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United States Nuclear Regulatory Commission

Protecting People and the Environment

NUREG-1927, Rev. 1

Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel

Draft Report for Comment

Office of Nuclear Material Safety and Safeguards

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Office of Nuclear Material Safety and Safeguards

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Federal Rulemaking Website: Go to http://www.regulations.gov and search for documents filed under Docket ID **NRC-2015-0106**. Address questions about NRC dockets to Carol Gallagher at 301-415-3463 or by e-mail at Carol.Gallagher@nrc.gov.

Mail comments to: Cindy Bladey, Chief, Rules, Announcements, and Directives Branch (RADB), Division of Administrative Services, Office of Administration, Mail Stop: OWFN-12-H08, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

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Please be aware that any comments that you submit to the NRC will be considered a public record and entered into the Agencywide Documents Access and Management System (ADAMS). Do not provide information you would not want to be publicly available.

ABSTRACT

This Standard Review Plan is intended for use by the U.S. Nuclear Regulatory Commission (NRC) reviewer. It provides guidance for the safety review of renewal applications for specific licenses of independent spent fuel storage installations and certificates of compliance (CoC) of dry storage systems, as codified in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste.”

To renew a specific license, an applicant (i.e., licensee) must submit a license renewal application at least 2 years before the expiration of the license in accordance with the requirements of 10 CFR 72.42(b). To renew a CoC, an applicant (i.e., CoC holder, user, or user’s representative) must submit a renewal application at least 30 days before the expiration of the associated CoC in accordance with the requirements of 10 CFR 72.240(b). The NRC may renew a specific license or a CoC for a term not to exceed 40 years, in accordance with 10 CFR 72.42(a), or 10 CFR 72.240(a), respectively. General licenses are not renewed since the general-license term is linked to the storage term of the CoC in use.

The NRC may revise and update this Standard Review Plan to clarify the content, correct errors, or incorporate modifications approved by the Division of Spent Fuel Management. Comments, suggestions for improvement, and notices of errors or omissions should be sent to the Director, Division of Spent Fuel Management, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

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ABBREVIATIONS

ACI	American Concrete Institute
AMA	aging management activity
AMP	aging management program
AMR	aging management review
ANS	American Nuclear Society
ANSI	American National Standard Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
°C	degrees Celsius
CAP	Corrective Action Program
CFR	*Code of Federal Regulations*
CISCC	chloride-induced stress corrosion cracking
CLB	current licensing basis
CoC	certificate of compliance
CRIEPI	Central Research Institute of Electric Power Industry
DE	destructive examination
DOE	U.S. Department of Energy
DSS	dry storage system
EPRI	Electric Power Research Institute
°F	degrees Fahrenheit
FSAR	Final Safety Analysis Report
GTCC	greater-than-Class-C
GWd/MTU	gigawatt days per metric ton uranium
HBU	high burnup
HDRP	HBU Dry Storage Cask Research and Development Project
INPO	Institute of Nuclear Power Operations
ISFSI	independent spent fuel storage installation
ISG	Interim Staff Guidance
ITS	important to safety
KJ	kilojoule
LWR	light water reactor
m	meters
mol	mole
N/A	not applicable
NDE	nondestructive examination
NEI	Nuclear Energy Institute

NMSS	Office of Nuclear Material Safety and Safeguards
NRC	U.S. Nuclear Regulatory Commission
OMB	Office of Management and Budget
PM	NRC Project Manager
ppm	parts per million
QA	quality assurance
s	second
SAR	safety analysis report
SER	safety evaluation report
SRP	Standard Review Plan
SSC	structure, system, and component
TEPCO	Tokyo Electric Power Company
TLAA	time-limited aging analysis
TS	technical specification
UFSAR	Updated Final Safety Analysis Report

INTRODUCTION

This Standard Review Plan (SRP) is intended to provide guidance to the U.S. Nuclear Regulatory Commission (NRC) staff for the safety review of renewal applications for specific licenses of independent spent fuel storage installations (ISFSIs) and certificates of compliance (CoC) of dry storage systems (DSSs), as codified in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste.”

To renew a specific license, an applicant (i.e., the licensee) must submit a license renewal application at least two years before the expiration of the license, in accordance with the requirements of 10 CFR 72.42(b). To renew a CoC, an applicant (i.e., CoC holder, user, or user’s representative) must submit a renewal application at least 30 days before the expiration of the associated CoC in accordance with the requirements of 10 CFR 72.240(b). The NRC may renew a specific license or a CoC for a term not to exceed 40 years, in accordance with 10 CFR 72.42(a), or 10 CFR 72.240(a), respectively. General licenses are not renewed. The general-license term is linked to the storage term of the CoC being used.

The NRC-approved DSSs listed in 10 CFR 72.214, “List of Approved Spent Fuel Storage Casks,” may be used by any 10 CFR Part 72 general licensee in accordance with 10 CFR 72.212, “Conditions of General License Issued Under § 72.210.” If the CoC holder chooses not to apply for the renewal of a particular CoC or is no longer in business, a DSS user or user’s representative may apply for renewal of the CoC in place of the CoC holder.

Both the specific-license and the CoC renewal applications must contain revised technical requirements and operating conditions (fuel storage, surveillance and maintenance, and other requirements) for the ISFSI or DSS that address aging mechanisms and aging effects that could affect structures, systems, and components relied upon for the safe storage of spent fuel. Renewal applications must include (1) time-limited aging analyses, if applicable, that demonstrate that structures, systems, and components important to safety will continue to perform their intended function for the requested period of extended operation, and (2) aging management programs for management of issues associated with aging that could adversely affect structures, systems, and components important to safety. Applicants are encouraged to meet with the NRC staff at public pre-application meetings to discuss their proposed plans for the renewal application.

The technical review of the renewal application is primarily a materials engineering effort. The materials discipline should coordinate its review of the renewal application with other disciplines, such as the structural, health physics, thermal, criticality, and quality assurance disciplines, as appropriate, to help ensure that relevant aspects of the application and review have been addressed.

This SRP defines an acceptable method for the NRC staff to review and determine if the applicant demonstrates that the specific-licensed ISFSI or the DSS will continue to meet the applicable regulatory requirements of 10 CFR Part 72 during the period of extended operation. The reviewer should be aware that additional interim staff guidance may have been developed to clarify or address issues following the publication of this guidance. This SRP defines an acceptable method for satisfying the applicable regulatory requirements; it is not a regulatory requirement. An applicant may propose alternate means for satisfying the appropriate regulatory requirements. However, deviation from this guidance in whole or in part may result in an extended NRC staff review schedule.

The NRC staff may revise and update this SRP to clarify the content, correct errors, or incorporate modifications approved by the Division of Spent Fuel Management. Comments, suggestions for improvement, and notices of errors or omissions will be considered by, and should be sent to the Director, Division of Spent Fuel Management, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

The guidance document is not intended to be used for the review of other 10 CFR Part 72 renewal applications, such as those for wet storage facilities or monitored retrievable storage installations.

Figure A is a flowchart of the specific-license and CoC renewal process.

Revision 1

Based on lessons learned from reviews of specific-license and CoC renewal applications and input received from the public and industry, the NRC staff proposed changes to NUREG-1927 (Revision 0) to add greater detail and clarity. The staff held a public meeting on July 14–15, 2014, to solicit stakeholder input on the staff's considerations for revisions to the guidance. The staff subsequently took into consideration comments received and developed on the draft version issued for public comment. This revision of NUREG-1927 has focused on expanding reviewer guidance for evaluating aging management programs (AMPs) and ensuring these programs respond to operating experience to remain adequate throughout the period of extended operation.

This revision to NUREG-1927 was developed in parallel with an ongoing effort by the Nuclear Energy Institute (NEI) to develop guidance for the industry in the preparation of applications for renewal of licenses and CoCs. NEI 14-03, Rev. 0, "Guidance for Operations-Based Aging Management for Dry Cask Storage" (ADAMS Accession No. ML14266A225), includes guidance on the continued evaluation of operating experience (see Section 3.6.1.10 of NUREG-1927, Rev. 1). 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. In addition, NEI 14-03 describes an initiative to aggregate and disseminate aging-related operating experience, research results, monitoring feedback, and inspection data between licensees. The staff provided comments on NEI 14-03, Rev. 0, to NEI on January 21, 2015 (ADAMS Accession No. ML15013A201). The staff will continue to work with NEI as it continues to develop its guidance for proposed NRC endorsement. However, until a time when NEI 14-03 may be endorsed by NRC, Section 3.6.1.10 of NUREG-1927, Rev. 1 provides guidance to reviewers regarding information in NEI 14-03 that may be used or referenced by applicants for license or CoC renewals.

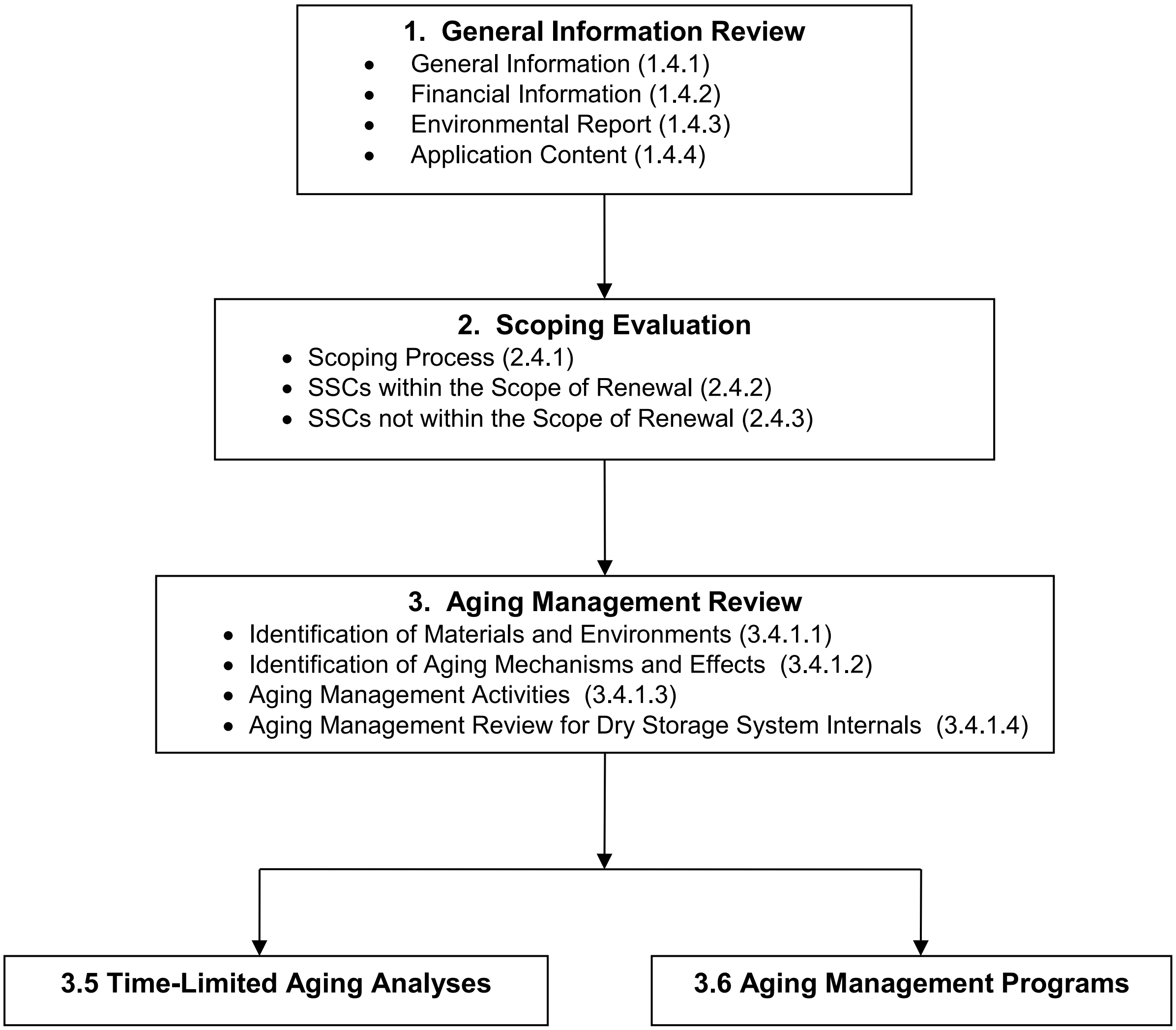

Figure A. Specific-License and CoC Renewal Process

Standard Review Plan Structure

Each chapter of this SRP contains the following sections:

Review Objective: This section provides the purpose and scope of the review and establishes the major review objectives for the chapter. It also discusses the information needed, or coordination expected, from other NRC staff to complete the technical review.

Areas of Review: This section describes the structures, systems, and components; analyses, data, or other information; and their sequence in the discussion of acceptance criteria.

Regulatory Requirements: This section summarizes the regulatory requirements in 10 CFR Part 72 pertaining to the scoping process, aging management review, and aging management activities that include the time-limited aging analyses review. This list is not all-inclusive, since some parts of the regulations, such as 10 CFR Part 20, “Standards for Protection Against Radiation,” are assumed to apply to all chapters of the safety analysis report. The reviewer should read the complete language of the current version of 10 CFR Part 72 to determine the proper set of regulations for the section being reviewed.

Review Guidance: This section discusses the specific technical information that should be included in the application and reviewed for regulatory compliance. The review guidance can be supplemented by interim staff guidance, NUREGs, etc.

Evaluation Findings: This section provides sample summary statements for evaluation findings to be incorporated into the safety evaluation report (SER) for each area of review. The reviewer prepares the evaluation findings based on the satisfaction of the regulatory requirements. The NRC publishes the findings in the SER.

1. GENERAL INFORMATION REVIEW

1.1 Review Objective

The purpose of the general information review is to ensure that the specific-license or certificate of compliance (CoC) renewal application meets the requirements listed in Section 1.3 below.

1.2 Areas of Review

Areas of review addressed in this chapter include the following:

- general information,
- financial information,
- environmental report, and
- application content.

Areas specifically excluded from the renewal review include the following:

- structures, systems, and components (SSCs) associated with physical protection of the independent spent fuel storage installation (ISFSI) or dry storage system (DSS), pursuant to Title 10 of the *Code of Federal Regulations* (CFR) Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste," Subpart H, "Physical Protection," and
- SSCs associated with the ISFSI emergency plan, pursuant to 10 CFR 72.32, "Emergency Plan."

1.3 Regulatory Requirements

Table 1-1 presents a matrix that identifies the specific regulatory requirements pertaining to application content, general information about the specific licensee or CoC holder, financial information, and the environmental report. Additional regulatory requirements for the environmental report can be found in 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

Table 1-1. Relationship of Regulations and General Information Review

Areas of Review	72.22[1] (a), (b), (c), (d)	72.22[1] (e)	72.30(c)[1]	72.34[1]	72.42[1]	72.48	72.240[2] (b), (c), (d)
Application Content	●				●	●	●
General Information	●						
Financial Information		●	●				
Environmental Report				●			

[1] These regulations apply only to specific license renewals per 10 CFR 72.13, "Applicability."
[2] These regulations apply only to CoC renewals per 10 CFR 72.13.

1.4 <u>Review Guidance</u>

This section provides review guidance for general information about the specific licensee and CoC holder (Section 1.4.1), financial information (Section 1.4.2), environmental report (Section 1.4.3), and application content (Section 1.4.4). This section also provides information on timely renewal (Section 1.4.5), amendment applications submitted during the renewal review or after the renewal is issued (Section 1.4.6) and license and CoC conditions (Section 1.4.7).

1.4.1 General Information

The NRC project manager (PM) should ensure that the specific licensee has provided information pursuant to 10 CFR 72.22(a)–(d), including the specific licensee's full name, address, and description of the business or occupation. Although 10 CFR 72.22(a)–(d) is not specifically identified as applying to CoC holders, the reviewer should ensure CoC holders submit the basic information cited in 10 CFR 72.22(a)–(d). If the specific licensee or CoC holder is a partnership, the application should identify the name, citizenship, and address of each partner and the principal location at which the partnership does business. If the specific licensee or CoC holder is a corporation or an unincorporated association, the application should specify the State in which it is incorporated or organized and the principal location at which it does business, along with the names, addresses, and citizenships of its directors and principal officers. If the specific licensee or CoC holder is acting as an agent or representative of another person in filing the application, the application should provide the above information for the principal. If the specific licensee is the U.S. Department of Energy, then the application should specify the organization responsible for the construction and operation of the ISFSI and describe any delegations of authority and assignments of responsibilities.

1.4.2 Financial Information

In general, the PM should ensure that the renewal application for a specific license contains the necessary documentation regarding financial data, pursuant to 10 CFR 72.22(e), which shows that the specific licensee can carry out the activities being sought for the requested duration. Information should state where the activity will be performed, the general plan for carrying out the activity, and the period of time for which the specific license is requested. The PM should ensure that the renewal application is based only on the approved design bases and does not include additional construction costs beyond the design bases. The application should identify other costs related to activities associated with managing aging mechanisms and effects, and it should identify ISFSI operating and decommissioning costs that have been revised from those specified in the original specific-license application for construction, operation, and decommissioning. In addition, the application should include a decommissioning funding plan that identifies any changes in decommissioning costs and the extent of contamination, pursuant to 10 CFR 72.30(c).

The scope of this standard review plan (SRP) does not include specific guidance for reviewing financial information. Financial reviews should be coordinated with financial reviewers in the Performance Assessment Branch of the Office of Nuclear Material Safety and Safeguards (NMSS) or the Office of Nuclear Reactor Regulation.

1.4.3 Environmental Report

The PM should ensure that the specific-license renewal application contains an environmental report or supplement, as required by 10 CFR 51.60, “Environmental Report—Materials Licenses” and 10 CFR 72.34, “Environmental Report.” The supplemental report may be limited to incorporating by reference, updating or supplementing the information previously submitted to reflect any significant environmental changes, including those that may result from operating experience as related to environmental conditions, or a change in operations or proposed decommissioning activities.

The environmental report should also meet the general requirements of 10 CFR 51.45, “Environmental Report,” as applicable. As required by 10 CFR 51.45(c), the environmental report should contain sufficient data to aid the NRC in its development of an independent analysis.

The review of the environmental report should be coordinated with the Environmental Review Branch of NMSS.

1.4.4 Application Content

The reviewer should look for a map or guide to the renewal application to assist in its review, since the format may vary from that of a standard safety analysis report (SAR). The PM or reviewer should verify that the renewal application for both CoC and specific-license renewals contain all of the following sections:

- General Information,
- Scoping Evaluation,
- Aging Management Review (AMR),
- Time-Limited Aging Analyses (TLAAs),
- Aging Management Programs (AMPs),
- Information pertaining to granted exemptions and their implication to aging management,
- Changes or additions to technical specifications or to the specific license or CoC,
- Supplement to the final safety analysis report (FSAR), including:
    - Scoping results
    - Table of AMR results
    - Summary of TLAAs and TLAAs' conclusions, and
    - Summary of AMPs

- A clear delineation of changes (on any SAR pages included with the renewal application) from either the SAR pages included with the last approved amendment (or initial) application, or the FSAR, *whichever is most recent*, and including:
    - Annotations to show renewal-related changes and
    - Annotations to show 10 CFR 72.48 ("Changes, Tests, and Experiments") changes since last biannual update as required by 10 CFR 72.48(d)(2).

