NEI 14-03 [Revision 1]

Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management

September 2015

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Nuclear Energy Institute

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NOTICE

FOREWORD

This document provides guidance for 10 CFR 72 specific licensees and Certificate of Compliance (CoC) holders to prepare applications to be submitted to the NRC seeking renewal of the license or CoC. NEI 14-03 complements NRC staff review guidance in NUREG-1927 and provides an administrative and licensing perspective to licensees and CoC holders as part of the overall regulatory framework for Part 72 license and CoC renewals. Specifically, NEI 14-03 provides guidance to renewal applicants in the areas of format and content of applications, methods that address potential aging effects and mechanisms during the period of extended operation (PEO), and the essential role that operating experience plays in the management of aging effects.

NEI 14-03 introduces "tollgates" into the Part 72 license and CoC renewal process. "Tollgate" is a new term created to address the fact that verification of the applicability of potential dry cask storage aging effects and mechanisms may not be available at the time license and CoC renewal applications are submitted. In such cases, information to be collected in the future will enhance the current understanding of how the spent fuel and the canisters containing the spent fuel age. Briefly put, tollgates are part of a learning, operations-based aging management program implemented by licensees via requirements in the renewed license or CoC, and associated Final Safety Analysis Report (FSAR). These requirements obligate the licensees to perform periodic assessments of the aggregate state of knowledge of aging-related operational experience, research, monitoring, and inspections to ascertain the ability of in-scope dry cask storage structures, systems and components (SSCs) to continue performing their intended safety functions throughout the PEO.

NEI 14-03 is written consistent with the overall philosophy described in NEI Petition for Rulemaking (PRM) 72-7 as it relates to aging management document hierarchy and change control. Of particular focus is the assignment of the information to the correct change control process for modifying the aging management information in the future, based on the risk-informed, public health and safety-focused philosophy described in the PRM. The NRC controls changes to the ISFSI license, CoC and associated attachments and appendices that include such items as technical specifications, authorized contents, design features and administrative controls. Other information, typically contained in the ISFSI or dry storage system (DSS) Updated Final Safety Analysis Report (UFSAR) and licensee implementing procedures, is subject to the change controls in 10 CFR 72.48. To maintain safety focus, efficiently use resources, and provide needed flexibility to enable a learning approach to aging management, NRC change control should remain limited to information that is particularly safety- and risk-significant, as described in the PRM.

In accepting PRM 72-7 for future rulemaking (FR Volume 79, No. 138, pp 41935 – 41938), the NRC stated that the recommended rule changes support the agency's strategic goals proposed in NRC's 2014-2018 Strategic Plan. The NRC further states that the issues in the petition considered for rulemaking could make the regulations for spent fuel dry cask storage more efficient. Consistent with those goals, the PRM recommends that information subject to NRC change control should only be that with a clear nexus to public health and safety. This guidance is written considering that same principle of effective regulation.

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ACRONYMS AND ABBREVIATIONS

ALARA	As Low as Reasonable Achievable
AMA	Aging Management Activity
AMID	Aging Management INPO Database
AMP	Aging Management Program
AMR	Aging Management Review
ASME	American Society of Mechanical Engineers
CFR	Code of Federal Regulations
CIS	Consolidated Interim Storage
CISCC	Chloride-Induced Stress Corrosion Cracking
CoC	Certificate of Compliance
DSS	Dry Storage System
DOE	U.S. Department of Energy
EPRI	Electric Power Research Institute
ESCP	Extended Storage Collaboration Program
FSAR	Final Safety Analysis Report
GALL	Generic Aging Lessons Learned
GTCC	Greater-than-Class C
HBU	High Burnup
HDRP	High Burnup Dry Storage Cask Research and Development Project
HSM	Horizontal Storage Module
INPO	Institute of Nuclear Power Operations
ISFSI	Independent Spent Fuel Storage Installation
ITS	Important to Safety
MAPS	Managing Aging Processes for Storage
MWd/MTU	Megawatt-day per Metric Ton Uranium
NEPA	National Environmental Policy Act
NRC	U.S. Nuclear Regulatory Commission
OE	Operating Experience
PEO	Period of Extended Operation
R&D	Research and Development
RAI	Request for Additional Information
RIRP	Regulatory Issue Resolution Protocol
RSI	Request for Supplemental Information
SCC	Stress Corrosion Cracking
SER	Safety Evaluation Report
SNF	Spent Nuclear Fuel
SSC	Structure, System, and Component
TG	Task Group
TIN	Technical Information Needs
TLAA	Time-Limited Aging Analysis
UFSAR	Updated Final Safety Analysis Report

GLOSSARY[1]

Aging Management Activity (AMA) (NUREG-1927) – An application of either an 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 are maintained during the license period of extended operation.

Aging Management Program (AMP) (10 CFR 72.3) – A program established by the specific licensee or DSS CoC holder for addressing aging effects that may include prevention, mitigation, condition monitoring, and performance monitoring. AMPs established by the CoC holder are implemented by the general licensee.

Aging Management Review (AMR) (NUREG-1927) – An assessment conducted by the specific licensee or CoC holder that addresses aging mechanisms and effects that could adversely affect the ability of SSCs to perform their intended important-to-safety functions during the period of extended operation.

Applicant – The entity submitting the specific license or CoC renewal application. For a specific license renewal, the applicant is the licensee. For a CoC (cask design) renewal, the applicant is expected to be the CoC holder. Alternatively, 10 CFR 72.240(a) states that in the event the CoC holder does not apply for cask design renewal, any licensee using a spent fuel storage cask, a representative of such licensee or another certificate holder may apply for a renewal of that cask design.

Bare Fuel Cask – A metal cask with a bolted lid and a fuel basket inside designed for spent fuel storage and/or transportation. A bare fuel cask performs the confinement function during storage and the containment function during transportation. A bare fuel cask does not employ a canister.

Baseline Inspection – The first inspection of lead components at a particular ISFSI in accordance with the AMP defined by the renewed site-specific license or CoC.

Canister – A fully welded metal cylinder with a fuel basket inside that is placed inside a vertical cask or overpack (ventilated or unventilated) or a ventilated horizontal module for storage at an ISFSI. The canister performs the confinement function during storage at the ISFSI.[2]

Cask (10 CFR 72.3) – All the components and systems associated with the container in which spent fuel or other radioactive materials associated with spent fuel are stored in an ISFSI. “Cask” is also a colloquial term that can mean a bare fuel cask, a transportation cask, or a ventilated or unventilated overpack. The term “cask,” in the context of the 10 CFR 72 regulations and this guidance, applies to bare fuel casks and both vertical and horizontal canister-based dry storage systems (see also “DSS”).

[1] See NUREG-1927 for additional definitions.
[2] The canisters storing Three Mile Island Unit 2 core debris are uniquely licensed as vented through a HEPA filter to prevent accumulation of gases due to radiolysis. No other dry storage canister designs used in the United States are vented.

Cask Vendor – The entity that is the design authority and supplier of a bare fuel cask or canister-based DSS. The vendor is usually the CoC holder.

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

Consolidated Interim Storage (CIS) – The concept of transporting spent nuclear fuel from various locations around the country (typically operating and shutdown commercial reactor sites) to one or more independent interim storage facilities for management until a final disposition path (e.g., geologic disposal) is available.

Certificate of Compliance (CoC) (10 CFR 72.3) – The certificate issued by the NRC that approves the design of a spent fuel storage cask in accordance with the provisions of 10 CFR 72, Subpart L. The CoC contains the terms, specifications and conditions for using the cask (DSS) under a Part 72 general license.

CoC Holder (10 CFR 72.3) – A person who has been issued a Certificate of Compliance by the NRC for a spent fuel storage cask design.

Contents – The material authorized for storage in the DSS by the specific license or the DSS CoC (e.g., spent fuel, non-fuel hardware, and reactor-related GTCC waste).

Design Bases (NUREG-1927) – Information that identifies the specific functions to be performed by a structure, system or component 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 restraints, derived from generally-accepted state-of-the-art practices for achieving functional goals, or requirements derived from analysis (based on calculation or experiments) of the effects of a postulated event under which a structure, system, or component must meet its functional goals. See 10 CFR 72.3 for additional detail.

Dry Storage System (DSS) - A spent fuel storage technology comprised of a canister inside a ventilated or unventilated vertical cask (overpack) or horizontal storage module used at an ISFSI (see also "cask").

General License – A license that has been provided to 10 CFR 50 and 10 CFR 52 licensees by regulation (10 CFR 72.210) to store spent fuel from a reactor at an ISFSI on the site governed by that Part 50 or Part 52 license, pursuant to 10 CFR 72, Subpart K.

Greater-Than-Class-C (GTCC) Waste (10 CFR 72.3) – Low-level radioactive waste that exceeds the concentration limits of radionuclides established for Class C waste in 10 CFR 61.55.

High Burnup (HBU) Fuel – Spent nuclear fuel with an average assembly burnup generally exceeding 45,000 MWd/MTU.

Horizontal Storage Module (HSM) – A ventilated concrete structure used to store a canister in the horizontal orientation at an ISFSI or CIS facility.

Important to Safety (ITS) (10 CFR 72.3) – A term used to describe ISFSI or DSS SSCs whose functions are:

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

Independent Spent Fuel Storage Installation (ISFSI) (10 CFR 72.3) - A complex designed and constructed for the interim storage of spent nuclear fuel, solid reactor-related GTCC waste and other radioactive materials associated with spent fuel and reactor-related GTCC waste storage.

Intended Function (NUREG-1927) – A design bases function defined as either (1) important to safety or (2) whose failure could impact a safety function. SSC intended functions are derived from the safety analyses described in the ISFSI or DSS UFSAR.

Lead Component – An SSC or subcomponent of an SSC at an ISFSI that is determined to be one of the most susceptible to the aging mechanism identified and for which an AMP is applicable.

Licensing Basis –The set of NRC requirements applicable to a specific ISFSI or DSS design and a licensee's or CoC holder's written commitments for ensuring compliance with and operation within applicable NRC requirements and the ISFSI- or DSS-specific design basis (including applicable modifications and additions to such commitments over the life of the license or CoC) that are docketed and in effect. The licensing basis includes applicable NRC regulations and appendices thereto, orders, license conditions, exemptions and technical specifications. The licensing basis includes the ISFSI- and cask-specific design-basis information defined in 10 CFR 72.3 as documented in the latest ISFSI UFSAR or applicable DSS UFSAR revision for the ISFSI site. The licensing basis also includes a specific ISFSI licensee's commitments remaining in effect that were made in docketed licensing correspondence such as responses to NRC bulletins, generic letters and enforcement actions, as well as licensee commitments documented in NRC safety evaluations or licensee event reports. For general licensees and CoC holders, this means the respective commitments pertaining to the site ISFSI for a general licensee and the commitments pertaining to the generic cask design certification for the CoC holder.

