period of extended operation. As the storage cask reinforced concrete is designed and analyzed in accordance with the applicable provisions of ACI-349 and constructed using standard commercial practices, in accordance with the applicable provisions of ACI-318, no additional preventive actions are required.
3 Parameters Monitored / Inspected	The accessible and exposed concrete surfaces are visually examined for indications of surface deterioration. The parameters monitored or inspected quantify the following aging effects: • Cracking • loss of material (spalling, scaling) • increased porosity/permeability Degradation could affect the ability of the concrete to provide radiation shielding, to provide a path for heat transfer and to provide tornado missile shielding. The inlet and outlet vents are also monitored by visual inspection to ensure they are not obstructed. For inaccessible concrete surfaces, an inspection using a video camera, fiber-optic scope or other remote inspection equipment via existing access points on one cask

FuelSolutions Reinforced Concrete Structures AMP

(5 pages)

Element	Description
	to determine if there is any evidence of concrete degradation. The parameters evaluated consider any surface geometries that may identify water ponding which potentially increases the rate of degradation. The accessible internal concrete surfaces of the storage cask are inspected for indications of degradation. These indications may impact the long-term ability of the storage cask to meet its intended functions.
4 Detection of Aging Effects	The AMP requires a visual inspection of the readily accessible exterior surfaces of the storage cask to detect if there are any aging effects. The visual inspection shall identify cracking, loss of material (spalling, scaling), increased porosity/permeability, staining or other degradation-related activity and the degree of damage. This visual inspection identifies the current exterior condition of the storage cask and shall identify the extent and cause of any aging effects noted. This visual inspection uses the inspection evaluation and acceptance criteria of ACI 349.3R-02 (ACI, 2010) and is conducted at least once every five (5) years on each storage cask in operation during the period of extended storage by personnel meeting the qualification requirements in Chapter 7 of ACI 349.3R-02 (ACI, 2010). A visual inspection of the lower vent interior concrete areas of one storage cask shall be performed using a using a video camera, fiber-optic scope or other remote inspection equipment. This visual inspection shall meet the requirements in accordance with the acceptance criteria in ACI 349.3R-02 (ACI, 2010) and be performed by personnel meeting the qualification requirements in Chapter 7 of ACI 349.3R-02 (ACI, 2010) at least once every five (5) years. Note: As the interior of the storage cask cavity and upper vents have a steel lining, the Metallic Surfaces AMP addresses these metallic portions of the storage cask. To manage and verify the shielding performance of the storage cask concrete during the period of extended operation radiological surveys of the storage cask are performed to verify compliance with 10 CFR 72.104, and. cask concrete surface dose rates are monitored per FuelSolutions STORAGE SYSTEM Technical Specification 5.3.5. *Cask Surface Dose Rate Evaluation Program*. The radiation surveys from the site Radiological Environmental Monitoring Program shall be used to verify compliance with 10 CFR 72.104. Based on satisfactory concrete shielding effectiveness during the first twenty years of storage, at a frequency of every five (5) years a radiological survey of exposed concrete surfaces on each storage cask in operation shall be conducted during the period of extended storage. The first survey should occur within 1 year after the 20th anniversary of initial storage cask loading at the site or within 1 year after the issuance of the renewed license, whichever is later. These surveys shall be conducted at the cask side wall and inlet vent positions required by Technical Specification 5.3.5 using calibrated gamma ray and neutron detection equipment and qualified radiation protection program personnel. Data from all inspection and monitoring activities, including evidence of degradation and its extent and location, shall be documented on a checklist or

FuelSolutions Reinforced Concrete Structures AMP

(5 pages)

Element	Description
	inspection form. The results for the inspection will be documented, including descriptions of observed aging effects and supporting sketches, photographs or video. The interior concrete inspection shall be performed on one of the storage casks at each ISFSI at a frequency of 5 years. The first inspection should occur within 1 year after the 20th anniversary of initial storage cask loading at the site or within 1 year after the issuance of the renewed license, whichever is later. As stated in Item 5 of FuelSolutions Storage System FSAR Section 9.2.2 the interior surface of the first cask placed in service at an ISFSI site is to be inspected for damage every five years. Alternatively, the site may conduct the interior inspection on the storage cask that contains the canister being inspected for the Welded Stainless Steel Canister AMP to consolidate efforts. The inspections shall be documented, including a detailed description of the surface condition and location of areas showing surface degradation.
5 Monitoring and Trending	Monitoring and trending of the results from documented inspection should support the ability to evaluate the results against acceptance criteria. Methods are commensurate with consensus defect evaluation guides and standards. The inspections and surveillances described for reinforced concrete are performed periodically in order to identify areas of degradation. The results will be evaluated by a qualified individual, and areas of degradation not meeting established criteria will be documented in the site's corrective action program for resolution or detailed evaluation. Inspection records, including photos and /or videos, are to be retained for comparison in subsequent examinations. The results from the visual inspections will be compared against previous inspections in order to trend progression of identified aging effects over time.
6 Acceptance Criteria	American Concrete Institute Standard 349.3R-02 includes quantitative three-tier evaluation and acceptance criteria for visual inspections of concrete surfaces as follows: • Tier 1 acceptance without further evaluation • Tier 2 acceptance after review • Tier 3 acceptance requiring further evaluation Acceptance signifies that a component is free of significant deficiencies or degradation that could lead to the loss of structural integrity. Acceptable after review signifies that a component contains deficiencies or degradation but will remain able to perform its design basis function until the next inspection or repair. Acceptance requiring further evaluation signifies that a component contains deficiencies or degradation that could prevent (or could prevent prior to the next inspection) the ability to perform its design basis function. Degradations or conditions meeting the ACI 349.3R-02 Tier 2 and 3 criteria will be entered into the site's corrective action program for evaluation and resolution.

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(5 pages)

Element	Description
	The loss of material due to age-related degradation will be evaluated by qualified personnel in accordance with ACI 349.3R-02. A technical basis will be provided for any deviation from ACI 349.3R-02 acceptance criteria. The radiological survey acceptance criteria in 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.
7 Corrective Actions	Results that do not meet the acceptance criteria are addressed by the site's corrective action program (CAP) in accordance with the ISFSI Quality Assurance (QA) program. The site's QA Program ensures that corrective actions are completed within the ISFSI Corrective Action Program (CAP) and include any necessary functionality assessments, cause evaluations, extent of condition, actions, identify any modifications to the existing AMP (e.g., increased frequency), and determine if the condition is reportable per 10 CFR 72.75.
8 Confirmation Process	The confirmation process will be commensurate with the ISFSI QA Program. The QA program ensures that the confirmation process includes provisions to preclude repetition of significant conditions adverse to quality and the completion of inspections, evaluations, and corrective actions.
9 Administrative Controls	The ISFSI QA program ensures that administrative controls include provisions that address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control. Administrative controls also address the frequency for updating the AMP based on inspection results along with industry operating experience. This AMP will be updated as necessary based on tollgate assessments.
10 Operating Experience	Previous operating experience for the W150 Storage Cask indicates very minimal degradation detected to date, mostly limited to concrete "bug hole" and grout degradation. That operating experience has been incorporated into the guidance on inspections and acceptance criteria contained in this AMP. A renewal application pre-submittal inspection was performed on the FuelSolutions storage cask at Big Rock Point in July 23, 2019[4]. Three separate tasks were completed consisting of a video inspection of the accessible area in the annulus between the cask and canister; a visual inspection of the cask interior and visual inspection of the cask storage pad. A representative canister and storage cask were selected by Entergy based on increased susceptibility for moisture intrusion and corrosion. Heat loads at the time of loading all of the canisters at Big Rock Point were within 0.5 kW of each other, and all storage casks were placed into service within months of each other (as noted, between November 2002 and May 2003).

[4] Report 4T002-RPT-001, Rev 0 "FuelSolutions Renewal Application Pre-Submittal Inspection," August 29, 2019

FuelSolutions Reinforced Concrete Structures AMP

(5 pages)

Element	Description
	The inspection revealed some minor observations; however, no structural deficiencies were identified and all parts continue to perform their design function. NRC Region III Inspectors[5] reviewed the previous five-year cask inspection documentation for Big Rock Point storage cask number 7 that included both pictures and video of the interior of the cask and did not identify any findings of significance. As storage cask inspections are performed in the future, inspection results will be uploaded into the ISFSI Aging Management Institute of Nuclear Power Operations Database (ISFSI AMID) to be shared with other users.

[5] Errata to Big Rock Point Independent Spent Fuel Storage Installation - Inspection Reports 07200043-12-001 and 05000155-12-007 (ADAMS Accession ML13071A379) dated 03/11/13.

FuelSolutions Monitoring of Metallic Surfaces AMP

(5 pages)

Element	Description
1 Scope of Program	This program manages the effects of aging for: (1) the external surfaces of steel, stainless steel and aluminum components that are directly exposed to outdoor air or are sheltered within W150 Storage Cask, and (2) the Fuel Transfer and Auxiliary Equipment. The scope of the program includes the following cask subcomponents and the applicable site fuel transfer and auxiliary equipment: • Storage Cask Thermal shield panel assembly • Storage Cask Shear lug and thermal shield support lug • Storage Cask steel liner and shield ring • Storage Cask canister support tubes • Storage Cask Tie rod hardware • Ram anchor • Storage Cask Top cover assembly • Storage Cask Top cover bolts • Storage Cask Support rails • Storage Cask Guide rails • Cask lifting yoke • Canister vertical lift fixture • Cask cavity axial spacer • Shielded docking collar • Cask restraints • Empty canister lift fixture • Standard lifting slings (inside plant facility) • Storage cask impact limiter steel casing The following aging effects are addressed in this program: • Loss of material is due to general corrosion, galvanic corrosion, pitting and crevice corrosion and wear • Loss of preload due to stress relaxation • Coating degradation on steel and aluminum surfaces Periodic visual inspections monitor for general and localized corrosion, wear, coating degradation, and loss of preload (bolting).
2 Preventive Actions	This program is a condition monitoring program to detect evidence of degradation. It does not provide guidance for the prevention of aging.
3 Parameters Monitored / Inspected	This program monitors the condition of external metallic surfaces to identify general corrosion, localized corrosion, wear, and loss of preload of bolted

FuelSolutions Monitoring of Metallic Surfaces AMP
(5 pages)

Element	Description
	connections. Localized corrosion of stainless steels may be a precursor to stress corrosion cracking (SCC). Parameters monitored or inspected for external metallic surfaces include: • visual evidence of discontinuities, imperfections, and rust staining indicative of corrosion, SCC, and wear • visual evidence of loose or missing bolts, physical displacement, and other conditions indicative of loss of preload • visual evidence of coating degradation (e.g., blisters, cracking, flaking, delamination) indicative of corrosion of the base metal Accessible storage cask internal surfaces are inspected for indications of corrosion and wear and coating degradation.
4 Detection of Aging Effects	Inspections are performed by personnel qualified in accordance with site procedures and programs to perform the specified task. Visual inspections follow site procedures that are demonstrated to be capable of evaluating conditions against the acceptance criteria. <u>Readily Accessible Surfaces</u> Inspections cover 100 percent of normally accessible surfaces, including the external metallic surfaces, bolting, covers, vents, and other metallic components. The visual survey performed on metallic surfaces will identify the source of any staining or corrosion-related activity and the degree of damage. A visual inspection of the metallic exterior surfaces of the storage cask to detect aging effects is conducted annually. Visual inspections of fuel transfer and auxiliary equipment shall be performed at a minimum of once a year while in use. If the fuel transfer and auxiliary equipment is not used, a pre-use visual inspection shall be performed. When the fuel transfer and auxiliary equipment is not in use, periodic inspections are not needed. The visual inspections are performed in accordance with site implementing procedures. <u>Normally Inaccessible Surfaces</u> A visual inspection of the interior metallic surfaces of the storage cask shall be performed with remote inspection techniques such as a video camera, fiber-optic scope or other remote inspection equipment. The visual inspection should include an examination of the accessible areas of the canister exterior surface and the storage cask thermal shield. The accessible areas of the storage cask guide rails and support rails should be examined for coating degradation and corrosion. This visual inspection of the metallic components shall meet the requirements of a VT-3 Examination, as given in the ASME Boiler & Pressure Vessel Code (B&PVC)

FuelSolutions Monitoring of Metallic Surfaces AMP

(5 pages)

Element	Description
	Section XI, Article IWA-2200, to the extent practical, even though they are not ASME components. The interior inspection shall be performed on one storage cask at each ISFSI, at a frequency of 5 years starting with the first inspection within the later of either one (1) year after the initial canister's 20th year loading anniversary or within one year after the issuance of first renewal of the CoC. As stated in Item 5 of FuelSolutions Storage System FSAR Section 9.2.2 the interior surface of the first cask placed in service at an ISFSI site is to be inspected for damage every five years. Alternatively, the site may conduct the interior inspection on the storage cask that contains the canister being inspected for the Welded Stainless Steel Canister AMP to consolidate efforts. Data from inspections shall be documented, including a detailed description of the surface condition and location of areas showing surface degradation.
5 Monitoring and Trending	Inspection results are compared to those obtained during previous inspections, so that the progression of degradation can be evaluated and predicted. Monitoring and trending methods and plans and procedures are used to: • establish a baseline before or at the beginning of the period of extended operation • track trending of parameters or effects not corrected following a previous inspection, including ▪ locations and size of any areas of corrosion, wear or cracking ▪ disposition of components with identified aging effects and the results of supplemental inspections
6 Acceptance Criteria	The acceptance criteria for the visual inspections are: • no detectable loss of material from the base metal, including uniform wall thinning, localized corrosion pits, and crevice corrosion • no indications of loose bolts or hardware, displaced parts • no degradation (e.g., blisters, cracking, flaking, delamination) of coatings on metallic surfaces indicative of base metal corrosion. If evidence of corrosion or wear is identified, then the severity of the degradation must be determined using approved site-specific procedures. These may include additional visual, surface or volumetric NDE methods to determine the loss of material.
7 Corrective Actions	Results that do not meet the acceptance criteria are addressed by the site's Corrective Actions Program (CAP) in accordance with the ISFSI Quality Assurance (QA) program. The site's QA Program ensures that corrective actions are completed within the ISFSI Corrective Action Program (CAP) and include any necessary functionality assessments, cause evaluations, extent of condition,

FuelSolutions Monitoring of Metallic Surfaces AMP

(5 pages)

Element	Description
	actions, identify any modifications to the existing AMP (e.g., increased frequency), and determine if the condition is reportable per 10 CFR 72.75.
8 Confirmation Process	The confirmation process will be commensurate with the ISFSI QA Program. The QA program ensures that the confirmation process includes provisions to preclude repetition of significant conditions adverse to quality and the completion of inspections, evaluations, and corrective actions are completed in accordance with the ISFSI CAP.
9 Administrative Controls	The ISFSI QA program ensures that administrative controls include provisions that address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control. Administrative controls also address the frequency for updating the AMP based on inspection results along with industry operating experience. This AMP will be updated as necessary based on tollgate assessments.
10 Operating Experience	Previous operating experience for the W150 Storage Cask indicates very minimal degradation detected to date, mostly limited to coating degradation. That operating experience has been incorporated into the guidance on inspections and acceptance criteria contained in this AMP. A renewal application pre-submittal inspection[6] was performed on the FuelSolutions storage casks at Big Rock Point in July 2019. Three separate tasks were completed consisting of a video inspection of the accessible area in the annulus between the cask and canister, visual inspection of the cask interior and a visual inspection of the cask storage pad. A representative canister and storage cask were selected by Entergy based on increased susceptibility for moisture intrusion and corrosion. Heat loads at the time of loading all of the canisters at Big Rock Point were within 0.5 kW of each other, and all storage casks were placed into service within months of each other (as noted, between November 2002 and May 2003). The inspection revealed some minor observations; however no structural deficiencies, and all parts continue to perform their design function. NRC Region III Inspectors reviewed [Insp Rpt].[7]the previous five-year cask inspection documentation for Big Rock Point storage cask number 7 that

[6] Report 4T002-RPT-001, Rev 0 "FuelSolutions Renewal Application Pre-Submittal Inspection," August 29, 2019

[7] Errata to Big Rock Point Independent Spent Fuel Storage Installation - Inspection Reports 07200043-12-001 and 05000155-12-007 (ADAMS Accession ML13071A379) dated 03/11/13.

FuelSolutions Monitoring of Metallic Surfaces AMP

(5 pages)

Element	Description
	included both pictures and video of the interior of the cask and did not identify any findings of significance. As storage cask inspections are performed in the future, inspection results will be uploaded into the ISFSI Aging Management Institute of Nuclear Power Operations Database (ISFSI AMID) to be shared with other users.

FuelSolutions W100 Transfer Cask AMP

(3 pages)

Element	Description
1 Scope of Program	The program covers the subcomponents of the W100 Transfer Cask to ensure that aging effects do not challenge the capability of the transfer cask to fulfill structural support, radiation shielding, and heat transfer functions. The effected SSCs include the guide rail, liquid neutron shield jacket coating, trunnion retainers and sleeves, steel bolts for the top cover, bottom cover, and ram access cover, and the pressure relief device in the environments of air-indoor/outdoor and demineralized water. Other effected SSCs include the solid neutron shielding material embedded in the top cover, bottom cover, and ram access cover. This program manages loss of material due to general corrosion, galvanic corrosion, pitting and crevice corrosion and wear, loss of shielding due to boron depletion and coating degradation due to radiation embrittlement and thermal aging to ensure that these aging effects do not challenge the capability of the transfer cask to fulfill structural support, radiation shielding, and heat transfer functions. The Transfer Cask AMP includes inspections of trunnion retainers, sleeves and guide rails for wear, cover bolts and pressure relief device for corrosion, and liquid neutron shield jacket coating for coating degradation. Radiological surveys are conducted on the cask top cover, bottom cover, and ram access cover for solid neutron shielding deterioration due to boron depletion.
2 Preventive Actions	The Transfer Cask AMP utilizes condition monitoring to detect degradation and ensure that the equipment maintains its intended function through the extended storage period. No preventative actions are included as part of this AMP.
3 Parameters Monitored / Inspected	The Transfer Cask AMP inspects for visual evidence of degradation of accessible surfaces, and deterioration of the solid neutron shielding material performance.
4 Detection of Aging Effects	The Transfer Cask AMP manages loss of material due to corrosion, predominately for stainless steel, steel, and brass components, degradation of the coating on the liquid neutron shield jacket, and deterioration of the solid neutron shielding material performance. Inspection shall be performed at a minimum once a year while in use. If the Transfer Cask is not used, a pre-use inspection is appropriate for the Transfer Cask. When the Transfer Cask is not in use, periodic inspections are not needed. Visual inspections are performed in accordance with the ASME Code Section XI, Article IWA-2213, for VT-3 examinations. The inspections cover 100 percent of the normally accessible cask surfaces, including the cask exterior, cask interior cavity, top cover surfaces, and the cask bottom (during lifting or down ending).

FuelSolutions W100 Transfer Cask AMP

(3 pages)

Element	Description
	A radiological surveillance inspection of the RX-277 or NS-3 solid neutron shielding material performance in the top, bottom, and ram access covers of a loaded transfer cask shall be performed once per loaded fuel canister transfer campaign using calibrated neutron detection equipment and qualified radiation protection program personnel. Data from these inspections, including evidence of degradation and its extent and location, shall be documented on a checklist or inspection form. The results of the inspection shall be documented, including descriptions of observed aging effects and supporting sketches, photographs, or video. Corrective actions resulting from each AMP inspection shall also be documented.
5 Monitoring and Trending	Inspection results are compared to those obtained during previous inspections, so that the progression of degradation can be evaluated and predicted. Monitoring and trending methods and plans/procedures are used to: • establish a baseline before the use of the transfer cask in the first loading campaign in the period of extended operation • track trending of parameters or effects not corrected following a previous inspection ➢ the locations, size, and depth of any areas of corrosion ➢ the disposition of components with identified aging effects and the results of supplemental inspections ➢ the deterioration of the solid neutron shielding material performance
6 Acceptance Criteria	For accessible surfaces, including bolts for the top, bottom and access covers, guide rails, trunnion retainers and sleeves, and pressure relief device, acceptance criteria are no detectable loss of material from the base metal, including uniform wall thinning, localized corrosion pits, crevice corrosion, and wear scratches/gouges. Coating acceptance criteria are no degradation or interruptions (e.g., chipping/scratches/flacking) of the coated surface. If evidence of corrosion, wear, or coating degradation are identified, then the severity of the degradation of the base metal must be determined using approved site-specific procedures. These may include additional visual, surface, or volumetric NDE methods to determine the loss of material. For acceptance of the RX-277 or NS-3 solid neutron shielding in the top, bottom, and ram access covers of a loaded transfer cask, the top, bottom, and ram access cover neutron dose rates shall not exceed the bounding neutron dose rates in FSAR WSNF-220 Table 5.1-2.

FuelSolutions W100 Transfer Cask AMP

(3 pages)

Element	Description
7 Corrective Actions	Results that do not meet the acceptance criteria are addressed by the site's Corrective Action Program (CAP) in accordance with the ISFSI Quality Assurance (QA) program. The QA Program ensures that corrective actions are completed within the ISFSI Corrective Action Program (CAP) and include any necessary actions, identify any changes to the existing AMP, and determine if the condition is reportable per 10 CFR 72.75.
8 Confirmation Process	The confirmation process will be commensurate with the site QA program. The QA program ensures that the confirmation process includes provisions to preclude repetition of significant conditions adverse to quality and the completion of inspections, evaluations, and corrective actions.
9 Administrative Controls	The QA program ensures that administrative controls include provisions that address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control. Administrative controls also address the frequency for updating the AMP based on inspection results along with industry operating experience. This AMP will be updated as necessary based on tollgate assessments.
10 Operating Experience	Previous operating experience for the W100 Transfer Cask indicates very minimal degradation detected to date, mostly limited to coating degradation. That operating experience has been incorporated into the guidance on inspections and acceptance criteria contained in this AMP. As transfer cask inspections are performed in the future, inspection information will be uploaded into the ISFSI Aging Management Institute of Nuclear Power Operations Database (ISFSI AMID) to be shared with other users.

FuelSolutions W21 Canister High-Burnup Fuel Monitoring and Assessment AMP

(4 pages)

Element	Description
1 Scope of Program	The FuelSolutions W21 Canister Storage system is approved for high burnup fuel up to 60,000 MWd/MTU. SNF assemblies stored in FuelSolutions W21 canisters are limited to intact zircaloy-clad fuel with no known or suspected cladding defects greater than pinhole leaks or hairline cracks. SNF is initially stored in a dry high purity helium environment. SNF assemblies with burnup exceeding 45 GWd/MTU (up to 60 GWd/MTU), are limited to cladding oxide thickness of 70 μm. The scope of this Aging Management Program (AMP) covers the FuelSolutions W21 Canister Storage system with high burn up fuel to operate through the extended storage period. The program covers fuel rod cladding aging in the helium environment for loss of ductility due to hydride reorientation and changes in dimensions due to thermal creep. The AMP program relies on the joint EPRI and DOE High Burnup Dry Storage Cask Research and Development Project (HDRP) conducted in accordance with the guidance in Appendix D of NUREG-1927, Rev 1, as a surrogate demonstration program that monitors the performance of high burnup fuel in dry storage. The AMP also relies on current and future industry experience with storage of high burnup fuel up to 60 GWd/MTU. The HDRP is a program designed to collect data from a SNF storage system containing high burnup fuel in a dry helium environment. The program entails loading and storing a bolted lid cask (the “Research Project Cask”), with intact high burnup fuel of nominal burnups between 50 GWd/MTU and 55 GWd/MTU). The fuel to be used in the program includes four kinds of zirconium based cladding. The Research Project Cask is licensed to the temperature limits contained in ISG-11 Rev 3 and loaded such that the fuel cladding temperature is as close to the limit as practicable. In addition to the HDRP, there are casks that are currently licensed for storage of high burnup fuel up to 68 GWd/MTU. The combination of the HDRP and the current and future industry experience with storage of high burnup fuel will encompass high burnup fuel applicable to the FuelSolutions W21 Canister Storage system up to 60 GWd/MTU. Since there are no high burnup fuel assemblies currently loaded in a W21 canister, industry high burnup fuel storage experience will lead any W21 Canister high burnup fuel storage efforts. The HDRP results shall be used for high burnup fuel up to 55 GWd/MTU. If the W21 canister fuel to be stored exceeds 55 GWd/MTU, industry experience monitored by the Appendix 9.A FuelSolutions Storage System FSAR WSNF 220 tollgate assessments will be utilized. The fuel parameters of the surrogate demonstration program are applicable to the FuelSolutions W21 Canister Storage system high burnup fuel because the allowable W21 canister fuel cladding is of the same type as those being tested, and the temperature limits and time at temperature of the fuel cladding are similar to those being tested.
2 Preventive Actions	During initial loading operations of the FuelSolutions W21 Canisters Technical Specification 3.1.2 “Canister Vacuum Drying Pressure” specifies “The CANISTER cavity

FuelSolutions W21 Canister High-Burnup Fuel Monitoring and Assessment AMP

(4 pages)

Element	Description
	vacuum pressure following drying shall be 3 torr, maintained for at least 30 minutes." FuelSolutions W21 Canisters Technical Specification 3.1.1 "W21 Canister Helium Backfill Density" specify the canister helium backfill density range and completion time. In addition, FuelSolutions W21 Canisters Technical Specification 5.3.6 "Vacuum Drying Program" delineates the controls to "assure that the spent fuel cladding does not exceed the temperature limit during loading operations." FuelSolutions W21 Canisters Technical Specification 5.3.7 "Cladding Oxide Thickness Measurement Program" denotes controls to verify cladding oxide layer thickness for fuel assemblies to be stored. These requirements ensure that the high burnup fuel is stored in an inert environment, preventing cladding degradation due to oxidation mechanisms. In addition, fuel meets the guidance for temperature criteria noted in ISG-11, which minimizes the impacts of degradation mechanisms on the fuel. Refer to FuelSolutions W21 Canister Storage System FSAR Section 4.3.2 "Fuel Cladding Allowable Temperatures" regarding established conservatism meeting the guidance of ISG-11, Rev 3. There are no additional specific preventative actions included as part of the AMP.
3 Parameters Monitored or Inspected	The parameters monitored and inspected in the HDRP which are applicable to the high burnup fuel stored in the W21 canister are the cladding temperatures during storage that will provide data on high burnup cladding times at temperature for input to hydride reorientation, ductility recovery, and creep evaluations.
4 Detection of Aging Effects	This AMP utilizes the surrogate demonstration program, HDRP, to monitor performance of high burnup fuel and detect aging effects as described in the HDRP for high burnup fuel. FuelSolutions W21 Canisters Technical Specification 5.3.6 "Vacuum Drying Program" delineates the controls for fuel temperature limits to prevent degradation. 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.
5 Monitoring and Trending	As information / data from the HDRP or from other sources (such as testing or research results and scientific analyses) become available, the licensee will monitor, evaluate, and trend the information via its operating experience program and /or corrective action program to determine what actions should be taken. The licensee will evaluate the information / data from the HDRP to determine whether the acceptance criteria in Element 6 of this AMP are met. • If all of the acceptance criteria are met, no further assessment is needed. • If any of the acceptance criteria are not met, the licensee must conduct additional assessments and implement appropriate corrective actions (see Element 7 of this AMP).