For CoC renewal applications, the PM or reviewer should also verify that the renewal application includes:

- A description of the structure of the renewal application as it relates to the different amendments (i.e., for the CoC as a whole). This could be in the form of a guide to the renewal application to identify the sections or appendices applicable to each CoC amendment;
- A clear description of each amendment; that is, what each amendment changed from (or added to) the initial certificate (i.e., "amendment 0"), and/or what each amendment changed from (or added to) the previous amendments; and
- A clear description of the scope and content of the renewal application should be provided for each amendment. If there are different SSCs, materials, and environments described in the different CoC amendments, changes to the following would need to be specified for each individual amendment:
    - Scoping evaluation,
    - Aging management review,
    - Time limited aging analyses,
    - Aging management programs,
    - Changes or additions to technical specifications or to the CoC, and
    - Supplement to the FSAR, including:

- Scoping results
- Table of AMR results
- Summary of TLAAs and TLAAs' conclusions
- Summary of AMPs.

A CoC renewal includes the initial certificate ("amendment 0") and all subsequent amendments. The subsequent amendments have the same termination date as the initial certificate. The CoC holder has the option to request that only certain (i.e., not all) amendments under a CoC be renewed. If amendments are not renewed, upon expiration, casks loaded under that amendment would need to be removed from service.

Drawings provided as part of the renewal application should be clear and legible. If information in drawings is unclear or illegible, the PM should ask the applicant for additional, larger or full-size drawings. The reviewer should ensure that dimensions, materials, and other details on the drawings are consistent with those described in both the text of the renewal application and the FSAR supplement.

The reviewer should verify that the applicant has updated the appropriate drawings to reflect any changes made to the design of the SSCs through the application of 10 CFR 72.48. Reviewers should be familiar with NUREG/CR-5502, "Engineering Drawings for 10 CFR Part 71 Package Approvals," issued May 1998. Although NUREG/CR-5502 was developed for transportation packages, the criteria for drawings should be consistent for storage designs and therefore useful to the review process.

If the applicant provided drawings and descriptions as proprietary information in the application and requested them to be withheld from the public, the PM should review the request for withholding and ensure all the necessary information is available for the NRC to make a decision on the withholding request, in accordance with the requirements of 10 CFR 2.390, "Public Inspections, Exemptions, Requests for Withholding."

The reviewer should ensure the specific-license or CoC renewal application does not include any changes to the design bases. Changes to the design bases must be requested through a separate amendment process.

1.4.5 Timely Renewal

To renew a specific license, an applicant must submit a renewal application at least 2 years before the expiration of the license in accordance with the requirements of 10 CFR 72.42(b). To renew a CoC, an applicant must submit a renewal application at least 30 days before the expiration of the associated CoC in accordance with the requirements of 10 CFR 72.240(b). When the applicant has submitted a timely application for renewal, the existing specific license or CoC will not expire until a final decision concerning the application for renewal has been made by the Commission. Therefore, any DSSs loaded during the initial license or CoC period may remain in service until the review of the renewal application is complete.

1.4.6 Amendment Applications Submitted During the Renewal Review or After the Renewal is Issued

By regulation, applicants must demonstrate that SSCs important to safety will continue to perform their intended function(s) for the requested period of extended operation as a part of the renewal request. For *concurrent amendment and renewal applications*, the amendment application should include a scoping evaluation and an AMR for that amendment to document the evaluation of the amendment's SSCs (and associated subcomponents) for extended operation, or the renewal application should be supplemented to address the proposed amendment to document the evaluation of the amendment's SSCs (and associated subcomponents) for extended operation. Any *amendment application submitted after the renewal has been issued* (*post-renewal amendment applications)* should include a scoping evaluation and an AMR for that amendment.

For post-renewal amendment applications or concurrent amendment applications that include a scoping evaluation and an AMR, the amendment application should either: (1) show that the in-scope SSCs (and associated subcomponents) described in the amendment are already encompassed in the TLAAs and/or AMPs included in the specific-license or CoC renewal application; or (2) include revised or new TLAAs and/or AMPs to address aging effects of any new in-scope SSCs (and associated subcomponents) proposed in the amendment application. The PM and technical reviewers should verify that the following information is included in the amendment application (see also Section 1.4.4):

- A scoping evaluation that identifies any new SSCs (and associated subcomponents) included in the amendment request and discusses whether the SSCs (and associated subcomponents) are included or excluded from the scope of renewal, following the guidance in Chapter 2;
- An aging management review that identifies any applicable aging mechanisms and effects for the new SSCs (and associated subcomponents) within the scope of renewal; and
- Changes to the FSAR, which should include:
    - Scoping results and identification of any new in-scope SSCs;
    - Revised table of AMR results;
    - Identification of the approved TLAAs (or the TLAAs included in the renewal application, for concurrent amendments) that address the new in-scope SSCs, or identification and a summary of any revised or new TLAAs and the TLAAs' conclusions that support the amendment; and
    - Identification of the approved AMPs (or the AMPs included in the renewal application, for concurrent amendments) that encompass the new in-scope SSCs (and associated subcomponents), or a summary of proposed changes to approved AMPs or new AMPs that will apply to the new in-scope SSCs (and associated subcomponents).

For concurrent amendment and renewal applications, if there are different PMs assigned to the renewal review and the amendment review, the PMs and technical reviewers should coordinate across the reviews to ensure that renewal aspects are covered for the amendment. Note that, before proceeding with the review of an amendment submitted *during* the renewal review, the PMs should consider how each review may impact the other, and decide, in conjunction with Branch and Division management, whether to proceed with both reviews, or to delay one review until the other is complete. For additional guidance, refer to Regulatory Issue Summary (RIS) 2004-20, "Lessons Learned from Review of 10 CFR Parts 71 and 72 Applications, (NRC 2004)."

The NRC staff may include a condition in the renewed license or CoC noting all future amendments would need to address aging management.

1.4.7 Conditions to Specific Licenses and CoCs in the Period of Extended Operation

In renewing a license or CoC, the staff should consider conditions necessary for issuance. Several conditions are likely to be included in the license or CoC.

Generally, the NRC staff will renew the license or CoC with a condition requiring the specific licensee or CoC holder, respectively, to incorporate a renewal supplement into the FSAR, as submitted in the renewal application and revised through the review process (see Section 1.4.4). The reviewer should recognize that the entirety of the AMP may not be incorporated into the FSAR, but may instead be documented by the reviewer as an appendix to the safety evaluation report (SER). The specific licensee will be required to continue to update the FSAR pursuant to the requirements in 10 CFR 72.70(b) and (c). The CoC holder will be required to continue to update the FSAR pursuant to the requirements in 72.248(a) and (b).

The NRC staff is also likely to renew a license or CoC with a condition requiring the applicant to update, revise, or create procedures for implementing the activities in the AMPs. These procedures will be subject to inspection to ensure they are maintained, implemented, and periodically updated to respond to operating experience and valid consensus codes and standards, while providing reasonable assurance that the pertinent SSCs maintain their intended function.

As the entirety of the AMP may not be included in the CoC or technical specifications, site procedures for AMP implementation may later be changed. Therefore, additional conditions or technical specifications may be required in the specific license or CoC to ensure critical elements of the AMPs are effectively maintained. These conditions should be specific to information in the AMP described in the renewal application which staff relied upon to make the requisite safety findings of reasonable assurance of adequate protection of public health and safety, and the environment.

The NRC staff may also include a condition in the renewed CoC to ensure that all future amendments address aging management. See Section 1.4.6 for guidance on post-renewal amendments.

The NRC staff may modify the above conditions or include additional conditions, as needed, in the specific license or CoC being renewed. In addition, the applicant may also propose additional license or CoC conditions as part of its application if these strengthen the technical bases for the reviewer to reach reasonable assurance of adequate protection of public health and safety, and the environment.

1.5 <u>Evaluation Findings</u>

The reviewer prepares a summary statement and evaluation findings based on compliance with the regulatory requirements in Section 1.3. The summary statement and evaluation findings should be similar in wording to the following example (the finding number is for convenience in cross-referencing within the SRP and SER):

> The NRC staff has reviewed the general information provided in the renewal application and supplemental documentation. The NRC staff performed its review following the

guidance provided in NUREG-1927, Rev. 1, “Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel,” and relevant interim staff guidance. Based on its review, the NRC staff finds:

F1.1 The information presented in the renewal application satisfies the requirements of 10 CFR 72.2, 72.22, 72.30, 72.34, 72.42, 72.48, and 72.240, as applicable.

F1.2 The applicant has provided a tabulation of all supporting information and docketed material incorporated by reference, in compliance with 10 CFR 72.42 or 10 CFR 72.240, as applicable.

2. SCOPING EVALUATION

2.1 Review Objective

The scoping evaluation should identify the structures, systems, and components (SSCs) of the independent spent fuel storage installation (ISFSI) or dry storage system (DSS) that should be reviewed for aging mechanisms and effects.

2.2 Areas of Review

The reviewer should ensure that the applicant has included information about the following areas of review:

- scoping process
- SSCs within the scope of specific-license or certificate of compliance (CoC) renewal
- SSCs not within the scope of specific-license or CoC renewal

2.3 Regulatory Requirements

The U.S. Nuclear Regulatory Commission (NRC) bases a specific-license or CoC renewal on the continuation of the approved design bases throughout the period of extended operation and on the maintenance of the intended functions of (a) SSCs important to safety and (b) SSCs which failure may affect a safety function. If new safety-related deficiencies in the design bases are discovered, they must be addressed and rectified through the specific-license or CoC amendment process. The renewal process cannot be used to facilitate approval of design changes.

Table 2-1 presents a matrix of regulatory requirements for renewal related to the scoping review.

Table 2-1 Relationship of Regulations and Scoping Review

Areas of Review	10 CFR Part 72 Regulations					
	72.3	72.24[1] (b), (c), (d)	72.24[1] (g)	72.42[1] (b)	Subpart F: Applicable Sections[1] 72.120, 72.122, 72.124, 72.126, 72.128	72.236[2] Applicable Sections
Scoping Process			●	●		●
SSCs within the Scope of Specific-License or CoC Renewal	●	●	●		●	●
SSCs not within the Scope of Specific-License Renewal		●	●		●	

[1] These regulations apply only to specific-license renewals per 10 CFR 72.13.
[2] These regulations apply only to CoC renewals per 10 CFR 72.13.

2.4 <u>Review Guidance</u>

This section provides review guidance for the scoping evaluation. Section 2.4.1 explains the scoping process, Section 2.4.2 discusses SSCs within the scope of renewal, while Section 2.4.3 provides guidance for SSCs not within the scope of renewal.

2.4.1 Scoping Process

Figure 2-1 provides a flowchart of the scoping evaluation process. The reviewer should ensure that the application provides documentation of the scoping process that includes the following:

- a description of the scoping process and methodology for the inclusion/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 function, 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, and
- any discussion or drawings needed to clarify the process, SSC intended functions and safety classifications.

The application should include a list and description of reference sources used to support the scoping evaluation. Sources may include the following:

- SARs (including final SARs (FSARs), updated FSARs, and topical SARs),
- license or CoC,
- technical specifications,
- operating procedures,
- design-bases documents (e.g., calculations, specifications, design change documents),
- drawings,
- quality assurance plan or program,
- docketed correspondence,
- operating experience reports (site-specific or industry-wide, as applicable),
- 10 CFR 72.48 (“Changes, Tests, and Experiments”) reviews,
- vendor information, or
- applicable NRC guidance.

The reviewer can refer to NUREG/CR-6407, “Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety,” as a reference for classification of components as important to safety to determine the accuracy and completeness of the scoping evaluation. The reviewer should ensure that the scoping evaluation has evaluated *all* SSCs identified in the design-bases documents, and properly differentiated them as either within or *not* within the scope of renewal. In addition, the identification of SSCs and SSC subcomponents in the scoping evaluation should be consistent throughout the application.

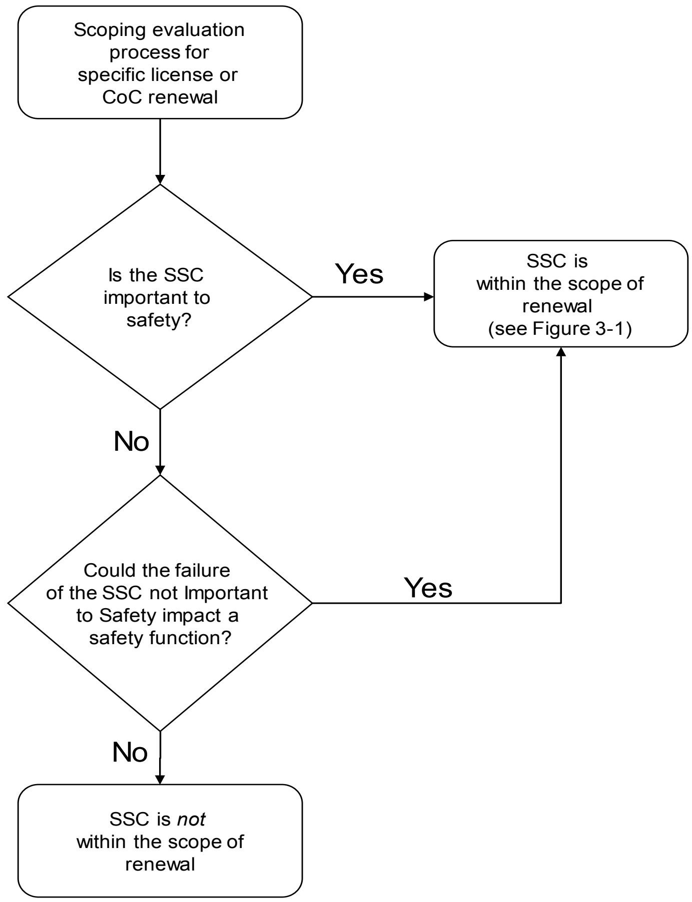

Figure 2-1 Flowchart of Scoping Evaluation Process

2.4.2 Structures, Systems, and Components within the Scope of Renewal

The reviewer should verify that the SSCs (and associated subcomponents) within the scope of renewal fall into the following scoping categories:

(1) They are classified as important to safety, as they are relied on to do one of the following functions:

   i. Maintain the conditions required by the regulations, specific license, 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 <u>not</u> important to safety but, according to the design bases, their failure could prevent fulfillment of a function that is important to safety.

The reviewer should verify that SSCs within the scope of renewal are screened to identify and describe the subcomponents with intended functions. The reviewer should recognize that 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 should clearly (i) define the intended function of each SSC subcomponent and (ii) differentiate SSC subcomponents per scoping criterions 1 or 2, as defined above. The reviewer should ensure that this information is tabulated or adequately described in the application. The reviewer should confirm that this information is comprehensive and accurate (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 Final Safety Analysis Report (FSAR) drawings or tables.

2.4.2.1 Scoping of Dry Storage System Internals

The requirements in 10 CFR 72.122(h)(1) seek to ensure safe fuel storage and handling and to minimize post-operational safety problems with respect to removal of the fuel from storage. Pursuant to 72.122(h)(1), the spent fuel cladding must be protected during storage against degradation that leads to gross ruptures, or the spent fuel must be otherwise confined such that degradation of the spent fuel during storage will not pose operational safety problems with respect to its removal from storage. Regulations in 10 CFR 72.122(l) require that all storage systems must be designed to allow for ready retrieval of the spent fuel. The NRC staff has indicated in Interim Staff Guidance (ISG) 11, Rev. 3 (NRC 2003) that the spent fuel configuration is expected to be maintained as analyzed in the safety analyses for the dry storage system, provided certain acceptance criteria (regarding maximum fuel clad temperature and thermal cycling) are met, and the fuel is stored in a dry inert atmosphere (see Section 3.4.1.4).

Traditional light water reactor spent nuclear fuel consists of fuel rods and assembly hardware. In turn, the fuel rods consist of uranium oxide pellets inside a cladding tube. The spent fuel cladding and assembly hardware provide structural support to ensure that the spent fuel is maintained in a known geometric configuration. Therefore, unless the intended functions of the dry storage system were analyzed with the fuel in a disrupted state, the condition of the fuel assembly and cladding are within the scope of renewal since their degradation may lead to a change in the analyzed fuel configuration.

2.4.2.2 Scoping of Transfer Casks, Transporter Devices, and Reinforced Concrete Pads

The reviewer should be aware that transfer casks, transporter devices, and reinforced concrete pads may be classified as important to safety or safety-related (under 10 CFR Part 50) in the design bases of various ISFSIs or DSSs. The reviewer should review the FSAR to determine if these SSCs are within the scope of renewal.

2.4.3 Structures, Systems, and Components not within the Scope of Renewal

For those SSCs (and associated subcomponents) excluded from the scope of renewal, the reviewer should verify that they do not meet either of the criterions described in Section 2.4.2. The reviewer should ensure that the applicant has properly justified any exclusions by referencing the design bases (i.e., FSAR description, drawings, or tables).

The following SSCs that are not important to safety may be excluded from the scope of renewal, provided that they do not meet scoping category (2) in Section 2.4.2 above:

- equipment associated with cask loading and unloading, such as (1) welding and sealing equipment, (2) lifting rigs and slings, (3) vacuum-drying equipment, (4) portable radiation survey equipment, and (5) other tools, fittings, hoses, and gauges associated with cask loading and unloading,
- Instrumentation and other active components/systems (i.e. not passive or long-lived, but subject to a change in configuration or replacement based on a qualified life/service time period),
- SSCs associated with physical protection of the ISFSI, pursuant to 10 CFR Part 72, Subpart H, “Physical Protection,”
- SSCs associated with the ISFSI emergency plan, pursuant to 10 CFR 72.32, “Emergency Plan,” and
- miscellaneous hardware that does not support or perform any function that is important to safety.

2.5 Evaluation Findings

The reviewer prepares the summary statement and evaluation findings based on compliance with the regulatory requirements described in Section 2.3. The summary statement and evaluation findings should be similar in wording to the following example (the finding number is for convenience in cross-referencing within the Standard Review Plan (SRP) and safety evaluation report (SER)):

> The NRC staff reviewed the scoping evaluation provided in the renewal application and supplemental documentation. The NRC staff performed its review following the

guidance provided in NUREG-1927, Rev. 1, “Standard Review Plan for Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel,” and relevant ISGs. The NRC staff used the information provided in NUREG/CR-6407 (“Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety”) in its review as a reference for classification of components as important to safety to determine the accuracy and completeness of the scoping evaluation. Based on its review, the NRC staff finds:

F2.1 The applicant has identified all SSCs important to safety and SSCs whose failure could prevent an SSC from fulfilling its safety function, per the requirements of 10 CFR 72.3, 10 CFR 72.24, 10 CFR 72.42, 10 CFR 72.120, 10 CFR 72.122, 10 CFR 72.124, 10 CFR 72.126, 10 CFR 72.128 and 10 CFR 72.236, as applicable.

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

3. AGING MANAGEMENT REVIEW

3.1 Review Objective

The purpose of the aging management review (AMR) is to assess the proposed aging management activities (AMAs) for structures, systems, and components (SSCs) determined to be within the scope of renewal. The AMR addresses aging mechanisms and effects[1] that could adversely affect the ability of the SSCs (and associated subcomponents) from performing their intended functions during the period of extended operation. The reviewer should verify that the renewal application includes specific information that clearly describes the AMR performed on SSCs within the scope of renewal.

3.2 Areas of Review

The reviewer should ensure that the AMR in the renewal application provides the following content with adequate technical bases:

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

Figure 3-1 contains a flowchart for the AMR process. The final safety analysis report (FSAR) and supporting documents related to the design are the primary documents that describe the safety classification, intended function, materials, and service environments for SSCs of independent spent fuel storage installations (ISFSIs), dry storage systems (DSSs), or both, identified to be within the scope for renewal (see Section 2.4.1).