Not Important to Safety – An item, function or condition related to the ISFSI, or its activities, that does not meet the definition of "Important to Safety."

Operating Plant Site – A nuclear plant site with at least one operating reactor.

Overpack – A storage cask used for housing a canister containing SNF at an ISFSI. An overpack may be sealed (unventilated) or ventilated.

Period of Extended Operation (PEO) – Pertaining the time frame, up to 40 years, after the initial specific license or CoC term.

Plant (or Plant Site) – An operating or shutdown nuclear generating station that has SNF stored on site and has, or had one or more reactors on the site.

Pre-application Inspection – This is an inspection performed at the discretion of the licensee and/or CoC holder prior to submittal of the license or CoC renewal application to (1) identify any unanticipated degradation, (2) to confirm existing TLAAs and inform the extension of those TLAAs throughout the PEO, and (3) to help determine the appropriate AMPs needed through the period of extended operation.

Safety Function (NUREG-1927) – A function defined as important to safety (ITS). The ITS functions that SSCs are designed to maintain include:

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

Shutdown Reactor – A reactor that has permanently ceased operating. A shutdown reactor may be located on an operating plant site or a shutdown plant site.

Shutdown Plant Site – A nuclear plant site where all reactors have permanently ceased operating.

Specific License – A license granted by the NRC to a specific entity to construct and operate an ISFSI at a specific geographic location in response to an application submitted for review in accordance with 10 CFR 72.40.

Spent Nuclear Fuel (SNF) (10 CFR 72.3) – Fuel that has been withdrawn from a nuclear reactor following irradiation, has undergone at least one year's decay since being used as a source of energy in a power reactor, and has not been chemically separated into its constituent elements by reprocessing. SNF includes the special nuclear material, byproduct material, source material, and other radioactive materials associated with fuel assemblies.

Surrogate – A DSS or other ISFSI SSC that has been determined by the licensee or CoC holder to provide applicable monitoring or inspection information for other similarly situated components based on its geographic location, length of service and other criteria deemed appropriate by the stakeholders. A surrogate could also be part of a research and development program evaluating relevant aging-related degradation mechanisms not necessarily co-located at an ISFSI site (e.g., a laboratory).

Time-Limited Aging Analysis (TLAA) (10 CFR 72.3) - A specific licensee or CoC holder calculation or analysis that has all of the following attributes:

- involves SSCs 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 functions
- is contained or incorporated by reference in the licensing basis.

Tollgate – A requirement included in a renewed ISFSI license or CoC, and associated UFSAR for the licensee to perform and document an assessment of the aggregate impact of aging-related dry cask storage operational experience, research, monitoring and inspections at specific points in time during the PEO.

Tollgate Assessment – A written evaluation, performed by licensees at each tollgate, of the aggregate impact of aging-related dry cask storage operational experience, research, monitoring, and inspections on the intended functions of in-scope dry cask storage SSCs. Tollgate assessments may include non-nuclear and international operating information on a best-effort basis. Corrective or mitigative actions arising from tollgate assessments are managed through the corrective action program of the specific or general licensee and/or the CoC holder.

Transfer Cask – A metal cask used to provide temporary shielding and structural protection for the spent fuel canister during fuel loading in a spent fuel pool and during transfer of the loaded canister to or from the storage overpack or transportation cask. The transfer cask has lifting trunnions to permit engagement with other components such as a transfer trailer and cask handling crane lift yoke.

Updated Final Safety Analysis Report (UFSAR) (10 CFR 72.48) – FSAR (as updated) means:

- for specific licensees, the Safety Analysis Report for a facility submitted and updated in accordance with 10 CFR 72.70
- for general licensees, the Safety Analysis Report for a spent fuel storage cask design, as amended and supplemented
- for CoC holders, the Safety Analysis Report for a spent fuel storage cask design submitted and updated in accordance with 10 CFR 72.248.

The FSAR for both specific licensees and CoC holders is the first version of the safety analysis report issued just after the initial approval of the ISFSI license or DSS design. The UFSAR for specific licensees and CoC holders is always the latest revision updated thereafter, pursuant to §72.70 or §72.248, as supplemented by changes authorized under the provisions of 10 CFR 72.48.

The above definition of UFSAR for general licensees requires additional clarification. For general licensees, the UFSAR is owned and maintained by the CoC holder for the cask design(s) used at the ISFSI. The UFSAR for the general licensee is the UFSAR revision used to load the particular serial number cask(s) and place them into storage at the ISFSI, as revised by any applicable 10 CFR 72.48 changes made by the CoC holder and the general licensee. Once the casks loaded under a particular cask UFSAR are placed into service at a generally licensed ISFSI, the UFSAR revision and 10 CFR 72.48 changes applicable to a given serial number cask remain constant unless the CoC holder requires a change to be applied to a previously loaded cask. A general licensee also has the option to choose to apply a later CoC amendment and associated UFSAR revision to previously loaded casks pursuant to 10 CFR 72.212(b)(4). Because of this unique situation for general licensees, different casks in service at the same ISFSI under the same CoC may have different licensing bases.

GUIDANCE FOR OPERATIONS-BASED AGING MANAGEMENT FOR DRY CASK STORAGE

1 INTRODUCTION

1.1 PURPOSE

The purpose of NEI 14-03 is to complement the 10 CFR 72 license and Certificate of Compliance (CoC) renewal review guidance in NUREG-1927, "Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel [10]," Section 3.0, "Aging Management Review," Section 1.4.4, "Application Content, and Section 1.4.6, "Amendment Applications Submitted During the Renewal Review or After the Renewal is Issued." NEI 14-03 is intended to facilitate a consistent approach to the preparation of 10 CFR 72 license and CoC renewal applications given that there is currently a limited amount of operational and research data available on aging mechanisms that could affect dry cask storage structures, systems and components (SSCs).[3] In addition, the industry determined it would be beneficial to develop additional clarifying guidance for the format and content of renewal applications.

In nearly 30 years of dry storage operation, there has been no instance in which aging-related degradation has been observed to have affected the ability of any SSC to perform its intended function. Nevertheless, some dry cask storage component aging mechanisms are well-known and a great deal of information is available from power plant experience (e.g., concrete and bolted connections exposed to the environment). These postulated aging mechanisms, while well-understood from a scientific standpoint, have not been observed to have affected important-to-safety SSCs at operating Independent Spent Fuel Storage Installations (ISFSIs). Therefore, there is insufficient operating data to predict whether or not they might occur or, if they do, to determine the timeframe during the period of extended operation (PEO) for such mechanisms to produce aging-related degradation.

Furthermore, there may be some dry cask storage component aging mechanisms that are not yet known due to the relatively short time periods the storage systems have been in service (less than 30 years nationwide as of this writing). These factors make it difficult to perform, at the time of the renewal application submittal, Aging Management Reviews (AMRs) for all in-scope SSCs that address the maintenance of intended safety functions through the end of the PEO. Two items of particular interest in this regard are High Burnup (HBU) fuel performance and stainless steel dry storage system (DSS) canister integrity, especially with respect to potential Chloride-Induced Stress Corrosion Cracking (CISCC). NEI 14-03 is designed to direct the development of operations-based AMRs and Aging Management Activities (AMAs) for ISFSIs and DSSs that incorporate future operating experience, research, monitoring and inspections in a "learning" manner.

[3] In this document, the term SSC includes associated subcomponents as defined in NUREG-1927 [10].

1.2 BACKGROUND

Title 10 of the Code of Federal Regulations, Part 72 (10 CFR 72) provides the regulatory requirements for the independent storage of spent nuclear fuel, high-level waste and Greater-Than-Class-C (GTCC) waste outside of the spent fuel pools at nuclear power plants. Storage of spent nuclear fuel in spent fuel pools at nuclear power plants is governed by the reactor's 10 CFR 50 or 10 CFR 52 license. 10 CFR 72 offers two types of licenses for the storage of spent nuclear fuel and other related materials at an ISFSI: specific and general. A specific license must be used for an ISFSI not co-located on a site governed by a 10 CFR 50 or 10 CFR 52 NRC license. Either a specific or a general Part 72 license may be used for an ISFSI co-located on a site governed by a 10 CFR 50 or 10 CFR 52 NRC license. A Part 50 or Part 52 license may govern a site with one or more operating reactors or a site with all reactors permanently shut down.

1.2.1 Specific License

A Part 72 specific license, as its name suggests, is a stand-alone license applicable to one ISFSI at one geographic location. The licensing basis for a specific ISFSI license includes the special nuclear materials license (including license conditions and technical specifications) and an associated Updated Final Safety Analysis Report (UFSAR). The licensing and design bases for a specific ISFSI license address only the facility, location, storage system design and spent fuel or other material (such as GTCC waste) to be stored at that ISFSI. There is one licensee for each 10 CFR 72 specific license. A Part 72 specific license may be renewed by the licensee for a term of up to 40 years beyond its initial term by submittal of a renewal application and approval by the NRC. There is no limit on the number of times a Part 72 specific license may be renewed. Renewal applications for specific ISFSI licenses must include appropriate measures to address aging management.

In accordance with 10 CFR 72.42(c), as long as the specific license renewal application has been submitted in a timely manner—at least two years prior to the license expiration date—the license will not expire until such time as the NRC has made a determination on the license renewal application. This process is known as "timely renewal."

1.2.2 General License

A Part 72 general license is granted by rule (10 CFR 72.210) to any holder of a 10 CFR Part 50 or 10 CFR Part 52 license for the operation of an ISFSI on the site of the reactor governed by that Part 50 or Part 52 license. General licensees must meet all of the conditions of the general license enumerated in 10 CFR 72.212 plus any regulations applicable to general licensees as listed in 10 CFR 72.13. One of the key general license conditions requires the licensee to use an NRC-certified cask[4] design at the ISFSI. Upon approval of a cask design, the NRC issues a CoC to the applicant (usually the cask vendor), who becomes the CoC holder as defined in 10 CFR 72. The CoC holder then issues an FSAR for the cask and updates it periodically in accordance with 10 CFR 72.248. The CoC for the approved cask design, including all approved amendments thereafter is listed in 10 CFR 72.214, "List of Approved Spent Fuel Storage Casks."