FuelSolutions W21 Canister High-Burnup Fuel Monitoring and Assessment AMP

(4 pages)

Element	Description
	Formal evaluations of the aggregate information from the HDRP, available operating experience, NRC-generated communications, and other information will be performed by the Tollgate Assessments in Appendix 9.A of the FuelSolutions Storage System FSAR WSNF 220.
6 Acceptance Criteria	The following criteria are to be addressed against the information obtained from the HDRP. The criteria are: • Hydrogen content – Maximum hydrogen content of the cover gas over the approved storage period should be extrapolated from the gas measurements to be less than the design-bases limit for hydrogen content • Moisture content – the moisture content in the canister, accounting for measurement uncertainty should be less than the expected upper-bound moisture content per the design-bases drying process • Fuel condition / performance – nondestructive and destructive examinations should confirm the design-bases fuel condition (i.e., no changes to the analyzed fuel configuration considered in the safety analyses of the approved design bases) The design-bases characteristics of the FuelSolutions W21 Canister system and high burnup fuel parameters are addressed in the FuelSolutions W21 Canister Storage FSAR Section 4.3.1 "W21 Canister." It should be noted that Westinghouse Electric Company was initially involved in developing mathematical correlations based on this test data used for development of a creep-based methodology for the determination of allowable peak cladding temperature during dry storage as well as addressing cladding creep correlation presented in WCAP-15168[8]. Note that because the cask design to be used in the HDRP is different from the FuelSolutions W21 Canister system, the acceptance criteria will be based on the Research Project Cask design bases. If the fuel in the Research Project Cask meets the applicable design bases, the fuel in the FuelSolutions W21 Canisters storage system should also meet its design bases, as described in Element 1.
7 Corrective Actions	The corrective actions are implemented in accordance with the licensee's NRC approved QA program. If the acceptance criteria are not met, the issue will be entered into the licensee corrective action program to assess fuel performance, assess the design-bases safety analyses, consider degraded fuel performance and determine the ability of the system to continue to perform its intended functions. The corrective action program will identify necessary actions, changes to the existing AMP and determine if the condition is reportable.

[8] WCAP-15168, "Dry Storage of High Burnup Spent Nuclear Fuel," Westinghouse Electric Company, March 1999

FuelSolutions W21 Canister High-Burnup Fuel Monitoring and Assessment AMP

(4 pages)

Element	Description
	In addition, the licensee will obtain the necessary NRC approval in the appropriate licensing / certification process for modification of the design bases to address any conditions outside of the approved design bases.
8 Confirmation Process	The confirmation process is commensurate with the licensee's NRC approved QA program. The QA program ensures that required corrective actions are completed and effective in accordance with the program to preclude repetition of significant conditions adverse to quality.
9 Administrative Controls	Administrative controls are in accordance with the licensee's QA program and include a formal review and approval processes, document control and record retention requirements. This AMP will be updated as necessary based on tollgate assessments.
10 Operating Experience	As the program continues, operating experience will be evaluated including: • information entered into the ISFSI Aging Management Institute of Nuclear Power Operations Database (ISFSI AMID) • applicable research (ORNL, ANL, EPRI) • internal and industrywide condition reports • vendor-issued safety bulletins • NRC Information Notices

APPENDIX B: FUELSOLUTIONS TLAAs

B.0 Introduction

This appendix outlines the Time Limited Aging Analyses (TLAA) for the FuelSolutions Storage System. TLAAs meet the all the following criteria:

(1) Involve SSCs important to safety within the scope of the specific-license renewal, as delineated in Subpart F of 10 CFR Part 72, or within the scope of the spent fuel storage CoC renewal, as delineated in Subpart L of 10 CFR Part 72, respectively.

(2) Consider the effects of aging.

(3) Involve time-limited assumptions defined by the current operating term.

(4) Were determined to be relevant by the specific licensee or certificate holder in making a safety determination

(5) Involve conclusions or provide the basis of conclusions related to the capability of SSCs to perform their intended safety functions.

(6) Are contained or incorporated by reference in the design bases.

B.1 Identification of FuelSolutions TLAAs

Using the TLAA-identification criteria discussed in Section 3.2.4.1, the CoC, SER, Technical Specifications were reviewed and the following TLAA's were identified for further evaluation and disposition:

1. W21 Neutron Absorber Boron Depletion
2. W74 Neutron Absorber Boron Depletion
3. W21 Canister Fatigue (Including Basket)
4. W74 Canister Fatigue (Including Basket)
5. W100 Transfer Cask Fatigue

B.2 W21 Neutron Absorber Boron Depletion

As described and analyzed in FuelSolutions W21 Canister Storage FSAR [2.4] Section 6.3, the FuelSolutions W21 canister design is based on both favorable geometry and fixed BORAL® neutron absorber material (poison) 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 only 75% of the manufacturer's minimum assured boron content and the continued efficacy of fixed BORAL® neutron absorber materials are demonstrated to be capable to perform its function until the end of the canister's service life.

The continued efficacy of BORAL® is demonstrated by the process controls under which the material is manufactured and verified. These controls assure a homogeneous dispersion of boron throughout the material. In addition, the effects of long-term exposure to neutron flux from irradiated fuel is negligible because the thermal neutron flux during dry storage is low. This fact, coupled with the use of the minimum specified boron concentration, reduced by 25%, more than accounts for any boron depletion which may occur over the 100-year design life of the FuelSolutions W21 canister.

With the conservatism in the W21 FSAR analysis, boron depletion is not an issue for the BORAL® neutron absorber material and satisfies the extended 60-year storage life as well as the 100-year canister service life.

B.3 W74 Neutron Absorber Boron Depletion

As described in FuelSolutions W74 Canister Storage FSAR [2.5] Section 6.3, the FuelSolutions W74 canister design is based on both favorable geometry and fixed borated stainless steel neutron absorber material (poison) to ensure that fuel assemblies are maintained in a subcritical condition with a k_{eff} less than 0.95 under all conditions of storage and hypothetical accident conditions.

The relatively low neutron flux during the storage period, which will continue to decay over time, does not result in significant depletion of the borated stainless steel's available boron. The boron content of the material used in the criticality safety analysis is conservatively based on the minimum specified boron concentration (rather than the nominal) verified by testing during material manufacture. The criticality safety evaluation credits only 75% of the manufacturer's minimum assured boron content, and the fixed neutron absorber material is demonstrated to be capable to perform its function during the canister's service life.

As described in FuelSolutions W74 Canister Storage FSAR Section 6.3.2, the effectiveness of the fixed borated stainless steel neutron absorbing material utilized in the canister basket design assures criticality safety during worst case design basis conditions over the 100-year service life of the canister. This FSAR analysis encompasses the requested 40-year renewal period of storage in addition to the initial 20 years of storage for a total 60 year extended period of storage.

B.4 W21 Canister Fatigue

B.4.1 W21 Canister Shell Fatigue

The FuelSolutions W21 Canister Storage FSAR [2.4], Section 3.5.1.4.1 performs the fatigue evaluation for the W21 canister shell and associated components in accordance with the requirements of ASME Code [B.1] Subsection NB-3222.4(d). Section NB-3222.4 "Analysis for Cyclic Operation", Subsection (a) "*Suitability for Cyclic Condition*" states that "*If the specified Service Loadings of the component meet all of the conditions of Subsection (d), no analysis for cyclic service is required, and it may be assumed that the limits on peak stress intensities as governed by fatigue have been satisfied by compliance with the applicable requirements for material, design, fabrication, examination, and testing of this Subsection*."

Subsection NB-3222.4(d) "*Components Not Requiring Analysis for Cyclic Service*" states that an analysis for cyclic service is not required, and it may be assumed that the limits on peak stress intensities as governed by fatigue have been satisfied for a component by compliance with the applicable requirements for material, design, fabrication, examination, and testing of this ASME Code Subsection, provided the specified Service Loading of the component or portion thereof meets all the conditions stipulated in the following six operating conditions:

1. Atmospheric to Service Pressure Cycle
2. Normal Service Pressure Fluctuation
3. Temperature Difference–Startup and Shutdown
4. Temperature Difference –Normal Service
5. Temperature Difference –Dissimilar Materials
6. Mechanical Loads

These six conditions are addressed in W21 Canister FSAR Section 3.5.1.4.1 for the W21 canister shell fatigue evaluation and demonstrate that fatigue is not a concern for the canister pressure boundary components. This evaluation is performed using a service life of 100 years. The results of this evaluation are applicable for the license extension to 60 years as well as for the 100-year service life of the canister shell.

B.4.2 W21 Canister Basket Fatigue

The W21 Storage Canister FSAR, Section 3.5.1.4.2 performs the fatigue evaluation for the canister basket assembly and associated components in accordance with the requirements of ASME Code [B.1] Subsection NG-3222.4(d). Section NG-3222.4 "Analysis for Cyclic Operation", Subsection (a) "Suitability for Cyclic Condition" states that "*If the specified Service Loadings of the structure meet all of the conditions of Subsection (d), no analysis for cyclic service is required, and it may be assumed that the peak stress limit discussed in subsection (b) has been satisfied by compliance with the applicable requirements for material, design, fabrication, examination, and testing of this Subsection*".

Subsection NG-3222.4(d) "Components Not Requiring Analysis for Cyclic Service" states that an analysis for cyclic service is not required, and it may be assumed that the peak stress limit discussed in NG-3222.4(b) has been satisfied for a structure by compliance with the applicable requirements for material, design, fabrication, examination, and testing of this ASME Code Subsection, provided the specified Service Loadings of the structure or portion thereof meets all the conditions stipulated in the following four operating conditions:

1. Temperature Difference – Startup and Shutdown
2. Temperature Difference – Normal Service
3. Temperature Difference – Dissimilar Materials
4. Mechanical Loads

These four conditions are addressed in FSAR Section 3.5.1.4.2 for the W21 canister basket assembly fatigue evaluation to demonstrate that fatigue is not a concern. This evaluation is performed using a service life of 100 years. The results of this evaluation are applicable for the license extension to 60 years as well as for the 100-year canister basket service life.

B.5 W74 Canister Fatigue

B.5.1 W74 Canister Shell Fatigue

The FuelSolutions W74 Canister Storage FSAR, Section 3.5.1.4.1, addresses the fatigue evaluation for the W74 canister shell and associated components in accordance with the requirements of ASME Code [B.1] Subsection NB-3222.4(d). Section NB-3222.4 "Analysis for Cyclic Operation", Subsection (a) "*Suitability for Cyclic Condition*" states that "*If the specified Service Loadings of the component meet all of the conditions of Subsection (d), no analysis for cyclic service is required, and it may be assumed that the limits on peak stress intensities as governed by fatigue have been satisfied by compliance with the applicable requirements for material, design, fabrication, examination, and testing of this Subsection*."

Subsection NB-3222.4(d) "*Components Not Requiring Analysis for Cyclic Service*" states that an analysis for cyclic service is not required, and it may be assumed that the limits on peak stress intensities as governed by fatigue have been satisfied for a component by compliance with the applicable requirements for material, design, fabrication, examination, and testing of this ASME Code Subsection, provided the specified Service Loading of the component or portion thereof meets all the conditions stipulated in the following six operating conditions:

1. Atmospheric to Service Pressure Cycle
2. Normal Service Pressure Fluctuation
3. Temperature Difference–Startup and Shutdown
4. Temperature Difference –Normal Service
5. Temperature Difference –Dissimilar Materials
6. Mechanical Loads

These six conditions are addressed in FSAR Section 3.5.1.4.1 for the W74 canister shell fatigue evaluation to demonstrate that fatigue is not a concern for the canister pressure boundary components. This evaluation is performed using a service life of 100 years. The results of this evaluation are applicable for the license extension to 60 years as well as for the 100-year canister shell service life.

B.5.2 W74 Canister Basket Fatigue

The W74 Canister FSAR [2.5], Section 3.5.1.4.2 performs the fatigue evaluation for the canister basket assembly and associated components in accordance with the requirements of ASME Code [B.1] Subsection NG-3222.4(d). Section NG-3222.4 "Analysis for Cyclic Operation", Subsection (a) "Suitability for Cyclic Condition" states that "*If the specified Service Loadings of the structure meet all of the conditions of Subsection (d), no analysis for cyclic service is required, and it may be assumed that the peak stress limit discussed in subsection (b) has been satisfied by compliance with the applicable requirements for material, design, fabrication, examination, and testing of this Subsection*".

Subsection NG-3222.4(d) "Components Not Requiring Analysis for Cyclic Service" states that an analysis for cyclic service is not required, and it may be assumed that the peak stress limit discussed in NG-3222.4(b) has been satisfied for a structure by compliance with the applicable requirements for material, design, fabrication, examination, and testing of this ASME Code Subsection, provided the specified Service Loadings of the structure or portion thereof meets all the conditions stipulated in the following four operating conditions:

1. Temperature Difference–Startup and Shutdown
2. Temperature Difference–Normal Service
3. Temperature Difference–Dissimilar Materials
4. Mechanical Loads

These four conditions are addressed in W74 Canister FSAR [2.5] Section 3.5.1.4.2 for the W74 canister basket assembly fatigue evaluation to demonstrate that fatigue is not a concern. This evaluation is performed using a service life of 100 years. The results of this evaluation are applicable for the license extension to 60 years as well as for the 100-year canister basket service life.

B.6 W100 Transfer Cask Fatigue

The FuelSolutions Storage System FSAR [2.3], Section 3.5.3.3.5 addresses the fatigue evaluation for the W100 Transfer Cask and associated components in accordance with the requirements of ASME Code [B.1] Section NC-3219.2, Condition B. Section NC-3219.2 "*Rules to Determine Need for Fatigue Analysis of Integral Parts of Vessels*" states that a fatigue analysis is not needed if all six criteria in Condition B are met. FuelSolutions Storage System FSAR Section 3.5.3.3.5 addresses the following six criteria, identified in ASME NC-3219.2, Condition B, that must be met so that a fatigue analysis is not required:

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- Dissimilar Materials

6. Mechanical Loading

For criterion (a), "*The expected design number of full range pressure cycles*", using the code and associated tables and code fatigue curve, the FSAR identified that the W100 Transfer Cask has a maximum of 20,000 full range cycles. The FSAR stated a design life of 40 years with a maximum number of canister transfers estimated at 25 per year for a total of 1000 full range liquid neutron shield jacket pressure cycles. The 1,000 cycles is less than the corresponding maximum number of cycles of 20,000 and therefore the criterion is satisfied. For the extended life of 60 years and the estimated cycles of 25 per year, the total of full range cycles will be 60 X 25 = 1,500 cycles which is still less than the maximum 20,000 cycles and criterion (a) is satisfied for the 60-year extended life.

For criterion (b), "*The expected design range of pressure cycles during normal service*", as identified in criterion (a) above, the cask lifetime of loading operations is 1000 cycles based on a 40-year life. Based on the code, the maximum number of liquid neutron shield jacket pressure fluctuations allowed by the code requirements is 10^6 with the significant liquid neutron shield jacket pressure fluctuation range of 27 psi. Conservatively assuming that there are 4 significant pressure fluctuations during each loading which provides the number of significant fluctuations of 1000 X 4 = 4000 cycles with a S_a of 80 ksi which provides a 76 psi allowable pressure range which is greater than the design range of 65 psi and the condition is met. For the extended life of 60 years, the corresponding number of loading cycles is 1,500, from criterion (a) above. Using the method above and described in the FSAR, the significant fluctuations at 6000 cycles, with S_a of 70 ksi which provides an allowable pressure range pressure of 67 psi is greater than the design range of 65 psi and the condition is met for a 60-year extended life.

For criterion (c), "*The temperature difference between any two adjacent points*", as identified in criterion (a) above, for the extended life of 60 years, the total number of startup and shutdown cycles in 1500. Based on 1500 cycles and the W100 material property data, the quantity of Sa / 2Eα is calculated as approximately 213°F. Under no condition does the temperature difference between any adjacent points approach this value. Therefore, the third criterion (c) is satisfied for the extended life of 60 years.

Criterion (d), "*The range of temperature difference between any two adjacent points*", for a 60-year extended life, the range of temperature difference between any two adjacent points does not change during normal service by more than approximately 213°F calculated in criterion (c) above. As identified in the W100 FSAR, any changes in the transfer cask temperature are relatively slow and gradual due to its large thermal capacity and absence of rapid changes in the external conditions.

Therefore, the fourth criterion (d) is satisfied for the extended life of 60 years.

For the fifth criterion (e), *Temperature Difference–Dissimilar Material*, as identified in the FSAR for the W100 Transfer Cask and components, are all fabricated of Type 304, F304, and F304N stainless steel. The moduli of elasticity and coefficients of thermal expansion are the same for all these materials. Therefore, no dissimilar materials are used, and the fifth criterion (e) is satisfied for the extended life of 60 years.

For the sixth criterion (f), "*Mechanical Loading*" the transfer cask maximum stress condition only occurs for a fully loaded transfer cask and canister. Based on experience for any given loading campaign there is only 1 transfer cask lift fully loaded (with fuel and water), 1 for flooded (water but no fuel), and 1 for fully loaded (dry fuel) for a total of 3 lift / setdowns + 5 significant vibrations +1 upending/downendings + 1 canister transfer for the total of 10. The total lifetime number of cycles for the 60-year extended life is then 10 X 1,500 = 15,000 and the Sa value for this number of cycles is 60 ksi. As shown in W100 FSAR Table 3.5-8, the total stress intensity at any point of the transfer cask does not exceed 55.3 ksi. Therefore, this criterion(f) is satisfied for the 60-year extended life.

Since the six criteria are met for the W100 Transfer Cask, fatigue is not a concern for the 60-year extended life.

B.7 References

B.1 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section III, Division 1, 1995 Edition.

APPENDIX C: SYSTEM INSPECTIONS

Introduction

It should be noted that starting in 2012, approximately 10 years after being placed in service, inspections of the FuelSolutions Storage System storage cask exterior and cask interior started being performed on a periodic basis to assure conformance within system parameters.

Periodic inspections of the exterior surfaces have been performed on each of the FuelSolutions W150 Storage Cask in service. In addition, an interior inspection of the FuelSolutions W150 storage Cask #7 at the Big Rock Point ISFSI as part of a five (5) year schedule since 2012 with no major degradation detected.

Periodic inspections of the FuelSolutions W100 Transfer Cask have also been performed. The inspections include coatings and accessible welds. The W100 Transfer Cask inspection have been performed since 2013 with no degradation detected.

Pre-application Inspection

In addition to the in-service inspections noted above, an extensive pre-submittal inspection of the FuelSolutions W74 Canister, a FuelSolutions Storage Cask W150 was performed in 2019 to gather information to support development of the renewal application and the supporting AMPs included in this application. As the seven (7) storage casks were placed in service within several months of each other and the canister heat loads at the time of the loading were within 0.5 kw of each other and, the storage cask selected for inspection is considered representative of the all the fuel storage casks in service. Although the ISFSI Storage Pad is not considered to be an in-scope item for the purpose of this CoC renewal application, it was prudently included in the inspection none the less.

The inspection consisted of three separate tasks. A video inspection of the access area in the annulus between the storage cask and the canister, a visual inspection of the exterior of the cask and a visual inspection of the cask storage pad itself. The canister selected was TSC-LO-005-N. The storage cask inspected was W150-610-NMC. As noted in the inspection report[9], "The videoscope was fed through each of the top vents to inspect the exterior of the canister, the interior of the cask shield plate and the support and guide rails. The videoscope was fed through the bottom vents to observe the bottom plate and support tubes. Videos were recorded during the inspection. Any indications observed were investigated to determine the extent of the indication."

The inspection of the FuelSolutions Storage Cask exterior concrete "…revealed only some minor local passive cracks. The cracks were less 0.4 mm in width. There were no observed instances of damage, scaling or spalling. There were no indications of leaching or chemical attacks. There were no indications of exposed reinforcing bar or reinforcing corrosion. Some of the grout placed in the joints between cask sections has been replaced. This grout is cosmetic only and is replaced as necessary." Results of the inspection of the FuelSolutions Storage Cask interior note "…there was

[9] Report 4T002-RPT-001, Rev 0 "FuelSolutions Renewal Application Pre-Submittal Inspection," August 29, 2019

some debris, dirt and water marks in the vents and on the shield plate inside the W150 cask. No structural deficiencies were observed. The cask continues to perform its design function."

Inspection of the FuelSolutions W74 canister exterior surface revealed *"Some dirt and water marks were observed on the cask surface. Several indications were observed. Two indications had a depth of 0.003" and one had a depth of 0.04", 0.535" long. These indications on a 5/8" thick shell result in negligible loss of section and are therefore considered to be minor in nature. All indications appear to be from the fabrication of the canister or during cask loading operations. There was no indication of cracks, unanticipated degradation or corrosion."*

As noted above, although the ISFSI pad is not considered to be in scope for this CoC renewal application, the results did reveal *"There were several observed locations of damage to the top surface of the pad. In addition, there were surface cracks throughout the pad. None of the observed damage or cracks affect the ability of the pad to perform its design function."*

In total, the pre-application inspection of the W150 Storage Cask and the exterior of the W74 Canister state there *"are no observed deficiencies or unanticipated degradation on the exterior of the cask."*

As noted in the pre-application inspection report: *"Inspection of the FuelSolutions W100 Transfer cask was not included in this inspection. In accordance with CCA-000190 the utilities most recent Transfer Cask inspections were used in lieu of performing the inspection. Inspections in accordance with Big Rock Point Procedure T365-37 performed in 2013 thru 2018 were reviewed. The inspections included the surface coatings, accessible welds, cover alignment, bolts and impact limiters. There were no identified deficiencies in the inspected components."*

Baseline Inspections

Baseline inspections confirm that the results of pre-application inspections are bounding of the site and verify the adequacy of the AMPs. Considering the renewal application pre-submittal inspection was performed at the site (Big Rock Point) currently using the FuelSolution Storage System, the AMP baseline inspections to be performed upon entering the period of extended operation can assess the condition of SSCs to confirm the results of the pre-application inspections conducted and serve to verify the technical justifications provided.

Baseline inspections are to be performed on the in-scope SSC at the ISFSI site at the time the system enters the period of extended storage (i.e., 20 years after the first FuelSolutions Storage System was placed in service). The baseline inspection meets the criteria defined in the AMPs in Appendix A. The first (baseline) inspection should occur within one year after the 20th anniversary of the initial storage cask loading at the site or within one year after the issuance of the renewed license, whichever is later. Subsequent inspections will occur on a 5-year frequency starting from the baseline date. This schedule applies to the canister external inspection and the storage cask internal inspection.

For the storage cask external inspections, the first (baseline) inspection should occur within one year after the 20th anniversary of the initial overpack loading at the site or within one year after the issuance of the renewed license, whichever is later. Future inspections will occur with a 5-year frequency starting from the baseline date. Other AMP inspections are pre-use type inspections for which the baseline inspection will occur before the first use of the applicable component once it has been in service more than 20 years. Note that the W21 Canister High-Burnup Fuel Monitoring and Assessment AMP does not have an inspection component and the schedule is based on the demonstration project as described in the AMP in Appendix A.

APPENDIX D: AGING MANAGEMENT FSAR CHANGES

The proposed changes to the three FuelSolutions FSARs - WSNF-220, WSNF-221 and WSNF-223 [2.3, 2.4 and 2.5] reflecting the CoC 1026 Renewal Application are shown in the attached marked up FSAR pages.

The marked up FSAR pages are grouped into three sets of pages, one for each of the three FuelSolutions FSARs - WSNF-220, WSNF-221 and WSNF-223. Each of these three FSARs includes a new Appendix 9.A which is the primary location for the aging management information applicable to the subject matter covered in each associate FSAR.

In particular, for the FuelSolutions Storage System FSAR, WSNF-220, the W150 Storage Cask and W100 Transfer Cask aging management information is addressed in the associated Appendix 9.A.

For the FuelSolutions W21 Canister FSAR, WSNF-221, the canister and high burnup fuel aging management information is addressed in the associated Appendix 9.A.

For the FuelSolutions W74 Canister FSAR, WSNF-223, canister aging management information is addressed in the associated Appendix 9.A.

The organization of these three FuelSolutions FSARs has been retained in the three new Appendices 9.A. Common aging management information such as Tollgate requirements only appears in the WSNF-220 Storage System FSAR Appendix 9.A, and it is referenced in Appendix 9.A of each canister FSAR, WSNF-221 and WSNF-223. Specific aging management information such as the AMP(s) for a specific component is located in the associated WSNF FSAR Appendix 9.A, and the location of this specific aging management information is referenced in Appendix 9.A of the other WSNF FSARs.

FuelSolutions Storage System FSAR WSNF-220 Markups

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10. Appendix 9.A Aging Management Program Cover Page
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Acceptance Tests and Maintenance

The fabrication acceptance basis and maintenance program to be applied to the FuelSolutions™ W150 Storage Cask and storage cask impact limiter are described in Chapter 9 of this FSAR. The operational controls and limits to be applied to the FuelSolutions™ W150 Storage Cask are contained in Chapter 12 of this FSAR. Application of these requirements will assure that the FuelSolutions™ W150 Storage Cask is fabricated, operated, and maintained in a manner that satisfies the design criteria defined in this chapter.

Decommissioning

Decommissioning considerations for the FuelSolutions™ Storage System, including the FuelSolutions™ W150 Storage Cask, are addressed in Chapter 14 of this FSAR.

2.1.2.2 Transfer Cask

General

The FuelSolutions™ W100 Transfer Cask is designed for ~~40~~ 60 years of service, while satisfying the requirements of 10CFR72. The design considerations that assure transfer cask performance throughout the service life include addressing the following:

- Exposure to environmental effects
- Structural fatigue effects
- Material degradation
- Maintenance and inspection provisions.