The reviewer should consult applicable consensus codes and standards that provide additional guidance on the applicability of aging mechanisms and effects. The use of ambiguous terminology from any standard (e.g., "change in material properties") should be properly defined or referenced in the application. Refer to Appendix A for assessing non-quantifiable terms.

The AMR should consider the duration of time between the fabrication of a system and its deployment in the ISFSI, which defines the start of the storage term (see Appendix F). The degradation of the system during that time period should be accounted for. For example, if a canister was stored for 5 years prior to use, the applicant should account for potential degradation of that canister during that 5-year period in any evaluation or analysis it conducts as part of the renewal application.

[1] In order to effectively manage an aging effect, it is necessary to determine the aging mechanisms that are potentially at work for a given material and environment application. Therefore, the aging management review process identifies both the aging effects and the associated aging mechanisms that cause them.

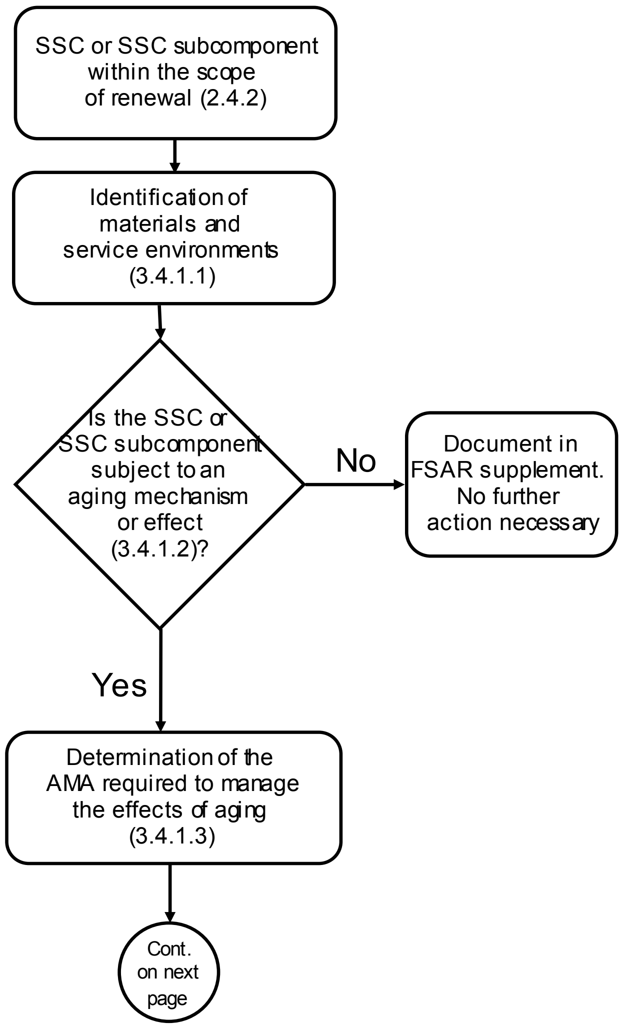

Figure 3-1 Flowchart of AMR Process

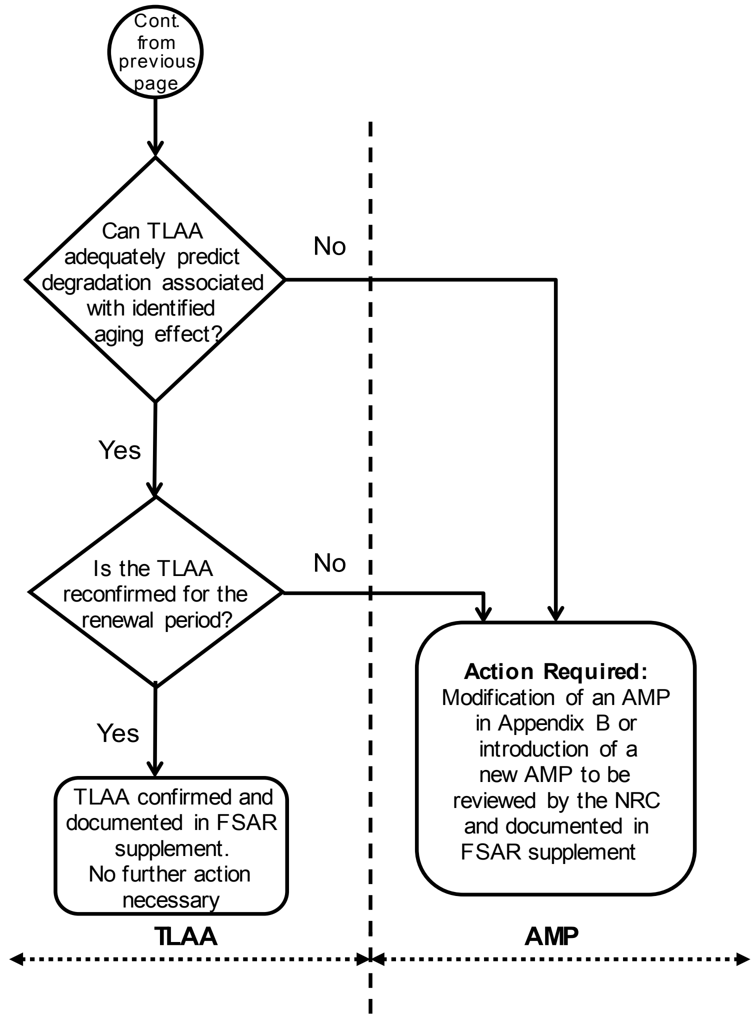

Figure 3-1 Flowchart of AMR process (continued)

3.3 Regulatory Requirements

Title 10 of the *Code of Federal Regulations* (10 CFR) 72.42 and 10 CFR 72.240 provide the overarching requirements for aging management activities for renewal of specific licenses and CoCs. Table 3-1 presents a matrix of regulatory requirements that must continue to be met to ensure that the intended functions of SSCs of ISFSIs and DSSs are maintained during the period of extended operation. Other parts of 10 CFR Part 72 may also apply.

Table 3-1 Relationship of Regulations and Aging Management Reviews

Areas of Review	10 CFR Part 72 Regulations				
	72.24[1] (d)	72.82[1] (d)	72.104[1] (a)	72.106[1] (b)	72.120[1] (a),(d)
Aging Effects	●		●	●	●
Aging Management, Maintenance, or Surveillance Programs		●			
TLAAs	●		●	●	●

Areas of Review	10 CFR Part 72 Regulations				
	72.122[1] (a),(b),(c),(h)(1), (h)(5),(l)	72.122[1] (f),(h)(4), (i)	72.124	72.126	72.128[1] (a)
Aging Effects	●		●	●	
Aging Management, Maintenance, or Surveillance Programs		●		●	●
TLAAs	●	●	●	●	●

Areas of Review	10 CFR Part 72 Regulations				
	72.158	72.162	72.164	72.168 (a)	72.170
Aging Effects	●	●	●		
Aging Management, Maintenance, or Surveillance Programs	●	●	●	●	●
TLAAs					●

Table 3-1 Relationship of Regulations and Aging Management Reviews (continued)

Areas of Review	10 CFR Part 72 Regulations		
	72.172	72.236[2] Applicable Sections	72.240(d)[2]
Aging Effects		●	●
Aging Management, Maintenance, or Surveillance Programs	●	●	●
TLAAs			

1 These regulations apply only to specific-license renewals per 10 CFR 72.13.
2 These regulations apply only to CoC renewals per 10 CFR 72.13.

3.4 Materials, Service Environments, Aging Mechanisms and Effects, and Aging Management Activities

3.4.1 Review Guidance

This section provides review guidance for the aging management review. Section 3.4.1.1 describes the identification of materials and their environments. Section 3.4.1.2 describes the identification of aging mechanisms and effects. Section 3.4.1.3 describes the review of aging management activities. Section 3.4.1.4 describes the aging management review for dry storage system internals.

3.4.1.1 Identification of Materials and Environments

The AMR process includes the identification of the materials of construction and the service environments for each SSC (or SSC subcomponent) within the scope of renewal. The identification of SSCs and SSC subcomponents in the AMR process should be consistent with the identification in the scoping evaluation. The reviewer should ensure that the renewal application has provided environmental data (and referenced the source of the data) such that the operating and service conditions of the SSCs can be determined. Environmental data may include:

- temperature,
- wind,
- relative humidity,
- relevant atmospheric pollutants and deposits,
- exposure to precipitation,
- marine fog, salt, or water exposure,
- radiation field (gamma and neutron),
- the service environment (e.g., embedded, sheltered, or outdoor), and
- gas compositions (e.g., external: air; internal: inert gas such as helium).

The reviewer should verify that the applicant considered the specific environment and material combinations in the DSS design for the evaluation of observed and potential aging mechanisms and effects that may lead to a loss of intended function. Particular attention should be paid to dissimilar metal combinations that may result in galvanic effects such as hydrogen uptake or galvanic corrosion. For sheltered environments that are in contact with the site atmosphere, the deposition and accumulation of atmospheric deposits should be evaluated. For example, chloride salt deposits that can promote accelerated corrosion of SSCs may be relevant in locations near salt water, adjacent to cooling towers, or in close proximity to roads that are treated with deicing salts.

3.4.1.2 Identification of Aging Mechanisms and Effects

The reviewer should ensure that the applicant has provided an analysis and documentation that identify aging mechanisms and effects pertinent to the SSCs determined to be within the scope of renewal. The AMR should include aging mechanisms and effects that could reasonably be expected to occur, as well as those that have actually occurred, based on industry and site-specific operating experience and component testing. The reviewer should ensure that the CoC renewal evaluates all potential environments where the DSS may be used and provides applicable operating experience to justify the AMR conclusions.

The reviewer should review the applicant's synopses of information used to identify applicable aging mechanisms and effects. Identification of applicable aging mechanisms and effects may be through review of:

- site maintenance, repair, and modification records;
- corrective action reports, including root cause evaluations;
- lead system inspection results (see Appendix C);
- maintenance and inspection records from ISFSI sites with similar SSC materials and operating environments;
- industry records;
- applicable operating experience outside the nuclear industry;
- applicable consensus codes and standards;
- NRC reports; or
- other applicable guidance for determining if an aging mechanism or effect should be managed for the period of extended operation.

Examples of potential aging mechanisms and effects that may be identified by reviewing the sources of information cited above include: (1) cracking or loss of strength as a result of cement aggregate reactions in the concrete, (2) cracking or loss of material as a result of freeze-thaw degradation of the concrete (requires the presence of moisture combined with temperatures below freezing), (3) reinforcement corrosion and concrete cracking as a result of chloride ingress, (4) accelerated corrosion of steel structures and components and stress corrosion cracking of austenitic stainless steels as a result of atmospheric deposition of chloride salts. The reviewer should ensure that, if the applicant relies on operating experience, it is specifically applicable to the SSC subcomponent/material/environment, and is not just a compendium of references on similar topics.

The applicant is not required to take further action if an SSC is determined to be within the scope of renewal but is found to have no potential aging effects for the period of extended operation. The reviewer should verify that the applicant's exclusion of an aging mechanism or effect is consistent with maintenance records, operational experience, and information obtained during lead system inspection(s). The reviewer should also ensure that the FSAR supplement or other application materials document the applicant's determination of SSCs requiring no further review.

3.4.1.3 Aging Management Activities

The reviewer should ensure that the applicant has identified those aging mechanisms and effects requiring either an AMP or TLAA. Figure 3-1 illustrates the process for handling those SSCs that are determined to be within the scope of renewal and subject to a potential aging effect. The AMR defines two methods for addressing potential aging mechanisms and effects: TLAA (Section 3.5) and AMP (Section 3.6).

The NRC may condition the approval of a renewal on the requirements of a given AMP being met during the period of extended operation (see Section 1.4.7). The CoC user (general licensee) would ordinarily carry out the activities described in this AMP. Pursuant to 10 CFR 72.212(b)(11) and 10 CFR 72.240(e), the NRC may make the AMP applicable to the general licensee by adding the appropriate condition(s) or technical specification(s) to the renewed CoC. Specific licenses may also be similarly conditioned (see Section 1.4.7).

3.4.1.4 Aging Management Review for Dry Storage System Internals

Since the DSS interior and cladding cannot be reasonably inspected, the reviewer should rely on lessons learned from NUREG/CR-6745, "Dry Cask Storage Characterization Project—Phase 1; CASTOR V/21 Cask Opening and Examination," (Bare et al., 2001), and NUREG/CR-6831, "Examination of Spent PWR Fuel Rods after 15 Years in Dry Storage," (Einziger et al., 2003). This research demonstrated that low burnup fuel cladding and other cask internals had no deleterious effects after 15 years of storage. This research confirmed the basis for the guidance on creep deformation in Interim Staff Guidance (ISG) 11, "Cladding Considerations for the Transportation and Storage of Spent Fuel," Revision 3, (NRC 2003). ISG-11 provides limits for temperature and stresses in the cladding to limit fuel reconfiguration. These research results suggest that degradation of low burnup fuel cladding and assembly hardware should not occur during the first renewal period, provided that the cask/canister internal environment is maintained.

The reviewer should assess whether the applicant has considered the most recent revision of ISG-11 and research results in this area, especially with respect to high burnup (HBU) fuel. Research into fuel performance in storage is an ongoing effort[2]. The reviewer should ensure that the applicant has monitored new research developments to ensure it has identified any new potential aging mechanisms and effects and provided new supporting data demonstrating HBU fuel performance during the period of extended operation. While NRC has confidence based on short-term testing (i.e., laboratory scale testing up to a few months) that there is no degradation of HBU fuel that would result in spent fuel being in an unanalyzed

[2] For example, research programs at Argonne National Laboratory (for NRC and the U.S. Department of Energy (DOE), and Central Research Institute of Electric Power Industry) have studied hydride reorientation effects; Oak Ridge National Laboratory has also studied bending responses of the fuel.

configuration in the period of extended operation, there is no operational data to demonstrate this as was done in the aforementioned demonstration on low burnup fuel.

Guidance for one acceptable approach to demonstrate the HBU fuel performance during the period of extended operation is provided in the "Example of a High Burnup Fuel Monitoring and Assessment Program" in Appendix B. This is a licensee program that monitors and assesses data and other information regarding HBU fuel performance, to confirm that the HBU fuel configuration is maintained during the period of extended operation. Guidance for determining if a surrogate demonstration program can provide the data to support a licensee's HBU Fuel Monitoring and Assessment Program is given in Appendix D. Alternative approaches, including the use of test or research results and safety analyses for the fuel, may be used to demonstrate that the dry storage system intended functions continue to be met during the period of extended operation, as appropriately justified by an applicant.

3.4.2 Evaluation Findings

The reviewer prepares the summary statement and evaluation findings based on compliance with the regulatory requirements in Section 3.3. The summary statement and evaluation findings should be similar in wording to the following example (the finding number is for convenience in cross-referencing within the SRP and SER):

> The NRC staff reviewed the aging management review provided in the renewal application and supplemental documentation. The NRC staff performed its review following the guidance provided in NUREG-1927, Rev. 1, "Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance of Dry Storage of Spent Nuclear Fuel," and relevant ISGs. Based on its review, the NRC staff finds:
>
> F3.1 The applicant's AMR process to be comprehensive in identifying the materials of construction and associated operating environmental conditions for those SSCs within the scope of renewal and has provided a summary of the information in the renewal application and FSAR supplement.
>
> F3.2 The applicant's AMR process to be comprehensive in identifying all pertinent aging mechanisms and effects applicable to the SSCs within the scope of renewal and has provided a summary of the information in the renewal application and FSAR supplement.

3.5 <u>Time-Limited Aging Analyses</u>

TLAAs are calculations or analyses used to demonstrate that in-scope SSCs will maintain their intended function throughout an explicitly stated period of extended operation (e.g., 40 years). These calculations or analyses may be used to assess fatigue life (number of cycles to predicted failure), or time-limited life (operating timeframe until expected loss of intended function). TLAAs should account for environmental effects. Pursuant to 10 CFR 72.3, "Definitions," TLAAs are those calculations and analyses meeting all six of 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; and
6. Are contained or incorporated by reference in the design bases.

Pursuant to 10 CFR 72.42(a)(1) or 72.240(c)(2), the reviewer should ensure that the application includes a list of TLAAs. The NRC staff uses the FSAR and other documents where the design bases are detailed to perform the review and confirm that the applicant did not omit any TLAAs submitted as part of the approved design bases. The number and type of TLAAs vary depending on the design bases of the ISFSI or DSS. The reviewer should ensure that all six criteria set forth in 10 CFR 72.3 (and repeated in this section) are satisfied to conclude that a calculation or analysis is a TLAA.

The following examples illustrate analyses that are not TLAAs and need not be addressed under 10 CFR 72.42(a)(1) or 72.240(c)(2):

- Analysis with time-limited assumptions defined short of the initial license or CoC term, for example, an analysis for a component based on a service life that would not reach the end of the initial license or CoC term.
- Analysis *not* contained or incorporated by reference in the design bases. Although not TLAAs by definition, the reviewer should note that these analyses may be included in the renewal application to justify not including aging management activities for a particular SSC within the scope of renewal.

3.5.1 Review Guidance

The reviewer should ensure that the applicant has appropriately identified TLAAs by applying the six criteria described below for SSCs within the scope of renewal:

1. *Involve SSCs important to safety within the scope of the specific-license or CoC renewal*. Chapter 2 of this SRP provides the reviewer guidance on the scoping methodology.
2. *Consider the effects of aging*. The effects of aging include but are not limited to loss of material, change in dimension, change in material properties, loss of strength, settlement, and cracking. The reviewer should ensure that any calculations or analyses relying on environmental susceptibility criteria are adequately supported by a valid technical basis, such as NRC endorsed criteria or operating experience. An AMP might be more applicable in these cases.
3. *Involve time-limited assumptions defined by the current operating term*. The defined operating term should be explicit in the analysis. Simply asserting that the SSC is designed for a DSS or ISFSI service life is not sufficient. Calculations, analyses, or testing that explicitly include a time limit should support the assertions.
4. *Were determined to be relevant by the licensee or certificate holder in making a safety determination*. Relevancy is a determination that the applicant makes based on a review of the information available. A calculation or analysis is relevant if it can be shown to

have a direct bearing on the action taken as a result of the analysis performed. Analyses are also relevant if they provide the basis for a safety determination, and, in the absence of analyses, the applicant might have reached a different conclusion.

5. *Involve conclusions or provide the basis of conclusions related to the capability of SSCs to perform their intended safety functions*. The TLAA should provide conclusions or a basis for conclusions regarding the capability of the SSC to perform its intended function through the end of the period of extended operation. If the TLAA does not provide a conclusion supporting the capability of the SSC to perform its intended function through the end of the period of extended operation, then the TLAA is not confirmed, and the applicant should propose an AMP to address/manage the aging mechanism or effect on the SSC. Analyses that do not affect the intended functions of SSCs are not TLAAs.

6. *Are contained or incorporated by reference in the design bases*. TLAAs should already be contained or incorporated by reference in the design-bases documents. Such documentation includes the (1) SAR, (2) technical specifications, (3) correspondence to and from the NRC, (4) quality assurance plan, and (5) topical reports included as references in the SAR. The reviewer should ensure that the applicant has provided any references cited in design-bases documents that may be needed to clarify the assumptions, methods or values used in TLAAs.