[4] The term "cask" or "dry storage system" is used in this guidance generically, as it is in the 10 CFR 72 regulations, to apply to all types of dry spent fuel storage technologies (i.e., vertical, horizontal, ventilated, bolted lid, underground, etc.)

General licensees may use any NRC-certified cask design (or more than one) at an ISFSI. The term of the general license is tied to the term of the CoC and begins for each licensee when the first cask is deployed at the ISFSI and ends when the last cask is removed from the ISFSI. Within the overall general license ISFSI term, each cask has its own general license term that begins when that cask is placed into service at the ISFSI. A Part 72 general license is renewed for the ISFSI and each cask if and when the CoC (including amendments) for that cask is renewed. A cask CoC may be renewed for up to 40 years beyond its initial term by submittal of a renewal application by the CoC holder (or by a user of that cask if the CoC holder does not submit it) and approval by the NRC. There is no limit on the number of times a Part 72 CoC may be renewed, thus renewing the associated users' general licenses. Renewal applications for CoCs must include appropriate measures to address aging management, which the general licensees are required to implement.

Timely renewal also applies to general licenses. In accordance with 10 CFR 72.240(b), as long as the CoC renewal application has been submitted in a timely manner—at least 30 days prior to the CoC expiration date— the general licenses for the casks in service remain valid and the casks may stay in service until such time as the NRC has made a determination on the CoC renewal application.

1.3 Applicable Regulations and Guidance

The following regulations and staff review guidance are applicable to ISFSI and cask licensing:

- Title 10 of the *Code of Federal Regulations* (10 CFR) 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste." [1]

- NUREG-1536, "Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility." [8]

- NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities." [9]

- NUREG-1927, "Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel." [10]

- NUREG/CR-6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Important to Safety." [11]

1.4 Scope

The scope of NEI 14-03 is to complement NUREG-1927 [10], the NRC standard review plan (SRP) governing the review of ISFSI license and DSS CoC renewal applications. NEI 14-03 is intended to provide guidance to specific licensees and CoC holders for addressing operations-based aging management in their renewal applications and to expand on the format and content guidance in NUREG-1927 for these applications. NRC endorsement of NEI 14-03 will also support its use in the staff's reviews of renewal applications.

NEI 14-03 provides a recommended process for addressing aging management of SSCs that maintains intended safety functions for storage through the end of the PEO. The SNF canister or bare fuel cask pressure boundary performs the confinement function that must be maintained throughout the PEO. The exterior surfaces and components of canisters, casks and storage modules fall into the realm of aging management because a) they are subject to atmospheric environmental conditions and b) they are accessible for inspection to varying degrees.

The stored contents and cask internals are also included in the scope of NEI 14-03. However, because these components are not subject to atmospheric environmental effects and are not readily accessible, they are addressed in a unique context. See Section 3.6.1.1 for additional discussion.

Not included in the scope of guidance provided in NEI 14-03 are NUREG-1927, Section 1.0, "General Information Review"[5] and Section 2.0, "Scoping Evaluation." Development of the information for these parts of the renewal application is adequately covered in NUREG-1927 with additional information provided in supporting documents such as Argonne National Laboratory Report FCRD-UFD-2014-000476, "Managing Aging Effects on Dry Cask Storage Systems for Extended Long-Term Storage and Transportation of Used Fuel" [12]. These documents are being used as bases by the NRC for its planned Managing Aging Processes for Storage (MAPS) document, which is intended to serve a role for dry cask storage similar to the role that NRC's Generic Aging Lessons Learned (GALL) Report (NUREG-1801) serves for nuclear power plant aging management.

NEI 14-03 does not address the details of technical issues, identification of Time-Limited Aging Analyses (TLAAs), or the development of specific Aging Management Programs (AMPs) for in-scope SSCs because these activities are the responsibility of the specific licensee and CoC holder based on the specific storage cask design and service environment(s) under consideration. NEI 14-03 is intended to provide guidance for licensee and CoC holders to submit renewal applications that are reasonably consistent in format and content to support efficient NRC review. Guidance pertaining to format and content of applications is found in Section 2 of this document and is intended to complement the guidance in NUREG-1927, Sections 1.4.4 and 1.4.6.

The scope of NEI 14-03 is limited to the first PEO of a maximum of up to 40 years beyond the initial term of the license or CoC. Issues pertaining to extended storage beyond the first renewal period are not part of initial renewal applications and are therefore not specifically addressed in NEI 14-03. Even though some of the issues overlap, the knowledge base and expected level of understanding of these issues should be significantly improved after decades of additional operating experience. That knowledge will be used for subsequent renewal activities, including updated TLAAs and AMPs.

Also, transportation of spent fuel and other cask contents after storage at an ISFSI is outside the scope of NEI 14-03. The industry recognizes that dry cask storage component aging mechanisms can have effects relevant to transportation and the requirements in 10 CFR 71. However, these issues are not directly considered in the renewal of 10 CFR 72 licenses and CoCs. While it is a prudent business practice for licensees to take appropriate steps to assure future transportability

[5] Except for Sections 1.4.4 and 1.4.6.

of stored spent fuel and other cask contents, it is not a regulatory requirement that must be met to assure the safe storage during the PEO.

1.5 USE OF PRECEDENT

As of this writing, four 40-year Part 72 specific license renewals have been granted for ISFSIs using dry storage casks: Surry, Robinson, Oconee and Calvert Cliffs.[6] One additional specific license renewal (Prairie Island) has completed the technical review, but the renewed license has not yet been issued. Two CoC renewals (VSC-24 and Standardized NUHOMS®) are currently under NRC review. The Surry, Robinson and Oconee renewals were approved prior to the publication of NUREG-1927, and the cask contents in those renewals only included low burnup fuel.

While the Surry, Robinson and Oconee renewal applications are useful to inform the preparation of future applications, they should not be considered wholly precedent-setting. Technical information, guidance and research made available since these licenses were renewed should be considered in future license and CoC renewal applications. The Calvert Cliffs, Prairie Island, VSC-24 and Standardized NUHOMS® applications are serving as useful precedents. Because these renewal applications were being prepared or were already under review by the NRC contemporaneously with the development of this guidance, they essentially piloted the learning aging management concept. It is anticipated that future renewal applications will further refine this concept.

1.6 APPLICABILITY TO A CONSOLIDATED INTERIM STORAGE FACILITY

Given the persistent delay in the development of disposal capability for spent fuel in the United States, there is a possibility that one or more consolidated interim storage (CIS) facilities may be designed, licensed and operated to receive and temporarily store spent nuclear fuel and other cask contents until a permanent federal repository is available. A CIS facility would likely be a 10 CFR 72 specific-licensed facility. At least some of the spent fuel and other contents will arrive at a CIS facility in canisters or dual-purpose transportable bare fuel storage casks that have been in ISFSI service for significant periods of time at reactor sites before being transported to the CIS facility. Thus, a CIS facility would receive canisters and dual-purpose bare fuel casks that were stored at the plant sites under the general or specific 10 CFR 72 license for the site ISFSIs, transported to the CIS facility under 10 CFR 71, and placed back into storage service under a different specific Part 72 license for the CIS facility.

It is likely that canisters and dual-purpose bare fuel casks placed into service at a CIS facility will enter the PEO either prior to or during their time in service at the CIS facility. Thus, these canisters and bare fuel casks would be subject to aging management at the CIS facility during the initial license term of the CIS facility. Thus, a CIS facility license application would need to address aging management of storage canisters and dual-purpose casks that have been in prior storage for an extended period of time at an ISFSI and NEI 14-03 would help inform the preparation of such an application.

[6] The licenses for the ISFSIs at Morris and Fort St. Vrain have also been renewed but are not considered germane to this guidance because neither uses casks for storage.

It is worth noting that while some canisters may be subject to aging management immediately upon deployment at a CIS facility or some short time thereafter, the storage casks, overpacks and horizontal storage modules (HSMs) may be newly constructed and not subject to aging management until the CIS facility license is renewed. That is, the time related to aging management applies to the time in service for each individual DSS and each SSC within the DSS, and may be different for different individual DSSs.

2 RENEWAL APPLICATION FORMAT AND CONTENT

2.1 EXPERIENCE

Four 10 CFR 72 specific ISFSI license renewal applications involving dry storage casks have been reviewed and approved by the NRC[7](Surry, Robinson, Oconee and Calvert Cliffs). A fifth (Prairie Island) has been reviewed and approved by NRC's technical staff but is awaiting the completion of the adjudicatory phase of the licensing process. Specific ISFSI licenses are less complex than CoC renewals because they address one ISFSI, and only the latest ISFSI license amendment and UFSAR are active. The precedents for format and content in these five applications as well as the staff review guidance in NUREG-1927 are instructive along with NEI 14-03, which addresses operations-based aging management and tollgates. The experience from these five applications has been considered in preparing NEI 14-03.

Also of interest, the VSC-24 Storage System (CoC 1007) and the Standardized NUHOMS® Storage System (CoC 1004) renewal applications are the only CoC renewal applications that have been submitted to the NRC as of this writing. These applications followed the guidance in NUREG-1927, Revision 0, and included elements of the original issue of NEI 14-03. These applications provide precedents for CoC renewal applications and have also been considered in the development of NEI 14-03, Revision 1.

It should be noted that the VSC-24 is a DSS design that is no longer being fabricated for future use at ISFSIs. The 57 VSC-24 systems that have been placed in service contain all low-burnup fuel, and the canisters are fabricated of carbon steel. Thus, the VSC-24 CoC renewal application contains no information pertaining to aging management with regard to CISCC of stainless steel canisters and HBU fuel performance. On the other hand, the Standardized NUHOMS® System continues to be fabricated and deployed at ISFSIs around the country. The allowed contents for the system include HBU fuel, and thus its license renewal application addresses these issues.

2.2 APPLICATION FORMAT AND CONTENT

NUREG-1927 provides basic information on renewal application format and content. The following provides additional guidance to complement NUREG-1927. Specific license renewal applications are required to contain information that CoC renewals are not, such as an environmental report and financial assurance, neither of which is discussed in detail in this guidance. The general structure and aging management portions of both specific license and CoC renewal applications should be organized as discussed in the subsections below.