The adequacy of the transfer cask design for the intended service life is discussed in Section 3.4.4 of this FSAR.

Structural

The FuelSolutions™ W100 Transfer Cask includes both structural steel and non-structural biological shielding components that are classified as important to safety. The structural steel components of the transfer cask, with the exception of the lifting trunnions, are designed and fabricated in accordance with the applicable requirements of Section III, Subsection NF,[10] of the ASME Code, as discussed in Section 2.6.2. The lifting trunnions and associated attachment welds are designed in accordance with the requirements of NUREG-0612[11] and ANSI N14.6[12] for non-redundant lifting devices. The properties for the lead gamma shielding at temperature are determined in accordance with NUREG/CR-0481.[13]

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[10] American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code, Section III, Division 1, Subsection NF, *Component Supports*, 1995 Edition.

[11] NUREG-0612, *Control of Heavy Loads in Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, July 1980.

[12] ANSI N14.6, *Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4,500 kg) or More*, American National Standards Institute, 1993.

[13] NUREG/CR-0481, *An Assessment of Stress-Strain Data Suitable for Finite-Element Elastic-Plastic Analysis of Shipping Containers*, Sandia National Laboratories, September 1978.

3.1.2.1.2 Supplemental Structural Criteria

The storage cask is designed for operation under extreme off-normal ambient temperatures as low as -40°F, hence, the cask materials of construction are selected to provide sufficient protection against brittle fracture failure at that temperature.

Brittle fracture failure is not applicable to the reinforced concrete components. In accordance with NUREG/CR-1815,[7] the storage cask liner (shell, bottom plate, and shield ring) and top cover plate are considered Category III components and must have sufficient fracture toughness to prevent fracture initiation at minor defects typical of good fabrication practices.
Section 5.3.1(4) of NUREG/CR-1815 states that this can be achieved by specifying a material with a minimum energy absorption (C_V) of 15 ft-lb at 10°F. Therefore, the storage cask carbon steel liner and top cover are fabricated from carbon steel with a supplementary requirement of demonstrating the above fracture toughness. As such, sufficient degree of safety is provided against brittle fracture failure in the storage cask liner and cover.

The storage cask cover is attached to the storage cask body using twelve 1¼ inch socket head cap screws fabricated from SAE Grade 8 bolting material. In accordance with Section 5 of NUREG/CR-1815, bolts are generally not considered as fracture-critical components because multiple load paths exist and bolting systems are generally redundant, as is the case with the storage cask.

The storage cask top, middle, and bottom reinforced concrete segments are joined together using eight full-length tie rods. The tie rods are fabricated from ASTM A564, Grade 630 (H1150) precipitation-hardened stainless steel. This material and associated clamp nut shall be tested to the same requirements as the storage cask liner and cover plate as noted above.

3.1.2.2 Transfer Cask

3.1.2.2.1 Applicable Codes and Standards

The transfer cask structural components that are important to safety are designed using linear elastic analysis in accordance with the criteria of ASME Code, Subsection NF[8] for Class 1 component supports. These criteria are applicable to the transfer cask inner liner, structural shell, top flange, bottom flange, lower trunnions, neutron shield jacket, top cover, bottom cover, ram access cover, closure bolts, and all structural welds, including the trunnion-to-shell welds. A summary of the transfer cask component functions, safety classes, and applicable codes and standards is provided in Table 3.1-1. The transfer cask allowable stress criteria of NF-3220 is summarized in Table 3.1-5. Subsection NF does not require the evaluation of thermal stress or

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[7] NUREG/CR-1815, *Recommendations for Protecting Against Failure by Brittle Fracture in Ferritic Steel Shipping Containers Up to Four Inch Thick*, Holman, W.R., Langland, R.T., UCRL-53013, US NRC, August 1981.

[8] American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section III, Division 1, Subsection NF, *Component Supports*, 1995 Edition.

peak stress. In order to address thermal and peak stresses, the design criteria of the more restrictive Subsection NC[9] of the ASME Code are used.

The transfer cask upper trunnions are used to lift and handle the transfer cask inside the fuel building in areas where its accidental drop could damage safe shutdown equipment. As such, the transfer cask upper trunnions are considered interfacing lift points and are designed in accordance with the requirements of paragraph 5.1.6(3)(b) of NUREG-0612[10] and Section 7.2 of ANSI N14.6[11] for non-redundant lifting devices supporting a critical load. Factors of safety of 6 on the material yield strength and 10 on the material ultimate strength are required for shear and bending stresses in the upper trunnions as they carry the maximum weight of the transfer cask and its contents plus any dynamic amplification due to handling loads.

The transfer cask lower trunnions are used only for rotating the transfer cask between vertical and horizontal orientation and supporting the transfer cask horizontally on the transfer skid. The lower trunnions are not interfacing lift points for any critical lift conditions. As such, the lower trunnions do not have to meet the requirements of NUREG-0612 and are designed in accordance with Subsection NF of the ASME Code, as discussed above.

3.1.2.2.2 Supplemental Structural Criteria

Brittle Fracture

All structural components of the FuelSolutions™ transfer cask are fabricated from austenitic stainless steels. With the exception of the transfer cask top and bottom cover bolts, all transfer cask materials are Type 304, Type F304, or Type F304N austenitic stainless steel. Since these materials do not undergo a ductile to brittle transition in the temperature range of interest (down to -40°F), they are not subject to brittle fracture.

The cover bolts are fabricated from SA-320, Grade L43 bolting steel. As discussed in NUREG/CR-1815, closure bolts are generally not considered fracture critical components if the bolting system is redundant. The top and bottom covers are each fastened to the transfer cask body using 16 bolts. Similarly, the ram access cover is attached using four bolts. Therefore, the transfer cask cover bolting systems are redundant and are not fracture critical components.

Fatigue

The transfer cask is designed to the requirements of Subsection NF of the ASME Code which does not require evaluation of fatigue. However, for completeness of the transfer cask design and analysis, fatigue is evaluated using the criteria of Subsection NC of the ASME Code. As discussed in Section 3.5.3.3.5, the analysis of the FuelSolutions™ transfer cask demonstrates that normal operating cycles do not present a fatigue concern for the FuelSolutions™ transfer cask components over the ~~40-year~~ service life.

60-year

[9] American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section III, Division 1, Subsection NC, *Class 2 Components*, 1995 Edition.

[10] NUREG-0612, *Control of Heavy Loads at Nuclear Power Plants*, US Nuclear Regulatory Commission July 1980.

[11] ANSI N14.6, American National Standard for Radioactive Material, *Special Lifting Devices for Shipping Containers Weighing 10000 Pounds (4500 kg) or More*, American National Standards Institute, 1993.

Buckling

In addition to the linear elastic stress analysis discussed in Section 3.1.2.2.1, general instability of the transfer cask shell is evaluated for the postulated 72-inch side drop accident at the storage pad. These evaluations are performed to assure that the transfer cask does not buckle and potentially compromise integrity of the canister or prevent retrieval of the canister following a drop accident. Because of these criteria, an elasto-plastic analysis of the transfer cask body is performed to determine the plastic instability load (i.e., load at which unbounded plastic deformation can occur without increase in load). In accordance with the requirements of F-1341.4(a) of the ASME Code, the maximum applied load is limited to 70% of the plastic instability load.

3.4 General Standards for Casks

3.4.1 Chemical and Galvanic Reactions

The FuelSolutions™ storage cask and transfer cask have been evaluated to determine that the materials of construction will not cause significant chemical, galvanic, or other reactions in the intended service conditions. Chemical, galvanic, and other reactions in storage cask and transfer cask are discussed in the following sections.

3.4.1.1 Storage Cask

No significant chemical, galvanic, or other reactions are expected for the FuelSolutions™ storage cask considering its materials of construction and intended service conditions. The storage cask is constructed with reinforced concrete, coated carbon steel, and austenitic stainless steel. During the on-site storage service of the storage cask, the cask exterior concrete is exposed to the environment while inside the storage cask is predominately dry and warm. The carbon steel components of the storage cask, i.e., the liner, top cover, non-load bearing guide rails, tie rod tubes, and air inlet and outlet liners, are all protected with long lasting temperature- and radiation-resistant coatings. Due to substantial variation in corrosion rates of coated carbon steel, storage sites located in coastal or industrial environments should evaluate the need to apply a top coat on a site-specific basis. The thermal shield is made of aluminum and the canister support pipes are made from austenitic stainless steel. All these components are highly resistant to oxidization/corrosion.

The dissimilar materials of the storage cask which are in direct contact with one another include the concrete, carbon steel liner, and reinforcing steel. Portland cement concrete provides an environment which protects the steel liner and reinforcing steel from corrosion. The high alkaline environment (pH>12.5) in concrete results in the formation of a tightly adhering film (gamma iron (III) oxides) which passivates the steel and thereby protects it from corrosion due to penetration of chloride ions. That, together with the heavy reinforcement which minimizes shrinkage cracking and the concrete cover provided to protect the reinforcement, assures maximum service life. In addition, the external concrete surface degradation is mitigated by using a weather-resistant protective coating.

The only contact between the canister assembly and the storage cask occurs at the external surface of the canister shell and the storage cask guide rails and bottom end support pipes. All exposed surfaces of the canister shell are austenitic stainless steel. The support pipes on which the canister rests are also made from austenitic stainless steel. The surfaces of the storage cask support rails which contact the canister are faced with Nitronic-60 sheet. Prolonged use of stainless steel in contact with stainless steel or inorganic zinc-coated carbon steel produces no significant chemical, galvanic, or other reaction.

3.4.1.2 Transfer Cask

No significant chemical, galvanic, or other reactions are expected for the FuelSolutions™ transfer cask considering its materials of construction and intended service conditions. The transfer cask is constructed with austenitic stainless steel, lead, and solid neutron shielding material. In addition, water fills a stainless steel jacket surrounding the cask. The transfer cask service environment includes short duration exposure to the spent fuel pool environment and long-term exposure to the on-site meteorological conditions. All exposed surfaces of the transfer cask are austenitic stainless steel which has a long history of non-galvanic behavior under similar service. Stainless steel quickly forms a protective passive film in these environments and its general corrosion rate drops to very low levels. ~~Austenitic stainless steels in direct contact with lead have been used in similar casks for over 30 years and have not shown any degradation.~~

The lead in the transfer cask is fully encased with austenitic stainless steel and is not exposed to water or atmospheric containments and therefore will not have any adverse chemical reaction with the stainless steel.

3.4.2 Positive Closure

The FuelSolutions™ storage cask cannot be inadvertently opened. The storage cask top cover consists of a heavy steel plate which is attached to the storage cask using twelve structural bolts. Following placement of the storage cask cover, a lock wire is installed over one or more of the top cover bolts. Failure

3.4.3 Lifting Devi

The FuelSolutions™ storage and transfer casks include provisions for lifting associated with normal handling operations. The following subsections address structural adequacy of the lifting devices for both casks. The lifting of FuelSolutions™ canisters is addressed in the respective Canister Storage FSARs.

3.4.3.1 Storage Cask

The storage cask be lifted either from the top using four of the tie rods or from the bottom using four jacks and air pallets. The design load for the storage cask vertical lift is equal to the deadweight of the heaviest loaded storage cask plus an additional 5% for as-built uncertainties and 15% for dynamic effects, as discussed in Section 2.3.1.7. As shown in Section 3.2, the weight of the heaviest storage cask with canister is less than 335 kips.

In the case of the top end lift, spreader beams are used to assure that the load is evenly distributed between all four tie rods. The resulting maximum tensile force in each tie rod due to the vertical lift of the long storage cask is

$$F_{rod} = \frac{1.05 \cdot 1.15 \cdot 335}{4} = 101.2\text{kips}$$

This maximum tensile force in the tie rods due to the vertical lift is less than the tie rod minimum preload after the relaxation during storage (see Section 3.1.1.1). Therefore, under normal vertical lifting loads, the tie rod preload will maintain compression across the storage cask segment joints to assure that the segments remain engaged.

The storage cask may also be lifted from the bottom end using four jacks positioned inside the inlet vent openings. The total load supported by the jacks is $1.05 \cdot 1.15 \cdot 335 = 404.5\text{kips}$ as discussed above. It is conservatively assumed that the total lift load is supported by only two diametrically opposed jacks in the event of uneven jacking. Therefore, the maximum jack load is 202.3 kips. Using the ACI 349 requirements for bearing loads, the concrete allowable bearing stress is calculated to be $\phi(2 \cdot 0.85 f_c') = 0.7 \cdot (2 \cdot 0.85 \cdot 5) = 5.95$ ksi and the necessary bearing area is 34.0 in^2. Consequently, each jack is fitted with a bearing plate of this or larger area.

The evaluation of the transfer cask inner liner and structural shell stresses in the regions of the upper lifting trunnions employs finite element analysis and is addressed in Section 3.5.3.3.2.

The transfer cask top cover is lifted by four attachment points on the top surface. The full weight of the top cover (4,414 pounds) and the ram access cover (752 pounds) are assumed to be supported by two lifting attachments, thus, providing redundancy of the load path. The design load for each attachment of the top cover lifting device is 2,600 pounds plus the 15% increase for crane hoist motion, or 2,990 pounds. The lifting slings and attachments which thread into the transfer cask top cover are designed with minimum factors of safety of 5 against ultimate in accordance with the requirements of NUREG 0612 for redundant lifting devices. The standard lifting slings and eyebolts used to handle the top cover are rated for the specified design load and have a minimum safety factor of 5 in accordance with ANSI/ASME B30.9.[17]

3.4.4 Storage and Transfer Cask Service Life

The [initial] term of the 10CFR72, Subpart L C of C granted by the NRC is 20 years[, renewed for an additional 40 years.] Nonetheless, the FuelSolutions™ W150 Storage Cask is designed for 100 years of service and the FuelSolutions™ W100 Transfer Cask ~~is designed for 40 years of service~~ [was initially designed for 40 years of service and has now been analyzed to be viable for 60 years of service life] while satisfying the conservative design requirements defined in Chapter 2 of this FSAR, including the regulatory requirements of 10CFR72. In addition, the storage cask and transfer cask are designed, fabricated and inspected under the comprehensive Quality Assurance Program discussed in Chapter 13 of this FSAR and in accordance with the applicable requirements of the ACI and ASME Codes. This assures high design margins, high quality fabrication, and verification of compliance through rigorous inspection and testing as described in Chapter 9 of this FSAR. *Technical specifications* defined in Chapter 12 of this FSAR assure that the integrity of the cask and the contained canister are maintained throughout the components service life. The service life of the FuelSolutions™ canister is discussed in each FuelSolutions™ Canister Storage FSAR. The service life of the storage cask and transfer cask are discussed further in the following sections.

3.4.4.1 Storage Cask

The principal design considerations which bear on the adequacy of the FuelSolutions™ W150 Storage Cask for the design basis service life are addressed as follows:

Exposure to Environmental Effects

Thermal gradients resulting from the SNF decay heat and fluctuations in the ambient temperature and isolation cause sustained forces and moments in the storage cask reinforced concrete wall section over time. The resulting creep deformations tend to relieve such stresses in reinforced concrete. Creep effects for the storage cask are evaluated and found to be insignificant, as discussed in Section 3.1.1.1 of this FSAR. As discussed in Chapter 9 of this FSAR, the aggregates, cement and water used in the storage cask concrete are carefully controlled to provide high durability and resistance to weathering. The configuration of the storage cask and the low water-cement ratio used provide added resistance to freeze-thaw degradation. The controlled environment of the ISFSI storage pad mitigates damage due to salts for ice removal or

[17] ANSI/ASME B30-9, *Slings*, American Society of Mechanical Engineers, New York, 1984

direct exposure to damaging chemicals which may be present in other industrial applications. In addition, the storage cask is specifically designed for a full range of enveloping design basis natural phenomena which could occur over the 100-year service life of the storage cask as defined in Section 2.3.4 and evaluated in Chapter 11 of this FSAR.

Material Degradation

The relatively low neutron flux to which the storage cask is subjected does not result in significant degradation of the cask's material properties or impair its intended safety function. The reinforced concrete of the storage cask is not subject to corrosion because the reinforcing steel has adequate concrete cover in accordance with the requirements of ACI 349. Any storage cask materials which come into contact with the canister, such as the canister support pipes and support rails, are coated or fabricated from corrosion resistant stainless steel. The storage cask tie rods are fabricated from high strength corrosion-resistant steel and are accessible to verify tensioning. Exposed carbon steel components, such as the storage cask cover, are coated and accessible for re-coating if necessary. Exposed carbon steel components, such as the storage cask liner, which are not readily accessible are coated and not relied upon structurally. The controlled environment of the ISFSI storage pad mitigates damage due to direct exposure to corrosive chemicals which may be present in other industrial applications.

Maintenance and Inspection Provisions

The requirements for periodic inspection and maintenance of the storage cask throughout the 100-year service life are defined in Chapter 9 of this FSAR. These requirements include provisions for routine inspection of the storage cask exterior and periodic inspection of the storage cask interior for damage as well as visual verification that the ventilation flow paths of the storage cask are free and clear of debris. ISFSIs located in areas subject to atmospheric conditions which may degrade the storage cask or canister should be evaluated by the licensee on a site-specific basis to determine the frequency for such inspections to assure long term performance. In addition, the FuelSolutions™ Storage System is designed for easy retrieval of the canister from the storage cask, should it become necessary to perform more detailed inspections and repairs to the storage cask.

The above findings are consistent with those of the NRC's Waste Confidence Decision Review[18] which concluded that dry storage systems designed, fabricated, inspected and operated in accordance with such requirements are adequate for a 100-year service life while satisfying the requirements of 10CFR72.

3.4.4.2 Transfer Cask

The principal design considerations which bear on the adequacy of the FuelSolutions™ W100 Transfer Cask for the design basis service life are addressed as follows:

Exposure to Environmental Effects

All transfer cask materials that come in contact with the spent fuel pool are fabricated from austenitic stainless steel, as described in Section 3.1.1.2. The exposed surfaces of the transfer

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[18] *Nuclear Regulatory Commission 10 CFR Part 51 Waste Confidence Decision Review*, U.S. Nuclear Regulatory Commission, September 11, 1990.

This stress is well below the corresponding allowable of 20 ksi for SA-240, Type 304 at 300°F. Due to the presence of ribs, the actual stress is expected to be much lower than the one calculated herein. For the same reason, buckling of the neutron shield jacket under the external hydrostatic pressure of 15 psig is not a concern.

3.5.3.3.5 Fatigue Evaluation

As stated in Section 3.1.2.2.2, the transfer cask is evaluated for fatigue using the criteria of ~~AMSE~~ ASME, Section III, Subsection NC. This evaluation is performed by applying the six Condition B criteria of the Article NC-3219.2 as discussed below.

a) *The expected design number of full pressure cycles*. The transfer cask cavity does not serve as a pressure boundary. Only the liquid neutron shield jacket is designed to withstand internal pressure. Using the data in Appendix I, the alternating stress for Type 304 stainless steel at the conservative temperature of 500°F is found to be $S_a = 3S_m = 3 \cdot 17.5 = 52.5$ ksi and the corresponding number of cycles is 20,000. The transfer cask design life is ~~40~~ 60 years with the maximum number of canister transfers estimated at 25 per year. Therefore, the neutron shield jacket will see only ~~40 · 25 = 1,000~~ 60 · 25 = 1,500 full-range cycles. This is much less than the Code value of 20,000, hence, the first criterion is satisfied.

b) *The expected design range of pressure cycles during normal service*. Similar to (a) above, only the liquid neutron shield jacket is designed to withstand internal pressure. During the canister transfer operations, the design range of pressure cycle can be conservatively defined to be from -15 psi (static head pressure of 35 feet of pool water when the jacket is empty) to the bounding internal design pressure of +50 psi. Therefore, the design pressure range during normal service is 65 psi.

The number of loading operations over the cask lifetime is ~~1,000~~ 1,500, as determined above. Based on the number of cycles of 10^6, the significant pressure fluctuation range is calculated as 27 psi. Conservatively assuming that there are four significant pressure fluctuations during each loading, the total number of significant fluctuations is ~~1,000~~ 1,500 · 4 = ~~4,000~~ 6,000. The S_a value corresponding to this number of cycles is ~~80~~ 70 ksi and the respective allowable range is

$$\frac{1}{3} \cdot \text{Design Pressure} \cdot \left(\frac{S_a}{S_m} \right) = \frac{1}{3} \cdot 50 \cdot \left(\frac{\cancel{80}\ 70}{17.5} \right) = \cancel{76}\ 67$$

psi. The design range of 65 psi is below this value and, therefore, the second criterion is satisfied.

c) *The temperature difference between any two adjacent points*. The specified number of startup and shutdown cycles is ~~1,000~~ 1,500 as determined above. Based on that value and the material property data, the quantity of $S_a / 2E\alpha$ is calculated as ~~233°F~~ 213. Under no condition does the temperature difference between any adjacent points approach this value. Therefore, the ~~fourth~~ third criterion is satisfied.

d) *The range of temperature difference between any two adjacent points*. The range of temperature difference between any two adjacent points does not change during normal service by more than ~~233°F~~ 213 calculated above. Any changes in the cask temperature are relatively slow and gradual due to its large thermal capacity and absence of rapid changes in the external conditions.

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The transfer cask maximum stress condition only occurs for a fully loaded transfer cask and canister. Based on experience for any given loading campaign there is only 1 transfer cask lift fully loaded (with fuel and water), 1 lift fully loaded for flooded (water but no fuel), and 1 lift fully loaded (dry fuel) for a total of 3

e) *Temperature difference - dissimilar materials*. All transfer cask components are fabricated from Type 304, F304, and F304N stainless steel. The moduli of elasticity and coefficients of thermal expansion are the same for all these materials. As such, the fifth criterion is satisfied.

f) *Mechanical Loading*. ~~The transfer cask mechanical loading is associated with handling loads. For each loading cycle, the number of significant mechanical loadings can be conservatively estimated as 5~~ lift/setdowns + 5 significant vibrations + ~~3~~ upending/downendings + ~~3~~ canister ~~transfers~~ for the total of ~~16~~. The total lifetime number of cycles is, then, ~~16 · 1,000 = 16,000~~ and the S_a value for this number of cycles is ~~58.1~~ ksi. As shown in Table 3.5-8, the total stress intensity at any point of the transfer cask does not exceed 55.3 ksi. Therefore, this criterion is also satisfied.

1 | 1 | transfer | 10 | 60 | 1 | 10 · 1,500 = 15,000

3.5.3.3.6 Transfer Cask Load Combinations and Comparison with Allowable Stresses

The transfer cask is evaluated for the load combinations in accordance with ANSI/ANS 57.9,[20] as summarized in Section 2.3.5.2 and Table 2.3-8. The transfer cask load combination stress evaluation is conservatively performed by combining the maximum transfer cask component stress intensities due to each individual load condition irrespective of sign and location. The transfer cask maximum stresses due to the controlling normal transfer and storage conditions are summarized in Table 3.5-7. The resulting transfer cask normal condition load combination stress intensities are reported in Table 3.5-8. The load combination stress results demonstrate that the transfer cask has significant design margin for all normal transfer and operating conditions. The minimum design margin in the transfer cask for combined normal loading is +9% for the primary plus secondary stress intensity in the structural shell.

3.5.4 Cold Ambient Conditions

The FuelSolutions™ storage cask and transfer cask have been evaluated for the effects of an extreme cold ambient condition with no internal decay heat load. The evaluation considers the effects of extreme cold temperatures on the material properties and the potential for freezing of the transfer cask liquid neutron shield.

As discussed in Section 3.1.2, brittle fracture of the transfer and storage cask components is not a concern due to the selection of materials with the adequate fracture toughness.

The effects of an extreme off-normal cold ambient temperature combined with maximum decay heat load are evaluated for the storage cask in Section 3.6.1.1 of this FSAR. The results of the storage cask off-normal cold thermal stress evaluation demonstrate that the storage cask will continue to perform its intended safety functions under these conditions. The effects of extreme cold ambient conditions combined with a lower decay heat load produce lower stresses in the storage cask since the temperature gradients are a function of the decay heat load. For the condition with zero decay heat load, the storage cask has a uniform temperature equal to the ambient temperature, hence, it remains stress free.

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[20] ANSI/ANS-57.9, *Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)*, American National Standards Institute, 1984.

9.2 Maintenance Program

This section discusses the maintenance programs for FuelSolutions™ Storage System components that are classified as important to safety. Noncompliances encountered during the required maintenance activities will be dispositioned in accordance with the Energy*Solutions* SFD Quality Assurance Program, discussed in Chapter 13 of this FSAR, or the licensee's NRC-approved Quality Assurance Program. The maintenance programs are intended to demonstrate that the FuelSolutions™ Storage System continues to perform properly and comply with regulatory requirements and the *technical specifications* contained in Chapter 12 of this FSAR.

9.2.1 Canisters

The maintenance program for FuelSolutions™ canisters is discussed in Section 9.2 of each FuelSolutions™ Canister Storage FSAR.

The Aging Management Programs (AMPs) applicable during the additional 40 year license renewal period for the cask C of C are contained in Appendix 9.A.

9.2.2 Storage Cask

The FuelSolutions™ W150 Storage Cask is a passive system requiring a minimal amount of maintenance. The licensee is to maintain records that include evidence that all maintenance and testing performed on a storage cask is in compliance with an NRC-approved quality assurance program. The maintenance program is summarized in

(close gap in sentence)

Table 9.2-1 and discussed in more detail in the paragraphs that follow.

The maintenance program for the FuelSolutions™ W150 Storage Cask, which is applicable for the 100-year design life of the cask, includes the following:

1. After canister loading into the storage cask, dose rate measurements are to be taken to verify compliance with the applicable *technical specification* contained in Section 12.3 of this FSAR. Subsequent periodic radiation surveys are to be performed at the site boundary in accordance with site radiological control procedures and 10CFR72.106(b).[8]

2. The storage cask is periodically monitored, by either visual inspection of the storage cask vent screens or measurement of the storage cask liner temperature via the liner thermocouple, in accordance with the applicable *technical specification* contained in Section 12.3 of the respective FuelSolutions™ canister storage FSAR. Both methods of periodic monitoring allow prompt identification of any ventilation flow obstructions and initiation of corrective actions to restore safe storage conditions.

3. The storage cask temperature monitoring instrumentation is to be checked for proper operation and calibrated at least annually.