3.5.2 Evaluation Findings

The reviewer prepares the summary statement and evaluation finding based on compliance with the regulatory requirements in Section 3.3. The summary statement and evaluation finding should be similar in wording to the following example (the finding number is for convenience in cross-referencing within the SRP and SER):

> The NRC staff reviewed the time-limited aging analyses (TLAAs) provided in the renewal application and supplemental documentation. The NRC staff performed its review following the guidance provided in NUREG-1927, Rev. 1, “Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel,” and relevant ISGs. The NRC staff verified that the TLAA assumptions, calculations, and analyses are adequate and bound the environment, and aging mechanism or aging effect for the pertinent SSCs. Based on its review, the NRC staff finds:
>
> F3.3 The applicant identified all aging mechanisms and effects pertinent to SSCs within the scope of renewal that involve TLAAs. The methods and values of the input parameters for the applicant’s TLAAs are adequate. Therefore, the applicant’s TLAAs provide reasonable assurance that the SSCs will maintain their intended function(s) for the period of extended operation, require no further aging management activities, and meet the requirements in 10 CFR 72.42(a)(1) or 10 CFR 72.240(c)(2), as applicable.

3.6 <u>Aging Management Programs</u>

Aging management programs (AMPs) monitor and control 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. An AMP includes all activities that are credited for managing aging mechanisms or effects for specific SSCs, including activities conducted during the initial storage period. An effective AMP prevents, mitigates, or detects the aging effects and provides for the prediction of the extent of the effects of aging and timely corrective actions before there is a loss of intended function.

Aging management programs should be informed, and enhanced when necessary, based on the ongoing review of both site-specific and industry-wide operating experience, including relevant international and non-nuclear operating experience. Operating experience provides direct confirmation of the effectiveness of an AMP and critical feedback for the need for improvement. As new knowledge and data become available from new analyses, experiments, and operating experience, licensees and CoC holders should revise existing AMPs (or pertinent procedures for AMP implementation) to address program improvements or aging issues.

3.6.1 Review Guidance

An AMP should contain the following 10 elements:

1. Scope of Program,
2. Preventive actions,
3. Parameters monitored or inspected,
4. Detection of aging effects,
5. Monitoring and trending,
6. Acceptance criteria,
7. Corrective actions,
8. Confirmation process,
9. Administrative controls, and
10. Operating experience.

Review of the AMPs should include an assessment of the 10 program elements to verify their technical adequacy. In general, the reviewer should examine the details of these 10 elements for managing the aging mechanisms and effects identified by the aging management review (AMR) process. The reviewer should recognize that an applicant may develop AMPs following a different format or style. For such reviews, the NRC staff should ensure that sufficient detail (i.e., supporting technical bases) is provided in the alternate format in comparison with the 10 AMP elements of this guidance.

The reviewer should determine if the proposed AMP is adequate for managing the aging mechanisms and effects of the SSCs identified by an AMR. The following sections provide specific guidance for the review of each element of an AMP.

3.6.1.1 Scope of Program

The scope of the program should list the specific SSCs and subcomponents covered by the AMP and the intended functions to be maintained. In addition, the element should state the specific materials, environments, and aging mechanisms and effects to be managed. The reviewer should verify that the scope defined for the AMP is clear and specific.

3.6.1.2 Preventive Actions

Preventive actions are used to prevent aging or mitigate the rates of aging for SSCs through the activities in the AMP. The reviewer should verify that these activities, if applicable, are described. For example, an applicant may cite a ground dewatering system to ensure control of long-term settlement of structures or the continuance of inspections to ensure that air inlet/outlet vents are not blocked. Some condition or performance monitoring programs do not rely on preventive actions and thus this information need not be provided.

The reviewer should ensure that any proposed preventive action will not result in an unintended consequence to the ability of an SSC to fulfill its intended function. For example, if the applicant has proposed to change a coating system in order to prevent loss of material due to corrosion, the reviewer should ensure that the applicant has verified coating compatibility to confirm that the proposed action will not compromise the intended function of the SSC.

3.6.1.3 Parameters Monitored or Inspected

This program element should identify the specific parameters that will be monitored or inspected and describe how those parameters will be capable of identifying degradation or potential degradation prior to a loss of intended function. The use of the parameters should be demonstrated to be capable of:

- monitoring the effectiveness of activities that prevent or mitigate aging (e.g., environmental controls),
- monitoring the performance of SSCs as an indirect indicator of degradation (e.g., radiation rate monitoring at the external surface of a cask), and
- detecting, through direct inspection, the presence and severity of conditions or discontinuities that may have an effect on the function of SSCs (e.g., nondestructive examination of a component surface).

The reviewer should ensure that this program element provides a clear link between the aging effects identified in the scope of the program and the parameters monitored or inspected.

3.6.1.4 Detection of Aging Effects

Detection of aging effects should occur before there is a loss of intended function for any SSC identified within the scope of the program. This element should include inspection and monitoring details, including method or technique (i.e., visual, volumetric, surface inspection), frequency, sample size, data collection, and timing of inspections to ensure timely detection of aging effects. In general, the information in this element describes the “when,” “where,” and “how” of the AMP (i.e., the specific aspects of the activities to collect data as part of the inspection or monitoring activities).

The reviewer should ensure that the applicant has provided sufficient details on the following aspects of the inspection or monitoring activities:

- Method or technique: The method should be adequate and proven to be capable of evaluating the condition of the SSC against the acceptance criteria for the specific aging mechanism or effect being monitored or inspected (as defined in AMP Element 6). For example, the applicant should provide a valid technical basis that a particular instrument has sufficient resolution to identify a specific crack or defect dimension.

- Frequency: The reviewer should ensure that the proposed intervals for inspection or monitoring are consistent with applicable site-specific or industry-wide operating experience. Inspections should have sufficient frequency to ensure that intended functions will be maintained until the next scheduled inspection.
- Sample size: The application should identify and justify the number of SSCs to be evaluated per inspection, including the extent of the inspection for each SSC (e.g., all accessible areas of five concrete overpacks in service). The reviewer should ensure the applicant has justified the use of a limited sample size (e.g., one cask per pad) with a technical basis, which should include applicable site-specific and industry-wide operating experience. The application should also define the areas that have been determined to be inaccessible or below-grade and propose how the condition of the inaccessible SSCs will be assessed. The reviewer should ensure that the scope of each inspection is properly defined for both accessible and inaccessible (including below-grade) areas.
- Data collection: The application should reference any specific methods to be used for data acquisition, including any applicable consensus codes and standards. For example, the application may reference field evaluation guides for evaluating and documenting cracks in concrete (e.g., ACI 224.1R, ACI 201.1R).
- Timing of inspections: The application may include results of a lead system inspection to serve as a baseline for the implementation of the AMP, which should be performed in accordance to Appendix C of this guidance. The reviewer should also consider any specific information on the proposed inspection schedule (e.g., time of the year) to support the effective detection of aging effects before a loss of intended function.

3.6.1.5 Monitoring and Trending

Monitoring and trending should provide for an evaluation of the extent of the effects of aging and the need for timely corrective or mitigative actions. This element describes how the data collected will be evaluated. This includes an evaluation of the results against the acceptance criteria and an evaluation regarding the rate of degradation in order to ensure that the timing of the next scheduled inspection will occur before a loss of intended function. For most cases, this element should have a baseline established prior to or at the beginning of the period of extended operation. The reviewer should determine if a baseline inspection is necessary to establish the parameters to be monitored and the trending analysis and, if so, whether the proposed baseline inspection is adequate (see Appendix C if the lead system inspection is being used to serve as a baseline inspection).

3.6.1.6 Acceptance Criteria

The acceptance criteria, against which the need for corrective action will be evaluated, should ensure that the SSC intended functions and the approved design bases are maintained during the period of extended operation. The proposed acceptance criteria should be appropriately justified.

The acceptance criteria could be specific numerical values or could consist of a discussion of the process for calculating specific numerical values of conditional acceptance criteria to ensure that the design bases are maintained. The reviewer should ensure that the acceptance criteria:

- Include a quantitative basis (justifiable by operating experience, engineering analysis, consensus codes/standards),
- Avoid use of non-quantifiable phrases (e.g., significant, moderate, minor, little, slight, few), and
- Are achievable and actionable, that is, the method/technique is qualified to meet the stated quantitative criteria (e.g., sufficient resolution/sensitivity).

The acceptance criteria may be taken directly from the design bases information included in either the final safety analysis report (FSAR) or technical specifications. The acceptance criteria also may be established by methodologies provided in NRC-approved topical reports or appropriate codes and standards.

3.6.1.7 Corrective Actions

Corrective actions are the measures to be taken when the acceptance criteria are not met. Timely corrective actions, including root cause determination and prevention of recurrence for significant conditions adverse to quality, are critical for maintaining the intended functions of the SSCs during the initial license or CoC term as well as the period of extended operation.

Corrective actions should be described in adequate detail or referenced to source documents. An applicant may reference to the use of a Corrective Action Program (CAP), which is consistent with the quality assurance (QA) requirements in either 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," or 10 CFR Part 72, Subpart G, "Quality Assurance," to capture and address aging effects identified in the period of extended operation. In this case, all conditions that do not meet the AMP acceptance criteria should be entered into the CAP. The QA Program ensures that corrective actions are completed within the specific or general licensee's CAP and includes provisions to:

- Perform functionality assessments,
- Perform apparent cause evaluations and root cause evaluations,
- Address the extent of condition,
- Determine actions to prevent recurrence,
- Justify non-repairs, and
- Trend conditions.

The CAP should be able to respond to and adequately address any ISFSI or DSS aging issues. Also, the CAP's response to addressing any ISFSI or DSS aging issues should include any specific corrective actions specified in the license or CoC renewal application.

The reviewer should review the corrective actions element with consideration of ISFSI site-specific and industry-wide operating experience to ensure that the proposed corrective actions are adequate and effective. All applicable corrective actions should be discussed in the application.

3.6.1.8 Confirmation Process

This element of the program is intended to verify that preventive actions are adequate and that appropriate corrective actions have been completed and are effective. The confirmation process is commensurate with the specific or general licensee QA Program and is consistent with 10 CFR Part 72, Subpart G, or 10 CFR Part 50, Appendix B. The QA Program ensures that the confirmation process includes provisions to preclude repetition of significant conditions adverse to quality. The reviewer should ensure the confirmation process describes or references procedures to:

- Determine follow-up actions to verify effective implementation of corrective actions, and
- Monitor for adverse trends due to recurring or repetitive findings.

The reviewer should be aware that the effectiveness of prevention and mitigation programs should be verified periodically. For example, in managing corrosion of the canister, a mitigation program (coating) may be used to minimize susceptibility to corrosion. However, it also may be necessary to have a condition monitoring program (visual or other types of inspections) to verify that corrosion is being prevented or controlled to prevent a loss of intended function.

3.6.1.9 Administrative Controls

Administrative controls provide a formal review and approval process. Thus, any programs relied on to manage aging for ISFSI or DSS renewal must be administratively controlled and included in the FSAR supplement. The administrative controls are in accordance with the specific or general licensee QA Program and are consistent with 10 CFR Part 72, Subpart G or 10 CFR Part 50, Appendix B, respectively. The QA Program ensures that the administrative controls include provisions that define:

- Instrument calibration and maintenance,
- Inspector requirements,
- Record retention requirements, and
- Document control.

The reviewer should ensure the administrative control element describes or references (a) the frequency and methods for reporting inspection results to the NRC, and (b) and the frequency for updating the AMP based on industry-wide operating experience.

3.6.1.10 Operating Experience

The reviewer should verify that operating experience element of the program provided by the applicant supports a determination that the effects of aging will be adequately managed so that the SSC intended functions will be maintained during the period of extended operation. Operating experience is useful in providing justification for the effectiveness of each AMP program element and critical feedback for enhancement. The reviewer should verify that any degradation in the referenced operating experience has been clearly identified as either age-related or event-driven, with proper justification for that assessment.

The reviewer should verify that the AMP references and evaluates applicable operating experience, including, but not necessarily limited to:

- Internal and industry-wide condition reports,
- Relevant international and non-nuclear operating experience,
- Licensee event reports,
- Vendor-issued safety bulletins,
- NRC Generic Communications, and
- Applicable industry-initiatives (e.g., Department of Energy or Electric Power Research Institute sponsored inspections).

The reviewer should verify that the AMP references the methods for capturing operating experience from other ISFSIs with similar in-scope SSCs. The reviewer should verify that the applicant: (1) references a specific repository to be used to obtain, aggregate, and enter site-specific and industry-wide operating experience (e.g., Institute of Nuclear Power Operations database), and (2) has discussed how it intends to provide timely reporting of operating experience to a repository.

The reviewer should consider operating experience of existing programs, including past corrective actions resulting in program enhancements or additional programs. A past failure would provide feedback from operating experience and should have resulted in appropriate program enhancements or new programs. This information can demonstrate where an existing program has been implemented correctly and where it has shortcomings in detecting degradation in a timely manner. This information should provide objective evidence to support or refute the conclusion that the effects of aging will be managed adequately so that the SSC intended functions will be maintained during the period of extended operation.

New AMPs that have yet to be implemented at an licensee's facility do not have operating experience. However, there may be other relevant site-specific operating experience or generic operating experience in the industry that is relevant to the new AMP elements. Therefore, relevant operating experience applicable to new AMPs should be included in the discussion.

<u>Learning AMPs</u>

The reviewer should ensure that applicants commit to future reviews of site-specific and industry-wide operating experience, including relevant international and non-nuclear operating experience, to confirm the effectiveness of their AMPs or indicate a need to enhance or modify an AMP. The commitment to future reviews should ensure that, as knowledge and data become available from new analyses, experiments, and operating experience, the licensees and CoC holders will revise the existing AMPs (or pertinent procedures for AMP implementation) as necessary to address any deficiencies identified during the review of operating experience (see Figure 3-2).

If an applicant follows this approach, the reviewer should ensure that the description of the periodic assessments includes specific performance criteria (e.g., program-specific performance indicators for each of the 10 AMP elements) and proposed actions based on the assessment findings. The reviewer should also ensure that the timing of the assessments appropriately considers the rate of aging degradation and the anticipated availability of data from industry initiatives. The reviewer should consider the frequency, acceptance criteria, and proposed corrective actions for these assessments for the requisite finding of reasonable assurance.

Nuclear Energy Institute (NEI) 14-03, “Guidance for Operations-Based Aging Management for Dry Cask Storage,” Rev. 0, provides a proposed framework for learning AMPs through the use of “tollgates.” NEI 14-03 defines “tollgates” as periodic points within the period of extended operation when licensees would be required to document an aggregate safety assessment. 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 performance that is part of normal ISFSI operations for licensees during the initial storage period as well as the period of extended operation. NEI 14-03 states that licensees will be obligated to comply with any tollgate license or CoC conditions approved as part of the license or CoC renewal. The reviewer should be aware that an applicant may reference the use of “tollgates” in the renewal application. The reviewer should (1) assess the applicant’s proposed periodic assessments of operating experience and other relevant data, and (2) make a determination regarding the ability of these assessments to ensure the continued effectiveness of AMPs. The reviewer should ensure that tollgates determined necessary to demonstrate the continued effectiveness of the AMPs are included as a condition of the renewed license or CoC.

NEI 14-03, Rev. 0, also describes a general framework for the aggregation and dissemination of operating experience across the industry through the use of an operating experience “clearinghouse.” Whether the applicant references the clearinghouse described in NEI 14-03 or proposes an alternative means to seek out operating experience, the reviewer should ensure that the application describes how industry-wide operating experience and results of industry initiatives will be accessed and utilized to ensure that AMPs are modified as appropriate.

As discussed in the Introduction, the staff will continue to work with NEI as it continues to develop NEI 14-03 for proposed NRC endorsement.

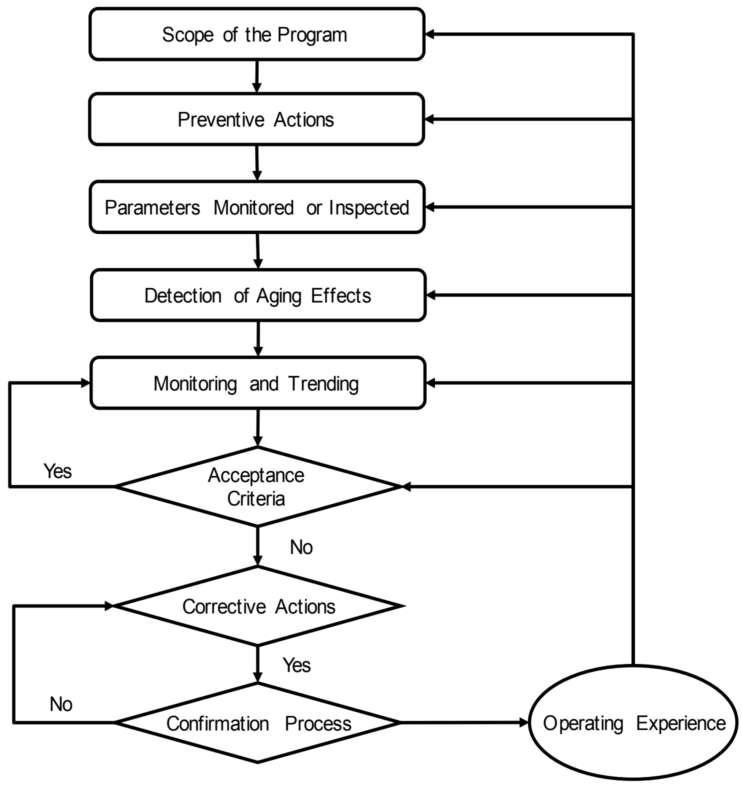

Figure 3-2: Learning AMP

3.6.2 Commencement of AMP(s) for CoC Renewals

An AMP for a renewed CoC commences at the end of the initial storage period for each loaded DSS (see Appendix F for discussion of storage terms, including an explanation of when storage begins). Activities in an AMP may start at different timeframes (e.g., an AMP can be implemented before the period of extended operation to capture baseline data and AMPs may have different frequencies of implementation). If the initial term of a CoC exceeds 20-years, the AMP may have been incorporated into the original CoC. In that case, the AMP commences at the time indicated in the CoC. Additional considerations for CoC renewals and general licensee implementation of AMPs are provided in Appendix E.

3.6.3 Implementation of AMP(s)

Generally, licensees should develop the infrastructure for AMP implementation (e.g., procure equipment or contracts, train personnel, or update, revise, or develop procedures for implementing AMP activities) before entering the period of extended operation.

If a license or CoC is in the period of timely renewal (where the applicant submitted a renewal application within the time frames established in the regulations but the NRC has not yet made a final decision concerning the renewal application before the original license or certificate expiration date), development of the infrastructure for AMP implementation before the period of extended operation (and/or actual AMP implementation) may not be possible. In such cases, the reviewer should ensure that timing of implementation for each AMP is addressed in the application in a clear manner. Generally, development of the infrastructure for AMP implementation should be no later than one year from the date the NRC issues a renewed specific license or CoC. However, in some situations, shorter or longer AMP implementation periods may be appropriately justified.

3.6.4 Evaluation Findings

The reviewer prepares the summary statement and evaluation finding based on compliance with the regulatory requirements in Section 3.3. The summary statement and evaluation finding should be similar in wording to the following example (the finding number is for convenience in cross-referencing within the SRP and SER):

> The NRC staff reviewed the aging management programs provided in the renewal application and supplemental documentation. The NRC staff performed its review following the guidance provided in NUREG-1927, Rev. 1, "Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel" and relevant ISGs. Based on its review, the NRC staff finds:
>
> F3.4 The applicant has identified programs that provide reasonable assurance that aging effects will be managed effectively during the period of extended operation, in accordance with 10 CFR 72.42(a)(2) or 10 CFR 72.240(c)(3), as applicable.