2.2.1 Cover Letter

A brief cover letter should be prepared and signed by an appropriate company authority for the license or CoC that identifies the date of submittal, docket number, the name of the facility or storage technology, the date of expiration for the license or CoC, and include a formal request for renewal of the license or CoC pursuant to either 10 CFR 72.42 (for specific licenses) or 10 CFR 72.240 (for CoCs). The cover letter should be addressed as directed in 10 CFR 72.4, provide a

[7] Not including the Morris and Fort St. Vrain ISFSIs.

name and contact information for a person responsible for interfacing with the NRC on matters pertaining to the application, and state whether the application contains any proprietary information. Lastly, if not included elsewhere in the application, the cover letter should clearly, but briefly, identify the information in the attachments and/or enclosures. A "cc" list should be provided indicating others to whom copies of the application were sent directly, e.g., the NRC project manager and general licensee users.

2.2.2 Enclosures

The overall structure of the enclosures should be consistent with NUREG-1927 and NEI 14-03. The applicant may organize the enclosures of the renewal application in any suitable way that is complete, accurate and comprehensive with respect to necessary content and clearly describe the location of the information in the submittal. References used in the application should be cited by edition or version and section or page number. If a reference is not readily available in the open literature (e.g., a consensus code or standard, or NRC-published document), it should be included with the application, pursuant to applicable copyright laws. Proprietary material should be identified and an affidavit requesting withholding pursuant to 10 CFR 2.390 included as appropriate. If proprietary material is included, a non-proprietary version of the document should be provided with the submittal or in a separate submittal shortly thereafter.

The enclosure(s) should begin with a table of contents that includes sections and subsections that align with the sections and subsections in NUREG-1927, which will be used to review the application and provides a template for the NRC's Safety Evaluation report (SER). These NUREG-1927 sections should be preceded with a background section that describes the ISFSI and/or storage technology and summarizes the licensing history and current state of use of the cask. For instance, if the casks are no longer being deployed or certain CoC amendments are no longer being used for cask loadings, it is important to include statements to this effect. A regulatory compliance matrix describing where the information is located in the application for each applicable regulation and NUREG-1927 review criterion is recommended. Include in this matrix or somewhere nearby in the application a table or listing that clearly indicates where deviations from the guidance in NUREG-1927 and/or NEI 14-03 are taken and justification for those deviations.

CoC holders should consider excluding from the renewal scope any amendment(s) that are not part of the licensing basis for casks in service under a general license at any of its users' ISFSIs. For those amendments being renewed, the application should include the information in NUREG-1927, Section 1.4.4, pertaining to multiple amendment renewals. The application may refer to information pertaining to another amendment being renewed if it applies to more than one amendment rather than repeating the information. The CoC holder should provide a list of drawings for the licensed components applicable to each amendment (i.e., part of the certification basis). If the latest drawings apply to earlier amendments and/or the initial certificate, those drawings should be listed with a discussion to that effect.

A standardized format for a renewal application is provided in the subsections below. It has been developed to be in alignment with NUREG-1927 and incorporates insights from power plant license renewal applications. This standardized format should be considered a baseline for renewal applications. As the license renewal process matures, lessons learned from recent

renewal applications and SERs should be incorporated into subsequent renewal applications. Applicants should add subsections, appendices, and attachments as appropriate.

2.2.2.1 Section 1, General Information

The renewal application contains the technical information that the NRC staff will review to determine if the effects of aging on long-lived passive structures and components are being managed such that the associated intended function(s) is maintained consistent with the applicable licensing basis in the period of extended operation. The technical information should be of sufficient detail to allow the NRC to make the finding that there is reasonable assurance that the activities authorized by the renewed license will continue to be in accordance with the licensing basis.

The application should contain a clear and concise presentation of the required information. Confusing or ambiguous statements and unnecessarily verbose descriptions do not contribute to expeditious technical review. Claims of adequacy in the aging management review should be supported by technical bases.

The NRC staff reviewers will use NUREG-1927 during their evaluation of the application. An applicant should identify differences from NUREG-1927 and NEI 14-03 in the application. Generally, applicants may find it beneficial to adapt elements of the NUREG-1927, Appendix C sample AMPs, where applicable. In their renewal application, applicants should identify any Interim Staff Guidance (ISG) documents or other guidance that is being used to augment or replace guidance in NUREG-1927 or NEI 14-03.

The application is based on the information contained in ISFSI-specific and cask-specific licensing and design basis documentation. However, detailed procedures/calculations should not be included in the license/CoC renewal application. Once the renewal is approved, the application is a historical licensing document and is not required to be updated.

2.2.2.2 Section 2, Scoping Evaluation

The scoping process involves identification of the SSCs of the ISFSI that are within the scope of renewal, and thus require evaluation for the effects of aging. This section should contain (1) a description of the scoping process, and (2) the scoping results.

a. Scoping Methodology

   This subsection should describe the process for identifying the in-scope components, the criteria used to scope, and the basis for scope determination consistent with NUREG-1927, Chapter 2. The scoping criteria used for this evaluation are defined in NUREG-1927, Section 2.4.2 may be based upon the Important-To-Safety (ITS) Quality Assurance classification system described in the ISFSI or DSS UFSAR. The applicant should also provide a list of source documents that were used during the scoping process. Minimum source documents should include the licensing basis (UFSAR, license/CoC, technical specifications, exemptions, docketed licensing correspondence).

b. Scoping Results

To aid NRC review, a standardized table should be used in this section which identifies the ISFSI or DSS SSCs, and present the scoping results. For each SSC, the applicant should identify the following:

- intended function
- safety classification
- whether it meets any of the NUREG-1927 scoping criteria (basis for scope determination)
- scope determination (in or out of scope).

The results of this section are used as the basis for Section 3 of the renewal application, Aging Management Review.

2.2.2.3 Section 3, Aging Management Review

The purpose of the AMR process is to assess the in-scope SSCs with respect to aging mechanisms and effects that could affect the ability of the SSC to perform its intended function during the renewed license period. The AMR process involves the following four major steps:

a. Identification of In-scope SSCs Requiring Aging Management Reviews (Screening)

Use the results from Section 2 of the renewal application to determine all SSCs associated with in-scope structures and components. SSCs that perform or support any one of the identified intended functions in a passive manner, without moving parts or a change in configuration or properties, are determined to require an aging management review. Those SSCs that either do not support an intended function, or perform an intended function by a change in configuration or properties (active), or are subject to replacement based on a qualified life or specified time period (short-lived), are excluded from further evaluation in the AMR with supporting justification.

The renewal application should include subsections for each of the in-scope SSCs. The subsection should describe the SSC and its function(s) at a level-of-detail that can be used in the safety evaluation report. SSC descriptions can often be developed from the ISFSI or DSS UFSAR. Functions should be consistent with those described in the UFSAR.

b. Identification of Materials and Environments

The materials of construction of in-scope SSCs and service environments are typically identified through a review of pertinent design and/or design basis documents. The materials and environments play a critical role in determining the potential aging effects.

Identified environments are those that the SSCs are normally exposed to (for prolonged periods of time). Applicants should include a description of environments used in the renewal application (see NUREG-1927, Section 3.4.1.1 for considerations when describing environments).

Specific licensees identify the materials and the specific environment at that particular ISFSI site. CoC holders should identify limiting materials and environments within the previously-approved range of use for the DSS. Differences in these parameters across CoC amendments may be identified, as appropriate, and flexible AMPs created according to those differences. For instance, a particular CoC amendment may only be permitted to be used at a limited number of ISFSI sites by a condition or other requirement in the CoC. In this case, the materials and environments for renewal of that amendment may be limited to those storage systems and sites, if desired by the applicant.

c. Identification of Aging Effects Requiring Management

Aging effects requiring management during the PEO are those that could, if not addressed in a timely manner, cause a loss of passive SSC intended function(s). If degradation of an SSC would be insufficient to cause a loss of intended function, or the relevant conditions do not exist at the ISFSI for the aging effect to occur and propagate, then no aging management is required.

The AMR should include aging effects and mechanisms 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. Although NRC guidance is not currently available regarding expected aging effects for ISFSIs, NUREG-1801, "Generic Aging Lessons Learned (GALL) Report" for nuclear power plant license renewal provides expected aging effects. The GALL Report may be a helpful source for applicants. The U.S. Department of Energy (DOE) document "Managing Aging Effects on Dry Cask Storage Systems for Extended Long-Term Storage and Transportation of Used Fuel" [12] and the planned NRC MAPS guidance document provide a similar level of detail for dry storage systems.

d. Determination of the Activities/Programs Required to Manage Aging

Either TLAAs or AMPs may be used to address and manage dry cask storage aging. This section merely lists the name of the TLAA or AMP. TLAAs are evaluated in Section 4 of the renewal application. Specific AMP details are provided in Appendix A of the renewal application.

To aid NRC review, standardized tables should be used in this section, one for each in-scope SSC. Each table should identify the SSCs, intended function(s), material, environment, aging mechanism, aging effect, whether aging management is required, and what program/activities are being used to manage the aging effect. If a material and environment has more than one aging effect or mechanism, each should be addressed in separate table rows. Appendix B to this document provides an example table for presentation of this information.

2.2.2.4 Section 4, Time-Limited Aging Analyses

An analysis, calculation or evaluation is a TLAA under 10 CFR 72.3 only if it meets *all* six of the following criteria:

> Time-limited aging analyses, for the purposes of this part, are those licensee or CoC holder calculations and analyses that:
>
> (1) involve SSCs within the scope of license renewal
>
> (2) consider the effects of aging
>
> (3) involve time-limited assumptions defined by the current operating term, for example, 40 years
>
> (4) were determined to be relevant by the licensee in making a safety determination
>
> (5) involve conclusions or provide the basis for conclusions related to the capability of the SSC to perform its intended functions
>
> (6) are contained or incorporated by reference in the design basis.

In this section of the renewal application, the applicant should describe and present the results of the process used to identify and screen TLAAs, consistent with NUREG-1927, Section 3.5. The applicant should perform a systematic review of the ISFSI design basis. If analyses do not meet *all* of the six criteria, they are not TLAAs.