4. An annual inspection of the exposed exterior of the storage cask for surface defects (e.g., concrete cracking, spalling, or paint chipping) should also be conducted. Any defects

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[8] Title 10, U.S. Code of Federal Regulations, Part 72 (10CFR72), *Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste*, 1995.

identified are to be documented and evaluated. Any repairs are to be performed using an approved procedure.

5. Every five years, the interior surface of the first storage cask placed into service is to be inspected for damage. Inspections may be by direct or indirect visual methods. Any defects identified are to be documented and evaluated. Any repairs are to be performed using an approved procedure.

6. If the storage cask is to be re-used following canister unloading and storage cask disassembly, the following inspections are to be performed prior to re-assembly:

    - The condition of the components, including the concrete segments, tie-rods, thermal shield, cover, etc., is to be inspected for the presence of any damage or defects.
    - Removal of the grout layer between segments is to be verified.
    - Cleanliness of the lifting coupling threads at the tie-rod sleeves for each concrete segment is to be verified.
    - The tie-rod and nut threads are to be inspected to verify that they are in good condition and not galled. Any defective component is to be repaired or replaced.
    - The storage cask is to be inspected to verify that no debris is present in the cavity, inlet vents, or outlet vents.

Table 9.2-1 - Maintenance Program for the FuelSolutions™ W150 Storage Cask

Maintenance Program		
Inspection	**Tests**	**Repair, Replacement, and Maintenance**
a) The storage cask concrete will be inspected annually in accordance with site-specific procedures to determine if damage has occurred. b) The vent screens will be visually inspected periodically to determine that they are in place and are in good condition. c) The temperature monitoring system will be read periodically. Any indication of malfunctioning will be evaluated. d) Radiation readings from the storage casks are read per the *technical specification*.	a) The temperature readout system will be tested and calibrated at least annually or more often if prescribed by a site-specific procedure.	a) If damage has occurred in the form of chipping or spalling of the concrete that exposes the rebar within, then the damaged area will be repaired with grout, as prescribed in the site-specific procedure. b) If significant damage to the storage cask vent screens (as described in the site-specific procedure) is observed, then the damaged screen will be repaired or replaced. c) If the temperature readout system for a storage cask is found to be malfunctioning, then it will be repaired or replaced, as prescribed in a site-specific procedure. d) If radiation readings exceed *technical specification* limits, the action steps outlined in the *technical specification* may require erecting temporary shielding.

The Aging Management Programs (AMPs) applicable during the additional 40 year license renewal period for the cask CoC are contained in Appendix 9.A.

9.2.3 Transfer Cask

The FuelSolutions™ W100 Transfer Cask is used for loading each canister into a storage cask and requires only a limited amount of periodic maintenance to properly perform its intended functions. The licensee is to maintain records that include evidence that all maintenance and testing performed on the transfer cask is in compliance with an NRC-approved quality assurance program. The maintenance program is summarized in Table 9.2-2 and discussed in more detail in the paragraphs that follow.

The maintenance program for the FuelSolutions™ W100 Transfer Cask, which is applicable for the ~~40-year design~~ 60-year service life of the cask, includes the following:

1. The transfer cask is to be visually inspected for any apparent defects prior to each use. This inspection is to evaluate the condition of the cask relative to sealing surfaces, interior surface condition and cleanliness, visual integrity of welds, damage to the trunnions, and general fit-up of the components. A surface contamination survey is to be made of the transfer cask interior.
2. Prior to each use, the liquid neutron shield pressure relief device is to be inspected and replaced as necessary. The replacement of this device should be performed in accordance with a site-specific procedure.
3. Prior to each use, the bottom cover O-rings and bolt seals are to be inspected for any defects that may result in leakage and replaced as necessary. The replacement of the O-rings or any of the bolts are to be performed in accordance with a site-specific procedure.
4. Following canister loading, dose rate measurements are to be taken to verify compliance with plant-specific procedures and ALARA requirements (discussed in Section 10.1.3 of this FSAR). Radiation surveys are to be performed during each canister transfer operation to assure occupational exposures are maintained ALARA.
5. Annually, the transfer cask is to be inspected for defects in accessible materials (including the neutron shield coating system) and welds, including the trunnion locations. Critical trunnion areas and accessible trunnion load bearing welds are to be dye penetrant tested or examined with an equivalent non-destructive examination method. Any defects identified are to be dispositioned using an approved procedure. Visual inspections of the cask trunnions are to be in accordance with ANSI N14.6 to verify that no permanent deformation has occurred since the last inspection. Load testing of the transfer cask trunnions is not required.
6. Annually, the functionality of all transfer cask threaded components and quick-connect fittings is to be verified.
7. Annually, the liquid neutron shield is to be filled and leak tested. Any leaks are to be repaired using an approved procedure.
8. Prior to each use, proper lubrication of all transfer cask threaded connections is to be verified. Transfer cask threaded connections are to be lubricated with a lubricant approved for use at the designated plant site.
9. Prior to each use, the transfer cask quick-connect fittings are to be inspected to verify no damage or defects and to assure proper operation.

9.2.4 Storage Cask Impact Limiter

Per-use and annual inspections of the FuelSolutions™ storage cask impact limiter include visual inspection for any apparent defects, the visual integrity of welds, the general condition of the impact limiter, and its fit-up with the horizontal canister transfer area pad depression. When not in use, the impact limiter will be disassembled and placed in storage for protection from degradation.

Table 9.2-2 - Maintenance Program for the FuelSolutions™ W100 Transfer Cask

Maintenance Program		
Inspection	**Tests**	**Repair, Replacement, and Maintenance**
a) A general visual inspection will occur prior to each use. b) Inspection of the neutron shield pressure relief device will occur prior to use. c) Bolts and O-rings used on the bottom cover will be inspected before each use. d) Quick-connect fittings will be inspected prior to each use. e) Critical trunnion areas and accessible trunnion load bearing welds will be dye penetrant inspected on an annual basis.	a) The neutron shield cavity will be leak tested annually. b) The neutron shield cavity pressure relief device will be tested/replaced annually.	a) Repairs will be made to correct any defects found during the pre-use inspection or annual inspections. b) Replacement of parts or components will be of the same quality designation as the original. c) Threaded connections will be lubricated prior to use.

5.0 Administrative Controls

Total Heat Load (Q)	Measured Thermocouple Temperature (•F) Normal Ambient (• 100•F)	Off-Normal Ambient (• 125•F)
Q > 20 kW	163	192
15 kW < Q • 20 kW	156	181
10 kW < Q • 15 kW	146	171
5 kW < Q • 10 kW	136	161
Q • 5 kW	126	151

Alternatively, the program may establish other suitable surveillance frequencies and liner thermocouple temperature limits to maintain the concrete temperature below the short-term allowable temperature of 350•F for a specific CANISTER heat load.

5.4 Special Requirements for First System in Place

See the CANISTER Technical Specifications for the applicable information.

5.3.9 Aging Management Program

Each general licensee shall have a program to establish, implement, and maintain written procedures for each AMP described in the 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.

The general licensee shall establish and implement these written procedures within one year of the effective date of the renewal of the CoC or one year of the 20th anniversary of the loading of the first dry storage system at licensee's site, whichever is later.

The general licensee shall include written evaluations in the 10 CFR 72.212 evaluations report describing the implementation of the renewed CoC aging management license conditions within this specified time frame.

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

Appendix 9.A Aging Management Program

In accordance with the renewed FuelSolutions license, sites must implement an aging management program. An aging management assessment of the components of the FuelSolutions Storage System was performed. This review identified inspection and monitoring activities necessary to provide reasonable assurance that system components within the scope of license renewal continue to perform their intended functions consistent with the current licensing basis for the renewed storage period. This appendix describes those aging management programs and the associated tollgate assessment requirements.

9.A.1 Aging Management Programs (AMPs)

The following AMPs apply to C of C 1026 Amendments 0 through 4.

9.A.1.1 FuelSolutions Welded Stainless Steel Canister AMP

The Welded Stainless Steel Canister AMP uses inspections to look for visual evidence of discontinuities and imperfections, such as localized corrosion, including pitting corrosion and stress corrosion cracking of the canister welds and heat affected zones. The full program is described in Table 9.A.1-1, Welded Stainless Steel Canister AMP, which is located in Appendix 9.A of the FuelSolutions W21 Canister FSAR WSNF-221 and Appendix 9.A of the FuelSolutions W74 Canister FSAR WSNF-223.

9.A.1.2 FuelSolutions Reinforced Concrete Structures AMP

The Reinforced Concrete Structures AMP uses inspections to look for indications of concrete deterioration that might affect the ability of the W150 Storage Cask to perform its important to safety function. The full program is described in the following Table 9.A.1-2.

9.A.1.3 FuelSolutions Monitoring of Metallic Surfaces AMP

The Monitoring of Metallic Surfaces AMP uses inspections to look for indications of metallic surface deterioration that might affect the ability of the W150 Storage Cask and Fuel Transfer and Auxiliary Equipment metallic surfaces to perform their important to safety functions. The full program is described in the following Table 9.A.1-3.

9.A.1.4 FuelSolutions W100 Transfer Cask AMP

The W100 Transfer Cask AMP utilizes inspections to ensure that the equipment maintains its intended function through the extended storage period. The full program is described in the following Table 9.A.1-4.

9.A.1.5 FuelSolutions W21 Canister High-Burnup Fuel Monitoring and Assessment AMP

The W21 Canister High-Burnup Fuel Monitoring and Assessment AMP only applies to W21 Canisters that store high-burnup fuel. The AMP relies on the EPRI and DOE research projects on high burnup fuel. The full program is described in Table 9.A.1-5, W21 Canister High-Burnup Fuel Monitoring and Assessment AMP, which is located in Appendix 9.A of the FuelSolutions W21 Canister FSAR WSNF-221.

Table 9.A.1-2 FuelSolutions Reinforced Concrete Structures AMP
(5 pages)

Element	Description
1 Scope of Program	The AMP addresses reinforced concrete structures such as the concrete portions of the W150 Storage Cask. The associated SSCs include the concrete shell, shear key, and reinforcing steel in air-outdoor or sheltered environments. The following aging effects are addressed in this program: • Cracking or loss of material (spalling, scaling) due to freeze-thaw degradation • Cracking, loss of strength, and loss of material (spalling, scaling) due to aggressive chemical attack • Cracking, and loss of strength due to reaction with aggregates • Loss of material (spalling, scaling) due to salt scaling • Loss of strength, increase in porosity and permeability and reduction of concrete pH (reducing corrosion resistance of steel embedments) due to leaching of calcium hydroxide • Cracking, loss of strength, loss of material (spalling, scaling), and loss of concrete/steel bond due to corrosion for reinforcing steel. Although the ISFSI Storage Pad is not considered Important to Safety, as noted in FuelSolutions Storage System FSAR Section 1.2, the pad should be inspected as may be required elsewhere.
2 Preventive Actions	Condition monitoring is utilized to manage aging effects including continuance of inspections of air inlet/outlet vents to confirm they are not blocked which also ensures design temperature limits are not exceeded and thermal dehydration of the concrete remains noncredible during the period of extended operation. As the storage cask reinforced concrete is designed and analyzed in accordance with the applicable provisions of ACI-349 and constructed using standard commercial practices, in accordance with the applicable provisions of ACI-318, no additional preventive actions are required.
3 Parameters Monitored / Inspected	The accessible and exposed concrete surfaces are visually examined for indications of surface deterioration. The parameters monitored or inspected quantify the following aging effects: • Cracking • loss of material (spalling, scaling) • increased porosity/permeability Degradation could affect the ability of the concrete to provide radiation shielding, to provide a path for heat transfer and to provide tornado missile shielding. The inlet and outlet vents are also monitored by visual inspection to ensure they are not obstructed. For inaccessible concrete surfaces, an inspection using a video camera, fiber-optic scope or other remote inspection equipment via existing access points on one cask to determine if there is any evidence of concrete degradation. The parameters evaluated consider any surface geometries that may identify water ponding which potentially increases the rate of

Table 9.A.1-2 FuelSolutions Reinforced Concrete Structures AMP
(5 pages)

	degradation. The accessible internal concrete surfaces of the storage cask are inspected for indications of degradation. These indications may impact the long-term ability of the storage cask to meet its intended functions.
4 Detection of Aging Effects	The AMP requires a visual inspection of the readily accessible exterior surfaces of the storage cask to detect if there are any aging effects. The visual inspection shall identify cracking, loss of material (spalling, scaling), increased porosity/permeability, staining or other degradation-related activity and the degree of damage. This visual inspection identifies the current exterior condition of the storage cask and shall identify the extent and cause of any aging effects noted. This visual inspection uses the inspection evaluation and acceptance criteria of ACI 349.3R-02 (ACI, 2010) and is conducted at least once every five (5) years on each storage cask in operation during the period of extended storage by personnel meeting the qualification requirements in Chapter 7 of ACI 349.3R-02 (ACI, 2010). A visual inspection of the lower vent interior concrete areas of one storage cask shall be performed using a using a video camera, fiber-optic scope or other remote inspection equipment. This visual inspection shall meet the requirements in accordance with the acceptance criteria in ACI 349.3R-02 (ACI, 2010) and be performed by personnel meeting the qualification requirements in Chapter 7 of ACI 349.3R-02 (ACI, 2010) at least once every five (5) years. Note: As the interior of the storage cask cavity and upper vents have a steel lining, the Metallic Surfaces AMP addresses these metallic portions of the storage cask. To manage and verify the shielding performance of the storage cask concrete during the period of extended operation radiological surveys of the storage cask are performed to verify compliance with 10 CFR 72.104, and. cask concrete surface dose rates are monitored per FuelSolutions STORAGE SYSTEM Technical Specification 5.3.5. Cask Surface Dose Rate Evaluation Program. The radiation surveys from the site Radiological Environmental Monitoring Program shall be used to verify compliance with 10 CFR 72.104. Based on satisfactory concrete shielding effectiveness during the first twenty years of storage, at a frequency of every five (5) years a radiological survey of exposed concrete surfaces on each storage cask in operation shall be conducted during the period of extended storage. The first survey should occur within 1 year after the 20th anniversary of initial storage cask loading at the site or within 1 year after the issuance of the renewed license, whichever is later. These surveys shall be conducted at the cask side wall and inlet vent positions required by Technical Specification 5.3.5 using calibrated gamma ray and neutron detection equipment and qualified radiation protection program personnel. Data from all inspection and monitoring activities, including evidence of degradation and its extent and location, shall be documented on a checklist or inspection form. The results for the inspection will be

Table 9.A.1-2 FuelSolutions Reinforced Concrete Structures AMP
(5 pages)

	documented, including descriptions of observed aging effects and supporting sketches, photographs or video. The interior concrete inspection shall be performed on one of the storage casks at each ISFSI at a frequency of 5 years. The first inspection should occur within 1 year after the 20th anniversary of initial storage cask loading at the site or within 1 year after the issuance of the renewed license, whichever is later. As stated in Item 5 of FuelSolutions Storage System FSAR Section 9.2.2 the interior surface of the first cask placed in service at an ISFSI site is to be inspected for damage every five years. Alternatively, the site may conduct the interior inspection on the storage cask that contains the canister being inspected for the Welded Stainless Steel Canister AMP to consolidate efforts. The inspections shall be documented, including a detailed description of the surface condition and location of areas showing surface degradation.
5 Monitoring and Trending	Monitoring and trending of the results from documented inspection should support the ability to evaluate the results against acceptance criteria. Methods are commensurate with consensus defect evaluation guides and standards. The inspections and surveillances described for reinforced concrete are performed periodically in order to identify areas of degradation. The results will be evaluated by a qualified individual, and areas of degradation not meeting established criteria will be documented in the site's corrective action program for resolution or detailed evaluation. Inspection records, including photos and /or videos, are to be retained for comparison in subsequent examinations. The results from the visual inspections will be compared against previous inspections in order to trend progression of identified aging effects over time.
6 Acceptance Criteria	American Concrete Institute Standard 349.3R-02 includes quantitative three-tier evaluation and acceptance criteria for visual inspections of concrete surfaces as follows: • Tier 1 acceptance without further evaluation • Tier 2 acceptance after review • Tier 3 acceptance requiring further evaluation Acceptance signifies that a component is free of significant deficiencies or degradation that could lead to the loss of structural integrity. Acceptable after review signifies that a component contains deficiencies or degradation but will remain able to perform its design basis function until the next inspection or repair. Acceptance requiring further evaluation signifies that a component contains deficiencies or degradation that could prevent (or could prevent prior to the next inspection) the ability to perform its design basis function. Degradations or conditions meeting the ACI 349.3R-02 Tier 2 and 3 criteria will be entered into the site's corrective action program for evaluation and resolution. The loss of material due to age-related degradation will be evaluated by qualified personnel in accordance with ACI 349.3R-02. A technical basis

Table 9.A.1-2 FuelSolutions Reinforced Concrete Structures AMP
(5 pages)

	will be provided for any deviation from ACI 349.3R-02 acceptance criteria. The radiological survey acceptance criteria in 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.
7 Corrective Actions	Results that do not meet the acceptance criteria are addressed by the site's corrective action program (CAP) in accordance with the ISFSI Quality Assurance (QA) program. The site's QA Program ensures that corrective actions are completed within the ISFSI Corrective Action Program (CAP) and include any necessary functionality assessments, cause evaluations, extent of condition, actions, identify any modifications to the existing AMP (e.g., increased frequency), and determine if the condition is reportable per 10 CFR 72.75.
8 Confirmation Process	The confirmation process will be commensurate with the ISFSI QA Program. The QA program ensures that the confirmation process includes provisions to preclude repetition of significant conditions adverse to quality and the completion of inspections, evaluations, and corrective actions.
9 Administrative Controls	The ISFSI QA program ensures that administrative controls include provisions that address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control. Administrative controls also address the frequency for updating the AMP based on inspection results along with industry operating experience. This AMP will be updated as necessary based on tollgate assessments.
10 Operating Experience	Previous operating experience for the W150 Storage Cask indicates very minimal degradation detected to date, mostly limited to concrete "bug hole" and grout degradation. That operating experience has been incorporated into the guidance on inspections and acceptance criteria contained in this AMP. A renewal application pre-submittal inspection[10] was performed on the FuelSolutions storage cask at Big Rock Point in July 23, 2019. Three separate tasks were completed consisting of a video inspection of the accessible area in the annulus between the cask and canister; a visual inspection of the cask interior and visual inspection of the cask storage pad. A representative canister and storage cask were selected by Entergy based on increased susceptibility for moisture intrusion and corrosion. Heat loads at the time of loading all of the canisters at Big Rock Point were within 0.5 kW of each other, and all storage casks were placed into service within months of each other (as noted, between November 2002 and May 2003). The inspection revealed some minor observations; however, no structural deficiencies were identified and all parts continue to perform their design function.

[10] Report 4T002-RPT-001, Rev 0 "FuelSolutions Renewal Application Pre-Submittal Inspection," August 29, 2019

Table 9.A.1-2 FuelSolutions Reinforced Concrete Structures AMP
(5 pages)

	NRC Region III Inspectors.[11] reviewed the previous five-year cask inspection documentation for Big Rock Point storage cask number 7 that included both pictures and video of the interior of the cask and did not identify any findings of significance. As storage cask inspections are performed in the future, inspection results will be uploaded into the ISFSI Aging Management Institute of Nuclear Power Operations Database (ISFSI AMID) to be shared with other users.

[11] Errata to Big Rock Point Independent Spent Fuel Storage Installation - Inspection Reports 07200043-12-001 and 05000155-12-007 (ADAMS Accession ML13071A379) dated 03/11/13.

Table 9.A.1-3 FuelSolutions Monitoring of Metallic Surfaces AMP
(4 pages)

Element	Description
1 Scope of Program	This program manages the effects of aging for: (1) the external surfaces of steel, stainless steel and aluminum components that are directly exposed to outdoor air or are sheltered within W150 Storage Cask, and (2) the Fuel Transfer and Auxiliary Equipment. The scope of the program includes the following cask subcomponents and the applicable site fuel transfer and auxiliary equipment: • Storage Cask Thermal shield panel assembly • Storage Cask Shear lug and thermal shield support lug • Storage Cask steel liner and shield ring • Storage Cask canister support tubes • Storage Cask Tie rod hardware • Ram anchor • Storage Cask Top cover assembly • Storage Cask Top cover bolts • Storage Cask Support rails • Storage Cask Guide rails • Cask lifting yoke • Canister vertical lift fixture • Cask cavity axial spacer • Shielded docking collar • Cask restraints • Empty canister lift fixture • Standard lifting slings (inside plant facility) • Storage cask impact limiter steel casing The following aging effects are addressed in this program: • Loss of material is due to general corrosion, galvanic corrosion, pitting and crevice corrosion and wear • Loss of preload due to stress relaxation • Coating degradation on steel and aluminum surfaces Periodic visual inspections monitor for general and localized corrosion, wear, coating degradation, and loss of preload (bolting).
2 Preventive Actions	This program is a condition monitoring program to detect evidence of degradation. It does not provide guidance for the prevention of aging.
3 Parameters Monitored / Inspected	This program monitors the condition of external metallic surfaces to identify general corrosion, localized corrosion, wear, and loss of preload of bolted connections. Localized corrosion of stainless steels may be a precursor to stress corrosion cracking (SCC). Parameters monitored or inspected for external metallic surfaces include: • visual evidence of discontinuities, imperfections, and rust staining indicative of corrosion, SCC, and wear

Table 9.A.1-3 FuelSolutions Monitoring of Metallic Surfaces AMP
(4 pages)

Element	Description
	• visual evidence of loose or missing bolts, physical displacement, and other conditions indicative of loss of preload • visual evidence of coating degradation (e.g., blisters, cracking, flaking, delamination) indicative of corrosion of the base metal Accessible storage cask internal surfaces are inspected for indications of corrosion and wear and coating degradation.
4 Detection of Aging Effects	Inspections are performed by personnel qualified in accordance with site procedures and programs to perform the specified task. Visual inspections follow site procedures that are demonstrated to be capable of evaluating conditions against the acceptance criteria. Readily Accessible Surfaces Inspections cover 100 percent of normally accessible surfaces, including the external metallic surfaces, bolting, covers, vents, and other metallic components. The visual survey performed on metallic surfaces will identify the source of any staining or corrosion-related activity and the degree of damage. A visual inspection of the metallic exterior surfaces of the storage cask to detect aging effects is conducted annually. Visual inspections of fuel transfer and auxiliary equipment shall be performed at a minimum of once a year while in use. If the fuel transfer and auxiliary equipment is not used, a pre-use visual inspection shall be performed. When the fuel transfer and auxiliary equipment is not in use, periodic inspections are not needed. The visual inspections are performed in accordance with site implementing procedures. Normally Inaccessible Surfaces A visual inspection of the interior metallic surfaces of the storage cask shall be performed with remote inspection techniques such as a video camera, fiber-optic scope or other remote inspection equipment. The visual inspection should include an examination of the accessible areas of the canister exterior surface and the storage cask thermal shield. The accessible areas of the storage cask guide rails and support rails should be examined for coating degradation and corrosion. This visual inspection of the metallic components shall meet the requirements of a VT-3 Examination, as given in the ASME Boiler & Pressure Vessel Code (B&PVC) Section XI, Article IWA-2200, to the extent practical, even though they are not ASME components. The interior inspection shall be performed on one storage cask at each ISFSI, at a frequency of 5 years starting with the first inspection within the later of either one (1) year after the initial canister's 20th year loading anniversary or within one year after the issuance of first renewal of the CoC. As stated in Item 5 of FuelSolutions Storage System FSAR Section 9.2.2 the interior surface of the first cask placed in service at an ISFSI site is to be inspected for damage every five years. Alternatively, the site may conduct the interior inspection on the storage

Table 9.A.1-3 FuelSolutions Monitoring of Metallic Surfaces AMP
(4 pages)

Element	Description
	cask that contains the canister being inspected for the Welded Stainless Steel Canister AMP to consolidate efforts. Data from inspections shall be documented, including a detailed description of the surface condition and location of areas showing surface degradation.
5 Monitoring and Trending	Inspection results are compared to those obtained during previous inspections, so that the progression of degradation can be evaluated and predicted. Monitoring and trending methods and plans and procedures are used to: • establish a baseline before or at the beginning of the period of extended operation • track trending of parameters or effects not corrected following a previous inspection, including ➢ locations and size of any areas of corrosion, wear or cracking ➢ disposition of components with identified aging effects and the results of supplemental inspections
6 Acceptance Criteria	The acceptance criteria for the visual inspections are: • no detectable loss of material from the base metal, including uniform wall thinning, localized corrosion pits, and crevice corrosion • no indications of loose bolts or hardware, displaced parts • no degradation (e.g., blisters, cracking, flaking, delamination) of coatings on metallic surfaces indicative of base metal corrosion. If evidence of corrosion or wear is identified, then the severity of the degradation must be determined using approved site-specific procedures. These may include additional visual, surface or volumetric NDE methods to determine the loss of material.
7 Corrective Actions	Results that do not meet the acceptance criteria are addressed by the site's Corrective Actions Program (CAP) in accordance with the ISFSI Quality Assurance (QA) program. The site's QA Program ensures that corrective actions are completed within the ISFSI Corrective Action Program (CAP) and include any necessary functionality assessments, cause evaluations, extent of condition, actions, identify any modifications to the existing AMP (e.g., increased frequency), and determine if the condition is reportable per 10 CFR 72.75.
8 Confirmation Process	The confirmation process will be commensurate with the ISFSI QA Program. The QA program ensures that the confirmation process includes provisions to preclude repetition of significant conditions adverse to quality and the completion of inspections, evaluations, and corrective actions are completed in accordance with the ISFSI CAP.
9 Administrative Controls	The ISFSI QA program ensures that administrative controls include provisions that address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control. Administrative controls also address the frequency for updating the AMP based on inspection results along with industry operating experience. This AMP will be updated as necessary based on tollgate assessments.

Table 9.A.1-3 FuelSolutions Monitoring of Metallic Surfaces AMP
(4 pages)

Element	Description
10 Operating Experience	Previous operating experience for the W150 Storage Cask indicates very minimal degradation detected to date, mostly limited to coating degradation. That operating experience has been incorporated into the guidance on inspections and acceptance criteria contained in this AMP. A renewal application pre-submittal inspection[12] was performed on the FuelSolutions storage casks at Big Rock Point in July 2019. Three separate tasks were completed consisting of a video inspection of the accessible area in the annulus between the cask and canister, visual inspection of the cask interior and a visual inspection of the cask storage pad. A representative canister and storage cask were selected by Entergy based on increased susceptibility for moisture intrusion and corrosion. Heat loads at the time of loading all of the canisters at Big Rock Point were within 0.5 kW of each other, and all storage casks were placed into service within months of each other (as noted, between November 2002 and May 2003). The inspection revealed some minor observations; however no structural deficiencies, and all parts continue to perform their design function. NRC Region III Inspectors reviewed [Insp Rpt].[13]the previous five-year cask inspection documentation for Big Rock Point storage cask number 7 that included both pictures and video of the interior of the cask and did not identify any findings of significance. As storage cask inspections are performed in the future, inspection results will be uploaded into the ISFSI Aging Management Institute of Nuclear Power Operations Database (ISFSI AMID) to be shared with other users.