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10 CFR Part 52. *Code of Federal Regulations*, Title 10, *Energy*, Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." Washington, DC.

10 CFR Part 72. *Code of Federal Regulations*, Title 10, *Energy*, Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste." Washington, DC.

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5. 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 conducted by the licensee or certificate of compliance (CoC) user 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 license or certificate of compliance (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 72.244 ("Application for Amendment of a Certificate of Compliance").

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).

Can for Damaged Fuel: 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.

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 overpack performs the radiological shielding and physical protection function. See NUREG-1536.

Certificate of compliance (CoC) (in 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.

Controlled area: The area immediately surrounding an ISFSI for which the licensee exercises authority over its use and within which it performs ISFSI operations. See 10 CFR 72.3.

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

Degradation: Any change in the properties of a material that adversely affects the performance of that material; adverse alteration. See NUREG-1536.

Design bases[1]: 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 system (DSS): A system that uses a cask or canister as a component in which to store spent nuclear fuel in a dry inert 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.

Dry storage: The storage of spent nuclear fuel in an inert gas after removal of the water in the DSS cavity.

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

[1] The NRC has removed references to either "current licensing basis" (CLB) or "licensing basis", and replaced with "design bases" in this guidance revision. Neither "current licensing basis" nor "licensing basis" is defined in 10 CFR Part 72. In addition, in the Statement of Considerations for the 2011 Part 72 rulemaking change (NRC, 2011), the NRC stated "The NRC does not believe that it is appropriate for the CLB to be applied to cask CoC renewals, which are generic."

limited to (1) that spent fuel which the general licensee is authorized to possess at the site under the specific license for the site and (2) storage of spent fuel in casks approved under the provisions of 10 CFR Part 72. See 10 CFR 72.210 ("General License Issued") and 72.212(a)(1)–(2).

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

<u>Horizontal storage module</u>: A reinforced, heavy-walled concrete structure designed to store dry spent fuel canisters in a horizontal position at an independent spent fuel storage installation. The horizontal storage module provides physical protection of canisters and radiological shielding, while allowing passive cooling.

<u>Important to safety (ITS</u>): See *structures, systems, and components (SSCs) important to safety*.

<u>Independent spent fuel storage installation (ISFSI)</u>: 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.

<u>Inspection</u>: 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.

<u>Intended function</u>: A design-bases function defined as either (1) important to safety or (2) whose failure could impact a safety function.

<u>Interim Staff Guidance (ISG):</u> 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. See NUREG-1536.

<u>Monitored Retrievable Storage Installation (MRS):</u> A complex designed, constructed, and operated by DOE for the receipt, transfer, handling, packaging, possession, safeguarding, and storage of spent nuclear fuel aged for at least one year, solidified high-level radioactive waste resulting from civilian nuclear activities, and solid reactor-related GTCC waste, pending shipment to a HLW repository or other disposal. See 10 CFR 72.3.

<u>Monitoring</u>: Testing and data collection 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, radiation, 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 or monitor the effectiveness of preventive measures (e.g., controlling water chemistry). With respect to radiation, per 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. See NUREG-1567.

<u>Normal events or conditions</u>: The maximum level of an event or condition expected to routinely occur. The ISFSI is expected to remain fully functional and to experience no temporary or permanent degradation from normal operations, events, and conditions. Compares to "Design Event I" of ANSI/ANS 57.9. 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. See NUREG-1567.

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 and for which there is a corresponding maximum specified resistance, specified limit of response, or requirement for a specified level of continuing capability. Similar to "Design Event II" of ANSI/ANS 57.9. ISFSI SSCs are expected to experience off-normal events and conditions without permanent deformation or degradation of capability to perform their intended functions (although operations may be suspended or curtailed during off-normal conditions) over the full license period. Off-normal is considered to include "anticipated occurrences" as used in 10 CFR Part 72. See NUREG-1536.

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

Radiation shielding: Barriers to radiation that are designed to meet the requirements of 10 CFR 72.104(a), 10 CFR 72.106(b), and 10 CFR 72.128(a)(2).

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 72.122(l). Interim Staff Guidance (ISG) 2, Revision 1, provides 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 updated within 90 days after the issuance of the license or CoC, reflecting any changes or applicant commitments developed during the license or CoC approval and/or hearing process. UFSAR indicates the SAR 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 *important to safety* (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, and
- retrievability. See NUREG-1536.

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 pursuant to regulations in 10 CFR Part 72.

Spent fuel storage cask or cask: 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.

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:

- 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, or
- 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, and

- is contained or incorporated by reference in the design bases.

Transfer cask: A shielded enclosure used to transfer the fuel canister between the spent fuel handling area and the overpack or storage module location.

APPENDIX A

NON-QUANTIFIABLE TERMS

Appendix A

Non-Quantifiable Terms

The following non-quantifiable terms, as well as others, may appear in the renewal application, safety analysis report (SAR), and updates to final SARs:

- large
- small
- slight
- slightly
- significant
- significance
- moderate
- moderately
- low
- minor
- many
- few
- little
- routine
- some
- major
- undetectable
- visible
- measurable
- unchanged
- changed
- no loss of

Table A-1 may be used as guidance for the terms listed above, for additional consideration, or to provide quantitative measures or information.

Table A-1. Screening Criteria for Non-Quantifiable Terms

	Terms	Actions
Screened In	**The term requires additional consideration if it is used for one of the following:** • characterizing an aging effect (e.g., degradation, cracking, fatigue, corrosion, loss of material, change in material properties) • providing important information about the operations, functions, or other characteristics of an in-scope SSC • describing dose, environmental impact, or other hazard, such as combustible material or dust	**If the term screens in, one of the following must be provided:** • quantitative information, if it is available • additional descriptions • definition of the meaning of the term (e.g., “insignificant” means the function of the SSC is not impaired)
Screened Out	**The term is considered immaterial to the SAR and ISFSI UFSAR for one of the following reasons:** • The term is included in the title of reference document. • The term is included in a quote. • The term is explained by adjacent quantitative information (e.g., small: less than 20 percent). • Use of the term is NOT related to any of the following: – in-scope SSCs per AMR results – aging effect – dose, environment impact, or other hazard (e.g., combustible material) • Use of the term does not provide important information. It is merely descriptive and the meaning of the statement is not changed if the term is deleted (e.g., the word “small” could be deleted from the following statement without altering the meaning: “Water in the grapple ring is drained through a small hole”).	No action

APPENDIX B

EXAMPLES OF AGING MANAGEMENT PROGRAMS

Appendix B

Examples of Aging Management Programs

Appendix B contains example aging management programs (AMPs) for:

- localized corrosion and stress corrosion cracking of welded stainless steel dry storage canisters (Table B-1),
- reinforced concrete structures (Table B-2), and
- high burnup (HBU) fuel monitoring and assessment program (Table B-3).

This appendix provides examples of acceptable AMPs for staff reference during review of renewal applications.

Example AMP for Localized Corrosion and Stress Corrosion Cracking of Welded Stainless Steel Dry Storage Canisters

Welded stainless steel canisters are used in the majority of the dry storage systems in the United States for spent nuclear fuel from commercial power reactors at both specific-licensed and general-licensed independent spent fuel storage installations (ISFSIs). The welded stainless steel canisters are the primary confinement boundary during storage. While there are no known operational occurrences of aging or localized corrosion of welded stainless steel canisters, operational experience with nuclear reactors that were located close to an open ocean or bay has shown that pitting corrosion, crevice corrosion, and chloride-induced stress corrosion cracking (CISCC) can occur in welded stainless steel components as a result of atmospheric deposition and deliquescence of chloride-containing salts. Laboratory and natural exposure tests suggest that CISCC can occur with sufficient surface chloride concentrations and that, with those concentrations of chloride, crack propagation rates can be of engineering significance for welded stainless steel canisters during the period of extended operation.

Based on reactor operating experience as well as laboratory and field testing, localized corrosion and CISCC are potential aging mechanisms for welded stainless steel canisters. Environments where chloride-containing salts may be deposited on welded stainless steel canisters include coastal locations near salt water and locations that are close to cooling towers or roads that are salted. To address these potential aging effects, an AMP for welded stainless steel canisters used in dry storage systems was developed by the NRC that relies on guidance from consensus codes and standards to perform in-service inspection of canisters to detect localized corrosion and CISCC. Elements of an NRC staff developed example AMP are described below.

Table B-1. Example AMP for Localized Corrosion and Stress Corrosion Cracking of Welded Stainless Steel Dry Storage Canisters

Element	**Description**
1. Scope of Program	Inspection of welded stainless steel dry storage canister confinement boundary external surfaces for atmospheric deposits, localized corrosion, and stress corrosion cracking. Examinations should be focused on the following areas: • Canister fabrication welds and weld heat affected zones • Closure welds and weld heat affected zones • Areas of the canister to which temporary supports or attachments were attached by welding and subsequently removed • Locations where a crevice is formed on the canister surface • Horizontal (±30°) surfaces where deposit accumulation 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
2. Preventive Actions	None, AMP is for condition monitoring. However, dry storage system canister designs may include preventative actions such as fabrication procedures and surface modification methods to impart compressive

Element	Description
	residual stresses on the canister welds and weld heat affected zones to reduce the potential for stress corrosion cracking. Preventative actions may also include the use of dry storage system canister confinement boundary materials that are resistant to localized corrosion and stress corrosion cracking. For such cases the preventative actions described should be supported with an analysis and data demonstrating the preventative actions are effective.
3. Parameters Monitored/ Inspected	Parameters monitored/inspected should include: • Visual evidence of discontinuities and imperfections such as localized corrosion, including pitting corrosion, crevice corrosion and stress corrosion cracking of the canister welds and weld heat affected zones • Size and location of localized corrosion and stress corrosion cracks • Appearance and location of deposits on the canister surfaces
4. Detection of Aging Effects	Visual inspection of deposits on the canister surfaces and to identify corrosion products that may be indicators of localized corrosion and stress corrosion cracking in the welds and weld heat affected zones. The ability to detect cracks on clean metal surfaces using visual examination methods is dependent on several factors and can be difficult for tight crack opening displacements (Cumblidge et al., 2004; 2007). Volumetric inspection to characterize localized corrosion or stress corrosion cracking when evidence of localized attack is identified. <u>Visual Examination</u> Pitting and crevice corrosion that is open to the surface can potentially be detected by visual testing (ASME Section V, Table A-110). Because of the high neutron and gamma radiation fields near the surface of the stainless steel dry storage canisters, direct visual examination is not possible. Procedures for remote visual examination should be performance demonstrated; procedure attributes including equipment resolution, lighting requirements, etc., should reference applicable standards, such as ASME Section XI, Article IWA-2200 for VT-1 and VT-3 examinations (ASME, 2007) and BWRVIP-03 (Selby 2005) for EVT-1 examinations. <u>Volumetric Examination</u> Additional assessment is necessary for suspected areas of localized corrosion and/or stress corrosion cracking. In these cases, the severity of degradation must be assessed including the dimensions of the affected area and the depth of penetration with respect to the thickness of the canister. For accessible areas where adequate cleaning can be performed, remote visual inspection meeting the requirements for VT-1

Element	Description
	Examination (ASME Section XI, IWA-2211) may be used to determine the type of degradation present (e.g., pitting corrosion or stress corrosion cracking) and the location of degradation. Examinations to characterize the extent and severity of localized corrosion and/or stress corrosion cracking should be conducted using surface and/or volumetric inspection techniques consistent with the requirements of ASME Section XI, IWB-2500 for category B-J components (ASME, 2007). <u>Sample Size</u> Minimum of one canister at each site. Preference should be given to the canisters with the greatest susceptibility for localized corrosion or SCC. Factors to be considered include older and colder canisters with the greatest potential for the accumulation and deliquescence of deposited salts that may promote localized corrosion and stress corrosion cracking, types of systems used at site, canister location with respect to potential sources of atmospheric deposits, system design, and operational experience. <u>Data Collection</u> Documentation of the examination of the canister, location and appearance of deposits. Assessment of the suspect areas where corrosion products were observed as described in corrective actions. <u>Frequency</u> Once every 5 years <u>Timing of Inspections</u> Initial inspection must be completed prior to entering the period of extended operation at each site. Alternative detection methods or techniques may be provided. For these cases: • The method or technique should be adequate and proven to be capable of evaluating the condition of the external surface of the canister against the acceptance criteria for the detection of localized corrosion and stress corrosion cracking • The proposed intervals for inspection or monitoring are consistent with applicable site-specific or industry-wide operating experience and should have sufficient frequency to ensure that the confinement function will be maintained until the next scheduled inspection • The data collection methods should be sufficient for evaluating localized corrosion and stress corrosion cracking and should reference specific methods to be used for data acquisition

Element	Description
	including any applicable consensus codes and standards.

5. Monitoring and Trending	Monitoring and trending methods are in accordance with ASME Section XI evaluation criteria.
	
	Monitoring and trending methods reference plans/procedures used to:
	• Establish a baseline prior to or at the beginning of the period of extended operation
	• Track trending of parameters or effects not corrected following a previous inspection including
	  o The locations and size of any areas of localized corrosion and/or the stress corrosion cracking
	  o The disposition of canisters with identified aging effects and the results of supplemental canister inspections
	
	Monitoring and trending should also include:
	• The appearance of the canister, particularly at welds and in crevice locations, should be documented with images and video that will allow comparison in subsequent examinations
	• Changes to the size and number of any rust colored stains as a result of iron contamination of the surface in subsequent 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. Confirmed or suspected areas of crevice corrosion, pitting corrosion and stress corrosion cracking must be assessed in accordance with acceptance standards identified in ASME Section XI, IWB-3514. Flaws exceeding the acceptance standards in IWB-3514.1 must be evaluated using the acceptance criteria identified in IWB-3640. <u>Indications Requiring Additional Evaluation</u> Although shop and handling procedures include controls to prevent iron contamination of the stainless steel surfaces, contamination does occur and is usually identified by rust-colored surface deposits. Iron contamination can exacerbate CISCC in stainless steels. In accessible locations, removal of the deposits and rust stains that reveal undamaged welds (i.e., absence of pits, crack, localized attack, or etching) and the original machining/grinding marks on the stainless steel base metal, including weld heat affected zones, may be used to confirm that localized corrosion or stress corrosion cracking have not been initiated.

Element	Description
	Indications of interest that are subject to additional examination and disposition include: • Localized corrosion pits, crevice corrosion, stress corrosion cracking, and etching [note that these indications may be covered by obstructions (i.e., crevices)]; deposits; or corrosion products • Discrete red-orange colored corrosion products that are 1 mm in diameter or larger especially those adjacent to fabrication welds, closure welds, locations where temporary attachments may have been welded to and subsequently removed from the stainless steel dry storage canister, and the weld heat affected zones of these areas • Linear appearance of any color of corrosion products of any size parallel to or traversing fabrication welds, closure welds, locations where temporary attachments may have been welded to and subsequently removed from the stainless steel dry storage canister, and the weld heat affected zones of these areas • Red-orange colored corrosion products greater than 1 mm in diameter combined with deposit accumulations in any location of the stainless steel canister • Red-orange colored corrosion tubercles of any size • Red-orange corrosion products present at the mouth of a crevice that includes a portion of the canister surface Alternative acceptance criteria may be provided. For such cases, the acceptance criteria should: • Include a quantitative basis (justifiable by operating experience, engineering analysis, consensus codes/standards), • Avoid use of non-quantifiable phrases (e.g., significant, moderate, minor, little, slight, few), and • Are achievable and clearly actionable, that is, the method/technique is qualified to meet the stated quantitative criteria (e.g., sufficient resolution/sensitivity).
7. Corrective Actions	The corrective actions are in accordance with the specific or general licensee Quality Assurance (QA) Program and consistent with 10 CFR Part 72, Subpart G, or 10 CFR Part 50, Appendix B. The QA Program ensures that corrective actions are completed within the specific or general licensee's Corrective Action Program (CAP), and include provisions to: • Perform functionality assessments, • Perform apparent cause evaluations, and root cause evaluations, • Address the extent of condition, • Determine actions to prevent recurrence; ensure justifications

Element	Description
	for non-repairs, • Trend conditions, • Identify operating experience actions, including modification to the existing AMP (e.g., increased frequency), and • Determine if the condition is reportable to the NRC (e.g., results in the loss of intended function). Identification of localized corrosion and/or stress corrosion cracking also requires an expansion of the sample size to determine the extent of condition at the site. Canisters with confirmed localized corrosion or stress corrosion cracking must be evaluated for continued service. Canisters with localized corrosion or stress corrosion cracking that do not meet the prescribed evaluation criteria must be repaired or replaced. <u>Extent of Condition</u> Confirmation of localized corrosion and/or stress corrosion cracking requires inspection of additional canisters at the same location to determine the extent of condition. Priority for additional inspections should be to canisters with similar time in service and initial loading. <u>Disposition of Canisters with Aging Effects</u> For austenitic stainless steel canisters covered by an AMP that utilizes the inspection and acceptance criteria in ASME B&PV code Section XI for Class 1 piping system, the disposition of canisters should be commensurate with in-service inspection results: • Canisters with no evidence of corrosion are permitted to remain in service and will continue to be inspected at 5-year intervals. • Canisters with rust deposits that are determined to be a result of iron contamination but do not have evidence of localized corrosion or stress corrosion cracking are permitted to remain in service and will continue to be inspected at 5-year intervals. • Canisters that show evidence of localized corrosion and/or stress corrosion cracking that does not exceed the acceptance standards in IWB-3514.1 are permitted to remain in service and will be inspected at 5-year intervals. Sample size will be increased to assess 25 percent of canisters with similar time in service (± 5 years) or a minimum of one additional canister with a time in service closest to the original sample within one year of the completed in-service inspection date. Results of the initial inspection and the schedule for additional inspections will be reported to the NRC. In addition, the results for the additional in-service inspections will be reported to the NRC upon completion. • Canisters that show evidence of localized corrosion and/or stress corrosion cracking that exceeds the acceptance standards in IWB-3514.1 but meet the acceptance criteria

Element	Description
	identified in IWB-3640 are permitted to remain in service and will be inspected at 3-year intervals. Sample size will be increased to assess 50 percent of canisters with similar time in service (± 5 years) or a minimum of one additional canister with a time in service closest to the original sample within one year of the completed in-service inspection date. Results of the initial inspection and the schedule for additional inspections will be reported to the NRC. In addition, the results for the additional in-service inspections will be reported to the NRC upon completion. • Canisters that show evidence of localized corrosion and/or stress corrosion cracking that exceeds acceptance criteria identified in IWB-3640 are not permitted to remain in service. Upon identification, the in-service inspection sample size will be increased to assess 100 percent of canisters with similar time in service (± 5 years) or a minimum of one additional canister with a time in service closest to the original sample within one year of the completed in-service inspection date. Results of the initial inspection, the schedule for mitigation either by repair or replacement and the schedule for additional inspections will be reported to the NRC. In addition, the results for the additional in-service inspections will be reported to the NRC upon completion.
8. Confirmation Process	The confirmation process will be commensurate with the specific or general licensee Quality Assurance (QA) Program and consistent with 10 CFR Part 72, Subpart G or 10 CFR Part 50, Appendix B. The QA Program ensures that the confirmation process includes provisions to preclude repetition of significant conditions adverse to quality. The confirmation process describes or references procedures to: • Determine follow-up actions to verify effective implementation of corrective actions • Monitor for adverse trends due to recurring or repetitive findings.
9. Administrative Controls	The specific or general licensee QA Program must be commensurate with 10 CFR Part 72, Subpart G or 10 CFR Part 50, Appendix B and specifically addresses: • Instrument calibration and maintenance, • Inspector requirements • Record retention requirements, and • Document control. The administrative controls describes or references: • Frequency/methods for reporting inspection results to the NRC • Frequency for updating AMP based on industry-wide operational experience

Element	Description
10. Operating Experience	The AMP references and evaluates applicable operating experience, including: • Internal and industry-wide condition reports, • Internal and industry-wide corrective action reports, • Vendor-issued safety bulletins, • NRC Information Notices, and • Applicable DOE or industry initiatives (e.g., EPRI or DOE sponsored inspections). The AMP clearly identifies any degradation in the referenced operating experience as either age-related or event-driven, with proper justification for that assessment. Past operating experience supports the adequacy of the proposed AMP, including the method/technique, acceptance criteria, and frequency of inspection. The AMP references the methods for capturing operating experience from other ISFSIs with similar in-scope SSCs. CISCC of austenitic stainless steels is a known degradation mechanism for aqueous environments; however, operational experience in aqueous environments is not directly applicable in assessing the potential for atmospheric CISCC for austenitic stainless steel dry storage canisters. Atmospheric CISCC of austenitic stainless steels has been reported in a range of industries including welded stainless steel components and piping in operating nuclear power plants. <u>Spent Fuel Storage</u> No cases of CISCC for stainless steel dry storage canisters have been reported. Inspections of dry storage canisters after 20 years in service have been conducted at a few independent spent fuel installation (ISFSI) sites. Details of the inspection conducted at the Calvert Cliffs nuclear power plant ISFSI are documented in a recent EPRI report (Waldrop et al., 2014). No evidence of localized corrosion was identified but some amount of chloride-containing salts were determined to be present and corrosion products believed to be related to iron contamination were identified. <u>Operating Power Reactors</u> NRC Information Notice 2012-20 (NRC 2012b) documents previous cases of atmospheric CISCC of welded stainless steel piping systems and tanks at operating reactor locations. Atmospheric CISCC growth rates determined from operational experience at both domestic and foreign nuclear power plants including events at San Onofre, Turkey Point, St. Lucie, and Koeberg (South Africa) range from 3.6×10^{-12} m/s to 2.9×10^{-11} m/s for components at ambient temperatures.