For each identified TLAA, applicants should describe the evaluation of the analysis for the PEO. TLAAs should provide conclusions or a basis for conclusions regarding the capability of the SSC to perform its intended function through the PEO. Level-of-detail should be provided such that the NRC can independently conclude the TLAA is adequate. The TLAA must demonstrate that either the existing analysis remains valid for the PEO or the analysis has been revised to extend to the end of the PEO. If one of these conditions cannot be demonstrated, an AMP is required for the affected SSC to manage the aging effect(s).

2.2.2.5 Appendix A, Aging Management Programs

Appendix A of the renewal application lists and describes the AMPs and activities referenced in Section 3 of the renewal application (see Subsection 2.2.2.3). These programs are used to monitor and control the degradation of in-scope SSCs. NUREG-1927, Appendix C provides example aging management programs for three SSCs. Aging management programs descriptions are also available in license and CoC renewal applications previously-accepted by the NRC, the DOE's dry cask storage aging management report [12], and the forthcoming NRC MAPS report. NUREG-1927 and prior applications provide certain methods to manage aging effects. Other aging management programs for in-scope SSCs may be demonstrated to be adequate by licensees and CoC in the renewal application.

Consistent with NUREG-1927, Section 3.6, for each AMP described in Appendix A, all ten elements should be addressed:

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
10. Operating Experience.

2.2.2.6 Appendix B, Granted Exemptions

Appendix B of the renewal application includes the methodology used to determine what exemptions are in effect for a specific ISFSI license. For each exemption in effect, the specific licensee describes how the exemption is affected by or affects aging management. CoC holders generally do not have approved exemptions outside of those granted within the CoC itself. General licensees should evaluate the impact of site-specific exemptions for their ISFSI on the requirements in the renewed CoC. These impacts should be addressed in the general licensee's 10 CFR 72.212 Report.

2.2.2.7 Appendix C, Proposed License/CoC Changes

Appendix C of the renewal application includes proposed conditions or other changes to the license or CoC governing implementation of the renewed license or CoC. Markups of the change pages is the preferred method of indicating the proposed changes. Justification may be included herein, or may reference other parts of the renewal application. The requirement for licensees to perform tollgate assessments should be included in the proposed license/CoC changes.

2.2.2.8 Appendix D, UFSAR Supplement

The contents of the ISFSI or storage system UFSAR supplement will be based on the technical information provided in the application. The UFSAR supplement should include:

- scoping results
- table of AMR results
- summary description of the programs and activities for managing the effects of aging for the period of extended operation as determined by the aging management review
- summary description of the evaluation of time-limited aging analyses for the period of extended operation
- summary of the frequency and content of tollgate assessments (see Section 4.6.5 of this document for guidance)
- listing of commitments (optional).

2.2.2.9 Additional Appendices

An applicant may use additional appendices for other information that does not fit into the main sections of the application or other appendices. For specific licensees, additional appendices should be used to provide an Environmental Report (ER) supplement and Financial Assurance information.

The specific license renewal application must contain an ER that supplements the original ER for the facility, as required by 10 CFR 51.61, "Environmental Report — Independent Spent Fuel Storage Installation (ISFSI) or Monitored Retrievable Storage Installation (MRS) License" 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.

For CoC holders, a separate appendix may be used to explain the structure of the renewal application, if desired. Specifically, the CoC holder should provide:

- a guide to the renewal application to identify which CoC amendments are being requested to be renewed
- a table describing each amendment, what changed from the original certificate and/or previous amendments.

2.2.3 10 CFR 72.48

Over the initial license period of the ISFSI or DSS, modifications to the ISFSI facility, cask design or procedures may have been implemented under the provisions of 10 CFR 72.48. By definition, modifications to the ISFSI or DSS design, operation or safety analyses authorized under the provisions of 10 CFR 72.48 (as opposed to a license or CoC amendment) do not require prior NRC review and approval. CoC holders and licensees are required to submit to the NRC biennially a summary of changes made pursuant to 10 CFR 72.48 and to clearly identify UFSAR changes made under 10 CFR 72.48 in the biennial updates to that document. Thus, it is not required to separately submit the details of each modification authorized by 10 CFR 72.48 as part of the renewal application.

That said, the changes made under 10 CFR 72.48 may affect the component drawings or other UFSAR information that is germane to the NRC's review of the renewal application. Thus, the drawing list and UFSAR information provided to the NRC in the renewal application (for each amendment in the case of a CoC renewal) should reflect all 10 CFR 72.48 changes applicable to that CoC amendment and associated UFSAR revision. At the applicant's discretion, the biennial 10 CFR 72.48 reports submitted to the NRC to date could be submitted with the application. See Section 2.2.4 for additional discussion of cask UFSARs.

10 CFR 72.48 is also the appropriate regulatory process to be used to modify UFSAR-described TLAAs and AMPs as a result of tollgate assessments or other operations-based aging management feedback received between tollgate assessments. 10 CFR 72.48 provides the appropriate set of public health and safety-based criteria for determining whether NRC review and approval of revised TLAAs and AMPs is required prior to implementation. 10 CFR 72.48 permits the timely revision to TLAAs and AMPS by licensees and CoC holders in response to information received indicating such changes are appropriate. This approach is also consistent with Part 50 power plant aging management programs, where such information resides in the plant UFSAR and is subject to the change controls in 10 CFR 50.59.

Fabrication deviations that were not generic design changes but were accepted as-is or repaired may have required a 10 CFR 72.48 review. Such deviations should be reviewed and appropriately addressed by the applicant in the context of the PEO and aging-related degradation.

2.2.4 Dry Storage System UFSARs

Generally speaking, DSS UFSARs are not currently developed and maintained such that a single, latest UFSAR revision is applicable to all active CoC amendments. This has resulted in the coexistence of multiple discrete cask licensing bases at many general license ISFSIs, comprised of the applicable CoC amendment under which each group of casks were loaded and the UFSAR revision associated with that amendment. Subsequent UFSAR revisions generally are not adopted by the general licensee unless a later CoC amendment is also adopted. CoC holders should ensure the application is clear when describing the applicability of TLAAs and AMPs to specific amendments and associated UFSAR revisions.

2.2.5 AMP Implementation

The license or CoC renewal application should include technical information supporting the basis for the AMPs, organized by the ten elements identified in NUREG-1927. A thorough and well-organized application reduces the likelihood for Requests for Supplemental Information (RSIs) before the NRC's technical review begins and will minimize the number of Requests for Additional Information (RAIs) during the technical review. Information provided should be of sufficient detail to allow the NRC staff reviewers to gain a clear understanding of the proposed aging management program to make a determination whether to renew the license or CoC. It is recognized that a considerable amount of detailed information will be in the documents that implement and support the application, and that this information is subject to NRC inspection. Therefore, the application should also include the proposed location of the more detailed levels of information for ongoing implementation of aging management activities by the licensee at the ISFSI as described in the subsections below.

2.2.5.1 License or Certificate of Compliance

The license or CoC should contain only high-level information as conditions of the license or CoC that are unlikely to change over the PEO. These conditions would obligate the specific or general licensee to implement the aging management activities described in the ISFSI or DSS UFSAR. Changes to these license or CoC conditions will require NRC review and approval. Too much detail in the license, and particularly the CoC, will inhibit the ability of licensees and CoC holders to implement changes to AMPs based on information learned from operations-based aging management (e.g., tollgate assessment findings) in a timely manner. This would be counterproductive to the objectives of a true "learning" approach to aging management and would have the potential to reduce the effectiveness of the AMPs.

2.2.5.2 ISFSI or DSS UFSAR

The applicant should include in the ISFSI or DSS UFSAR summaries of the TLAAs, at the same level of detail as the descriptions of the safety analyses included for original licensing. The level of detail in the ISFSI or DSS UFSAR should be limited to a summary of each AMP with reference to the renewal application for additional information. Changes to aging management information in the ISFSI or DSS UFSAR, including that incorporated by reference, are subject to review pursuant to 10 CFR 72.48 to determine if prior NRC review and approval is required.

2.2.5.3 AMP Implementing Procedures

AMPs are implemented by licensees in accordance with written procedures developed pursuant to the information in the ISFSI or DSS UFSAR. In most cases, these procedures will involve monitoring or inspections of in-scope SSCs. They direct personnel on what to look at and what techniques to use. They may or may not have detailed, actionable acceptance criteria extracted from the AMPs as described in the UFSAR. If they do not have actionable acceptance criteria, the subjective criteria for personnel to determine additional assessment or evaluation of a finding is required via the corrective action program should be sufficiently conservative to ensure virtually any unexpected finding is reviewed further. For instance, a corrosion inspection may have a subjective criterion of "any observable corrosion" or a concrete inspection may have a subjective criterion of "more than normal settlement cracking" for a concrete structure exposed

to the atmospheric environment. Refer to Appendix A of NUREG-1927 for guidance on the use of non-quantifiable terms.

Findings from monitoring and inspections would be entered into the site's corrective action program where a technical assessment would take place and specific, actionable acceptance criteria found in the UFSAR or renewal application would be used to determine any corrective actions required, including changes to the AMPs themselves.

Licensees should have an overarching aging management program document to govern site implementation of aging management consistently. This may be a new document or a revision to an existing program document such as the program document for aging management of a power plant operating under a renewed Part 50 license co-located with the ISFSI. This programmatic document is also an appropriate location for the actionable acceptance criteria for AMPs that can be referred to when a monitoring or inspection finding is being assessed in the corrective action program.

Changes to AMP implementing procedures and the program document would be subject to review pursuant to 10 CFR 72.48 to determine if prior NRC review and approval is required.

3 OPERATIONS-BASED AGING MANAGMENT

3.1 APPROACH

3.1.1 Summary

The overall approach of NEI 14-03 is to create a broad framework for integrating feedback from dry cask storage operating experience, research, monitoring and inspections into the management of aging-related degradation for in-scope SSCs at ISFSIs. This feedback has been, and will continue to be, assessed in accordance with licensee and CoC holder corrective action and operating experience programs. In conjunction with the development of NEI 14-03, the Institute of Nuclear Power Operations (INPO) has implemented the ISFSI Aging Management INPO Database for ISFSI licensees and CoC holders to collect and aggregate aging-related operating information. This database of information provides an efficient resource for ISFSI licensees and CoC holders to have timely access to aging dry cask storage aging management information. See Subsection 4.5 for additional discussion of this database.