[12] Report 4T002-RPT-001, Rev 0 "FuelSolutions Renewal Application Pre-Submittal Inspection," August 29, 2019

[13] Errata to Big Rock Point Independent Spent Fuel Storage Installation - Inspection Reports 07200043-12-001 and 05000155-12-007 (ADAMS Accession ML13071A379) dated 03/11/13.

Table 9.A.1-4 FuelSolutions W100 Transfer Cask AMP
(3 pages)

Element	Description
1 Scope of Program	The program covers the subcomponents of the W100 Transfer Cask to ensure that aging effects do not challenge the capability of the transfer cask to fulfill structural support, radiation shielding, and heat transfer functions. The effected SSCs include the guide rail, liquid neutron shield jacket coating, trunnion retainers and sleeves, steel bolts for the top cover, bottom cover, and ram access cover, and the pressure relief device in the environments of air-indoor/outdoor and demineralized water. Other effected SSCs include the solid neutron shielding material embedded in the top cover, bottom cover, and ram access cover. This program manages loss of material due to general corrosion, galvanic corrosion, pitting and crevice corrosion and wear, loss of shielding due to boron depletion and coating degradation due to radiation embrittlement and thermal aging to ensure that these aging effects do not challenge the capability of the transfer cask to fulfill structural support, radiation shielding, and heat transfer functions. The Transfer Cask AMP includes inspections of trunnion retainers, sleeves and guide rails for wear, cover bolts and pressure relief device for corrosion, and liquid neutron shield jacket coating for coating degradation. Radiological surveys are conducted on the cask top cover, bottom cover, and ram access cover for solid neutron shielding deterioration due to boron depletion.
2 Preventive Actions	The Transfer Cask AMP utilizes condition monitoring to detect degradation and ensure that the equipment maintains its intended function through the extended storage period. No preventative actions are included as part of this AMP.
3 Parameters Monitored / Inspected	The Transfer Cask AMP inspects for visual evidence of degradation of accessible surfaces, and deterioration of the solid neutron shielding material performance.
4 Detection of Aging Effects	The Transfer Cask AMP manages loss of material due to corrosion, predominately for stainless steel, steel, and brass components, degradation of the coating on the liquid neutron shield jacket, and deterioration of the solid neutron shielding material performance. Inspection shall be performed at a minimum once a year while in use. If the Transfer Cask is not used, a pre-use inspection is appropriate for the Transfer Cask. When the Transfer Cask is not in use, periodic inspections are not needed. Visual inspections are performed in accordance with the ASME Code Section XI, Article IWA-2213, for VT-3 examinations. The inspections cover 100 percent of the normally accessible cask surfaces, including the cask exterior, cask interior cavity, top cover surfaces, and the cask bottom (during lifting or down ending). A radiological surveillance inspection of the RX-277 or NS-3 solid neutron shielding material performance in the top, bottom, and ram access covers of a loaded transfer cask shall be performed once per loaded fuel canister transfer campaign using calibrated neutron detection equipment and qualified radiation protection program personnel.

Table 9.A.1-4 FuelSolutions W100 Transfer Cask AMP
(3 pages)

	Data from these inspections, including evidence of degradation and its extent and location, shall be documented on a checklist or inspection form. The results of the inspection shall be documented, including descriptions of observed aging effects and supporting sketches, photographs, or video. Corrective actions resulting from each AMP inspection shall also be documented.
5 Monitoring and Trending	Inspection results are compared to those obtained during previous inspections, so that the progression of degradation can be evaluated and predicted. Monitoring and trending methods and plans/procedures are used to: • establish a baseline before the use of the transfer cask in the first loading campaign in the period of extended operation • track trending of parameters or effects not corrected following a previous inspection ➢ the locations, size, and depth of any areas of corrosion ➢ the disposition of components with identified aging effects and the results of supplemental inspections ➢ the deterioration of the solid neutron shielding material performance
6 Acceptance Criteria	For accessible surfaces, including bolts for the top, bottom and access covers, guide rails, trunnion retainers and sleeves, and pressure relief device, acceptance criteria are no detectable loss of material from the base metal, including uniform wall thinning, localized corrosion pits, crevice corrosion, and wear scratches/gouges. Coating acceptance criteria are no degradation or interruptions (e.g., chipping/scratches/flacking) of the coated surface. If evidence of corrosion, wear, or coating degradation are identified, then the severity of the degradation of the base metal must be determined using approved site-specific procedures. These may include additional visual, surface, or volumetric NDE methods to determine the loss of material. For acceptance of the RX-277 or NS-3 solid neutron shielding in the top, bottom, and ram access covers of a loaded transfer cask, the top, bottom, and ram access cover neutron dose rates shall not exceed the bounding neutron dose rates in FSAR WSNF-220 Table 5.1-2.
7 Corrective Actions	Results that do not meet the acceptance criteria are addressed by the site's Corrective Action Program (CAP) in accordance with the ISFSI Quality Assurance (QA) program. The QA Program ensures that corrective actions are completed within the ISFSI Corrective Action Program (CAP) and include any necessary actions, identify any changes to the existing AMP, and determine if the condition is reportable per 10 CFR 72.75.
8 Confirmation Process	The confirmation process will be commensurate with the site QA program. The QA program ensures that the confirmation process includes provisions to preclude repetition of significant conditions adverse to quality and the completion of inspections, evaluations, and corrective actions.
9 Administrative Controls	The QA program ensures that administrative controls include provisions that address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control.

Table 9.A.1-4 FuelSolutions W100 Transfer Cask AMP
(3 pages)

	Administrative controls also address the frequency for updating the AMP based on inspection results along with industry operating experience. This AMP will be updated as necessary based on tollgate assessments.
10 Operating Experience	Previous operating experience for the W100 Transfer Cask indicates very minimal degradation detected to date, mostly limited to coating degradation. That operating experience has been incorporated into the guidance on inspections and acceptance criteria contained in this AMP. As transfer cask inspections are performed in the future, inspection information will be uploaded into the ISFSI Aging Management Institute of Nuclear Power Operations Database (ISFSI AMID) to be shared with other users.

9.A.2 Tollgates

As noted in NUREG-1927 "Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel," Revision 1, the guidance was developed by the NRC as an ongoing effort (and as of this CoC renewal application, still is) with efforts by the Nuclear Energy Institute (NEI) to develop guidance for the nuclear industry when preparing CoC renewal applications. NEI 14-03, Revision 1, “Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management”, included guidance on the continued evaluation of operating experience. One of the principles introduced in NEI 14-03 is the use of “tollgates” as a structured approach for assessing operating experience and data from applicable research and industry initiatives. NUREG-1927, Revision 1, Section 3.6.1.10, provides the associated guidance that may be used for CoC renewals.

NEI 14-03 provides a proposed framework for learning AMPs through the use of “tollgates” and defines “tollgates” as periodic points within the period of extended operation when licensees would be required to evaluate aggregate feedback and perform and document a safety assessment that confirms the safe storage of spent fuel. Tollgates are described as an additional set of in-service assessments beyond the normal continual assessment of operating experience, research, monitoring, and inspections on DSS component and ISFSI SSC performance that is part of normal ISFSI operations for licensees during the initial storage period as well as the period of extended operation.

In addition, NEI 14-03, Revision 1, also describes a framework for the aggregation and dissemination of operating experience across the industry through the use of an aging-related operating experience “clearinghouse,” titled the ISFSI Aging Management Institute of Nuclear Power Operations Database (ISFSI AMID). Aggregate feedback will be assessed by each licensee regarding ISFSI components and if necessary, take actions to:

- Modify monitoring and inspection programs in AMPs
- Modify TLAAs
- Perform mitigation

Tollgate assessments address the following elements as applicable:

Frequency:

- Established from technical basis
- Reflects aging mechanism initiation and rate of progression
- Reflects risk significance
- Considers findings from prior tollgate assessments

Content of tollgate assessments:

- Summary of research findings, operating experience, monitoring data, and inspection results
- Aggregate impact of findings (including trends)
- Consistency with the assumptions and inputs the TLAAs
- Effectiveness of AMPs
- Corrective actions, including changes to AMPs
- Summary and conclusions

A schedule for these tollgate assessments is shown in Table 9A.2-1.

Table 9.A.2-1: Tollgate Assessments for General Licensees

Tollgate	Year	Assessments
1	Year of first canister loading plus 25 years	Evaluate information from the following sources (as available) and perform a written assessment of the aggregate impact of the information, including but not limited to trends, corrective actions required, and the effectiveness of the AMPs with which they are associated: • Results, if any, of research and development programs focused specifically on aging-related degradation mechanisms identified as potentially affecting the storage system and ISFSI site. One example of such research and development would be EPRI Chloride-Induced Stress Corrosion Cracking (CISCC) research. • Relevant results of other domestic and international research, which may include non-nuclear research • Relevant domestic and international operating experience, which may include non-nuclear operating experience • Relevant results of domestic and international ISFSI and dry storage system performance monitoring Much of this information can be gathered from the Aging Management INPO Database (AMID).
2	Year of first canister loading plus 30 years	Evaluate additional information gained from the sources listed in Tollgate 1 along with any new relevant sources and perform a written assessment of the aggregate impact of the information. This evaluation should be informed by the results of Tollgate 1. The aging effects and mechanisms evaluated at this tollgate and the time at which it is conducted may be adjusted based on the results of the Tollgate 1 assessment.
3	Year of first canister loading plus 35 years	Same as Tollgate 2 as informed by the results of Tollgates 1 and 2
4	Year of first canister loading plus 40 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, and 3
5	Year of first canister loading plus 45 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, 3, and 4
6	Year of first canister loading plus 50 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, 3, 4, and 5
7	Year of first canister loading plus 55 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, 3, 4, 5, and 6
8	Year of first canister loading plus 60 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, 3, 4, 5, 6, and 7

FuelSolutions W21 Canister FSAR WSNF-221 Markups

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yield strength. Therefore, the allowable weld shear stress is 6.0 ksi. The shear stress in the top shield plug support ring weld for this lift condition is:

$$f_v = \frac{42.6}{[4(5.0+2x1)](0.337)} = 4.5 \text{ ksi}$$

Conservatively assuming a 2:1 load spread over the height of the shield plug support ring. Therefore, the top shield plug support ring weld provides the required factor of safety.

The canister top shield plug, inner closure plate, and outer closure plate are each lifted from four attachment points on the top surface of the plates for placement on the canister inside the spent fuel building. For design purposes, the full weight of the components is assumed to be supported by two lifting attachments. The design load for each attachment includes an additional 15% allowance for crane hoist motion. Standard slings and lifting attachments used for critical lifts are designed in accordance with the requirements of ANSI/ASME B30-9.[17]

3.4.4 Canister Service Life

initial

, renewed for an additional 40 years.

The term of the 10CFR72, Subpart L C of C granted by the NRC is for 20 years. Nonetheless, the FuelSolutions W21 canister is designed for 100 years of service while satisfying the conservative design requirements defined in Chapter 2 of this FSAR, including the regulatory requirements of 10CFR72. Additional assurance of the integrity of the canister and the contained SNF assemblies throughout the 100-year service life of the canister is provided through the following:

- Design, fabrication, and inspection in accordance with the applicable requirements of the ASME Code as described in Section 2.1.2 of this FSAR assures high design margins.
- Fabrication and inspection performed in accordance with the comprehensive Quality Assurance program discussed in Chapter 13 of the FuelSolutions™ Storage System FSAR assures component compliance with the fabrication requirements.
- Use of materials with known characteristics, verified through rigorous inspection and testing as described in Chapter 9 of this FSAR, assures component compliance with design requirements.

Technical specifications, as defined in Chapter 12 of this FSAR and the FuelSolutions™ Storage System FSAR, have been developed and imposed on the canister to assure that the integrity of the canister and the contained SNF assemblies is maintained throughout the 100-year service life of the canister.

The principal design considerations bearing on the adequacy of the FuelSolutions™ W21 canister for the design basis service life and the means in which they are addressed follows:

[17] ANSI/ASME-B30-9, *Slings*, 1984.

stresses in the W21 support rod threads due to normal thermal conditions are lower than the corresponding Service Level A allowable primary membrane stress intensities.

In addition to the stress evaluation described above, the support sleeve axial compressive stresses due to normal thermal conditions are combined with the maximum support sleeves stressed due to dead weight and normal handling and evaluated for buckling in accordance with NUREG/CR-6322, as discussed in Section 3.5.5.2.

3.5.1.3.4 Guide Tubes

As shown in Section 3.5.1.2.2, the W21 guide tubes expand freely within the basket assembly and canister shell under all conditions. Therefore, thermal loading does not result in any stress in the W21 guide tubes.

3.5.1.4 Fatigue Evaluation

3.5.1.4.1 Shell Assembly

The canister confinement components, consisting of the cylindrical shell, top inner and outer closure plates, the bottom closure, and closure welds, are evaluated in accordance with the requirements of NB-3222.4(d). Specifically, the six criteria of NB-3222.4(d) are evaluated to demonstrate that a detailed analysis of the W21 canister shell for cyclical service is not required. These criteria are discussed below.

1. *Atmospheric to Service Pressure Cycle*: The maximum number of pressure cycles associated with startup and shutdown is limited to 30,000 for the W21 canister shell, based on the fatigue curve from Figure I-9.2.1 of the ASME Code for $3S_m$ = 51 ksi, where the lower bound value of S_m is conservatively taken as 17 ksi for the W21T canister shell Type 304 material design temperature of 550°F. The canister normal service includes one vacuum drying operation and one helium fill after closure. All other pressure fluctuations during storage are due to changes in atmospheric conditions. Hence, the canister is never cycled back to the atmospheric pressure during normal service. Therefore, the first criterion is satisfied.

2. *Normal Service Pressure Fluctuation*: The total number of pressure cycles is less than 10^6 because the pressure cycles only occur due to changes in the ambient temperature (assuming one cycle a day, obtain 1×365×100 =36,500 over the lifetime). As specified in this criterion, the value of S is determined for 10^6 cycles and is 28.3 ksi from Figure I-9.2.1 of the ASME Code. The design pressure is 10 psig. Therefore, the cut-off for the significant pressure fluctuation is:

$$SPF = \tfrac{1}{3} \times DP \times \left(\tfrac{S}{S_m} \right) = \tfrac{1}{3} \times 10 \times \left(\tfrac{28.3}{17} \right) = 5.5\text{psi}$$

   As shown in Chapter 4, the W21 canister shell internal pressure ranges from a minimum of 6 psig to a maximum of 10 psig for normal conditions. Hence, no significant pressure fluctuations are expected during storage. Therefore, the second criterion is satisfied.

3. *Temperature Difference - Startup and Shutdown*: The temperature difference between any two adjacent points on the canister shell during startup and shutdown is limited to:

$$S_a / 2E\alpha = 1{,}289\,^\circ F$$

where S_a is determined to be 708 ksi from Figure I-9.2.1, conservatively based on 10 startup-shutdown cycles, and the values of E and α are conservatively taken as $28.9(10)^6$ psi and $9.5(10)^{-6}$ in/in/°F, respectively. Since the temperature difference between any two points in the canister never approaches this quantity, the third criterion is clearly satisfied.

4. *Temperature Difference - Normal Service*: As determined in (2) above, the value of S is 28.3 ksi. The significant temperature fluctuation is determined as:

$$STF = 28.3 / 2(28{,}900)(9.5 \cdot 10^{-6}) = 51^\circ F$$

The normal service in this criterion does not include startups and shutdowns, hence, the only temperature variations are due to changes in the ambient conditions. As shown in Table 3.5-2, the temperature difference between any two points in the canister shell does not change significantly from normal cold to normal hot condition. Temperatures at all points drop uniformly by approximately 110°F. Therefore, there are no significant variations in the temperature gradient during normal service and the fourth criterion is satisfied.

5. *Temperature Difference - Dissimilar Materials*: The canister shell confinement components are fabricated entirely of Type 304 (W21T) or Type 316 (W21M) stainless steel. Hence, no dissimilar materials are used. Therefore, the fifth criterion is satisfied.

6. *Mechanical Loads*: The only significant mechanical loads during the canister service are those due to lifting and transfers. Conservatively estimating the number of these load fluctuations as 100, the S_a value is found to be 261 ksi (Table I-9.1 of the ASME Code). The mechanical loads do not exceed this value and, therefore, the sixth criterion is satisfied.

Therefore, fatigue is not a concern for the W21 canister shell assembly confinement boundary components.

3.5.1.4.2 Basket Assembly

The canister basket assembly components, consisting of the guide tubes, support rods, support sleeves, and spacer plates are evaluated in accordance with NG-3222.4(d) for fatigue. In accordance with NG-3222.4(d), these components do not need a detailed fatigue evaluation if the four specified criteria are satisfied. These criteria are discussed below.

The above shell assembly fatigue criteria are satisfied for the 60-year service period and for the 100-year service life.

1. *Temperature Difference - Startup and Shutdown*: The temperature difference between any two adjacent points on the canister basket assembly during startup and shutdown, excluding the stainless steel spacer plates, is limited to:

$$S_a/_{2E\alpha} = 680^\circ F$$

where S_a is determined to be 400 ksi from Figures I-9.1 and I-9.2.1 of the ASME Code, conservatively based on 10 startup-shutdown cycles, and the values of E and α are conservatively taken as $30(10)^6$ psi and $9.8(10)^{-6}$ in/in/°F, respectively.

As shown in Chapter 4, the temperature difference within any basket component does not exceed 400°F. All of these values are below 680°F. Therefore, the first criterion is satisfied.

2. *Temperature Difference - Normal Service*: The conservative value of S for 10^6 cycles is 12 ksi (Figures I-9.1 and I-9.2.1 of the ASME Code). The significant temperature fluctuation for all W21 basket assembly components except the stainless steel spacer plates is:

$$STF = 12/_{2(30{,}000)(9.8 \cdot 10^{-6})} = 20^\circ F$$

As shown in Chapter 4, the temperature difference between any two points in the W21 basket assembly does not change significantly from normal cold to normal hot condition. The largest temperature difference within the W21 basket assembly occurs in the spacer plates. As shown in Section 4.4, the difference in the maximum spacer plate gradient for normal hot storage and normal cold storage is less than 20°F. Therefore, there are no significant variations in the temperature gradient during normal service. The second criterion is satisfied.

3. *Temperature Difference - Dissimilar Materials*: The cut-off value for significant temperature fluctuations in the W21M basket is determined as:

$$STF = \frac{S}{2(E_1\alpha_1 - E_2\alpha_2)} = \frac{12}{2\left(25{,}300 \cdot \left(9.60 \cdot 10^{-6}\right) - 26{,}700 \cdot \left(7.32 \cdot 10^{-6}\right)\right)} = 126^\circ F$$

where S = 12 ksi (from (2) above), and values for E and α are taken from Section 3.3.1 for the basket assembly material with the highest coefficient of thermal expansion (e.g., SA-240, Type 316 stainless steel) and the lowest coefficient of thermal expansion (e.g., SA-517, Grade P carbon steel) at the mean basket temperature of 600°F.

Similarly, for the W21T basket assembly, the significant temperature fluctuation is:

$$STF = \frac{S}{2(E_1\alpha_1 - E_2\alpha_2)} = \frac{12}{2\left(26{,}700 \cdot \left(7.32 \cdot 10^{-6}\right) - 26{,}100 \cdot \left(5.93 \cdot 10^{-6}\right)\right)} = 148°F$$

where S = 12 ksi (from (2) above), and values for E and α are taken from Section 3.3.1 for the basket assembly material with the highest coefficient of thermal expansion (e.g., SA-517, Grade P carbon steel) and the lowest coefficient of thermal expansion (e.g., SA-564, Grade 630 precipitation hardened stainless steel) at the mean basket temperature of 600°F, excluding the guide tubes since they expand freely within the basket assembly.

As shown in Section 4.4, the temperature fluctuation between normal cold storage and normal hot storage conditions is approximately 100°F. Therefore, only a very few significant temperature fluctuations per year are possible. Assuming the number of 10 per year and a canister lifetime of 100 years, there are 1000 significant temperature fluctuations over the life of the canister. The lower bound value of S_a is 78 ksi (Table I-9.1 of the ASME Code). The resulting allowable temperature range for all W21 basket assembly components except the stainless steel spacer plate is:

$$\frac{S_a}{2(E_1\alpha_1 - E_2\alpha_2)} = \frac{78}{2\left(25{,}300 \cdot \left(9.60 \cdot 10^{-6}\right) - 26{,}700 \cdot \left(7.32 \cdot 10^{-6}\right)\right)} = 822°F$$

This value is higher than the temperature difference in the basket during normal service. Therefore, the third criterion is satisfied.

4. *Mechanical Loads*: The only significant mechanical loads during the canister service are those due to transfers. Conservatively estimating the number of these load fluctuations as 100, the S_a value is found to be 175 ksi (Table I-9.1 of the ASME Code). The basket assembly stresses due to normal transfer loads do not exceed this value and, therefore, the fourth criterion is satisfied.

Therefore, fatigue is not a concern for the W21 basket assembly structural components.

The above basket assembly fatigue criteria are satisfied for the 60-year service period and for the 100-year service life.

3.5.2 Internal Pressure

The canister shell assembly is evaluated for internal pressure loads associated with canister loading operations (draining internal pressure) and normal on-site transport and storage conditions. These conditions are described and evaluated in the following sections.

3.5.2.1 Canister Draining Internal Pressure

After installation of the inner closure plate, a compressed gas pressure of 30 psig is applied to the canister cavity to speed the water draining process during canister closure operations, thus minimizing the personnel dose. The automated canister welder/opener and auxiliary shield plate, described in Section 1.2.1.4.1 of the FuelSolutions™ Storage System FSAR, are attached to the inner closure plate and a strongback is installed on the transfer cask top flange, as shown in Figure 1.2-14 of the FuelSolutions™ Storage System FSAR. The strongback and auxiliary shield plate provide structural support for the canister top inner closure plate and assure that no

The factors that primarily affect the reactivity of the FuelSolutions™ canister system are radiative neutron absorption and fuel assembly separation. The parameters that affect radiative neutron absorption are the neutron absorber panel thickness, the guide tube wall thickness, and the spacer plate thickness. The parameters that affect fuel assembly separation include: fuel assembly location; spacer plate opening size and location; and guide tube inside width. With the exception of the accident induced guide tube deformation and axial detachment, tolerances are applied in the normal conditions model consistent with the description provided in Section 6.3.1.1 for accident conditions.

6.3.2 Material Properties

The number densities used to model moderator materials and the FuelSolutions™ W21 canister basket, shell and reflector materials are presented in Table 6.3-2 through Table 6.3-11. These material properties are used in all FuelSolutions™ W21 canister single package and multiple package array models.

The FuelSolutions™ W21 canister basket incorporates panels of BORAL® neutron-absorbing material. BORAL® is a thermal neutron absorber (poison) material composed of boron carbide and 1100 alloy aluminum. The boron carbide, in the form of fine particles, is homogeneously dispersed throughout the central layer of the BORAL® panels. The outer layers of the panel are composed of 1100 alloy aluminum. The two materials, boron carbide and aluminum, are ideally suited for long-term use in dry storage cask radiation and thermal environments. Aluminum contact with borated pool water during short-term wet loading operations in PWR spent fuel pools is prevented by sealing the panels in stainless steel guide tube wrappers. BORAL® is manufactured by AAR Advanced Structures under the control and surveillance of a Quality Assured/Quality Control Program that conforms to the requirements of 10CFR50 Appendix B, “Quality Assurance Criteria for Nuclear Power Plants.” Additional product literature for this material is provided in Section 1.5.2 of this FSAR.

The continued efficacy of BORAL® is demonstrated by the process controls under which the material is manufactured and verified. These controls assure a homogeneous dispersion of boron throughout the material. In addition, the effects of long-term exposure to neutron flux from irradiated fuel is negligible because the thermal neutron flux during dry storage is low. This fact, coupled with the use of the minimum specified boron concentration further reduced by 25%, more than accounts for any boron depletion which may occur over the 100-year design life of the FuelSolutions™ W21 canister.

The neutron shield region of the modeled transportation cask geometry contains NS-4-FR neutron shielding material, at a volume fraction of 94.2%, stainless steel 304 backing bars at a volume fraction of 2.6%, and pure copper fins at a volume fraction of 3.2%. These components are mixed into a homogenous material that fills the neutron shield region in the criticality analyses. Table 6.3-11 gives the material description for pure NS-4-FR neutron shield material. The densities shown in the table are multiplied by 0.942 to yield the densities present in the homogenous mixture. The stainless steel 304 atom densities shown in Table 6.3-5 are multiplied by 0.026 and added to the mixture. Finally, the atom density of pure copper (0.08493 atoms/barn-cm) is multiplied by 0.032 and added to the mixture.

The boron depletion evaluation demonstrates that boron depletion levels are acceptable for the 60-year service period and for the 100-year design life.

9.2 Maintenance Program

This section discusses the maintenance program for the FuelSolutions™ W21 canister, which is classified as important to safety. Noncompliances encountered during the required maintenance activities will be dispositioned in accordance with the Energy*Solutions* SFD Quality Assurance program, discussed in Chapter 13 of the FuelSolutions™ Storage System FSAR, or the licensee's NRC-approved Quality Assurance program. The maintenance program is intended to demonstrate that the FuelSolutions™ W21 canister continues to perform properly and complies with regulatory requirements and the *technical specifications* contained in Chapter 12 of this FSAR and the FuelSolutions™ Storage System FSAR.

The FuelSolutions™ W21 canister relies on no mechanical components or moving parts once in its storage configuration. Exposed materials are corrosion-resistant stainless steel. No inspection of a loaded canister during storage is required due to the integrity of the canister, as verified during fabrication, acceptance testing, and canister closure. Periodic monitoring of the FuelSolutions™ storage cask, in accordance with the *technical specification* contained in Section 12.3 of this FSAR, provides added assurance that fuel cladding degradation does not occur. Thus, no prescribed maintenance program is necessary during the 100-year design life of the FuelSolutions™ W21 canister.