Element	Description
	Relevant Literature and Testing Electric Power Research Institute (EPRI) has recently conducted a literature review of CISCC which summarizes the results of many previous laboratory investigations (Gorman et al., 2014). The NRC has recently published the results of a completed investigation of CISCC testing of type 304, 304L and 316L stainless steel and welds (He et al., 2014). This study indicates that SCC was initiated at stresses just above the yield strength in tests conducted using 304 stainless steel C-ring specimens. Testing with U-bend specimens showed that CISCC was observed with the lowest simulated sea salt concentrations tested (100 mg salt/m^2 or ~55 mg chloride/m^2) at temperatures of 52°C using a maximum absolute humidity of 30 g/m^3, which is generally accepted as being near the maximum absolute humidity in a natural environment. Both laboratory and field investigations have been conducted by CRIEPI and TEPCO. This includes the early work by Tokiwai et al. (1985) who reported the critical surface chloride concentrations of 8 mg/m^2 for CISCC on sensitized 304 stainless steel. Kosaka (2008) reported crack growth rates of 9.6×10^{-12} m/s obtained in natural exposure tests on Miyakojima Island with type 304 base metals and welds, type 304L welds and type 316LN welds. Hayashibara et al. (2008) reported activation energy for crack growth in type 304 stainless steel of 5.6 to 9.4 kcal/mol (23 to 39 kJ/mol) based on testing conducted at temperatures of 50 to 80°C.
References	American Society Of Mechanical Engineers, “Boiler and Pressure Vessel Code Section XI - Rules for Inservice Inspection of Nuclear Power Plant Components,” New York, NY: ASME (2007). S.E. Cumblidge, M.T. Anderson, S.R. Doctor. 2004. “An Assessment of Visual Testing,” NUREG/CR-6860, Pacific Northwest National Laboratory, Richland, WA. Agencywide Documents Access and Management System (ADAMS) Accession No. ML043630040. S.E. Cumblidge, M.T. Anderson, S.R. Doctor, F.A. Simonen, A.J. Elliot. 2007. “A Study of Remote Visual Methods to Detect Cracking in Reactor Components,” NUREG/CR-6943, Pacific Northwest National Laboratory, Richland, WA. ADAMS Accession No. ML073110060. J. Gorman, K. Fuhr, J. Broussard, “Literature Review of Environmental Conditions and Chloride-Induced Degradation Relevant to Stainless Steel Canisters in Dry Cask Storage Systems,” EPRI-3002002528, Palo Alto, CA: EPRI, 2014. H. Hayashibara, M. Mayuzumi, Y. Mizutani, J. Tani, “Effect of Temperature and Humidity on Atmospheric Stress Corrosion Cracking of Stainless Steel,” Corrosion 2008, paper 08492, Houston, TX: NACE International, 2008. A. Kosaki, “Evaluation Method of Corrosion Lifetime of Conventional

Element	Description
	Stainless Steel Canister under Oceanic Air Environment," *Nuclear Engineering and Design*, Vol. 238, pp.1233–1240, 2008 NRC. 2012b. Information Notice 2012-20: "Potential Chloride-Induced Stress Corrosion Cracking of Austenitic Stainless Steel and Maintenance of Dry Cask Storage System Containers." November 14, 2012. ADAMS Accession No. ML12319A440. G. Selby, "BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines," EPRI 1011689, TR-105696-R8 (BWRVIP-03) Revision 8, Palo Alto, CA: EPRI 2005. M. Tokiwai, H. Kimura, H. Kusanagi, "The Amount of Chlorine Contamination for Prevention of Stress Corrosion Cracking in Sensitized Type 304 Stainless Steel," *Corrosion Science*, Vol. 25 Issue 8–9, pp. 837–844, 1985 X. He, T.S. Mintz, R. Pabalan, L. Miller, and G. Oberson, "Assessment of Stress Corrosion Cracking Susceptibility for Austenitic Stainless Steels Exposed to Atmospheric Chloride and Non-Chloride Salts," NUREG/CR-7170, U.S. Nuclear Regulatory Commission, February 2014, ADAMS Accession No. ML14051A417. K. Waldrop, W. Bracey, K. Morris, C. Bryan, D. Enos, "Calvert Cliffs Stainless Steel Dry Storage Canister Inspection," EPRI-1025209, EPRI, Palo Alto, CA, 2014.

Example AMP for Reinforced Concrete Structures

An example aging management program (AMP) for reinforced concrete structures is provided below. The AMP consists of condition monitoring, performance monitoring, mitigation and prevention activities. The program includes periodic visual inspections by personnel qualified to monitor reinforced concrete for applicable aging effects, such as those described in the American Concrete Institute guides (ACI) 349.3R-02, ACI 201.1R-08, and American National Standards Institute/American Society of Civil Engineers guidelines (ANSI/ASCE) 11-99. Identified aging effects are evaluated against acceptance criteria derived from the design bases or industry guides and standards, including ACI 349, ACI 318, ACI 349.3R-02 and the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, Subsection IWL.

The program also includes periodic sampling and testing of groundwater and the need to assess the impact of any changes in its chemistry on below-grade concrete structures. Additional activities include radiation surveys to ensure the shielding functions of the concrete structure are maintained and daily inspections to ensure the air convection vents are not blocked (per the requirements of the approved design bases). The program also includes provisions where modifications may be appropriate for specific-license renewals.

Table B-2. Example AMP for Reinforced Concrete Structures

Element	Description
1. Scope of Program	The scope of the program includes the following aging management activities: 1. Visual inspection of above-grade (accessible, inaccessible) and below-grade (underground) concrete areas (See Element 4 for sample size and justification of areas to be inspected) 2. Groundwater chemistry program to manage below-grade (underground) aging mechanisms: • Corrosion of embedded steel, and • Chemical attack (chloride and sulfate induced degradation) 3. Radiation surveys to: • Ensure compliance with 10 CFR 72.104, and • Monitor performance of the concrete as a neutron shield at near system locations (i.e., determine dose uptrends); Validate modeling analyses and calculations described in the design bases. The scope of the program provides means to address the following aging effects and mechanisms, as described in ACI 349.3R-02 and SEI/ASCE 11-99: • Cracking or loss of material (spalling, scaling) due to freeze-thaw degradation, • Cracking or loss of material (spalling, scaling) due to chemical attack (chloride, sulfate induced), • Cracking and loss of strength due to cement aggregate reactions • Cracking, loss of material, and loss of bond due to corrosion of embedded steel,

	• Increase in porosity/permeability and loss of strength due to leaching of $Ca(OH)_2$, • Cracking and distortion due to long-term settlement, • Cracking and reduction in strength due to high temperature dessication, and • Cracking and reduction in strength due to gamma and neutron irradiation. Calculations or analyses (time-limited aging analyses, when appropriate) may be used to demonstrate that aging effects due to irradiation and high temperature dessication do not require an AMP. More specifically, the renewal application may demonstrate that no part of the concrete exceeds: • <u>Critical cumulative fluences per ACI 349.3R-02:</u> 10^{17} neutrons/m^2; 10^{10} rad (gamma dose); • <u>Temperature limits per ACI 349-06:</u> 150°F (general), 200°F (localized). Additional site-specific AMPs may be required for the following scenarios: • A dewatering system is used to prevent long-term settlement • The design bases includes embedded aluminum subcomponents without a protective insulating coating • Protective coatings are relied upon to manage the effects of aging for a subcomponent
2. Preventive Actions	Preventive actions include continuance of inspections to ensure that air inlet/outlet vents are not blocked and design temperature limits are not exceeded. These inspections would be part of the approved design bases and be continued for the sample size and inspection frequency identified in the respective technical specification. Additional preventive actions are not required for structures designed and fabricated in accordance to ACI 318 or ACI 349, as specified in the design bases. Otherwise, a site-specific AMP may be required.
3. Parameters Monitored or Inspected	For visual inspections, the parameters monitored/inspected quantifies the following aging effects: • Cracking, • Material loss (spalling, scaling), • Loss of bond, and • Increased porosity/permeability. The AMP references the following parameters for characterizing the above aging effects, as appropriate: • Affected surface area, • Geometry/depth of defect, • Cracking, crazing, delaminations, • Curling, settlements or deflections,

	• Honeycombing, bug holes, • Popouts and voids, • Exposure of embedded steel, • Staining/ evidence of corrosion, and • Heavy dusting, efflorescence of any color. The parameters evaluated are adequate for surface geometries that may support water ponding. For the groundwater chemistry program, the parameters monitored/inspected include: • Water pH and • Concentration of chlorides and sulfates in the water. For radiation surveys, the parameters monitored/inspected include gamma dose and/or neutron fluence.

4. Detection of Aging Effects	<u>Method/technique</u>
	
	The method/technique achieves the acceptance criteria, as defined in AMP Element 6. An engineering justification or technical bases is provided, which references applicable consensus guides, codes and standards, and/or adequate calibration procedures to ensure the method or technique will provide reliable data.
	
	For visual inspections, the method/technique is defined as:
	
	• Visual method for above-grade (accessible) areas
	    • e.g., feeler gauges, crack comparators.
	• Visual method for above-grade (inaccessible) and below-grade (underground) areas
	    • site-qualified system with valid sensitivity/resolution (e.g., video/ fiber optic camera).
	
	For the groundwater chemistry program, the method/technique is defined as an adequate chemical analysis method.
	
	For radiation surveys, the method/technique is defined as a calibrated detector with a valid energy range.
	
	<u>Frequency of Inspection</u>
	
	The proposed inspection schedule is commensurate with ACI 349.3R-02. Alternative inspection frequencies provide a valid technical basis (engineering justification, operational experience data) for any deviation from ACI 349.3R-02.
	
	For visual inspections, the frequency of inspection is defined as:
	
	• For above-grade (accessible and inaccessible) areas: ≤ 5 years
	• For below-grade (underground) areas: ≤ 10 years, and when excavated for any reason
	• The use of opportunistic inspections in lieu of planned inspections per the above schedule provides a valid technical

	basis (engineering justification, operational experience data). For the groundwater chemistry program, the frequency of monitoring is justified (e.g., quarterly, semiannual). For radiation surveys, the frequency of monitoring is justified (e.g., quarterly). <u>Sample size</u> For visual inspections, the sample size includes all surface areas, or a justified sample size. For visual inspections, the groundwater chemistry program, and radiation surveys, the sample size clearly identifies and justifies specific locations where inspection/monitoring will be conducted. The AMP properly defines accessible and inaccessible areas, and defines their respective sample size. <u>Data collection:</u> Data collection for visual inspections is commensurate with applicable consensus codes/standards/guides: • For example, ACI 224.1R for quantitative analysis (crack width, depth, extent), ACI 562, ACI 364.1R. The AMP references an adequate clearinghouse for documenting inspection/monitoring operating experience. <u>Timing</u> The timing of the inspections includes the lead system inspection or general-licensee baseline inspection, performed per Appendix C of this NUREG, and at the frequency justified by the AMP.

5. Monitoring and Trending	Monitoring and trending methods are commensurate with defect evaluation guides and standards (e.g., ACI 201.1R, ACI 207.3R, ACI 364.1R, ACI 562, or ACI 224.1R for crack evaluation).
	
	Monitoring and trending methods reference plans/procedures used to:
	• Establish a baseline prior to or at the beginning of the period of extended operation.
	• Track trending of parameters or effects not corrected in a previous inspection, for example:
	  • Crack growth rates,
	  • Corrosion rates,
	  • Pore density/ affected areas, or
	  • Dose rates.

6. Acceptance Criteria	For visual inspections, the acceptance criteria are commensurate with the 3-tier quantitative criteria in ACI 349.3R-02: • Acceptance without further evaluation, • Acceptance after review, and

	• Acceptance requiring further evaluation. The acceptance criteria clearly identify when a finding is to be entered in the Corrective Action Program (e.g., when Tier 2 acceptance per ACI 349.3R-02 is exceeded). For the groundwater chemistry program, the acceptance criteria are commensurate with ASME Code Section XI, Subsection IWL, which states that an aggressive below-grade environment is defined as: • pH < 5.5, chlorides > 500 ppm, or sulfates > 1500 ppm. For radiation surveys, the acceptance criteria are justified and sufficient to ensure compliance with 10 CFR 72.104 and identify statistically significant uptrends in dose rates at or near overpack surfaces. The adequacy of the acceptance criteria considers design bases calculations documented in the FSAR. NUREG-1536 and NUREG-1567 provide further guidance for the selection of cask or overpack locations at which dose rates are calculated per the initial ISFSI or DSS design review, which may be used for verification of shielding performance during the period of extended operation. Alternative acceptance criteria may be provided. For such cases, the acceptance criteria: • Include a quantitative basis (justifiable by operating experience, engineering analysis, consensus codes/standards), • Avoid use of non-quantifiable phrases (e.g., significant, moderate, minor, little, slight, few), and • Are achievable and clearly actionable, that is, the method/technique is qualified to meet the stated quantitative criteria (e.g., sufficient resolution/sensitivity).
7. Corrective Actions	The corrective actions are in accordance with the specific- or general-licensee QA Program and consistent with 10 CFR Part 72, Subpart G, or 10 CFR Part 50, Appendix B, respectively. The QA Program ensures that corrective actions are completed within the specific or general licensee's CAP, and include provisions to: • Perform functionality assessments, • Perform apparent cause evaluations, and root cause evaluations, • Address the extent of condition, • Determine actions to prevent recurrence; ensure justifications for non-repairs, • Trend conditions, • Identify operating experience actions, including modification to the existing AMP (e.g., increased frequency), and • Determine if the condition is reportable to the NRC (e.g., results in the loss of intended function). The AMP references applicable concrete rehabilitation guides or standards, for example: • Cracking: ACI 224.1R, ACI 562, ACI 364.1R, and ACI RAP

	Bulletins, or • Spalling/scaling: ACI 562, ACI 364.1R, ACI 506R, and ACI RAP Bulletins.
8. Confirmation Process	The confirmation process is commensurate with the specific- or general-licensee QA Program and is consistent with 10 CFR Part 72, Subpart G, or 10 CFR Part 50, Appendix B, respectively. The QA Program ensures that the confirmation process includes provisions to preclude repetition of significant conditions adverse to quality. The confirmation process describes or references procedures to: • Determine follow-up actions to verify effective implementation of corrective actions, and • Monitor for adverse trends due to recurring or repetitive findings.
9. Administrative Controls	The administrative controls are in accordance with the specific- or general-licensee QA Program and consistent with 10 CFR Part 72, Subpart G, or 10 CFR Part 50, Appendix B, respectively. The QA Program ensures that the administrative controls include provisions that define: • Instrument calibration and maintenance, • Inspector requirements (commensurate with ACI 349.3R-02), • Record retention requirements, and • Document control. The administrative controls describes or references: • Frequency/methods for reporting inspection results to the NRC, and • Frequency for updating the AMP based on industry-wide operational experience.
10. Operating Experience	The AMP references and evaluates applicable operating experience, including: • Internal and industry-wide condition reports, • Internal and industry-wide corrective action reports, • Vendor-issued safety bulletins, • NRC Information Notices, and • Applicable DOE or industry initiatives (e.g., EPRI or DOE sponsored inspections). The AMP clearly identifies any degradation in the referenced operating experience as either age-related or event-driven, with proper justification for that assessment. Past operating experience supports the adequacy of the proposed AMP, including the method/technique, acceptance criteria, and frequency of inspection. The AMP references the methods for capturing operating experience from other ISFSIs with similar in-scope SSCs.

References	ACI 201.1R-08 (2008), “Guide for Conducting a Visual Inspection of Concrete in Service” ACI 207.3R-94 (2008), “Practices for Evaluation of Concrete in Existing Massive Structures for Service Conditions” ACI 224.1R-07 (2007), “Causes, Evaluation, and Repair of Cracks in Concrete Structures” ACI 318-11 (2011), “Building Code Requirements for Structural Concrete” ACI 349.3R-02 (2010), “Evaluation of Existing Nuclear Safety-Related Concrete Structures.” ACI 349-06 (2007), “Code Requirements for Nuclear Safety-Related Concrete Structures” ACI 364.1R-07 (2007), “Guide for Evaluation of Concrete Structures before Rehabilitation” ACI 506R-05 (2005), “Guide to Shortcrete” ACI 562-13 (2013), “Code Requirements for Evaluation, Repair, and Rehabilitation of Concrete Buildings” ASME Boiler and Pressure Vessel Code, Section XI, Subsection IWL (2013), “Requirements for Class CC Concrete Components of Light-Water-Cooled Plants” NRC. 2000. “Standard Review Plan for Spent Fuel Dry Storage Facilities,” NUREG-1567, Revision 0. Washington, DC. ADAMS Accession No. ML003686776. NRC. 2010a. “Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility,” NUREG-1536, Revision 1, Washington, DC. ADAMS Accession No. ML091060180. NRC. 2010c. “Generic Aging Lessons Learned (GALL) Report,” NUREG-1801, Revision 2, Washington, DC. ADAMS Accession No. ML103490041. SEI/ASCE 11-99 (2000), “Guideline for Structural Condition Assessment of Existing Buildings”

Example of a High Burnup Fuel Monitoring and Assessment Program

An example of a High Burnup (HBU) Fuel[1] Monitoring and Assessment Program is provided below. This is a licensee program that monitors and assesses data and other information regarding HBU fuel performance, to confirm that the design-bases HBU fuel configuration is maintained during the period of extended operation. This example HBU Monitoring and Assessment Program relies on a surrogate demonstration program to provide data on HBU fuel performance. Guidance for determining if a surrogate demonstration program can provide the data to support a licensee's HBU Fuel Monitoring and Assessment Program is given in Appendix D. Although this example focuses on the use of a surrogate demonstration program, a licensee may use alternative approaches that are appropriately justified, including the use of test or research results and safety analyses for the fuel, to demonstrate that the dry storage system intended functions continue to be met during the period of extended operation.