NEI 14-03 provides guidance to be used in renewal applications that instructs licensees to perform aggregate assessments at pre-determined points in time during the PEO at their ISFSIs. These aggregate assessments are also intended to encourage licensees to consider relevant, publicly available information that pertains to dry cask storage aging effects and mechanisms from other appropriate sources, which may include international nuclear facilities. Non-nuclear facilities may also generate useful aging-related degradation information as well, and can be considered in tollgate assessments at the discretion of the licensee. This information should be factored into the implementation of the three primary steps of an aging management review, as appropriate:

1. materials and environments
2. identification of aging effects requiring management
3. activities required to manage the effects of aging
    a. time-limited aging analyses
    b. aging management programs.

3.1.2 Programmatic Hierarchy

Aging management is required by 10 CFR 72.42 and 10 CFR 72.240 to be addressed in specific ISFSI license renewal applications and CoC renewal applications, respectively. AMPs for in-scope SSCs not governed by TLAAs are required to be implemented by ISFSI licensees in order to operate the ISFSI during its PEO. This over-arching requirement should be included in the renewed license or CoC in the form of a high-level programmatic commitment. Like other plant programs, examples of which are included in the Administrative Controls section of a plant's technical specifications, a commitment for licensees to implement the AMPs for applicable SSCs does not include the details of implementation.

The detailed assessment of aging mechanisms, their effects, and the actions to be implemented to monitor the mechanisms and manage their effects are described in the ISFSI or cask UFSAR and

ultimately in site procedures which direct personnel actions in the field. See Section 2.2.5 for additional information on the location of aging management information in the ISFSI or DSS licensing basis documents.

3.1.3 Key Principles

Managing aging effects in a "learning" manner means ISFSI owners would monitor for indicators of aging-related degradation (e.g., SSC degradation mechanisms and the symptoms that would be indicators of potential SSC degradation). NEI 14-03 is intended to assist licensees and CoC holders in developing and implementing operations-based aging management reviews with the following attributes:

- safety-focused
- operations-based
- implemented within existing corrective action and operating experience programs
- qualitatively risk-informed based on relevant failure modes and effects
- forward-looking
- proactive
- responsive to condition-based monitoring.

The concept of "tollgates" is introduced with NEI 14-03. Tollgates are periodic points within the PEO when licensees would be required to document an aggregate safety assessment. Licensees will be obligated to comply with tollgate license or CoC conditions approved as part of the license or CoC renewal. Tollgate assessments are an additional set of in-service assessments beyond the normal continual assessment of operating experience, research, monitoring, and inspections on dry cask storage component performance that is part of normal ISFSI operations for licensees during the initial license period as well as the PEO. See Section 3.6.5 for additional discussion of tollgates.

3.2 LICENSING BASIS

It is important for the licensee or CoC holder who is preparing a renewal application to understand and be able to document the licensing basis (or bases) upon which the ISFSI license or CoC renewal application is based. The renewal application for a CoC should recognize the fact that general licensees may use whatever DSS CoC amendment and associated UFSAR revision they choose, and that some general licensees may have more than one such licensing basis governing the DSSs at their ISFSI. The licensing basis for renewal excludes physical security and emergency planning as stated in NUREG-1927 [10]. The licensing basis for renewal includes:

- the current 10 CFR 72 regulations as they apply to license/CoC renewal
- the specific 10 CFR Part 72 license, as amended
- approved exemptions from 10 CFR 72 (as applicable)
- the initial CoC and all approved amendments the CoC holder desires to renew
- the ISFSI or DSS UFSAR, as modified by changes authorized under 10 CFR 72.48 and to reflect approved amendments
- the versions of codes, standards and guidance specifically committed to in the license, CoC, and UFSAR (e.g., Regulatory Guides, NUREGs, ISGs, ASME Code, ACI Code, ANSI Standards, ASTM Standards, etc.).

License and CoC renewals are specifically focused on the management of aging effects required to provide reasonable assurance of continued safe storage of the cask contents through the PEO (up to 40 years for each renewal).

For CoCs, it is important to discuss the certification basis for each amendment to the CoC that is listed in 10 CFR 72.214 and identify for which of these amendments (if not all of them) renewal is being requested. The NRC will be reviewing each amendment for which renewal is requested by the CoC holder in the CoC renewal application. The certification basis for the initial CoC and for each CoC amendment includes the revision of the UFSAR (including separately revised licensing drawings) and the 10 CFR 72.48 changes applicable to that revision of the UFSAR. The renewal application should also specify the effective edition of the 10 CFR 72 regulations that applied to the initial CoC and the amendments for which renewal is being requested. The effects of any differences in the certification basis on the TLAAs and AMPs should be clearly explained in the application.

3.3 Design Basis Issues

The approved licensing basis for the ISFSI or DSS design as described above is the foundation for the renewal application and is static with respect to the scope of the application and the NRC review. The renewal application is not a re-evaluation of the ISFSI or DSS technology, or a vehicle for the applicant to seek non-renewal-related changes to the licensing basis, such as changes to the authorized cask contents, technical specifications or design changes to the ISFSI or DSS.

Issues that arise during operations-based aging management program implementation that are design-basis-related rather than aging-related issues should be handled in the corrective action program, the 10 CFR 72.48 program, the license/CoC amendment process or the exemption process. If design basis issues are generic in nature, the NRC and the industry should address them through the NRC's Generic Safety Issue program (NRC Management Directive 6.4 [26]). Such issues may ultimately have an effect on the implementation of aging management activities, but are addressed outside the renewal application. Likewise, emerging design basis issues discovered as a result of industry research or operating events are handled under the licensee or CoC holder corrective action program or, for NRC-identified issues, under the generic safety issue or other appropriate process separate from the review of the renewal application.

3.4 10 CFR 72 License and CoC Renewal Regulatory Framework

NEI 14-03 is administrative in nature and intended for use by Part 72 licensees and CoC holders in developing their license or CoC renewal applications. It complements the NRC staff's renewal application review guidance in NUREG-1927 by providing information on preparing those applications that is directed specifically to the licensee and CoC holder rather than the NRC staff reviewer. It is intended that the combined effect of NEI 14-03 and NUREG-1927 is that the preparer and reviewer of a specific ISFSI license or CoC renewal application will each approach the renewal with consistent expectations. These guidance documents are two elements of a broader regulatory framework that includes technical information and proposed AMP guidance being developed by others, and environmental impact statements and assessments covering storage of spent fuel and other contents at ISFSIs beyond the initially contemplated time periods.

Specific licensees and CoC holders should use the technical information and proposed AMPs developed by EPRI, the DOE, the NRC and others to identify (and update as necessary) the appropriate storage technology-specific and ISFSI-specific TLAAs, and develop AMPs for inclusion in their renewal applications. NEI 14-03 also introduces the concept of tollgates to be included in the renewal applications as described in further detail in later sections. Renewal applications should be developed using NUREG-1927 as supplemented by NEI 14-03.

3.5 TIME-LIMITED AGING ANALYSES AND AGING MANAGEMENT PROGRAMS

AMRs for degradation mechanisms having known (or well-understood) durations should be conducted as they have been historically for power plants. Appropriate TLAAs should be identified in the licensing basis and revised as appropriate for the PEO. For in-scope SSCs that do not have TLAAs, AMPs should be created by the specific licensees and CoC holders as described in NUREG-1927 and the ISFSI or DSS licensing basis. The AMPs should be further informed by the NRC's MAPS document (when available), the Argonne National Laboratory work [12], and other relevant work that may be produced in the future.

Feedback from dry cask storage operating experience, research, monitoring and inspections will be used as appropriate to perform tollgate assessments and update TLAAs, AMPs and/or licensee aging management implementing procedures based on new information. In particular, aging management pertaining to CISCC, fuel performance and cask internals will be managed in this manner.

To effectively manage an aging effect, it is necessary to determine the aging mechanisms that are plausible for a given material and environment application. Therefore, the aging management review process needs to address both the aging mechanisms as well as the aging effects. Some mechanisms are only applicable under certain environmental conditions, such as high temperature or moisture. The identified aging mechanisms should be characterized by a set of applicable conditions that must be met for the mechanism to occur and/or propagate. The application for ISFSI license or CoC renewal should identify aging effects based on the aging mechanisms plausible in given environments on susceptible subcomponent materials, such as:

- general corrosion of carbon steel
- stress corrosion cracking and crevice and pitting corrosion of stainless steel
- cyclic stress fatigue
- radiation embrittlement
- boron depletion in neutron absorber material due to neutron flux.

Aging effects of material/environment combinations, which are manifestation of aging mechanisms, are compiled from industry and plant operating experience through use of industry standards and reference materials, including metallurgical literary references. The majority of aging mechanisms can be extracted from industry documents (including NRC and EPRI) for the applicable material/environmental combinations. For instance, the EPRI Dry Cask Characterization Project final report is a primary source for fuel assembly and DSC internals aging mechanism evaluations [23]. The potential aging effects, given the identified materials and environmental conditions of storage are identified and addressed.

TLAAs are analyses and evaluations in the ISFSI or cask design basis that are performed to determine the life of in-scope SSCs that have time-dependent aging mechanisms. TLAAs are defined in the glossary of this document, consistent with the definition in 10 CFR 72.

Examples of TLAAs described in the past applications that were re-evaluated for license renewal include:

- cracking of the storage canister shell due to fatigue from thermal cycling
- changing material properties of epoxy seals in penetrations (for temperature monitoring) due to exposure to ionizing radiation
- depletion of fuel basket poison plate boron due to increase in neutron exposure for 60 year life of ISFSI
- changing properties of the boron-polyethylene front access cover plate due to increased radiation exposure over the 60 year life of the ISFSI.

It is the responsibility of the ISFSI licensee or CoC holder to identify all TLAAs and update them as necessary to address the PEO. If the TLAA cannot be successfully updated to confirm the SSC's operability through the PEO, other actions may be required, such as replacement or implementation of an AMP for that SSC.

3.6 Use of Operations-Based Aging Management in Renewal Applications

The concept of operations-based aging management is to manage dry cask storage aging effects so that SSCs can maintain intended functions through the PEO. Aging effects will be managed using existing corrective action and operating experience programs with the objective of preventing loss of intended safety functions due to aging effects.

Because some postulated aging mechanisms and/or timeframes for in-scope dry cask storage SSCs are not well characterized by operating data, aging management should be implemented in a manner that feeds information back in a timely fashion to the licensees who operate the ISFSIs. This feedback will be used to perform corrective actions on dry cask storage components to preclude the loss of safety function over the period of extended operation.