The Aging Management Programs (AMPs) applicable during the additional 40 year license renewal period for the canister C of C are contained in Appendix 9.A.

5.0 ADMINISTRATIVE CONTROLS

5.1 Training Modules

See the Storage System Technical Specification for the applicable information.

5.2 Preoperational Testing and Training Exercises

See the Storage System Technical Specification for the applicable information.

5.3 Programs

5.3.1-5.3.5

See the Storage System Technical Specification for the applicable information.

5.3.6 Vacuum Drying Program

The FuelSolutions™ W21 CANISTER has been evaluated for allowable fuel cladding temperature during LOADING and STORAGE OPERATIONS. During LOADING OPERATIONS, the fuel cladding temperature is limited to 400•C to assure cladding integrity.

This program shall establish administrative controls and procedures to assure that the spent fuel cladding does not exceed the temperature limit during LOADING OPERATIONS. For a CANISTER loaded with fuel with a total heat load of 22.0 kW, the total vacuum drying cycle shall be limited to 12 hours. If the vacuum drying LCO 3.1.2 has not been satisfied, the CANISTER shall be backfilled with helium for 4 hours, vacuum dried for 8 hours, backfilled for 4 hours, etc., until the LCO is met.

For a heat load of 17.5 kW or lower, there is no time limit on the initial vacuum drying cycle. For heat loads greater than 17.5 kW but less than 22.0 kW, the program shall either use the 22.0 kW requirements, or establish suitable time limits to maintain the cladding temperature to less than or equal to 400•C for the specific CANISTER heat load.

5.3.7 Cladding Oxide Thickness Measurement Program

For fuel with a burnup exceeding 45 GWd/MTU, it is necessary to verify that cladding oxide layer thickness for fuel assemblies to be stored does not exceed 70 • m.

This program shall establish administrative controls and procedures to verify oxide layer thickness by measurement of a statistical sample of limiting fuel assemblies.

5.3.8 Storage Cask Periodic Monitoring Program

See the ~~STORAGE CASK~~ Storage System Technical Specifications for the applicable information.

5.3.9 Aging Management Program

See the Storage System Technical Specification for the applicable information.

5.4 Special Requirements for First System in Place

The heat transfer characteristics of the cask system will be recorded by temperature measurements of the first STORAGE CASK placed in service with a heat load equal to or greater than 10kW. In accordance with 10CFR72.4, a letter report summarizing the results of the measurements shall be submitted to the NRC.

For each cask subsequently loaded with a higher heat load (up to the 22.0 kW limit), the calculation and measured temperature data shall be reported to the NRC at every 2 kW increase. The calculation and comparison need not be reported to the NRC for STORAGE CASKS that are subsequently loaded with lesser loads then the latest reported case.

Appendix 9.A Aging Management Program

In accordance with the renewed FuelSolutions license, sites must implement an aging management program. An aging management assessment of the components of the FuelSolutions W21 Canister was performed. This review identified inspection and monitoring activities necessary to provide reasonable assurance that components within the scope of license renewal continue to perform their intended functions during the renewed storage period. This appendix describes those aging management program requirements.

9.A.1 Aging Management Programs (AMPs)

The following AMPs apply to C of C 1026 Amendments 0 through 5.

9.A.1.1 FuelSolutions Welded Stainless Steel Canister AMP

The FuelSolutions Welded Stainless Steel Canister AMP uses inspections to look for visual evidence of discontinuities and imperfections, such as localized corrosion, including pitting corrosion and stress corrosion cracking of the canister welds and heat affected zones. The full program is described in the following Table 9.A.1-1, FuelSolutions Welded Stainless Steel Canister AMP.

9.A.1.2 FuelSolutions Reinforced Concrete Structures AMP

The FuelSolutions Reinforced Concrete Structures AMP uses inspections to look for indications of concrete deterioration that might affect the ability of the W150 Storage Cask to perform its important to safety function. The full program is described in Table 9.A.1-2, FuelSolutions Reinforced Concrete Structures AMP, located in Appendix 9.A of the FuelSolutions Storage System FSAR WSNF-220.

9.A.1.3 FuelSolutions Monitoring of Metallic Surfaces AMP

The FuelSolutions Monitoring of Metallic Surfaces AMP uses inspections to look for indications of metallic surface deterioration that might affect the ability of the W150 Storage Cask and Fuel Transfer and Auxiliary Equipment metallic surfaces to perform their important to safety functions. The full program is described in Table 9.A.1-3, FuelSolutions Monitoring of Metallic Surfaces AMP, which is located in Appendix 9.A of the FuelSolutions Storage System FSAR WSNF-220.

9.A.1.4 FuelSolutions W100 Transfer Cask AMP

The FuelSolutions W100 Transfer Cask AMP utilizes inspections to ensure that the equipment maintains its intended function through the extended storage period. The full program is described in Table 9.A.1-4, FuelSolutions W100 Transfer Cask AMP, which is located in Appendix 9.A of the FuelSolutions Storage System FSAR WSNF-220.

9.A.1.5 FuelSolutions W21 Canister High-Burnup Fuel Monitoring and Assessment AMP

The FuelSolutions W21 Canister High-Burnup Fuel Monitoring and Assessment AMP only applies to W21 Canisters that store high-burnup fuel. The AMP relies on the EPRI and DOE research projects on high burnup fuel. The full program is described in the following Table 9.A.1-5, FuelSolutions W21 Canister High-Burnup Fuel Monitoring and Assessment AMP.

Table 9.A.1-1 FuelSolutions Welded Stainless Steel Canister AMP
(4 pages)

Element	Description
1 Scope of Program	This program manages the effects of aging for the surfaces of welded stainless steel canisters that are directly exposed to the sheltered environment within the W150 Storage Cask. The scope of the program includes the following canister sub-components: • Shell • Bottom closure plate • Shell extension • Bottom end plate • Top outer closure plate • Leak test port cover The following aging effects are addressed in this program: • Cracking due to stress corrosion cracking • Loss of material (precursor to stress corrosion cracking) due to pitting and crevice corrosion Examinations are performed on the accessible portions of the welded stainless steel dry storage canister confinement boundary external surfaces for atmospheric deposits, localized corrosion, and Stress Corrosion Cracking (SCC). In particular, examinations focus on accessible canister welds, weld heat-affected-zone areas, and known areas of the canister to which temporary supports or attachments were attached by welding and subsequently removed (based on available fabrication records) with the following attributes: • Locations where a crevice is formed on the canister surface • Horizontal (±30-degree) surfaces where deposits may accumulate at a faster rate compared to vertical surfaces • Canister surfaces that are cold relative to the average surface temperature • Canister surfaces with higher amounts of atmospheric deposits Examinations can be performed in coordination of the ASME Section XI code inspections provided in Code Case N860, “Examination Requirements and Acceptance Standards for Spent Nuclear Fuel Storage and Transportation Containment Systems.”
2 Preventive Actions	Condition monitoring is utilized to manage aging effects. During fabrication of the canisters, however, preventative actions were used to minimize corrosion and stress corrosion cracking by selection of stainless steel materials. In addition, fabrication controls were in place during canister fabrication to support improved canister corrosion resistance. Although these preventative actions minimize the likelihood of aging effects, they cannot replace condition monitoring during the storage period. As this AMP is based on condition monitoring, new preventative actions are not included.

Table 9.A.1-1 FuelSolutions Welded Stainless Steel Canister AMP
(4 pages)

Element	Description
3 Parameters Monitored / Inspected	The parameters monitored and/or inspected under this AMP include: • Visual inspections to look for evidence of discontinuities and imperfections, such as localized corrosion, including pitting corrosion and stress corrosion cracking of the accessible canister welds and weld heat affected zones. • The size and location of localized corrosion or stress corrosion cracks • The inspections also look for the appearance and location of deposits on the canister surfaces.
4 Detection of Aging Effects	Visual inspection of the canister surface is to be performed per ASME Code Section XI, Article IWA-2200 for VT-3 examinations utilizing a video camera, fiber-optic scope or other remote inspection device for the accessible areas of the canister surface since direct visual examination may not be possible due to neutron and gamma radiation fields near canister surfaces within the storage cask. Additional assessments are to be performed as necessary for suspected areas of localized corrosion and SCC. VT-1 visual examinations are performed per acceptance criteria when indicated by the assessment of the VT-3 results. Indications of corrosion within 2 inches of a weld are to receive an augmented surface examination for the presence of cracking. Volumetric examination consistent with the requirements of ASME Code Section XI, IWB-2500, for category B-J components may also be utilized to assess the presence of cracking. Inspection of selected areas on the canister may be upgraded to the VT-1 standard. The inspection is to be performed on a minimum of one canister at each ISFSI based on the following criteria: • EPRI Susceptibility Criteria {Ref: Technical Report 3002005371} • Age of the Canister (First canister placed in service) • Canister loaded with Lowest Heat Load • Canisters with the greatest potential for the accumulation and deliquescence of deposited salts that may promote localized corrosion and greatest potential for the accumulation and deliquescence of deposited salts that may promote localized corrosion and SCC • Where applicable, canister with previously identified manufacturing deviations which may affect the surface. Inspections are to be performed by qualified individual(s) every 5 years starting with the first inspection performed within either the later of one (1) year after the initial canister's 20th year loading anniversary or within one year after the issuance of first renewal of the CoC. If possible, examinations should occur on the same canister to support trending.
5 Monitoring and Trending	Monitoring and trending of the results from documented inspection should support the ability to evaluate the results against acceptance criteria. Inspection records including photos and /or videos are to be retained for comparison in subsequent examinations. Changes to the size or location of discolored areas

Table 9.A.1-1 FuelSolutions Welded Stainless Steel Canister AMP
(4 pages)

Element	Description
	(e.g., rust), localized corrosion, pitting and crevice corrosion, and/or stress corrosion cracking should be identified and assessed for further evaluation or subsequent inspections. Trending of parameters or effects include the locations and size of any areas of localized corrosion or SCC, disposition of canisters with identified aging effects and the results of any supplemental canister inspections.
6 Acceptance Criteria	No indications of localized corrosion pits, etching, crevice corrosion, stress corrosion cracking, red-orange-colored corrosion products emanating from crevice locations, or red-orange-colored corrosion products in the vicinity of canister fabrication welds, closure welds, and welds associated with temporary attachments during canister fabrication. Minor surface corrosion is acceptable. Identified flaws may be assessed in accordance with the acceptance standards identified in ASME Code Section XI, IWB-3514. <u>Results of Inspections Requiring Additional Evaluation</u> Indications of interest (locations on the canister surface susceptible to SCC including areas adjacent to fabrication welds, closure welds, locations where temporary attachments may have been welded to and subsequently removed from the canister and the weld heat-affected zones) that are subject to additional examination and disposition through the corrective action program include: • Localized corrosion pits, crevice corrosion, stress corrosion cracking, and etching; deposits or corrosion products • Red-orange colored corrosion products or red-orange colored corrosion tubercles with deposit accumulations especially when adjacent to welds or weld heat affected zones of these areas and locations where temporary attachments were welded to and subsequently removed from the canister • Appearance of any color of liner corrosion products of any size parallel to or traversing fabrication welds, closure welds, and the weld heat affected zones. • Red-orange colored corrosion products greater than 1 mm in diameter combined with deposit accumulations on any location of the canister • Red-orange colored corrosion tubercles of any size
7 Corrective Actions	Indications not meeting the acceptance criteria above (AMP Element 6) require additional evaluation after being entered into the site's corrective action program. An evaluation is to be performed to determine the extent and impact of the corrosion on the canister's ability to perform its intended function. The site's Quality Assurance (QA) program ensures that corrective actions are completed within the Corrective Action Program (CAP) and include any necessary functionality assessments, cause evaluations, extent of condition, actions, identify any modifications to the existing AMP (e.g., increased frequency), and determine if the condition is reportable per 10 CFR 72.75.
8 Confirmation Process	The confirmation process is to be commensurate with the site's QA program. The QA program ensures that the confirmation process includes provisions to preclude

Table 9.A.1-1 FuelSolutions Welded Stainless Steel Canister AMP
(4 pages)

Element	Description
	repetition of significant conditions adverse to quality and the completion of inspections, evaluations, and corrective actions.
9 Administrative Controls	The site QA program ensures that administrative controls include provisions that address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control. Administrative controls also address the frequency for updating the AMP based on inspection results along with industry operating experience. This AMP will be updated as necessary based on tollgate assessments.
10 Operating Experience	Previous operating experience for the W74 Canister indicates very minimal corrosion detected to date. That operating experience has been incorporated into the guidance on inspections and acceptance criteria contained in this AMP. A renewal application re-submittal inspection was performed on the W74 system at Big Rock Point in July 2019.[14] Three separate tasks were completed consisting of a video inspection of the accessible area in the annulus between the cask and canister; a visual inspection of the cask interior and visual inspection of the cask storage pad. A representative canister and storage cask were selected by Entergy based on increased susceptibility for moisture intrusion and corrosion. Heat loads at the time of loading all of the canisters at Big Rock Point were within 0.5 kW of each other, and all storage casks were placed into service within months of each other (between November 2002 and May 2003). The inspection revealed some minor observations; however, no structural deficiencies were identified, and all parts continue to perform their design function. Surface rust was observed (Cask Serial Number W150-610-NMC) on washers under the nut on the tie rods (minimal depth) causing discoloration in the bearing plate and nut. Both these components are stainless steel and are not in danger of corroding. NRC Region III Inspectors[15] reviewed the previous five-year cask inspection documentation for Big Rock Point storage cask number 7 that included both pictures and video of the interior of the cask and did not identify any findings of significance. As canister inspections are performed in the future, inspection results will be uploaded into the ISFSI Aging Management Institute of Nuclear Power Operations Database (ISFSI AMID) to be shared with other users.

[14] Report 4T002-RPT-001, Rev 0 "FuelSolutions Renewal Application Pre-Submittal Inspection," August 29, 2019

[15] Errata to Big Rock Point Independent Spent Fuel Storage Installation - Inspection Reports 07200043-12-001 and 05000155-12-007 (ADAMS Accession ML13071A379) dated 03/11/13.

Table 9.A.1-5
FuelSolutions W21 Canister High-Burnup Fuel Monitoring and Assessment AMP
(4 pages)

Element	Description
1 Scope of Program	The FuelSolutions W21 Canister Storage system is approved for high burnup fuel up to 60,000 MWd/MTU. SNF assemblies stored in FuelSolutions W21 canisters are limited to intact zircaloy-clad fuel with no known or suspected cladding defects greater than pinhole leaks or hairline cracks. SNF is initially stored in a dry high purity helium environment. SNF assemblies with burnup exceeding 45 GWd/MTU (up to 60 GWd/MTU), are limited to cladding oxide thickness of 70 µm. The scope of this Aging Management Program (AMP) covers the FuelSolutions W21 Canister Storage system with high burn up fuel to operate through the extended storage period. The program covers fuel rod cladding aging in the helium environment for loss of ductility due to hydride reorientation and changes in dimensions due to thermal creep. The AMP program relies on the joint EPRI and DOE High Burnup Dry Storage Cask Research and Development Project (HDRP) conducted in accordance with the guidance in Appendix D of NUREG-1927, Rev 1, as a surrogate demonstration program that monitors the performance of high burnup fuel in dry storage. The AMP also relies on current and future industry experience with storage of high burnup fuel up to 60 GWd/MTU. The HDRP is a program designed to collect data from a SNF storage system containing high burnup fuel in a dry helium environment. The program entails loading and storing a bolted lid cask (the "Research Project Cask"), with intact high burnup fuel of nominal burnups between 50 GWd/MTU and 55 GWd/MTU). The fuel to be used in the program includes four kinds of zirconium based cladding. The Research Project Cask is licensed to the temperature limits contained in ISG-11 Rev 3 and loaded such that the fuel cladding temperature is as close to the limit as practicable. In addition to the HDRP, there are casks that are currently licensed for storage of high burnup fuel up to 68 GWd/MTU. The combination of the HDRP and the current and future industry experience with storage of high burnup fuel will encompass high burnup fuel applicable to the FuelSolutions W21 Canister Storage system up to 60 GWd/MTU. Since there are no high burnup fuel assemblies currently loaded in a W21 canister, industry high burnup fuel storage experience will lead any W21 Canister high burnup fuel storage efforts. The HDRP results shall be used for high burnup fuel up to 55 GWd/MTU. If the W21 canister fuel to be stored exceeds 55 GWd/MTU, industry experience monitored by the Appendix 9.A FuelSolutions Storage System FSAR WSNF 220 tollgate assessments will be utilized. The fuel parameters of the surrogate demonstration program are applicable to the FuelSolutions W21 Canister Storage system high burnup fuel because the allowable W21 canister fuel cladding is of the same type as those being tested, and the temperature limits and time at temperature of the fuel cladding are similar to those being tested.
2 Preventive Actions	During initial loading operations of the FuelSolutions W21 Canisters Technical Specification 3.1.2 "Canister Vacuum Drying Pressure" specifies "The CANISTER

Table 9.A.1-5
FuelSolutions W21 Canister High-Burnup Fuel Monitoring and Assessment AMP
(4 pages)

Element	Description
	cavity vacuum pressure following drying shall be 3 torr, maintained for at least 30 minutes.” FuelSolutions W21 Canisters Technical Specification 3.1.1 “W21 Canister Helium Backfill Density” specify the canister helium backfill density range and completion time. In addition, FuelSolutions W21 Canisters Technical Specification 5.3.6 “Vacuum Drying Program” delineates the controls to “assure that the spent fuel cladding does not exceed the temperature limit during loading operations.” FuelSolutions W21 Canisters Technical Specification 5.3.7 “Cladding Oxide Thickness Measurement Program” denotes controls to verify cladding oxide layer thickness for fuel assemblies to be stored. These requirements ensure that the high burnup fuel is stored in an inert environment, preventing cladding degradation due to oxidation mechanisms. In addition, fuel meets the guidance for temperature criteria noted in ISG-11, which minimizes the impacts of degradation mechanisms on the fuel. Refer to FuelSolutions W21 Canister Storage System FSAR Section 4.3.2 “Fuel Cladding Allowable Temperatures” regarding established conservatism meeting the guidance of ISG-11, Rev 3. There are no additional specific preventative actions included as part of the AMP.
3 Parameters Monitored or Inspected	The parameters monitored and inspected in the HDRP which are applicable to the high burnup fuel stored in the W21 canister are the cladding temperatures during storage that will provide data on high burnup cladding times at temperature for input to hydride reorientation, ductility recovery, and creep evaluations.
4 Detection of Aging Effects	This AMP utilizes the surrogate demonstration program, HDRP, to monitor performance of high burnup fuel and detect aging effects as described in the HDRP for high burnup fuel. FuelSolutions W21 Canisters Technical Specification 5.3.6 “Vacuum Drying Program” delineates the controls for fuel temperature limits to prevent degradation. 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.
5 Monitoring and Trending	As information / data from the HDRP or from other sources (such as testing or research results and scientific analyses) become available, the licensee will monitor, evaluate, and trend the information via its operating experience program and /or corrective action program to determine what actions should be taken. The licensee will evaluate the information / data from the HDRP to determine whether the acceptance criteria in Element 6 of this AMP are met. • If all of the acceptance criteria are met, no further assessment is needed. • If any of the acceptance criteria are not met, the licensee must conduct additional assessments and implement appropriate corrective actions (see Element 7 of this AMP).

Table 9.A.1-5
FuelSolutions W21 Canister High-Burnup Fuel Monitoring and Assessment AMP
(4 pages)

Element	Description
	Formal evaluations of the aggregate information from the HDRP, available operating experience, NRC-generated communications, and other information will be performed by the Tollgate Assessments in Appendix 9.A of the FuelSolutions Storage System FSAR WSNF 220.
6 Acceptance Criteria	The following criteria are to be addressed against the information obtained from the HDRP. The criteria are: • Hydrogen content – Maximum hydrogen content of the cover gas over the approved storage period should be extrapolated from the gas measurements to be less than the design-bases limit for hydrogen content • Moisture content – the moisture content in the canister, accounting for measurement uncertainty should be less than the expected upper-bound moisture content per the design-bases drying process • Fuel condition / performance – nondestructive and destructive examinations should confirm the design-bases fuel condition (i.e., no changes to the analyzed fuel configuration considered in the safety analyses of the approved design bases) The design-bases characteristics of the FuelSolutions W21 Canister system and high burnup fuel parameters are addressed in the FuelSolutions W21 Canister Storage FSAR Section 4.3.1 “W21 Canister.” It should be noted that Westinghouse Electric Company was initially involved in developing mathematical correlations based on this test data used for development of a creep-based methodology for the determination of allowable peak cladding temperature during dry storage as well as addressing cladding creep correlation presented in WCAP-15168[16]. Note that because the cask design to be used in the HDRP is different from the FuelSolutions W21 Canister system, the acceptance criteria will be based on the Research Project Cask design bases. If the fuel in the Research Project Cask meets the applicable design bases, the fuel in the FuelSolutions W21 Canisters storage system should also meet its design bases, as described in Element 1.
7 Corrective Actions	The corrective actions are implemented in accordance with the licensee's NRC approved QA program. If the acceptance criteria are not met, the issue will be entered into the licensee corrective action program to assess fuel performance, assess the design-bases safety analyses, consider degraded fuel performance and determine the ability of the system to continue to perform its intended functions. The corrective action program will identify necessary actions, changes to the existing AMP and determine if the condition is reportable.

[16] WCAP-15168, “Dry Storage of High Burnup Spent Nuclear Fuel,” Westinghouse Electric Company, March 1999

Table 9.A.1-5
FuelSolutions W21 Canister High-Burnup Fuel Monitoring and Assessment AMP
(4 pages)

Element	Description
	In addition, the licensee will obtain the necessary NRC approval in the appropriate licensing / certification process for modification of the design bases to address any conditions outside of the approved design bases.
8 Confirmation Process	The confirmation process is commensurate with the licensee's NRC approved QA program. The QA program ensures that required corrective actions are completed and effective in accordance with the program to preclude repetition of significant conditions adverse to quality.
9 Administrative Controls	Administrative controls are in accordance with the licensee's QA program and include a formal review and approval processes, document control and record retention requirements. This AMP will be updated as necessary based on tollgate assessments.
10 Operating Experience	As the program continues, operating experience will be evaluated including: • information entered into the ISFSI Aging Management Institute of Nuclear Power Operations Database (ISFSI AMID) • applicable research (ORNL, ANL, EPRI) • internal and industrywide condition reports • vendor-issued safety bulletins • NRC Information Notices

9.A.2 Tollgates

Tollgates are established as requirements in the renewed CoC and implemented by ISFSI generic licensees to evaluate aging management feedback and perform a safety assessment that confirms the safe storage of spent nuclear fuel. The impact of the aggregate feedback will be assessed by the site as it pertains to components at the site's ISFSI and actions taken as necessary, such as:

- Adjustment of aging-related degradation monitoring and inspection programs in AMPs
- Modification of TLAAs
- Performance of mitigation activities

Each tollgate assessment will address the following elements as applicable:

- Summary of research findings, operating experience, monitoring data, and inspection results made available since last assessment
- Aggregate impact of findings, including any trends
- Consistency of data with the assumptions and inputs in the TLAAs
- Effectiveness of AMPs
- Corrective actions, including any changes to AMPs
- Summary and conclusions

A schedule for these tollgate assessments is shown in Table 9A.2-1, which is located in Appendix 9.A of the FuelSolutions Storage System FSAR WSNF-220.

FuelSolutions W74 Canister FSAR WSNF-223 Markups

1. Table of Contents Markups
2. List of Tables Markups
3. Section 3.4.4 Canister Service Life Markups
4. Section 3.5.1.4 Fatigue Evaluation Markups
5. Section 6.3.2 Material Properties Markups
6. Section 9.2 Maintenance Program Markups
7. Section 12.3.1 Technical Specification 5.3.9 Aging Management Program Markups
8. Appendix 9.A FuelSolutions Aging Management Program Cover Page
9. Table 9.A.1-1 FuelSolutions Welded Stainless Steel Canister AMP
10. Section 9.A.2 Tollgates

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The governing tensile, shear, and bending stresses at the weld location are 0.4 ksi, 0.7 ksi, and 12.0 ksi, respectively. The corresponding maximum primary membrane plus bending stress intensity in the handle is 12.5 ksi. Conservatively assuming this stress occurs in the weld, the minimum design margin for the handle attachment weld is +0.27.

The stresses in the damaged fuel can top lid assembly base plate due to the vertical lift condition are evaluated using the ¼-symmetry finite element model shown in Figure 3.4-1. The base plate is modeled using elastic shell elements (SHELL63) with a 3/8-inch uniform thickness. The slotted holes that accommodate the engagement hardware are included in the model. Symmetry boundary conditions are applied at the two planes of symmetry, as shown in Figure 3.4-1. In addition, the nodes at the location of the handle are restrained in the vertical direction (i.e., UZ=0).

The loads applied to the model are determined based on a bounding weight of 720 pounds for the BRP fuel assembly and the damaged fuel can. Each attachment dog supports one fourth of the total design load, or 180 pounds. The loads applied to the finite element model are determined assuming that the attachment dog behaves as a rigid beam.

A free body diagram of the attachment dog for the vertical lift condition is shown in Figure 3.4-2. Based upon the principal of static equilibrium, the reaction loads R_1 and R_2 are determined to be +285 pounds (upward) and –105 pounds (downward), respectively. The reaction load at the outside attachment bolt (i.e., R_1) is applied to the nodes around the perimeter of the slotted hole at the outside end, as shown in Figure 3.4-1. The reaction load at the inner end of the attachment dog (i.e., R_2) is applied to the base plate nodes corresponding to the end of the attachment dog when in the extended position, as shown in Figure 3.4-1.

As shown in Figure 3.4-3, the results of the finite element evaluation show that the maximum stresses in the top lid assembly base plate occur in the region at the corner of the rectangular cutout. The maximum general primary membrane (P_m), primary membrane plus bending (P_L+P_b), and primary plus secondary (P_L+P_b+Q) stress intensities are 10.4 ksi, 17.5 ksi, and 28.8 ksi, respectively. The corresponding Service Level A general primary membrane, primary membrane plus bending, and primary plus secondary stress intensities for SA-240,Type 316 stainless steel at 700°F are 16.3 ksi, 24.5 ksi, and 48.9 ksi, respectively. Therefore, the minimum design margin in the top lid assembly base plate for the vertical lift condition is +0.40, due to primary membrane plus bending.