The aging management review is not expected to identify any aging effects that could lead to fuel reconfiguration, as long as the HBU fuel is stored in a dry inert environment, temperature limits are maintained, and thermal cycling is limited (see Sections 2.4.2.1 and 3.4.1.4). Short-term testing (i.e., laboratory scale testing up to a few months) and scientific analyses examining the performance of HBU fuel have provided a foundation for the technical basis that storage of HBU fuel in the period of extended operation may be performed safely and in compliance with regulations. However, there has been relatively little operating experience, to date, with dry storage of HBU fuel.

Therefore, the purpose of a HBU Fuel Monitoring and Assessment Program is to monitor and assess data and other information regarding HBU fuel performance to confirm there is no degradation of HBU fuel that would result in an unanalyzed configuration during the period of extended operation. The following description of an example HBU Fuel Monitoring and Assessment Program presents the applicable information in a format using each element of an effective aging management program, to provide a framework for such a monitoring and assessment program.

Table B-3. Example of a High Burnup Fuel Monitoring and Assessment Program

Element	**Description**
1. Scope of the Program	The scope of the program provides a description of: (1) the design-bases characteristics of the HBU fuel; (2) the surrogate demonstration program that will be used to provide data on the applicable design-bases HBU fuel performance; and (3) how the parameters of the surrogate demonstration program are applicable to the design-bases HBU fuel. Aging effects will be determined for material/environment combinations per an alternative surrogate demonstration program meeting the guidance in Appendix D. Example language to address this "scope of the program" element follows:

[1] Fuel assemblies with discharge burnup greater than 45 gigawatt-days per metric ton of uranium (GWd/MTU)

Element	Description
	Fuel stored in a *[define cask/canister model]* is limited to an assembly average burnup of *[define design-bases limit]* GWd/MTU. The cladding materials for the HBU fuel are *[define types of cladding],* and the fuel is stored in a dry helium environment. HBU fuel was first placed into dry storage in a *[define cask/canister model]* on *[start date of storage term of first storage of HBU fuel].* The program relies on the joint Electric Power Research Institute (EPRI) and Department of Energy (DOE) “HBU Dry Storage Cask Research and Development Project” (HDRP) (EPRI 2014), conducted in accordance with the guidance in Appendix D, as a surrogate demonstration program that monitors the performance of HBU fuel in dry storage. The HDRP is a program designed to collect data from a spent nuclear fuel storage system containing HBU fuel in a dry helium environment. The program entails loading and storing a AREVA TN-32 bolted lid cask (the “Research Project Cask”) at Dominion Virginia Power’s North Anna Power Station with intact HBU fuel (of nominal burnups ranging between 53 GWd/MTU and 58 GWd/MTU). The fuel to be used in the program include four kinds of cladding (Zircaloy-4, low-tin Zircaloy-4, Zirlo^{TM}, and M5^{TM}). The Research Project Cask is to be licensed to the temperature limits contained in Interim Staff Guidance (ISG) 11, Rev. 3 (NRC 2003), and loaded such that the fuel cladding temperature is as close to the limit as practicable. *[If an alternative surrogate demonstration program is used, provide a description of the program.]* The parameters of the surrogate demonstration program are applicable to the design-bases HBU fuel, as the: (1) maximum burnup of the design-bases HBU fuel *[define value]* is less than the burnup of the fuel in the surrogate demonstration program *[define value]*; (2) the cladding type of the design-bases HBU fuel *[define type]* is the same as the surrogate demonstration program *[define type]*; and (3) the temperatures in the surrogate demonstration program *[define values]* bound the design-bases temperature/heat load of the loaded systems *[define values]*.
2. Preventive Actions	There are no specific preventive actions associated with this HBU Fuel Monitoring and Assessment Program. However, the applicant should discuss the design-bases characteristics of the licensed/certified dry storage system, in terms of initial cask loading operations, to show the HBU fuel is stored in a dry inert environment. Example language follows: During the initial loading operations of the cask/canister, the design and ISFSI Technical specifications (TS) require that the fuel be stored in a dry inert environment. TS *[name and number]* demonstrates that the cask/canister cavity is dry by maintaining a cavity absolute pressure less than or equal to *[value]* for a *[time period]* with the cask/canister

Element	Description
	isolated from the vacuum pump. TS *[name and number],* requires that the cask/canister then be backfilled with helium. These two TS requirements ensure that the HBU fuel is stored in an inert environment thus preventing cladding degradation due to oxidation mechanisms. TS *[name and number]* also requires that the helium environment be established within *[time]* hours of commencing cask/canister draining. The cask/canister is loaded in accordance with the criteria of ISG-11.
3. Parameters Monitored or Inspected	The applicant identifies the parameters monitored and inspected in a surrogate demonstration program that are applicable to its particular design-bases HBU fuel and describes how this meets the guidance of Appendix D.
4. Detection of Aging Effects	The applicant identifies the detection of aging effects in a surrogate demonstration program that are applicable to its particular design-bases HBU fuel and describes how this meets the guidance of Appendix D.
5. Monitoring and Trending	As information/data from a surrogate demonstration program or from other sources (such as testing or research results and scientific analyses) becomes available, the licensee will monitor, evaluate, and trend the information via its operating experience program and/or the Corrective Action Program (CAP) to determine what actions should be taken. The licensee will evaluate the information/data from a surrogate demonstration program or from other sources to determine whether the acceptance criteria in Element 6 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). Formal evaluations of the aggregate information from a surrogate demonstration program and other available domestic or international operating experience (including data from monitoring and inspection programs, NRC-generated communications, and other information) will be performed at specific points in time during the period of extended operation, as delineated in Table B-4 below.
6. Acceptance Criteria	The High Burnup Fuel Monitoring and Assessment Program acceptance 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 cask/canister,

Element	Description
	accounting for measurement uncertainty, should be less than the expected upper bound moisture content per the design-bases drying process[2]; and • Fuel condition/performance[3] – nondestructive examination (e.g., fission gas analysis) and destructive examination (e.g., to obtain data on creep, fission gas release, hydride reorientation, cladding oxidation, and cladding mechanical properties) 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 applicant should provide information on the design-bases characteristics of the dry storage system, with regard to these criteria. The applicant should reference the source of specific values, or explain any assumptions made, for defining design-bases characteristics of the fuel condition/performance.
7. Corrective Actions	The corrective actions are in accordance with the specific- or general-licensee QA Program and consistent with 10 CFR Part 72, Subpart G, or 10 CFR Part 50, Appendix B, respectively. Corrective actions should be implemented if data from a surrogate demonstration program or other sources of information indicate that any of the High Burnup Fuel Monitoring and Assessment Program acceptance criteria (in Element 6) are not met. If any of the acceptance criteria are not met, the licensee will: (1) assess fuel performance (impacts on fuel and changes to fuel configuration); and (2) assess the design-bases safety analyses, considering degraded fuel performance (and any changes to fuel configuration), to determine the ability of the dry storage system to continue to perform its intended functions under normal, off-normal, and accident conditions. The licensee will determine what corrective actions should be taken to: (1) manage fuel performance, if any; or (2) manage impacts related to degraded fuel performance to ensure that all intended functions for the dry storage system are met.

[2] The applicant will need to provide the expected upper bound moisture content based on its design-bases drying process. If the design-bases drying process involves a vacuum drying method of evacuating a cask/canister to less than or equal to 3 torr and maintaining a constant pressure for 30 minutes after the cask/canister is isolated from the vacuum pump, the expected water content is about 0.43 gram-mole. (See NUREG-1536, Rev. 1.)

[3] While it is not a fuel performance criterion, the spatial distribution and time history of the temperature must be known to evaluate the relationship between the performance of the rods in a surrogate demonstration program and the high burnup fuel rod behavior expected in the cask.

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 specific- or general- licensee QA Program and is consistent with 10 CFR Part 72, Subpart G, or 10 CFR Part 50, Appendix B, respectively. The QA Program ensures that the confirmation process includes provisions to ensure corrective actions are adequate and appropriate, have been completed, and are effective. The focus of the confirmation process is on the follow-up actions that must be taken to verify effective implementation of corrective actions. The measure of effectiveness is in terms of correcting the adverse condition and precluding repetition of significant conditions adverse to quality. Procedures include provisions for timely evaluation of adverse conditions and implementation of any corrective actions required, including root cause evaluations and prevention of recurrence where appropriate. These procedures provide for tracking, coordinating, monitoring, reviewing, verifying, validating, and approving corrective actions, to ensure effective corrective actions are taken.
9. Administrative Controls	The administrative controls are in accordance with the specific- or general-licensee QA Program and consistent with 10 CFR Part 72, Subpart G, or 10 CFR Part 50, Appendix B, respectively. The QA Program ensures that the administrative controls include provisions that define: • Formal review and approval processes • Record retention requirements, and • Document control.
10. Operating Experience	The program references and evaluates applicable operating experience, including: • Internal and industry-wide condition reports, • Internal and industry-wide corrective action reports, • Vendor-issued safety bulletins, • NRC Information Notices, • Applicable DOE or industry initiatives (e.g., HDRP), and • Applicable research (e.g., Oak Ridge National Laboratory studies on bending responses of the fuel, Argonne National Laboratory and Central Research Institute of Electric Power Industry studies on hydride reorientation effects). The review of operating experience clearly identifies any HBU fuel degradation as either age-related or event-driven, with proper justification for that assessment. Past operating experience supports the adequacy of the HBU Fuel Monitoring and Assessment Program. Surrogate demonstration programs with storage conditions and fuel

Element	Description
	types similar to those in the licensed/certified dry storage system that meet the guidance in Appendix D are a viable method to obtain operating experience. New data/research on fuel performance from both domestic and international sources that are relevant to the licensed/certified HBU fuel in the dry storage system should be evaluated on a periodic basis.
References	Center for Nuclear Waste Regulatory Analyses. 2013. "Extended Storage and Transportation: Evaluation of Drying Adequacy," June 2013, NRC Contract No. NRC-02-07-006. ADAMS Accession No. ML13169A039. EPRI. 2014. "HBU Dry Storage Cask Research and Development Project Final Test Plan," February 27, 2014, DOE Contract No.: DE-NE-0000593. NRC. 2010. "Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility," NUREG-1536, Revision 1, Washington, DC. ADAMS Accession No. ML101040620. NRC. 2003. NRC Interim Staff Guidance 11, "Cladding Considerations for the Transportation and Storage of Spent Fuel," Revision 3, November 17, 2003. ADAMS Accession No. ML033230335.

Table B-4. Formal Evaluations of Aggregate Information on HBU Fuel Performance

	Year	Assessment
1	Date – prior to HBU fuel exceeding the initial storage term[4]	Evaluate information obtained from a surrogate demonstration program loading and initial period of storage along with other available sources of information. If a surrogate demonstration program nondestructive examination (NDE) (i.e., cask/canister gas sampling, temperature data) has not been obtained at this point, then the licensee has to provide evidence that the acceptance criteria in Element 6 are met or initiate a corrective action.
2	Date – 10 years after Assessment 1 above	Evaluate, if available, information obtained from the destructive examination (DE) and NDE of the fuel placed into storage in a surrogate demonstration program along with other available sources of information. If the DE data from a surrogate demonstration program has not been obtained at this point, then the licensee has to provide evidence to the NRC, by opening a cask/canister or separate effects surrogate experiments, that the acceptance criteria in Element 6 are met or initiate a corrective action.
3	Date – 10 years after Assessment 2 above	Evaluate any new information.

[4] See Appendix F for a discussion of storage terms.

APPENDIX C

LEAD SYSTEM INSPECTION FOR SPECIFIC LICENSE AND CERTIFICATE OF COMPLIANCE RENEWALS

Appendix C

Lead System Inspection for Specific License and Certificate of Compliance Renewals

C.1 Purpose of the Lead System Inspection

Dry storage system (DSS) materials are selected to be resistant to environmentally-induced degradation during the initial storage period. However, because inspections of the DSSs are not typically conducted or are limited in scope during the initial storage period, it is important for an applicant to determine the condition of the system and demonstrate that structures, systems, and components (SSCs) within the scope of the renewal application have not undergone unanticipated aging and degradation prior to entering the period of extended operation. If the system inspection reveals unanticipated aging or degradation, then the applicant would need to address the condition of the SSCs in the renewal application. A lead system inspection is a U.S. Nuclear Regulatory Commission (NRC) staff-accepted approach to verify system condition at an independent spent fuel storage installation (ISFSI).

The lead system inspection is an important element in an operations-focused aging management approach and provides valuable operating experience. This inspection may provide data to confirm a time-limited aging analysis (TLAA) prediction of the system's condition at the end of the initial storage period or to revise TLAAs for the period of extended operation. The results from the lead system inspection will be used by the applicant to develop detailed aging management programs (AMPs), including inspection and maintenance frequencies, and provide a baseline for the monitoring and trending element of AMPs in the period of extended operation. The staff considers the results of the lead system inspection, in conjunction with other relevant operating experience (including operating experience that is identified and evaluated by the applicant) in its review of the renewal application.

C.2 Selecting System(s) for Inspection

If multiple storage systems or designs are in use at the ISFSI, then the lead system inspection should address the different storage systems or designs that are used. The inspection should include all SSCs within the scope of the renewal application.

The selection of system(s) for inspection should consider the results of the aging management review and should be based on the degradation mechanism(s) of concern for the SSC. An SSC for inspection should be selected based on site-specific conditions, system design, material combinations, and operating parameters that may contribute to aging and degradation. Consideration should also be given to event-driven (not age-related) fabrication or operational issues that may contribute to degradation (e.g., welding repairs, occurrence of natural or man-induced events) when selecting SSCs for inspection.

For example, if chloride-induced stress corrosion cracking (CISCC) of a stainless steel canister is a potential aging mechanism that must be managed in the period of extended operation, then the inspection should be conducted on the canister that has the greatest susceptibility to CISCC. The determination of susceptibility may involve the initial heat load of the canister, expected temperature variations on the canister surface with priority given to the coolest locations and welds, and the canister location if it is determined that some DSS at a site may be located closest to or oriented toward the source of atmospheric chlorides. For concrete aging due to freeze-thaw cycles of environmental moisture, the inspection may involve the overpack or horizontal storage module that has been in service for the longest time. Other concrete aging mechanisms, such as chemical attack or aggregate reactions, are in part dependent on the specific composition of the concrete placed, including additives, water to cement ratio, and the aggregate used in the concrete. Therefore, the criteria for lead system selection will not only depend on length of service. Different lead systems may need to be inspected depending on the susceptibility to the different aging mechanisms.

Therefore, the lead system inspection may involve SSCs in various/multiple DSSs at the ISFSI. Applicants are encouraged to discuss their considerations for selecting the lead system(s) to inspect and their plans for the lead system inspection with NRC staff in pre-application meetings before submitting their renewal application.

C.3 Guidelines for the Lead System Inspection

The inspections should utilize consensus codes and standards where they exist for the examination methods, including equipment calibration and personnel qualifications, and acceptance criteria. Alternatively, applicants may propose the use of an inspection method for SSCs within the scope of the renewal that has been demonstrated to detect aging effects prior to a loss of intended function. If a demonstrated surface or volumetric examination method does not exist yet, visual examination may be used, when appropriate, to determine if aging effects have occurred on the SSCs within the scope of the review. Visual examination should also follow consensus codes and standards and be demonstrated on the SSCs subject to examination. The inspections should consider previous operating experience to determine areas which may require more thorough examination.

The lead system inspection is expected to be performed before submittal of the specific-license or certificate of compliance (CoC) renewal application. The inspection results become part of the justification (technical bases) for renewal. The reviewer should evaluate these inspection results provided with the application.

The applicant’s proposed aging management programs should incorporate the results of the lead system inspection and provide justification for the selection of examination methods, frequency, and sample size for subsequent inspections in the period of extended operation. Observations of unexpected conditions or aging effects on an SSC within the scope of the renewal may require changes to the planned inspection frequency and sample size. In addition, the applicant should discuss how it handled such lead system inspection findings or observations, per its quality assurance program.

C.4 Use of Surrogate Inspections

Because there is not yet a good base of operating experience associated with ISFSI and DSS inspections, an applicant should not refer to inspections conducted at other sites as a surrogate for its lead system inspection. Differences in DSS materials, DSS fabrication practices, DSS design modifications, and environmental conditions at various sites could make comparisons between different ISFSI sites invalid.

C.5 Considerations for Lead System Inspections for CoC Renewals

The CoC holder, as the applicant for a CoC renewal, is responsible for demonstrating that the storage of spent fuel has not, in any significant manner, adversely affected SSCs important to safety. A lead system inspection is a NRC staff-accepted approach to support this demonstration and should be performed before submittal of the renewal application, as the inspection results become part of the justification for renewal. Therefore, the CoC holder should include the results of lead system inspections in its renewal application.

The CoC holder is, however, in a somewhat unique position regarding lead system inspections. Unlike specific-license applicants, the CoC holder is responsible for this demonstration for systems at multiple environments and locations. Moreover, the CoC holder may not own the deployed DSSs at general-licensed ISFSI sites and may not have the authority to conduct lead system inspections at general-licensed ISFSI sites. This demonstration, and thus, the lead system inspection to support it, is nevertheless the responsibility of the CoC holder as applicant. One acceptable method for making this demonstration is for a lead system inspection to be conducted for a subset of sites that may be considered bounding for most sites where the system is used. CoC holders could work within their users groups to identify bounding lead systems for inspection. General licensees who have systems that may be good candidates for bounding lead systems could conduct inspections to support the CoC renewal application. If an approach like this is presented, the reviewer should ensure that the CoC renewal application provides a clear description of the criteria used to identify these systems as bounding.

The preceding discussion (Section C.2 above) on selecting systems for inspection should be considered in determining the bounding systems, along with the range of environmental conditions at all existing sites where the DSS is used, variations in designs, materials, and material combinations in the approved amendments to the CoC, and the potential aging mechanisms for the SSCs within the scope of renewal.

The CoC holder should define an approach for ensuring that all CoC users (general licensees) are bounded by the lead systems described in the renewal application. An acceptable approach is that the CoC users conduct a baseline inspection[1] at their sites prior to entering their respective period of extended operation.[2] [3] The parameters, requirements and timing for this baseline inspection should be defined in the renewal application (e.g., in each SSC-specific AMP or in the form of a separate standalone AMP). Each general licensee would conduct a baseline inspection at its ISFSI site following the criteria in the appropriate AMP. The general licensee should demonstrate that the results from its baseline inspection did not reveal any aging effects that were not identified in the bounding lead system inspections of the renewal

[1] For purposes of this discussion, a baseline inspection is defined as a site-specific inspection conducted by a general licensee after the CoC has been renewed, but prior to entering its respective period of extended operation. The general licensees would evaluate the results of the baseline inspections against those of the bounding lead system inspections described in the renewal application.