Operations-based aging management programs include the following attributes for the degradation mechanisms and time frames:

- recognition and evaluation (key technical issues)
- storage system inspections
- monitoring and operational inspections
- analysis and assessment

- tollgate assessment
- feedback and corrective actions (mitigation/repair and/or analysis).

3.6.1 Recognition and Evaluation (Key Technical Issues)

A number of organizations, including EPRI, the DOE and the NRC have embarked on efforts to identify areas where sufficient technical information is currently not available to characterize dry cask storage aging mechanisms. These so-called "gaps" in technical information are being identified in various reports, including the NRC's Technical Information Needs (TIN) Report [14] and the DOE's Technical Gap Report [24]. The DOE High Burnup Dry Storage Cask Research and Development Project (HDRP)[8] [19] and the Extended Storage Collaboration Program (ESCP) are two vehicles already in place to pursue filling those gaps in knowledge.

The mission of ESCP and technical needs for extended storage of spent nuclear fuel are summarized in Reference [17]. ESCP is, at present, comprised of the following subcommittees:

- fuel/internals
- marine environment
- non-destructive examination
- concrete
- high burnup dry storage cask research and development project
- international.

EPRI has issued reports such as dry cask storage Failure Modes and Effects Analysis [15], the Flaw Growth and Flaw Tolerance Assessment for Dry Cask Storage Canisters [29], and the international dry cask storage gap analysis report [16]. These reports are just three current examples that provide information about aging-related degradation mechanisms applicable to dry cask storage. Continuing research activities by EPRI, the DOE, the NRC, and others are expected to expand the body of available information pertaining to dry cask storage aging in the future.

SECY-13-0057 [13] and the NRC's report on technical issues pertaining to extended storage and transportation [14] identify material degradation mechanisms for which ongoing research and development is being conducted. DOE also is pursing closure of technical gaps identified in Report DOE FCRD-USED-2011-000136 [24].

[8] The High Burnup Dry Storage Cask Research Project is an EPRI-managed, DOE and EPRI co-funded project being implemented at the Dominion North Anna ISFSI.

Specific 10 CFR Part 72 licensees address only aging mechanisms applicable to the particular ISFSI site. CoC holders, on the other hand, address aging mechanisms that could affect the in-scope SSCs wherever the storage system may be used. The aging management reviews for CoC renewals should be devised to permit the licensee users to identify which of the identified aging mechanisms apply at their particular site and how their effects will be managed to avoid the loss of intended safety function over the PEO.

General licensees should review the generic AMPs described in the renewed CoC and UFSAR and may customize them appropriately for their particular site conditions, subject to the change control provisions of 10 CFR 72.48. Such customization needs to be appropriately evaluated to ensure the intent of the AMP is maintained by reviewing licensing basis documentation associated with the renewed CoC including, but not limited to the CoC renewal application, NRC requests for additional information (RAIs) and responses, and the SER for the renewed CoC. General licensee implementation of the generic AMPs at their particular ISFSI should be discussed in the site 10 CFR 72.212 Evaluation Report as required by 10 CFR 72.212(b)(11) with a specific focus on any deviations from the generic AMPs.

3.6.1.1 Cask Contents and Internals and Aging Management

The SNF canister and bare fuel cask pressure boundaries perform the confinement function that must be maintained throughout the PEO. The exterior surfaces and components of canisters, casks and storage modules clearly require aging management because a) they are subject to atmospheric environmental conditions and b) they are accessible for inspection to varying degrees. It is understood that yet-to-be developed tools or techniques may be required to perform inspections of canister exterior surfaces. The cask contents and internals are not part of the cask confinement boundary. However, the stored spent fuel and internals play roles in maintaining the shielding, heat removal, and criticality control design functions of the DSS, and the fuel cladding (for undamaged fuel) also provides an additional, barrier to fission product release.

There are regulatory requirements that must be met by the cask contents and internals through the PEO. Specifically, 10 CFR 72.122(h)(1) states that "the spent fuel cladding must be protected during storage against degradation that leads to gross ruptures or the fuel must otherwise be confined such that degradation of the fuel during storage will not pose operational safety problems with respect to its removal from storage." Additionally, the fuel basket structure (including neutron absorber panels) must maintain its ability to perform its structural, heat removal, criticality control and any other design functions credited in the cask safety analysis.

3.6.1.2 Addressing Potential Aging-related Degradation of Contents and Internals

The contents and the internals of the DSS cannot practically be inspected in-situ due to radiation levels and difficult accessibility. The storage cavities of the casks are carefully processed in preparation for dry storage, including moisture removal and a final backfill to establish an inert gas environment (typically helium). DSS designs require maintaining the dry, inert gas environment throughout the initial license term and PEO so that these internal components will not corrode during storage. Because canister and cask fuel cavities are inaccessible in situ, a research project was conducted [16, 17] that provides the current basis for ensuring that the spent

fuel and internals are not degrading to the point of gross cladding rupture during the PEO. However, this research project evaluated lower burnup fuel[9] and the results, while applicable to the internals irrespective of the burnup of the fuel being stored, may not fully describe the aging characteristics of the HBU fuel assemblies now being placed in dry storage.

There is currently high confidence, based on prior research [16, 17], that the non-fuel internals of dry storage casks see little aging-related degradation after many years in storage (see Section 4.4.2 of this document). However, potential aging mechanisms unique to HBU fuel have been postulated that could degrade the performance of the spent fuel cladding during PEO. The information needed to evaluate these potential mechanisms and whether they could impact the spent fuel, however, contains several gaps. Activities are underway to provide information to fill in higher priority gaps, but in some cases they will take several years to complete. The DOE, EPRI and other international research organizations are prioritizing and conducting research to fill information gaps using a risk-informed approach: degradation mechanisms and modes that have a higher likelihood of occurrence and/or higher health consequences are receiving the most attention.

The HDRP [19] is one such activity that is being undertaken to provide confirmatory data to enhance our scientific understanding of the performance of HBU fuel in DSS for extended storage intervals. In cases where gaps in knowledge exist and those gaps cannot be addressed prior to the start of a renewed storage period, the tollgate process, as described in Section 3.6.5, has been created to ensure analysis and assessment of licensed storage systems are conducted once that information becomes available and that licensees and CoC holders have processes in place to appropriately evaluate that information as it pertains to DSSs.

3.6.2 Storage System Inspections

There are two types of initial storage system inspections related to ISFSI license/CoC renewal applications and initial AMP implementation, respectively. The first type, known as a pre-application inspection, is intended to gather information to inform the development of the renewal application in general, and AMPs for specific SSCs in particular. The second, known as a baseline inspection, is essentially the first AMP inspection of the SSC, which is performed at a particular ISFSI at approximately the time when the storage system enters the PEO. Each of these inspections is discussed in further detail in the subsections below.

3.6.2.1 Pre-application Inspections

The purpose of performing one or more pre-application inspections is for a specific licensee or CoC holder to gather additional information needed to help develop the technical basis for the license or CoC renewal application. There is no regulatory requirement for specific licensees or CoC holders to perform pre-application storage system inspections or to perform a minimum number of inspections if they choose to do so. It may be determined that a licensee or CoC holder possesses sufficient information without a pre-submittal inspection to develop the renewal application. However, if desired by the licensee or CoC holder, one or more pre-application inspections could be performed to gather additional information. The number of storage systems inspected, if any, the location(s) of the system(s) inspected, the timing and scope of the

[9] Generally less than 45,000 MWd/MTU.

inspection(s), and the inspection techniques used are determined by the licensee or CoC holder based on the type of information sought and the schedule for the renewal application submittal. Relevant inspection data available from efforts not specifically designated as "pre-application" inspections may also be used in lieu of conducting a formal pre-application inspection. Reference [28] should be used as a resource for identifying stainless steel canisters for pre-submittal inspections pertaining to CISCC.

Specific licensees have the authority to decide to perform a pre-application inspection based on site-specific considerations and priorities. However, CoC holders do not have the regulatory authority to compel a general licensee to perform a pre-application inspection because such inspections are not included in the pre-renewed CoC. With or without a pre-application inspection, it is the obligation of the licensee and CoC holder to ensure the renewal application includes a sound technical basis for the AMRs and associated TLAAs and AMPs described in the application. It is recommended that the licensee or CoC holder arrange a pre-application meeting with the NRC where this subject can be discussed.

If the specific licensee or CoC holder decides to arrange for one or more pre-application storage system inspections, the "lead component" for the inspection may be located in different storage systems at different ISFSI sites, based on a number of factors, including time in service, general environmental conditions and the specific location of the storage system at the ISFSI. The specific licensee and CoC holder should consider these factors, as well as accessibility of the cask and the 10 CFR 20.1101 requirement to maintain personnel dose as low as reasonably achievable (ALARA) in choosing the lead components to be included in a pre-application inspection to ensure the information obtained is meaningful from an aging-related degradation perspective.

3.6.2.2 Baseline Inspections

Baseline inspections are the first AMP inspections conducted at a particular ISFSI at the approximate time the ISFSI enters the period of extended operation (i.e., after the first DSS is placed into service). Licensees may voluntarily choose to perform a baseline inspection prior to the PEO. Similar to the pre-application inspections, lead components should be chosen with due consideration of the applicable aging mechanisms. The lead components for a baseline inspection should be components that provide a sufficiently bounding case for the aging mechanism of interest. Again, cask accessibility and maintaining personnel dose ALARA should be important considerations in the choice of lead components.

Baseline inspections at specific-license ISFSIs are necessarily conducted at that particular ISFSI because the AMPs are written specifically for that ISFSI. Baseline inspections for general licensees need not be conducted at every ISFSI using the same storage technology. Appropriately justified use of surrogate inspections for bounding lead components may be used by multiple general licensees.

The scope, techniques, timing and acceptance criteria for the baseline inspections should align with the inspections to be conducted under the AMPs for those SSCs. In particular, the CISCC susceptibility criteria developed by EPRI [28] should be used to determine the appropriate timing and location of storage system inspections to ensure bounding cases are chosen.

Dry storage system inspection techniques and results from research (e.g., on stainless steel canister CISCC) may not be available at the time of license/CoC renewal, but can be expected to be developed and refined over subsequent years. Licensees and CoCs holder should define the requirements for future storage system inspections and tollgate assessments in the renewal applications accordingly (see Subsection 3.6.5 of this document). In particular, tollgates should be constructed recognizing that the body of knowledge regarding canister CISCC susceptibility and the state-of-the-art for canister inspection techniques is evolving.