, renewed for an additional 40 years.

3.4.4 Canister Service Life

initial

The term of the 10CFR72, Subpart L C of C granted by the NRC is for 20 years. Nonetheless, the FuelSolutions™ W74 canister is designed for 100 years of service while satisfying the conservative design requirements defined in Chapter 2 of this SAR, including the regulatory requirements of 10CFR72. In addition, the canister is designed, fabricated and inspected in accordance with the applicable requirements of the ASME Code as described in Section 2.1.2 under the comprehensive Quality Assurance program discussed in Chapter 13 of the FuelSolutions™ Storage System SAR which assures high design margins, the use of materials with known characteristics, high quality fabrication, and verification of compliance through rigorous inspection and testing as described in Chapter 9 of this SAR. Technical specifications, as defined in Chapter 12 of this SAR and the FuelSolutions™ Storage System SAR, have been calculations. The weld stress evaluation addresses thermal stresses due to differential thermal expansion of dissimilar materials and thermal gradients within the basket assembly.

As discussed above, differential thermal expansion of the W74M basket assembly due to normal thermal conditions results in an axial load of 24.2 kips. The resulting average shear stress in the LTP spacer plate attachment weld is 1.5 ksi. Additional shear stresses occur in these welds due to the moment reaction resulting from thermal curvature of the support tubes. As discussed in Section 3.5.1.3.2, the maximum moment reaction at the LTP spacer plate attachment weld resulting from thermal curvature of the support tubes is 18.7 in-kips. The moment reaction is carried in shear through the weld, resulting in a maximum weld shear stress of 0.4 ksi. Therefore, the combined shear stress in the weld is 1.9 ksi. The corresponding Service Level A allowable average shear stress is 6.9 ksi, based on SA-240, Type XM-19 stainless steel material properties at 700°F and including a 40% weld efficiency factor for single groove weld with surface PT examination in accordance with Table NG-3352-1 of the ASME Code. Therefore, the minimum design margin for shear stress in the W74M LTP spacer plate attachment weld due to normal thermal loading is +2.70.

3.5.1.3.5 Guide Tubes

As shown in Section 3.5.1.2.2, the W74 guide tubes expand freely under all normal thermal conditions. Consequently, no significant thermal stresses occur in the W74 guide tubes as a result of normal thermal loading.

3.5.1.4 Fatigue Evaluation

3.5.1.4.1 Shell Assembly

The canister confinement components, consisting of the cylindrical shell, top inner and outer closure plates, and bottom closure plate, are evaluated in accordance with the requirements of NB-3222.4(d). Specifically, the six criteria of NB-3222.4(d) are evaluated to demonstrate that a detailed analysis of the W74 canister shell for cyclical service is not required. These criteria are discussed below.

1. *Atmospheric to Service Pressure Cycle*: The maximum number of pressure cycles associated with startup and shutdown is limited to 30,000 for the W74 canister shell, based on the fatigue curve from Figure I-9.2.1 of the ASME Code for $3S_m = 51$ ksi, where the lower bound value of S_m is conservatively taken as 17 ksi for the W74T canister shell Type 304 material design temperature of 550°F. The canister normal service includes one vacuum drying operation and one helium fill after closure. All other pressure fluctuations during storage are due to changes in atmospheric conditions. Hence, the canister is never cycled back to the atmospheric pressure during normal service. Therefore, the first criterion is satisfied.
2. *Normal Service Pressure Fluctuation*: The total number of pressure cycles is less than 10^6 because the pressure cycles only occur due to changes in the ambient temperature (assuming one cycle a day, obtain $1 \times 365 \times 100 = 36{,}500$ over the lifetime). As specified in this criterion, the value of S is determined for 10^6 cycles and is 28.3 ksi from Figure I-9.2.1 of the ASME Code. The design pressure is 10 psig. Therefore, the cut-off for the significant pressure fluctuation is

$$SPF = \frac{1}{3} \times DP \times \left(\frac{S}{S_m} \right) = \frac{1}{3} \times 10 \times \left(\frac{28.3}{17} \right) = 5.5 psi$$

As shown in Table 4.4-4, the W74 canister shell internal pressure ranges from a minimum of 6 psig to a maximum of 10 psig for normal conditions. Hence, no significant pressure fluctuations are expected during storage. Therefore, the second criterion is satisfied.

3. *Temperature Difference - Startup and Shutdown*: The temperature difference between any two adjacent points on the canister shell during startup and shutdown is limited to:

$$\frac{S_a}{2E\alpha} = 1{,}289^{\circ}F$$

where S_a is determined to be 708 ksi from Figure I-9.2.1, conservatively based on 10 startup-shutdown cycles, and the values of E and α are conservatively taken as $28.9(10)^6$ psi and $9.5(10)^{-6}$ in/in/°F, respectively. Since the temperature difference between any two points in the canister never approaches this quantity, the third criterion is clearly satisfied.

4. *Temperature Difference - Normal Service*: As determined in (2) above, the value of S is 28.3 ksi. The significant temperature fluctuation is determined as:

$$STF = \frac{28.3}{2(28{,}900)(9.5 \cdot 10^{-6})} = 51^{\circ}F$$

The normal service in this criterion does not include startups and shutdowns, hence, the only temperature variations are due to changes in the ambient conditions. As shown in Table 3.5-2, the temperature difference between any two points in the canister shell does not change significantly from normal cold to normal hot condition. Temperatures at all points drop uniformly by approximately 125°F. Therefore, there are no significant variations in the temperature gradient during normal service and the fourth criterion is satisfied.

5. *Temperature Difference- Dissimilar Materials*: The canister shell confinement components are fabricated entirely of Type 304 (W74T) or Type 316 (W74M) stainless steel. Hence, no dissimilar materials are used. Therefore, the fifth criterion is satisfied.

6. *Mechanical Loads*: The only significant mechanical loads during the canister service are those due to lifting and transfers. Conservatively estimating the number of these load fluctuations as 100, the S_a value is found to be 261 ksi (Table I-9.1 of the ASME Code). The mechanical loads do not exceed this value and, therefore, the sixth criterion is satisfied.

Therefore, fatigue is not a concern for the canister pressure boundary components.

The above shell assembly fatigue criteria are satisfied for the 60-year service period and for the 100-year service life.

3.5.1.4.2 Basket Assembly

The canister basket assembly components, consisting of the guide tubes, support tubes, support sleeves, general spacer plates, LTP spacer plates, and engagement spacer plate are evaluated in accordance with NG-3222.4(d) for fatigue. Per NG-3222.4(d), these components do not need a detailed fatigue evaluation if the four specified criteria are satisfied. These criteria are discussed below.

1. *Temperature Difference - Startup and Shutdown*: The temperature difference between any two adjacent points on the canister basket assembly during startup and shutdown is limited to:

$$S_a / 2E\alpha = 680^\circ F$$

where S_a is determined to be 400 ksi from Figures I-9.1 and I-9.2.1 of the ASME Code, conservatively based on 10 startup-shutdown cycles, and the values of E and α are conservatively taken as $30(10)^6$ psi and $9.8(10)^{-6}$ in/in/°F, respectively.

   As shown in Chapter 4, the axial temperature difference within any basket component does not exceed 400°F and the radial temperature difference within any basket spacer disk does not exceed 350°F. All of these values are below 680°F. Therefore, the first criterion is satisfied.

2. *Temperature Difference - Normal Service*: The conservative value of S for 10^6 cycles is 12 ksi (Figures I-9.1 and I-9.2.1 of the ASME Code). The significant temperature fluctuation is:

$$STF = 12 / 2(30{,}000)(9.8 \cdot 10^{-6}) = 20^\circ F$$

   As shown in Chapter 4, the temperature difference between any two points in the tubes does not change significantly from normal cold to normal hot condition. Temperatures at all points drop uniformly by approximately 100°F. Therefore, there are no significant variations in the temperature gradient during normal service. The second criterion is satisfied.

3. *Temperature Difference- Dissimilar Materials*: The cut-off value for significant temperature fluctuations is determined as (S =12 ksi per (2) above):

$$STF = \frac{S}{2(E_1\alpha_1 - E_2\alpha_2)} = \frac{12}{2\left(24{,}800 \cdot \left(9.8 \cdot 10^{-6}\right) - 25{,}500 \cdot \left(7.5 \cdot 10^{-6}\right)\right)} = 116^\circ F$$

   The E and α values are taken for SA-240, Type 316 stainless steel and SA-517 or A514, Grades F or P carbon steel at the mean temperature of 700°F. These values provide the minimum STF and bound all other basket materials.

As shown in Table 4.4-3, the temperature fluctuation between normal cold and normal hot conditions is approximately 100°F. Therefore, only a very few significant temperature fluctuations per year are possible. Assuming the number of 10 per year and a canister lifetime of 100 years, there are 1000 significant temperature fluctuations over the life of the canister. The lower bound value of S_a is 78 ksi (Table I-9.1 of the ASME Code). The resulting allowable temperature range is:

$$\frac{S_a}{2(E_1\alpha_1 - E_2\alpha_2)} = \frac{78}{2\left(24{,}800 \cdot \left(9.8 \cdot 10^{-6}\right) - 25{,}500 \cdot \left(7.5 \cdot 10^{-6}\right)\right)} = 753°F$$

This value is higher than the temperature difference between any two components in the basket during normal service. Therefore, the third criterion is satisfied.

4. *Mechanical Loads*: The only significant mechanical loads during the canister service are those due to transfers. Conservatively estimating the number of these load fluctuations as 100, the Sa value is found to be 175 ksi (Table I-9.1 of the ASME Code). The mechanical loads do not exceed this value and, therefore, the fourth criterion is satisfied.

Therefore, fatigue is not a concern for the fuel basket components.

The above basket assembly fatigue criteria are satisfied for the 60-year service period and for the 100-year service life.

3.5.2 Internal Pressure

The canister shell assembly is evaluated for internal pressure loads associated with canister loading operations (draining internal pressure) and normal on-site transport and storage conditions. These conditions are described and evaluated in the following sections.

As discussed in Chapter 4 of this SAR, the FuelSolutions™ W74 canister internal pressure design loads for normal conditions bound those for a FuelSolutions™ W74 canister containing any amount of intact BRP MOX fuel and partial fuel assemblies, and up to eight damaged fuel assemblies. Therefore, the FuelSolutions™ W74 canister shell assembly and basket assembly stresses calculated for the design basis normal internal pressure loads are bounded for a FuelSolutions™ W74 canister containing any amount of intact BRP MOX fuel and partial fuel assemblies, and up to eight damaged fuel assemblies.

3.5.2.1 Canister Draining Internal Pressure

After installation of the inner closure plate, a compressed gas pressure of 30 psig is applied to the canister cavity to speed the water draining process during canister closure operations, thus minimizing the personnel dose. The automated canister welder/opener and auxiliary shield plate, described in Section 1.2.1.4.1 of the FuelSolutions™ Storage System SAR, are attached to the inner closure plate and a strongback is installed on the transfer cask top flange, as shown in Figure 1.2-14 of the FuelSolutions™ Storage System SAR. The strongback and auxiliary shield plate provide structural support for the canister top inner closure plate and ensure that no permanent deformation of the inner closure plate results from the drainage pressure loading which could potentially interfere with the proper placement and installation of the outer closure plate.

The structural evaluation of the W74 canister shell assembly for the drainage internal pressure load is performed using a combination of hand calculations and finite element analysis. Hand

6.3.2 Material Properties

The number densities used to model moderator materials and the FuelSolutions™ W74 canister basket, shell, and reflector materials are presented in Table 6.3-3 through Table 6.3-12. These material properties are used in all FuelSolutions™ W74 canister single package and multiple package array models.

The FuelSolutions™ W74 canister basket incorporates panels of borated stainless steel neutron-absorbing material. The borated stainless steel alloy incorporates a minimum of 1.25 weight percent (w/o) natural boron. As discussed at the beginning of Section 6.3, the MOX and damaged BRP assembly criticality analyses model the above boron concentration of 1.25 w/o. The intact and partial BRP assembly analyses, however, conservatively model a lower boron concentration of 1.0 w/o. The borated stainless steel material descriptions given in Table 6.3-7 and Table 6.3-13 correspond to boron concentrations of 1.0 w/o and 1.25 w/o, respectively. Stainless steel alloys are ideally suited for use in fuel pools containing demineralized or borated water, as well as long-term dry storage cask radiation and thermal environments. The borated stainless steel is manufactured and verified under the control and surveillance of the QA program described in Chapter 13 of the FuelSolutions™ Storage System FSAR. Product literature for this type of material is provided in Section 1.5.2 of this FSAR.

The continued efficacy of borated stainless steel is demonstrated by the process controls under which the material is manufactured and verified which assure a homogeneous dispersion of boron throughout the alloy. In addition, the effects of long-term exposure to neutron flux from irradiated fuel is negligible because the thermal neutron flux during dry storage is low. This fact, coupled with the use of the minimum boron concentration specified by the material manufacturer (rather than the nominal) further reduced by 25%, more than accounts for any boron depletion which may occur over the 100 year design life of the FuelSolutions™ W74 canister.

The boron depletion evaluation demonstrates that boron depletion levels are acceptable for the 60 year service period and for the 100 year design life.

9.2 Maintenance Program

This section discusses the maintenance program for the FuelSolutions™ W74 canister and damaged fuel can, which are both classified as important to safety. Noncompliances encountered during the required maintenance activities will be dispositioned in accordance with the Energy*Solutions* SFD Quality Assurance program, discussed in Chapter 13 of the FuelSolutions™ Storage System FSAR, or the licensee's NRC-approved Quality Assurance program. The maintenance program is intended to demonstrate that the FuelSolutions™ W74 canister and any associated damaged fuel cans continue to perform properly and comply with regulatory requirements and the *technical specifications* contained in Chapter 12 of this FSAR and the FuelSolutions™ Storage System FSAR.

The FuelSolutions™ W74 canister and damaged fuel cans rely on no mechanical components or moving parts once in their storage configuration. Exposed materials (damaged fuel cans are completely housed inside W74 canisters and have no exposed materials) are corrosion-resistant stainless steel. No inspection of a loaded canister during storage is required due to the integrity of the canister, as verified during fabrication, acceptance testing, and canister closure. Periodic monitoring of the FuelSolutions™ storage cask, in accordance with the *technical specification* contained in Section 12.3 of this FSAR, provides added assurance that fuel cladding degradation does not occur. Thus, no prescribed maintenance program is necessary during the 100-year design life of the FuelSolutions™ W74 canister or any associated damaged fuel cans.

The Aging Management Program (AMP) applicable during the additional 40 year license renewal period for the canister C of C is contained in Appendix 9.A.

5.0 ADMINISTRATIVE CONTROLS

5.1 Training Modules

See the Storage System Technical Specification for the applicable information.

5.2 Preoperational Testing and Training Exercises

See the Storage System Technical Specification for the applicable information.

5.3 Programs

5.3.1-5.3.5

See the Storage System Technical Specification for the applicable information.

5.3.6 Vacuum Drying Program

The FuelSolutions™ W74 CANISTER has been evaluated for allowable fuel cladding temperature during LOADING and STORAGE OPERATIONS. During LOADING OPERATIONS, the fuel cladding temperature is limited to 400•€ to assure cladding integrity.

This program shall establish administrative controls and procedures to assure that the spent fuel cladding does not exceed the temperature limit during LOADING OPERATIONS. For a CANISTER loaded with fuel with a total heat load of 24.8 kW, the initial vacuum drying cycle shall be limited to 7 hours. If the vacuum drying LCO 3.1.2 has not been satisfied, the CANISTER shall be backfilled with helium for 4 hours, vacuum dried for 4 hours, backfilled for 4 hours, etc., until the LCO is met.

For a heat load of 12.2 kW or lower, there is no time limit on the initial vacuum drying cycle. For heat loads greater than 12.2 kW but less than 24.8 kW, the program shall either use the 24.8 kW requirements, or establish suitable time limits to maintain the cladding temperature to less than or equal to 400•€ for the specific CANISTER heat load.

5.3.7 Cladding Oxide Thickness Measurement Program

Not applicable for the W74 CANISTER.

5.3.8 Storage Cask Periodic Monitoring Program

See the Storage System Technical Specification for the applicable information.

5.3.9 Aging Management Program

See the Storage System Technical Specification for the applicable information.

5.4 Special Requirements for First System in Place

The heat transfer characteristics of the cask system will be recorded by temperature measurements of the first STORAGE CASK placed in service with a heat load equal to or greater than 10kW. In accordance with 10CFR72.4, a letter report summarizing the results of the measurements shall be submitted to the NRC.

For each cask subsequently loaded with a higher heat load (up to the 24.8 kW limit), the calculation and measured temperature data shall be reported to the NRC at every 2 kW increase. The calculation and comparison need not be reported to the NRC for STORAGE CASKS that are subsequently loaded with lesser loads then the latest reported case.

Cask users may satisfy these requirements by referencing validation test reports submitted to the NRC by other users.

Appendix 9.A Aging Management Program

In accordance with the renewed FuelSolutions license, sites must implement an aging management program. An aging management assessment of the components of the FuelSolutions W74 Canister was performed. This review identified inspection and monitoring activities necessary to provide reasonable assurance that components within the scope of license renewal continue to perform their intended functions during the renewed storage period. This appendix describes those aging management program requirements.

9.A.1 Aging Management Programs (AMPs)

The following AMPs apply to C of C 1026 Amendments 0 through 5.

9.A.1.1 FuelSolutions Welded Stainless Steel Canister AMP

The FuelSolutions Welded Stainless Steel Canister AMP uses inspections to look for visual evidence of discontinuities and imperfections, such as localized corrosion, including pitting corrosion and stress corrosion cracking of the canister welds and heat affected zones. The full program is described in the following Table 9.A.1-1, FuelSolutions Welded Stainless Steel Canister AMP.

9.A.1.2 FuelSolutions Reinforced Concrete Structures AMP

The FuelSolutions Reinforced Concrete Structures AMP uses inspections to look for indications of concrete deterioration that might affect the ability of the W150 Storage Cask to perform its important to safety function. The full program is described in Table 9.A.1-2, FuelSolutions Reinforced Concrete Structures AMP, located in Appendix 9.A of the FuelSolutions Storage System FSAR WSNF-220.

9.A.1.3 FuelSolutions Monitoring of Metallic Surfaces AMP

The FuelSolutions Monitoring of Metallic Surfaces AMP uses inspections to look for indications of metallic surface deterioration that might affect the ability of the W150 Storage Cask and Fuel Transfer and Auxiliary Equipment metallic surfaces to perform their important to safety functions. The full program is described in Table 9.A.1-3, FuelSolutions Monitoring of Metallic Surfaces AMP, which is located in Appendix 9.A of the FuelSolutions Storage System FSAR WSNF-220.

9.A.1.4 FuelSolutions W100 Transfer Cask AMP

The FuelSolutions W100 Transfer Cask AMP utilizes inspections to ensure that the equipment maintains its intended function through the extended storage period. The full program is described in Table 9.A.1-4, FuelSolutions W100 Transfer Cask AMP, which is located in Appendix 9.A of the FuelSolutions Storage System FSAR WSNF-220.

9.A.1.5 FuelSolutions W21 Canister High-Burnup Fuel Monitoring and Assessment AMP

The FuelSolutions W21 Canister High-Burnup Fuel Monitoring and Assessment AMP only applies to W21 Canisters that store high-burnup fuel. The AMP relies on the EPRI and DOE research projects on high burnup fuel. The full program is described in Table 9.A.1-5, FuelSolutions W21 Canister High-Burnup Fuel Monitoring and Assessment AMP, which is located in Appendix 9.A of the FuelSolutions W21 Canister FSAR WSNF-221.

Table 9.A.1-1 FuelSolutions Welded Stainless Steel Canister AMP
(4 pages)

Element	Description
1 Scope of Program	This program manages the effects of aging for the surfaces of welded stainless steel canisters that are directly exposed to the sheltered environment within the W150 Storage Cask. The scope of the program includes the following canister sub-components: • Shell • Bottom closure plate • Shell extension • Bottom end plate • Top outer closure plate • Leak test port cover The following aging effects are addressed in this program: • Cracking due to stress corrosion cracking • Loss of material (precursor to stress corrosion cracking) due to pitting and crevice corrosion Examinations are performed on the accessible portions of the welded stainless steel dry storage canister confinement boundary external surfaces for atmospheric deposits, localized corrosion, and Stress Corrosion Cracking (SCC). In particular, examinations focus on accessible canister welds, weld heat-affected-zone areas, and known areas of the canister to which temporary supports or attachments were attached by welding and subsequently removed (based on available fabrication records) with the following attributes: • Locations where a crevice is formed on the canister surface • Horizontal (±30-degree) surfaces where deposits may accumulate at a faster rate compared to vertical surfaces • Canister surfaces that are cold relative to the average surface temperature • Canister surfaces with higher amounts of atmospheric deposits Examinations can be performed in coordination of the ASME Section XI code inspections provided in Code Case N860, “Examination Requirements and Acceptance Standards for Spent Nuclear Fuel Storage and Transportation Containment Systems.”
2 Preventive Actions	Condition monitoring is utilized to manage aging effects. During fabrication of the canisters, however, preventative actions were used to minimize corrosion and stress corrosion cracking by selection of stainless steel materials. In addition, fabrication controls were in place during canister fabrication to support improved canister corrosion resistance. Although these preventative actions minimize the likelihood of aging effects, they cannot replace condition monitoring during the storage period. As this AMP is based on condition monitoring, new preventative actions are not included.

Table 9.A.1-1 FuelSolutions Welded Stainless Steel Canister AMP
(4 pages)

Element	Description
3 Parameters Monitored / Inspected	The parameters monitored and/or inspected under this AMP include: • Visual inspections to look for evidence of discontinuities and imperfections, such as localized corrosion, including pitting corrosion and stress corrosion cracking of the accessible canister welds and weld heat affected zones. • The size and location of localized corrosion or stress corrosion cracks • The inspections also look for the appearance and location of deposits on the canister surfaces.
4 Detection of Aging Effects	Visual inspection of the canister surface is to be performed per ASME Code Section XI, Article IWA-2200 for VT-3 examinations utilizing a video camera, fiber-optic scope or other remote inspection device for the accessible areas of the canister surface since direct visual examination may not be possible due to neutron and gamma radiation fields near canister surfaces within the storage cask. Additional assessments are to be performed as necessary for suspected areas of localized corrosion and SCC. VT-1 visual examinations are performed per acceptance criteria when indicated by the assessment of the VT-3 results. Indications of corrosion within 2 inches of a weld are to receive an augmented surface examination for the presence of cracking. Volumetric examination consistent with the requirements of ASME Code Section XI, IWB-2500, for category B-J components may also be utilized to assess the presence of cracking. Inspection of selected areas on the canister may be upgraded to the VT-1 standard. The inspection is to be performed on a minimum of one canister at each ISFSI based on the following criteria: • EPRI Susceptibility Criteria {Ref: Technical Report 3002005371} • Age of the Canister (First canister placed in service) • Canister loaded with Lowest Heat Load • Canisters with the greatest potential for the accumulation and deliquescence of deposited salts that may promote localized corrosion and greatest potential for the accumulation and deliquescence of deposited salts that may promote localized corrosion and SCC • Where applicable, canister with previously identified manufacturing deviations which may affect the surface. Inspections are to be performed by qualified individual(s) every 5 years starting with the first inspection performed within either the later of one (1) year after the initial canister's 20th year loading anniversary or within one year after the issuance of first renewal of the CoC. If possible, examinations should occur on the same canister to support trending.
5 Monitoring and Trending	Monitoring and trending of the results from documented inspection should support the ability to evaluate the results against acceptance criteria. Inspection records including photos and /or videos are to be retained for comparison in subsequent

Table 9.A.1-1 FuelSolutions Welded Stainless Steel Canister AMP
(4 pages)

Element	Description
	examinations. Changes to the size or location of discolored areas (e.g., rust), localized corrosion, pitting and crevice corrosion, and/or stress corrosion cracking should be identified and assessed for further evaluation or subsequent inspections. Trending of parameters or effects include the locations and size of any areas of localized corrosion or SCC, disposition of canisters with identified aging effects and the results of any supplemental canister inspections.
6 Acceptance Criteria	No indications of localized corrosion pits, etching, crevice corrosion, stress corrosion cracking, red-orange-colored corrosion products emanating from crevice locations, or red-orange-colored corrosion products in the vicinity of canister fabrication welds, closure welds, and welds associated with temporary attachments during canister fabrication. Minor surface corrosion is acceptable. Identified flaws may be assessed in accordance with the acceptance standards identified in ASME Code Section XI, IWB-3514. <u>Results of Inspections Requiring Additional Evaluation</u> Indications of interest (locations on the canister surface susceptible to SCC including areas adjacent to fabrication welds, closure welds, locations where temporary attachments may have been welded to and subsequently removed from the canister and the weld heat-affected zones) that are subject to additional examination and disposition through the corrective action program include: • Localized corrosion pits, crevice corrosion, stress corrosion cracking, and etching; deposits or corrosion products • Red-orange colored corrosion products or red-orange colored corrosion tubercles with deposit accumulations especially when adjacent to welds or weld heat affected zones of these areas and locations where temporary attachments were welded to and subsequently removed from the canister • Appearance of any color of liner corrosion products of any size parallel to or traversing fabrication welds, closure welds, and the weld heat affected zones. • Red-orange colored corrosion products greater than 1 mm in diameter combined with deposit accumulations on any location of the canister • Red-orange colored corrosion tubercles of any size
7 Corrective Actions	Indications not meeting the acceptance criteria above (AMP Element 6) require additional evaluation after being entered into the site’s corrective action program. An evaluation is to be performed to determine the extent and impact of the corrosion on the canister’s ability to perform its intended function. The site’s Quality Assurance (QA) program ensures that corrective actions are completed within the Corrective Action Program (CAP) and include any necessary functionality assessments, cause evaluations, extent of condition, actions, identify any modifications to the existing AMP (e.g., increased frequency), and determine if the condition is reportable per 10 CFR 72.75.
8 Confirmation Process	The confirmation process is to be commensurate with the site’s QA program. The QA program ensures that the confirmation process includes provisions to preclude

Table 9.A.1-1 FuelSolutions Welded Stainless Steel Canister AMP
(4 pages)

Element	Description
	repetition of significant conditions adverse to quality and the completion of inspections, evaluations, and corrective actions.
9 Administrative Controls	The site QA program ensures that administrative controls include provisions that address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control. Administrative controls also address the frequency for updating the AMP based on inspection results along with industry operating experience. This AMP will be updated as necessary based on tollgate assessments.
10 Operating Experience	Previous operating experience for the W74 Canister indicates very minimal corrosion detected to date. That operating experience has been incorporated into the guidance on inspections and acceptance criteria contained in this AMP. A renewal application re-submittal inspection was performed on the W74 system at Big Rock Point in July 2019.[17] Three separate tasks were completed consisting of a video inspection of the accessible area in the annulus between the cask and canister; a visual inspection of the cask interior and visual inspection of the cask storage pad. A representative canister and storage cask were selected by Entergy based on increased susceptibility for moisture intrusion and corrosion. Heat loads at the time of loading all of the canisters at Big Rock Point were within 0.5 kW of each other, and all storage casks were placed into service within months of each other (between November 2002 and May 2003). The inspection revealed some minor observations; however, no structural deficiencies were identified, and all parts continue to perform their design function. Surface rust was observed (Cask Serial Number W150-610-NMC) on washers under the nut on the tie rods (minimal depth) causing discoloration in the bearing plate and nut. Both these components are stainless steel and are not in danger of corroding. NRC Region III Inspectors[18] reviewed the previous five-year cask inspection documentation for Big Rock Point storage cask number 7 that included both pictures and video of the interior of the cask and did not identify any findings of significance. As canister inspections are performed in the future, inspection results will be uploaded into the ISFSI Aging Management Institute of Nuclear Power Operations Database (ISFSI AMID) to be shared with other users.