[2] The period of extended operation of a general-licensed site is defined by the storage terms of the DSS (see Appendix F).

[3] If a CoC is in the period of timely renewal (where the applicant submitted a renewal application within the time frames established in the regulations but the NRC has not yet made a final decision concerning the renewal application before the CoC expiration date), conducting the baseline inspection before the period of extended operation may not be possible. In this case, the applicant should address the timing for conducting the baseline inspection, in the renewal application.

application. The CoC holder should also update the AMPs if these inspection results reveal inadequacies or need for enhancement.

Pursuant to 10 CFR 72.240(e), in approving the renewal, the NRC may revise the CoC to include terms, conditions, and specifications that will require the implementation of an AMP. 10 CFR 72.212(b)(11) further requires each general licensee to comply with the terms, conditions, and specifications in the CoC, including the requirements of an AMP. Therefore, the staff may impose conditions in the renewed CoC to ensure that all general licensees perform a baseline inspection prior to entering their period of extended operation.

APPENDIX D

SUPPLEMENTAL GUIDANCE FOR THE USE OF A DEMONSTRATION PROGRAM AS A SURVEILLANCE TOOL FOR CONFIRMATION OF INTEGRITY OF HIGH BURNUP FUEL DURING THE PERIOD OF EXTENDED OPERATION

Appendix D

Supplemental Guidance for the Use of a Demonstration Program as a Surveillance Tool for Confirmation of Integrity of High Burnup Fuel During the Period of Extended Operation

This guidance provides the U.S. Nuclear Regulatory Commission (NRC) staff a basis for reviewing if a demonstration of high burnup (HBU) fuel has the necessary properties to qualify as one method that an applicant might use in license and certificate of compliance applications to confirm the integrity of HBU fuel during continued storage.

D.1 Discussion

The experimental confirmatory basis that low burnup fuel (≤45 GWd/MTU) will maintain its integrity in dry cask storage over extended time periods was provided in a demonstration test (NRC 2003, Bare et al., 2001, Einziger et al 2003). A similar confirmation test, which includes information over a similar length of the time available for low burnup fuel, does not exist for other light water reactor (LWR) fuels, HBU fuel[1] and mixed oxide fuels. Certification and licensing HBU fuel for storage was permitted for an initial 20-year-term using the guidance contained in Interim Staff Guidance (ISG) 11 (NRC 2003) which was based on short-term laboratory tests and analysis that may not be applicable to the storage of HBU fuel beyond 20 years, particularly with the current state of knowledge regarding HBU fuel cladding properties.

One concern stated in ISG-11 was the potential detrimental effects, such as reduced ductility, of hydride reorientation on cladding behavior (NRC 2003). Research performed in Japan and the United States indicated that: (1) hydrides could reorient at a significantly lower stress than previously believed (Billone et al., 2013, Kamimura 2010, Daum et al 2006), and (2) the radial hydrides could raise the cladding ductile-to-brittle transition temperature enough to compromise the ability of the cladding to withstand stress without undergoing brittle failure (Billone et al., 2013). This phenomenon could influence the retrievability of HBU fuel assemblies and result in operational safety concerns in the handling of individual assemblies as HBU fuel cooled. Circumferential zirconium hydrides in the fuel cladding regions would dissolve into the fuel cladding during drying and reprecipitate (reorient) as radial hydrides as the fuel cladding cooled. Thus, fuel cladding with radial hydrides that is below a ductile-to-brittle transition temperature could be too brittle to retrieve (remove from the DSS) on an assembly basis. The maximum temperatures and internal rod pressures in ISG-11 were recommended to mitigate hydride reorientation and are applicable to HBU fuel during the initial 20-year storage, as the decay heat of HBU fuel is expected to maintain cladding temperatures above a ductile-to-brittle transition temperature (~200°C).

There is no evidence to suggest that HBU fuel cannot similarly be stored safely and then retrieved for time periods beyond 20 years, but the supporting experimental data is not extensive. Therefore, confirmatory data or a commitment to obtain data on HBU fuel and taking appropriate steps in an aging management plan (AMP) will provide further information that will be useful in evaluating the safe handling of individual assemblies of HBU fuel for extended durations.

[1] High burnup fuel is fuel with burnup ≥ 45 GWd/MTU.

A demonstration program could provide an acceptable method for an applicant to demonstrate compliance with the cited regulations for storage of light water reactor fuels (LWR) for periods of greater than 20 years by:

- Confirming the expected fuel conditions, based on technical arguments made in ISG-11 (NRC 2003), after a substantial storage period that is sufficiently long (~ 10 years) to extrapolate the findings to the storage duration of interest. The behavior of the cladding for the period of extended operation will depend on its physical condition at the end of the initial 20-year storage period.
- Providing data for benchmarking, confirming predictive models, and updating aging management plans.
- Confirming the time-limited aging analysis (TLAA) cladding creep predictions that are the basis for the guidance recommendation for the maximum temperature in ISG-11 (NRC 2003) are not exceeded and that sufficient creep margin exists for the extended storage period.
- Determining the system is sufficiently dry to eliminate moisture-driven degradation from consideration.
- Providing operational experience on the fuel behavior and drying procedure as input to an AMP on the behavior of the fuel.
- Identifying any aging effects that may be missed through short-term accelerated studies and analyses.

Monitoring of the fuel temperatures, gas composition, and other conditions in the canister or cask combined with physical examination of the fuel at periodic intervals should be able to provide confirmation if:

- The models of the phenomena used for the first 20-year predictions can be used for the TLAA beyond 20 years.
- The condition of the fuel, after an appropriately long period of storage, does not degrade.
- New degradation mechanisms are not being exhibited.

Extrapolation outside the recorded data carries risk, but that risk can be minimized if the length of the extrapolation is reduced and those extrapolations are updated as the demonstration continues to monitor and measure fuel properties.

D.2 Technical Review Guidance:

The applicant may use the results of a completed demonstration or an on-going demonstration if the conditions of the demonstration meet the requirements stated below for the fuels and conditions of storage for which the term is to be renewed. The approach in this guidance can be applied to a generic demonstration program or a site/system-specific program as long as the demonstration's parameters are reasonably applicable to the applicant's fuel type and characteristics.

The technical reviewers should establish that the following conditions are met if the demonstration is to be used by the applicant to support fuel assembly conditions for storage of LWR fuel beyond 20 years and to be applicable to support a license or certificate application:

1. That the maximum burnup of the fuel in the application is less than the burnup of the fuel

in the demonstration. If the burnup is higher than that in the demonstration, the applicant should provide evidence, based on characteristics of the fuel, derived either from reactor rod qualification testing or other separate effects tests, that the demonstration fuel is reasonably characteristic of the stored fuel and the added burnup will not change the results determined by the demonstration. Similarly, if there is a different cladding type used, arguments based on comparison of composition and fabrication technique (e.g., stress-relieved and annealed, recrystallized) should justify the use of the demonstration results.

2. If the applicant uses direct observations of the rod behavior to imply the condition of the rods in its system, either (a) the temperatures in the demonstration must bound the temperatures in the application, or (b) if the applicant uses predictive tools that have been confirmed by the demonstration, then the temperatures of the rods in the application do not have to be bounded by the temperature of the rods in the demonstration. The temperature models used in the application should either be benchmarked (a) against the demonstration temperature data, or (b) against actual measured rod temperature data in the same temperature range.

3. If the applicant is using gas analysis or another gas detection method to establish the condition of the fuel, then the interior of a demonstration canister or cask should be quantitatively monitored for, at a minimum, moisture, oxygen, and fission gas. The duration and frequency of the gas monitoring should be determined by analysis of the potential degradation. Gases should always be quantitatively monitored prior to opening of the canister. If the applicant claims that no galvanic degradation is feasible, then, if after drying, moisture is detected in the canister, moisture and H_2 should be monitored at a reasonable frequency to be determined by the applicant until the moisture disappears. Gas monitoring is not expected during movement of the canister. If the applicant is using the gas analysis to show no breaches would occur during transport, gas quantitative monitoring must be conducted before and after transport.

4. Temperature monitoring should be conducted at a frequency that is suitable for determining the profile over the duration of the demonstration.

5. If possible, some population of stored rods should be examined whenever the system is opened. These rods should be extracted from the fuel assembly to determine properties of the rods that affect degradation such as cladding creep, fission gas release, hydride reorientation, cladding oxidation, and mechanical properties.

6. The demonstration program fuel shall include at least two full fuel assemblies. The assemblies may be reconstituted.

7. Data from the demonstration program must be indicative of a storage duration long enough to justify extrapolation to the total storage time requested but no less than 10 years if the data is to be used to support license extension from the initial 20 years to an additional 40 years[2].

[2] A demonstration is to provide that there was satisfactory performance during the first 20 years and that the results could be extrapolated to support an additional 40 years. The NRC staff agreed that a demonstration of ≤ 10 years storage duration is insufficient to support these goals.

D.3 References

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R.S. Daum, S. Majumbdar, Y. Liu, and M.C. Billone. 2006. "Radial-hydride Embrittlement of High-burnup Zircaloy-4 Cladding", *Journal of Nuclear Science and Technology*, Vol. 43, No. 9, p.1054, 2006.

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NRC. 2003. NRC Interim Staff Guidance 11, "Cladding Considerations for the Transportation and Storage of Spent Fuel," Revision 3, November 17, 2003.

APPENDIX E

CONSIDERATIONS FOR RENEWALS OF CERTIFICATES OF COMPLIANCE

Appendix E

Considerations for Renewals of Certificates of Compliance

E.1 Development of Time-Limited Aging Analyses and Aging Management Programs

Per Title 10 of the *Code of Federal Regulations* (10 CFR) 72.240, “Conditions for Spent Fuel Storage Cask Renewal,” the certificate of compliance (CoC) renewal application must include time-limited aging analyses (TLAAs), if applicable, and aging management programs (AMPs). The CoC holder, as the applicant for the CoC renewal and the owner of the storage cask design, will develop the TLAAs and AMPs. The renewal application should address age-related degradation of the dry storage system (DSS) design in a bounding manner (i.e., fully address pertinent aging mechanisms and effects in all possible service environments where the DSS is being used and can be used). If there is an AMP that may not be applicable to certain CoC users, because of the service environment in which the DSS is located, the AMP should specify this. In addition, the CoC holder and the staff should consider the need for a CoC condition to specify this potential limited use of the AMP, so it is clear for general licensee implementation.

For a CoC renewal that encompasses CoC amendments with different design bases, the CoC holder will need to address in the renewal application how the TLAAs or AMPs apply to each amendment covered by the CoC. For example, if different materials are used in different CoC amendments, or if different environments (e.g., underground vs. aboveground system) are reflected in different CoC amendments, then there may be different TLAAs or AMPs specified for the individual amendments.

E.2 Implementation of AMPs

In approving the renewal of the DSS design, the U.S. Nuclear Regulatory Commission (NRC) may revise the CoC to include terms, conditions, and specifications that will ensure the safe operation of the DSS during the period of extended operation, including but not limited to, terms, conditions, and specifications that will require the implementation of an AMP by a general licensee, in accordance with 10 CFR 72.240(e).

Regulations in 10 CFR 72.212, “Conditions of General License Issued under § 72.210,” provide requirements for general licensees using approved CoCs. Regulations in 10 CFR 72.212(b)(11) require general licensees to comply with the terms, conditions, and specifications of the CoC, including but not limited to, the requirements of any AMP put into effect as a condition of the NRC approval of a CoC renewal application in accordance with 10 CFR 72.240.

General licensees (CoC users) are responsible for implementing the AMPs. To document the licensee’s compliance with the renewed CoC, the general licensee should update the evaluation required under 10 CFR 72.212(b)(5) to show how it will meet the new CoC terms, conditions, or specifications for aging management. The licensee should update the 10 CFR 72.212(b)(5) evaluation before entering the period of extended operation. If AMP details in the FSAR specify that the AMP is not applicable for certain users (e.g., if it is not applicable in certain climates or environments), the general licensee can include the technical justification in its 10 CFR 72.212(b)(5) report for not implementing such an AMP. The general licensee would need to evaluate any changes to the 10 CFR 72.212(b)(5) report, using the requirements of 10 CFR 72.48 (See NRC Regulatory Issue Summary 2012-05, “Clarifying the Relationship Between 10 CFR 72.212 and 10 CFR 72.48 Evaluations”).

E.3 Corrective Actions

As discussed in Section 3.6, corrective actions are measures to be taken when the AMP acceptance criteria are not met. Corrective actions are critical for maintaining the intended functions of the structures, systems, and components during the initial storage term as well as the period of extended operation. The CoC holder should discuss in its renewal application the applicable and appropriate corrective actions that may be taken if the AMP acceptance criteria are not met.

A general licensee will use its Corrective Action Program (CAP) (that is consistent with the criteria in 10 CFR Part 50, Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants”) to capture and address aging effects identified in the period of extended operation. In this case, all conditions that do not meet the AMP acceptance criteria should be entered into the CAP. The general licensee’s CAP should be able to respond to and adequately address and rectify any ISFSI or DSS aging issues. Also, the CAP’s response to address any DSS aging issues should include any specific corrective actions specified in the CoC renewal application.

APPENDIX F

STORAGE TERMS

Appendix F

Storage Terms

F.1 Introduction

This appendix provides a flow chart for calculating storage terms of a dry storage system (DSS) loaded during either the initial storage period or renewal period(s) of a certificate of compliance (CoC).

F.2 Storage Term Defined

The storage term (length of time a DSS can remain loaded) is determined by the period specified in the applicable certificate of compliance (CoC) in effect at the time the DSS is placed into service (from Title 10 of the *Code of Federal Regulations* (10 CFR) 72.212(a)(3) and Ref. 1). The initial storage period begins when the DSS is first used by the general licensee to store spent fuel (10 CFR 72.212(a)(3)). The clock starts when the loaded cask has been deployed in the ISFSI (76 FR 8872). Pursuant to 10 CFR 72.212(a)(3), the general license for storage of spent fuel in each cask terminates when the CoC expires. If a CoC is not renewed, upon expiration, casks loaded under that CoC would need to be removed from service.

- If the DSS is loaded during the initial CoC term (e.g., 20 years) and the CoC is not renewed, the storage term is the entirety of the initial CoC term (e.g., 20 years).

- If the DSS is loaded during the initial CoC term and the CoC is renewed once, the storage term is the remaining time in the initial CoC term added to the entirety of the first renewal period.

- If the DSS is loaded during the first renewal period (e.g., 40 years), and the CoC is not subsequently renewed, the storage term is the entirety of the first renewal period (e.g., 40 years).

- If the DSS is loaded during the first renewal period, and the CoC is subsequently renewed, the storage term is the remaining time in the first renewal period added to the entirety of the subsequent renewal period (cumulative).

F.3 Flowchart for Calculating Storage Terms

A flowchart is provided below to assist the user in calculating the storage term for a DSS loaded under a CoC.

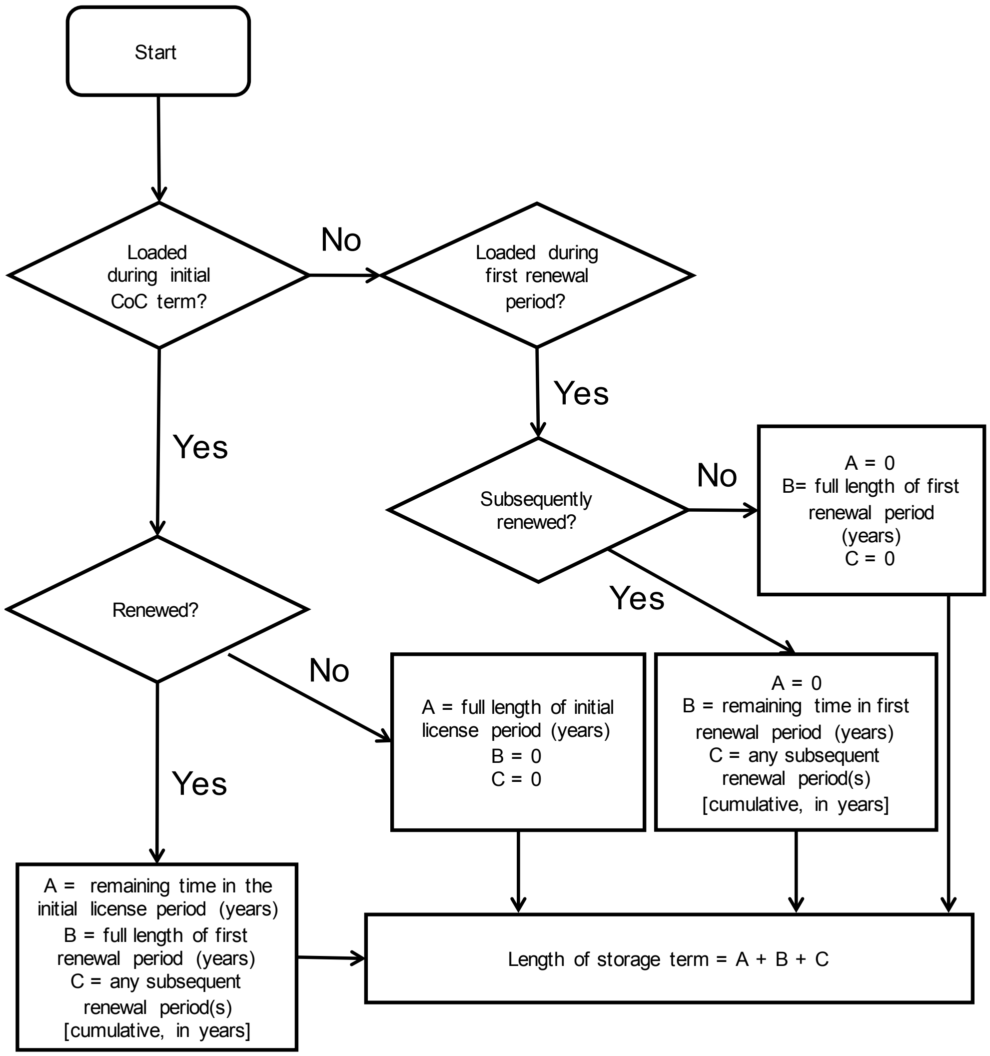

Figure F-1. Flowchart for Calculating Storage Terms

F.4 References

76 FR 8872. February 16, 2011. "10 CFR Part 72, License and Certificate of Compliance Terms, Final Rule." *Federal Register*, U.S. Nuclear Regulatory Commission, Washington, DC.

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This Standard Review Plan is intended for use by U.S. Nuclear Regulatory Commission (NRC) reviewers. It provides guidance for the safety review of renewal applications for specific licenses of independent spent fuel storage installations and certificates of compliance (CoC) of dry storage systems, as codified in Title 10 of the Code of Federal Regulations (10 CFR) Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste."

To renew a specific license, an applicant (i.e., licensee) must submit a license renewal application at least 2 years before the expiration of the license in accordance with the requirements of 10 CFR 72.42(b). To renew a CoC, an applicant (i.e., CoC holder, user, or user's representative) must submit a renewal application at least 30 days before the expiration of the associated CoC in accordance with the requirements of 10 CFR 72.240(b). The NRC may renew a specific license or a CoC for a term not to exceed 40 years, in accordance with 10 CFR 72.42(a), or 10 CFR 72.240(a), respectively. General licenses are not renewed since the general-license term is linked to the storage term of the CoC in use.

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