[17] Report 4T002-RPT-001, Rev 0 "FuelSolutions Renewal Application Pre-Submittal Inspection," August 29, 2019

[18] Errata to Big Rock Point Independent Spent Fuel Storage Installation - Inspection Reports 07200043-12-001 and 05000155-12-007 (ADAMS Accession ML13071A379) dated 03/11/13.

9.A.2 Tollgates

Tollgates are established as requirements in the renewed CoC and implemented by ISFSI generic licensees to evaluate aging management feedback and perform a safety assessment that confirms the safe storage of spent nuclear fuel. The impact of the aggregate feedback will be assessed by the site as it pertains to components at the site's ISFSI and actions taken as necessary, such as:

- Adjustment of aging-related degradation monitoring and inspection programs in AMPs
- Modification of TLAAs
- Performance of mitigation activities

Each tollgate assessment will address the following elements as applicable:

- Summary of research findings, operating experience, monitoring data, and inspection results made available since last assessment
- Aggregate impact of findings, including any trends
- Consistency of data with the assumptions and inputs in the TLAAs
- Effectiveness of AMPs
- Corrective actions, including any changes to AMPs
- Summary and conclusions

A schedule for these tollgate assessments is shown in Table 9A.2-1, which is located in Appendix 9.A of the FuelSolutions Storage System FSAR WSNF-220.

APPENDIX E: AGING MANAGEMENT CoC CHANGES

The proposed changes to the FuelSolutions Storage System CoC 1026 as a result of the renewal, and the proposed changes to the CoC 1026 Appendix A FuelSolutions™ Storage System Technical Specifications, W21 Canister Technical Specifications and W74 Canister Technical Specifications, are shown in the attached CoC and Technical Specification markups. While only one CoC 1026 amendment markup is shown, the markups will be applied to each CoC 1026 amendment, all of which are being renewed.

NRC FORM 651
(10-2004)
10 CFR 72

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF COMPLIANCE FOR SPENT FUEL STORAGE CASKS

Page 1 of 4

The U.S. Nuclear Regulatory Commission is issuing this Certificate of Compliance pursuant to Title 10 of the *Code of Federal Regulations*, Part 72, "Licensing Requirements for Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste" (10 CFR Part 72). This certificate is issued in accordance with 10 CFR 72.238, certifying that the storage design and contents described below meet the applicable safety standards set forth in 10 CFR Part 72, Subpart L, and on the basis of the Final Safety Analysis Report (FSAR) of the cask design. This certificate is conditional upon fulfilling the requirements of 10 CFR Part 72, as applicable, and the conditions specified below.

Certificate No.	Effective Date	Expiration Date	Docket No.	Amendment No.	Amendment Effective Date	Package Identification No.
1026	02/15/01	02/15/21	72-1026	6	TBD	USA/72-1026
	Renewed Effective Date TBD	Renewed Expiration Date TBD		Revision No. 0	Revision Effective Date NA	

Issued To: (Name/Address)

1. CASK

   a. Model No.: FuelSolutions™ Storage System

   The FuelSolutions™ Storage System (the cask) consists of the following components: (1) canister for dry storage of spent nuclear fuel (W21 and W74); (2) transfer cask for canister loading, closure and handling capability (W100); and (3) storage cask which provides passive vertical dry storage of a loaded canister (W150). The cask stores up to 21 pressurized water reactor (PWR) assemblies or 64 boiling water reactor (BWR) assemblies.

   b. Description

The FuelSolutions™ Storage System is certified as described in the Safety Analysis Report (SAR) and in NRC's Safety Evaluation Report (SER) accompanying the Certificate of Compliance (CoC). The cask comprises three discrete components: the W21 and W74 canisters, the W100 transfer cask, and the W150 storage cask.

The canister is the confinement system for the stored fuel. A typical canister consists of a shell assembly, top and bottom inner closure plates, vent and drain port covers, internal basket assembly, top and bottom shield plugs, and top and bottom outer closure plates. All structural components are constructed of high-strength carbon (electroless nickel coated) or stainless steel. The canister shell, top and bottom inner closure plates, and the vent and drain port covers form the confinement boundary. The W21 fuel basket is a right circular cylinder configuration with 21 stainless steel guide tubes for the PWR contents. The guide tubes are laterally supported by a series of spacer plates held in position by support rods that run through

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1. b. Description (continued)

sleeves between the spacer plates. The guide tubes include neutron poison sheets (Boral) on all four sides. The W21 canister has two classes of canister, W21M and W21T, differing in materials of construction used for the canister shell and basket assembly. Each class of canister has four different types. The W21T canister class consists of a long lead (LL), long steel (LS), short lead (SL), and short steel (SS) canister. The W21M canister has long, depleted uranium (LD); long steel (LS); short, depleted uranium (SD), and short steel (SS) designs. The W74 fuel basket assembly consists of two right circular cylindrical baskets, with a total of 74 cell locations and a capacity of up to 64 BWR assemblies. The ten unfueled cell locations are mechanically blocked to prevent loading in these positions. The guide tubes are supported by a series of spacer plates, held in position by support tubes that run through sleeves placed between the spacer plates. The guide tubes include neutron poison sheets (borated stainless steel) in an arrangement that assures there is a poison sheet between all assemblies. The W74 canister has two classes of canister, W74M and W74T, differing in materials of construction used for the canister shell and basket assembly. Each canister class has only a long steel (LS) design.

The W150 is the storage overpack for both the W21 and W74 canisters. There is a long and a short version of the cask, both of reinforced concrete with a steel liner. The W150 provides structural support, shielding, protection from environmental conditions, and natural convection cooling of the canister during long-term storage. The storage cask has an annular air passage to allow the natural circulation of air around the canister. The spent fuel decay heat is transferred from the fuel assemblies to the guide tubes, and then via conduction through the spacer plates and radiation to the canister wall. Heat flows by radiation and convection from the canister wall to the circulating air and is exhausted through the air outlets. The passive cooling system is designed to maintain acceptable reinforced concrete and peak cladding temperatures for the authorized fuel types during storage.

The W100 transfer cask provides shielding during canister movements between the spent fuel pool and the storage cask. The cask is a multi-wall (steel/lead/steel/water/steel) design. Covers are bolted on each end of the cask to allow access to the cask cavity from either end. The top cover includes a secondary central cover for ram access during horizontal loading and unloading operations. The W100 neutron shield cavity is filled with clean water either prior to placement in or following removal from the spent fuel pool. To prevent contamination of the annular region between the W100 and the canister, an inflatable annulus seal is used during loading. Heat transfer from the transfer cask is primarily by conduction through the cask wall. A thermocouple probe is included to ensure that the transfer cask system temperatures are within limits during horizontal transfer.

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2. OPERATING PROCEDURES

Written operating procedures shall be prepared for cask handling, loading, unloading, movement, surveillance, and maintenance. The user's site-specific written operating procedures shall be consistent with the technical basis described in Chapter 8 of the SAR.

3. ACCEPTANCE TEST AND MAINTENANCE PROGRAM

Written cask acceptance tests and a maintenance program shall be prepared consistent with the technical basis described in Chapter 9 of the SAR.

4. QUALITY ASSURANCE

Activities in the areas of design, procurement, fabrication, assembly, inspection, testing, operation, maintenance, repair, modification of structures, systems and components, and decommissioning that are important to safety shall be conducted in accordance with a Commission-approved quality assurance program which satisfies the applicable requirements of 10 CFR Part 72, Subpart G, and which is established, maintained, and executed with regard to the cask system.

5. HEAVY LOADS REQUIREMENTS

Each licensed facility must ensure that cask lifting is evaluated in accordance with the existing heavy loads requirements and procedures of the licensed facility in which the lift is made. An additional safety review by the facility (under 10 CFR 50.59 or 10 CFR 72.48, if applicable) is required to show operational compliance with existing facility/site-specific heavy loads requirements.

6. APPROVED CONTENTS

Contents of the FuelSolutions™ Storage System must meet the specifications given in Appendix A to this certificate.

7. DESIGN FEATURES

Features or characteristics for the site, cask, or ancillary equipment must be in accordance with Appendix A to this certificate.

8. CHANGES TO THE CERTIFICATE OF COMPLIANCE

The holder of this certificate who desires to make changes to this certificate, which includes Appendix A (Technical Specifications), shall submit an application for amendment of the certificate.

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9. AUTHORIZATION

The FuelSolutions™ Storage System, which is authorized by this certificate, is hereby approved for general use by holders of 10 CFR Part 50 licenses for nuclear reactors at reactor sites under the general license issued pursuant to 10 CFR 72.210, subject to the conditions specified by 10 CFR 72.212, and the attached Appendix A.

10. FSAR UPDATE 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 renewal. The updated FSARs shall reflect the changes and CoC holder commitments resulting from the review and approval of the renewal of the CoC.

11. 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 assure they remain adequate for any changes to SSCs within the scope of renewal.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

TBD, Chief
Licensing Branch
Division of Fuel Management
Office of Nuclear Material Safety and Safeguards
Washington, DC 20555

Appendix A – FuelSolutions™ Storage System Technical Specifications

Appendix B – FuelSolutions™ W21 Canister Technical Specifications

Appendix C – FuelSolutions™ W74 Canister Technical Specifications

CoC Appendix A – FuelSolutions™ Storage System Technical Specifications
Aging Management Program Markups
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5.0 Administrative Controls

5.2 Preoperational Testing and Training Exercises

A preoperational training exercise of the FuelSolutions™ Storage System is to be conducted prior to the first use of any system component or conduct of any specific operation that may include, but is not limited to, the following:

- Moving a transfer cask/canister into the spent fuel pool.
- Loading an SNF assembly. This includes operations associated with selecting, loading, and independent verification of a dummy SNF assembly.
- Placing the top shield plug and removal of transfer cask/canister from the spent fuel pool.
- Canister sealing, vacuum drying, and cover gas backfill operations using a mock-up canister subassembly.
- Transfer cask upending/downending on the horizontal transfer trailer.
- Storage cask upending/downending.
- Horizontal canister transfer from the transfer cask to and retrieval from the storage cask.
- Horizontal canister transfer from the transfer cask to and retrieval from the transportation cask.
- Horizontal canister transfer from the transportation cask to and retrieval from the storage cask.
- Vertical canister transfer from the transfer cask to and retrieval from the storage cask.
- Vertical canister transfer from the transfer cask to and retrieval from the transportation cask.
- Canister reflood and opening using a mock-up canister subassembly.

Subsequent training will be in accordance with site-specific procedures.

5.3 Programs

The following programs shall be established, implemented, and maintained:

5.3.1 <u>Cask Sliding Evaluation</u>

The FuelSolutions™ W150 STORAGE CASK has been evaluated for sliding in the unlikely events of a seismic event. A sliding coefficient of friction of 0.3 is used in these analyses. This program provides a means for evaluating the coefficient of friction to assure that the cask will not slide significantly during the seismic event.

5.3.1.1 Pursuant to 10CFR72.212, this program shall evaluate the site-specific ISFSI pad configurations/conditions to assure that the cask would not slide significantly during the postulated design basis earthquake. The program shall conclude that the surface sliding friction coefficient of friction is greater than or equal to 0.3.

5.0 Administrative Controls

5.3.1.2 Alternatively, for site-specific ISFSI pad configuration/conditions with a lower sliding coefficient of friction than 0.3, the program shall evaluate the site-specific conditions to assure that the FuelSolutions™ W150 STORAGE CASK will not slide significantly during the postulated design basis earthquake. The program shall also evaluate storm winds, missile impacts and flood forces to assure that the cask will not slide such that it could result in impact with other casks or structures at the ISFSI. The program shall assure that these alternative analyses are documented and controlled.

5.3.2 <u>Cask Transport Evaluation Program</u>

This program provides a means for evaluating various transport configurations and transport route conditions to assure that the design basis drop limits are met.

5.3.2.1 Pursuant to 10CFR72.212, this program shall evaluate the site-specific transport conditions. To demonstrate compliance with Technical Specification 4.2.2, the program shall conclude that the expected lift height above the transport surface shall be less than or equal to that described by Technical Specification 4.2.2. Also, the program shall conclude that the transport route conditions (e.g., surface hardness and pad thickness) are equivalent to or less limiting than those prescribed for the typical pad surfaces which form the basis for Technical Specification 4.2.2.

5.3.2.2 Alternatively, for site-specific transport conditions which are not encompassed by those of Technical Specification 4.2.2, the program shall evaluate the site-specific conditions to assure that the STORAGE CASK end-drop loading does not exceed 88.5 *g* and the TRANSFER CASK side drop loading does not exceed 60 *g*. This alternative analysis shall be commensurate with the analysis which forms the basis of Technical Specification 4.2.2 (Reference FuelSolutions™ Storage System FSAR, Section 3.7). The program shall assure that these alternative analyses are documented and controlled.

5.3.2.3 This program shall establish administrative controls and procedures to assure that cask transport operations are conducted within the limits imposed by the Technical Specification or the alternative analysis described above.

5.3.3 <u>Technical Specifications (TS) Bases Control Program</u>

This program provides a means for processing changes to the Bases of these Technical Specifications.

5.3.3.1 Changes to the Bases of the TS shall be made under appropriate administrative controls and reviews.

5.0 Administrative Controls

5.3.3.2 Licensees may make changes to Bases without prior NRC approval provided the changes do not involve either of the following:

- A change in the TS incorporated in the license
- A change to the FSAR or Bases that involves an unreviewed safety question, a significant increase in occupational exposure, or a significant unreviewed environmental impact as defined in 10CFR72.48.

5.3.3.3 The Bases Control Program shall contain provisions to ensure that the Bases are maintained consistent with the FSAR.

5.3.3.4 Proposed changes that do not meet the criteria of 5.3.3.2 above shall be reviewed and approved by the NRC prior to implementation. Changes to the Bases implemented without prior NRC approval shall be provided to the NRC on a frequency consistent with 10CFR72.48(b)(2).

5.3.4 Radioactive Effluent Control Program

This program implements the requirements of 10CFR72.44(d).

5.3.4.1 The FuelSolutions™ Storage System does not create any radioactive materials or have any radioactive waste treatment systems. Therefore, specific operating procedures for the control of radioactive effluents are not required. Specification 3.1.3, CANISTER Leak Rate, provides assurance that there are essentially no radioactive effluents from the CANISTERs.

5.3.4.2 This program includes an environmental monitoring program. The FuelSolutions™ Storage System may be included in a site environmental monitoring program.

5.3.4.3 An annual report shall be submitted pursuant to 10CFR72.44(d)(3) specifying the quantity of each of the principal radionuclides released to the environment in liquid and in gaseous effluents during the previous calendar year of operation.

5.3.5 Cask Surface Dose Rate Evaluation Program

This program provides a means for ensuring that ISFSIs using FuelSolutions™ STORAGE CASKS do not violate the requirements of 10CFR72 and 10CFR20 regarding radiation doses and dose rates.

5.3.5.1 As part of its evaluation pursuant to 10CFR72.212, the licensee shall perform an analysis to confirm that the limits of 10CFR20 and 10CFR72.104 will be satisfied under the actual site conditions and configurations considering the planned number of casks to be used and the planned fuel loading conditions.

5.3.5.2 On the basis of the analysis in 5.3.5.1, the licensee shall establish a set of cask surface dose rate limits which are to be applied to FuelSolutions™ STORAGE CASKS used at the site. Limits shall establish average gamma-ray and neutron dose rates for:

5.0 Administrative Controls

- The outside vertical surface of the STORAGE CASK at approximately 6 feet above the base.
- The inlet or outlet vent screen surfaces.
- The top lid.

5.3.5.3 Notwithstanding the limits established in TS 5.3.5.2, the dose rate limits may not exceed the following values:

- 50 mrem/hr on the side.
- 510 mrem/hr at the inlet or outlet vent screen surfaces.
- 50 mrem/hr on the top lid.

5.3.5.4 Within 12 hours following placement of the loaded STORAGE CASK on the ISFSI pad, the licensee shall measure the cask surface dose rates and calculate average values as described in 5.3.5.7 and 5.3.5.8.

The measured average dose rates shall be compared to the limits established in TS 5.3.5.2 or the limits in 5.3.5.3, whichever are lower.

5.3.5.5 If the measured average surface dose rates do not meet the limits of TS 5.3.5.2 or TS 5.3.5.3, whichever are lower, the licensee shall take the following actions:

- Notify the U.S. Nuclear Regulatory Commission (Director of the Office of Nuclear Material Safety and Safeguards) within 30 days.
- Administratively verify that the correct fuel was loaded.
- Perform an analysis to determine that placement of the as-loaded cask at the ISFSI will not cause the ISFSI to exceed the radiation exposure limits of 10CFR20 and 10CFR72.

5.3.5.6 If the analysis in 5.3.5.5 shows that placement of the as-loaded cask at the ISFSI will cause the ISFSI to exceed the radiation exposure limits of 10CFR20 and 10CFR72, the licensee shall remove all fuel assemblies from the cask within 30 days of the time of cask loading.

5.3.5.7 The surface dose rates shall be measured at the following points:

- At least eight readings taken at equal spacing around the outside vertical surface of the STORAGE CASK at approximately 6 feet above the base.
- The inlet or outlet vent screen surfaces.
- At least five readings taken on the top lid, with one reading from the center and the other four taken at equal spacing 30 inches from the center.

5.3.5.8 The average dose rates shall be determined as follows:

In each of the three measurement zones in 5.3.5.7, the sum of the dose rate measurements is divided by the number of measurements to determine the average for that zone. The neutron and gamma-ray dose rates are averaged separately. Uniformly spaced dose rate measurement locations are chosen such that each point in a given zone represents approximately the same surface area.

5.3.6 Vacuum Drying Program

See the CANISTER Technical Specifications for the applicable information.

5.3.7 Cladding Oxide Thickness Measurement Program

See the CANISTER Technical Specifications for the applicable information.

5.3.8 Storage Cask Periodic Monitoring Program

The STORAGE CASK containing a CANISTER loaded with fuel has been evaluated for the unlikely event of full blockage of all STORAGE CASK inlet and outlet vent screens during STORAGE OPERATIONS. Transient thermal analyses have been performed for the blocked vent accident condition to determine the time at which the limiting short-term allowable temperature is reached in the STORAGE CASK. Periodic monitoring is required at intervals that are less than the time required to reach the limiting short-term temperature limit.

This program shall establish administrative controls and procedures to assure that the licensee will be able to determine when corrective action needs to be taken to maintain safe storage conditions. The required surveillance frequency for a STORAGE CASK containing a CANISTER loaded with fuel is as follows:

Total Heat Load (Q)	Surveillance Frequency
Q > 20 kW	24 hours (1 day)
15 kW < Q • 20 kW	48 hours (2 days)
10 kW < Q • 15 kW	96 hours (4 days)
5 kW < Q • 10 kW	168 hours (1 week)
Q • 5 kW	336 hours (2 weeks)

Acceptable means of monitoring the STORAGE CASK include periodic visual inspection of all STORAGE CASK inlet and outlet vent screens OR periodic STORAGE CASK liner thermocouple temperature readings. When the STORAGE CASK liner thermocouple temperature measurements are used as the means of monitoring, the following limits shall be met:

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5.0 Administrative Controls

	Measured Thermocouple Temperature (•F)	
Total Heat Load (Q)	Normal Ambient (• 100•F)	Off-Normal Ambient (• 125•F)
Q > 20 kW	163	192
15 kW < Q • 20 kW	156	181
10 kW < Q • 15 kW	146	171
5 kW < Q • 10 kW	136	161
Q • 5 kW	126	151

Alternatively, the program may establish other suitable surveillance frequencies and liner thermocouple temperature limits to maintain the concrete temperature below the short-term allowable temperature of 350•F for a specific CANISTER heat load.

5.4 Special Requirements for First System in Place

See the CANISTER Technical Specifications for the applicable information.

5.3.9 Aging Management Program

Each general licensee shall have a program to establish, implement, and maintain written procedures for each AMP described in the 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.

The general licensee shall establish and implement these written procedures within one year of the effective date of the renewal of the CoC or one year of the 20th anniversary of the loading of the first dry storage system at licensee's site, whichever is later.

The general licensee shall include written evaluations in the 10 CFR 72.212 evaluations report describing the implementation of the renewed CoC aging management license conditions within this specified time frame.

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

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5.0 ADMINISTRATIVE CONTROLS

5.1 Training Modules

See the Storage System Technical Specification for the applicable information.

5.2 Preoperational Testing and Training Exercises

See the Storage System Technical Specification for the applicable information.

5.3 Programs

5.3.1-5.3.5

See the Storage System Technical Specification for the applicable information.

5.3.6 Vacuum Drying Program

The FuelSolutions™ W21 CANISTER has been evaluated for allowable fuel cladding temperature during LOADING and STORAGE OPERATIONS. During LOADING OPERATIONS, the fuel cladding temperature is limited to 400•€ to assure cladding integrity.

This program shall establish administrative controls and procedures to assure that the spent fuel cladding does not exceed the temperature limit during LOADING OPERATIONS. For a CANISTER loaded with fuel with a total heat load of 22.0 kW, the total vacuum drying cycle shall be limited to 12 hours. If the vacuum drying LCO 3.1.2 has not been satisfied, the CANISTER shall be backfilled with helium for 4 hours, vacuum dried for 8 hours, backfilled for 4 hours, etc., until the LCO is met.

For a heat load of 17.5 kW or lower, there is no time limit on the initial vacuum drying cycle. For heat loads greater than 17.5 kW but less than 22.0 kW, the program shall either use the 22.0 kW requirements, or establish suitable time limits to maintain the cladding temperature to less than or equal to 400•€ for the specific CANISTER heat load.

5.3.7 Cladding Oxide Thickness Measurement Program

For fuel with a burnup exceeding 45 GWd/MTU, it is necessary to verify that cladding oxide layer thickness for fuel assemblies to be stored does not exceed 70 • m.

This program shall establish administrative controls and procedures to verify oxide layer thickness by measurement of a statistical sample of limiting fuel assemblies.

5.3.8 Storage Cask Periodic Monitoring Program

See the ~~STORAGE CASK~~ Storage System Technical Specifications for the applicable information.

5.3.9 Aging Management Program

See the Storage System Technical Specification for the applicable information.

5.4 Special Requirements for First System in Place

The heat transfer characteristics of the cask system will be recorded by temperature measurements of the first STORAGE CASK placed in service with a heat load equal to or greater than 10kW. In accordance with 10CFR72.4, a letter report summarizing the results of the measurements shall be submitted to the NRC.

For each cask subsequently loaded with a higher heat load (up to the 22.0 kW limit), the calculation and measured temperature data shall be reported to the NRC at every 2 kW increase. The calculation and comparison need not be reported to the NRC for STORAGE CASKS that are subsequently loaded with lesser loads then the latest reported case.

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5.0 ADMINISTRATIVE CONTROLS

5.1 Training Modules

See the Storage System Technical Specification for the applicable information.

5.2 Preoperational Testing and Training Exercises

See the Storage System Technical Specification for the applicable information.

5.3 Programs

5.3.1-5.3.5

See the Storage System Technical Specification for the applicable information.

5.3.6 Vacuum Drying Program

The FuelSolutions™ W74 CANISTER has been evaluated for allowable fuel cladding temperature during LOADING and STORAGE OPERATIONS. During LOADING OPERATIONS, the fuel cladding temperature is limited to 400•€ to assure cladding integrity.

This program shall establish administrative controls and procedures to assure that the spent fuel cladding does not exceed the temperature limit during LOADING OPERATIONS. For a CANISTER loaded with fuel with a total heat load of 24.8 kW, the initial vacuum drying cycle shall be limited to 7 hours. If the vacuum drying LCO 3.1.2 has not been satisfied, the CANISTER shall be backfilled with helium for 4 hours, vacuum dried for 4 hours, backfilled for 4 hours, etc., until the LCO is met.

For a heat load of 12.2 kW or lower, there is no time limit on the initial vacuum drying cycle. For heat loads greater than 12.2 kW but less than 24.8 kW, the program shall either use the 24.8 kW requirements, or establish suitable time limits to maintain the cladding temperature to less than or equal to 400•€ for the specific CANISTER heat load.

5.3.7 Cladding Oxide Thickness Measurement Program

Not applicable for the W74 CANISTER.

5.3.8 Storage Cask Periodic Monitoring Program

See the Storage System Technical Specification for the applicable information.

5.3.9 Aging Management Program

See the Storage System Technical Specification for the applicable information.

5.4 Special Requirements for First System in Place

The heat transfer characteristics of the cask system will be recorded by temperature measurements of the first STORAGE CASK placed in service with a heat load equal to or greater than 10kW. In accordance with 10CFR72.4, a letter report summarizing the results of the measurements shall be submitted to the NRC.

For each cask subsequently loaded with a higher heat load (up to the 24.8 kW limit), the calculation and measured temperature data shall be reported to the NRC at every 2 kW increase. The calculation and comparison need not be reported to the NRC for STORAGE CASKS that are subsequently loaded with lesser loads then the latest reported case.

Cask users may satisfy these requirements by referencing validation test reports submitted to the NRC by other users.