In the case of CoC renewals covering multiple sites, as discussed above, applicants should explain the basis for pre-application inspections (if any), baseline inspections, and tollgate assessments. For example, when addressing the potential effects of CISCC on welded stainless steel canisters, the number of canisters to be inspected and use of earlier inspections as surrogates at multiple subsequent sites—obviating the need for continual, frequent inspections at each site—should be considered. A narrowing of inspections to fewer sites over time will be extremely important to assuring that industry is able to maintain personnel doses ALARA. This information should be periodically reviewed and applied over time to inform and refine the frequency and nature of future tollgate assessments.

The use of surrogates should be carefully considered, justified with detailed technical information, and the multi-site applicability thoroughly explained. Every parameter relevant to the degradation mechanism should be accounted for. Sites using the same design but located in environments which are easily justified as less conducive to aging, particularly if inspections at the surrogate site(s) have detected little or no degradation, should be given the option to avoid unnecessary dose and cost, if warranted.

3.6.3 Consensus Codes and Standards

As a starting point, using or adapting existing industry standards is desirable as a basis for establishing monitoring and inspection techniques, frequency and acceptance criteria. For example, American Society of Mechanical Engineers (ASME) Section XI is one resource that the NRC has accepted for aging management activities at Part 50 power plants. Other consensus bodies such as the American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), and the American Concrete Institute (ACI) also produce standards for monitoring and inspection that may be used as appropriate for the aging effect or variable being monitored or inspected.

The approach to aging management for dry spent fuel storage facilities that the NRC has suggested in NUREG-1927 [10] is to use approved consensus codes and standards to the extent applicable and available for aging management inspections of the canisters. A new ASME Task Group (TG) entitled “Inservice Inspection of Spent Fuel Storage and High Level Waste Transportation Containments” was created in 2015 under Section XI of the ASME *Boiler and Pressure Vessel Code*. This task group is developing a Code Case to recommend the use of existing Section XI criteria for examination, evaluation of examination results and repair/replacement requirements for dry cask storage and transportation containment vessels.

The ASME Section XI TG effort was just beginning at the time of this writing and was specifically requested of ASME by the NRC. Once the Code Case is approved, it is anticipated that NRC would apply the code case to licensees through the appropriate regulatory process and

these new Section XI rules would govern inspections for storage canisters subject to aging management requirements contained in renewed specific ISFSI licenses or DSS CoCs.

3.6.4 Analysis and Assessments

Operations-based aging management has, at its core, the requirement for collecting ongoing feedback in the form of operating experience, research, monitoring and inspections. Licensee programs already require assessment and actions, as appropriate, of incoming information on a real-time basis via the corrective action and operating experience programs. This will not change, but it will be reinforced. NEI 14-03 introduces the concept of "tollgates" to assure that future knowledge is always captured as part of this process. Individual conditions and events that could affect the ability of an SSC to perform its intended storage safety function for the duration of the renewed period of operation would be handled via the licensee's and/or CoC holder's corrective action program. In addition, confirmatory information showing positive results such as no evidence of specific degradation effects or longer durations for the progression of known degradation mechanisms will also be recognized and assessed at the tollgates. This is not a new concept and is simply an expansion of practices that were used during the initial license term.

3.6.5 Tollgate Assessment

NEI 14-03 introduces the concept of tollgates to be included as part of an operations-based aging management program. The tollgate concept provides a structured way for licensees to pause and formally assess aggregated feedback at specific points in time during the PEO.

Tollgates are established as requirements in the renewed specific ISFSI license or CoC and are implemented by licensees to formally evaluate the aggregate feedback at points in time during the PEO and perform a safety assessment that confirms the safe storage of SNF and other contents. The impact of the aggregate feedback should be assessed by the licensee as it pertains to components at that site's ISFSI and corrective actions taken when warranted, such as:

- modification of TLAAs
- adjustment of aging-related degradation monitoring and inspection programs in AMPs (e.g., scope, frequency)
- performance of mitigation activities, e.g., repairs or replacements.

Licensees should share their tollgate assessments with their CoC holder(s), other licensees, and other CoC holders for evaluation of generic applicability and impacts on AMPs and TLAAs.

The tollgate concept amplifies the existing practice of continual evaluation of site-specific and industrywide dry cask storage operational experience for impacts on a given licensee's dry cask storage aging management program. It also offers the opportunity for licensees to seek out other sources of nuclear operating experience outside the United States and, if desired, outside of the nuclear industry. Tollgates are a proposed set of milestones at appropriate points in the PEO. The tollgate assessments should be described in the renewal application and incorporated in the UFSAR upon approval of the renewal application by the NRC. The requirements for tollgate assessments specified in the renewal application should address the following elements:

- frequency:
  - established from technical basis
  - reflects aging mechanism timing
  - reflects risk significance
  - considers findings from prior tollgate assessments
- content of tollgate assessment:
  - summary of research findings, operating experience, monitoring data, and inspection results
  - aggregate impact of findings (including trends)
  - consistency with assumptions and inputs in TLAAs
  - effectiveness of AMPs
  - corrective actions, including changes to AMPs
  - summary and conclusions.

Appendix A provides the performance criteria for assessing each of the ten elements of an AMP. These criteria should be addressed in the tollgate assessment and actions taken to adjust AMPs as appropriate.

Only a high-level requirement for licensees to perform tollgate assessments is included as a requirement in the license or CoC. This is because licensees and CoC holders should have the flexibility to take appropriate corrective actions, including modifying AMPs and/or implementing procedures in a timely manner as a result of tollgate assessments (pursuant to 10 CFR 72.48). This timeliness may not be achievable if a license or CoC amendment is required to implement the needed change to a detail of AMP implementation. Furthermore, general licensees would be under no obligation to adopt the later CoC amendment.

The tollgate frequency may be equally divided over the renewed PEO or may be irregular, as defined by the specific licensee or CoC holder. Licensees and CoC holders may consider the projected time frames for expected results from applicable research and development programs (e.g., the HDRP and development of canister CISCC susceptibility criteria) in the establishment of tollgate timing, but need not tie the tollgates specifically to these events. This will avoid delaying tollgate assessments if the results of these programs are delayed for any reason. Figure 3-1 provides a pictorial representation of how tollgates fit into the PEO of an ISFSI.

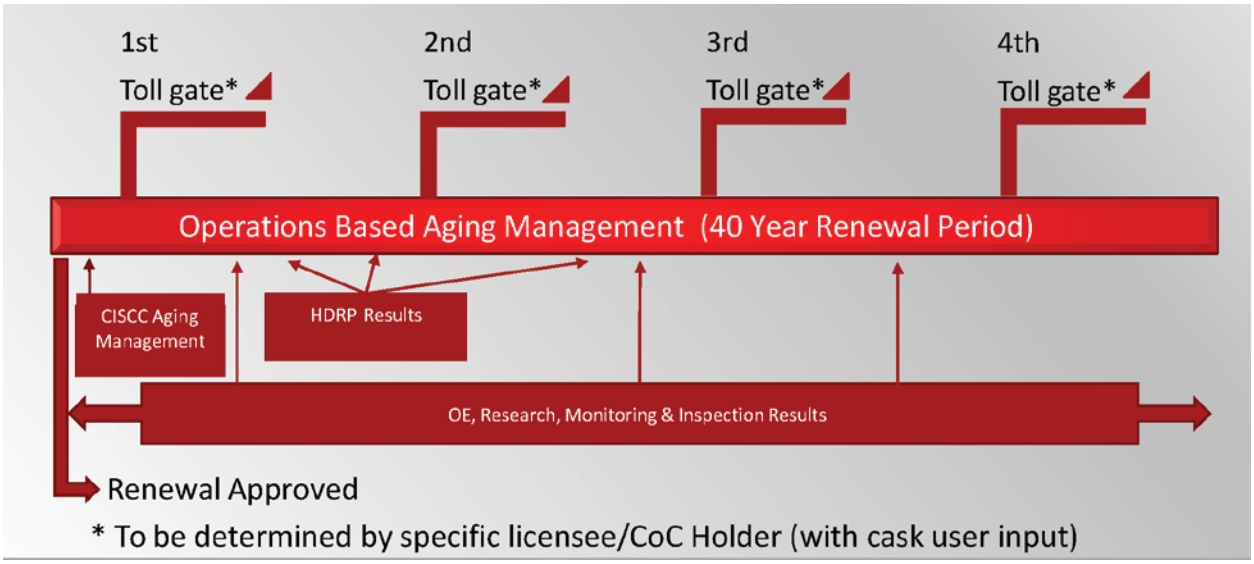

Figure 3-1
Pictorial Representation of Tollgates

Tollgates are not, by definition, stopping points for dry cask storage operations. No particular action other than performing an assessment is required to continue ISFSI operation through the PEO. To proceed through a tollgate, the licensee must perform an assessment of aggregated operating experience, research findings, and data from monitoring and inspections to confirm the continued safe storage of the SNF and other contents until the next tollgate is approached and document the results of this assessment. The aggregated OE (including NRC-generated generic communications), research results, monitoring data and inspection findings used in the tollgate assessment are to be reviewed from ISFSIs across the country and across storage technologies.

The ISFSI Aging Management INPO Database was created to facilitate the aggregation and dissemination of aging-related information pertaining to dry cask storage by ISFSI licensees and CoC holders. Licensees are expected to use the relevant information in this database to inform their tollgate assessments.

Internationally-generated dry cask storage OE and aging-related degradation data should also be considered in the assessment. The acquisition of international nuclear OE should be considered a best-effort undertaking by licensees and CoC holders. Optionally, aging-related degradation OE and other data from non-nuclear industry experience may also be considered for the tollgate assessment, if desired. Information should be publicly available, relevant to DSS aging mechanisms and published by reliable source.

Tollgate assessments will generally result in one of three conclusions:

1. The information reviewed confirms the adequacy of current TLAAs and AMPs. Continued safe storage is expected to the next tollgate.

2. Information is currently unavailable for a particular potential aging-related degradation mechanism. Plans to address the information gap should be developed and implemented.

3. The industry information reviewed introduces issues not currently managed adequately by current TLAAs and AMPs. Corrective actions are required. This could be as simple as alterations to the TLAAs or AMPs, as appropriate, or could involve additional inspections, mitigation, repairs, or replacements of DSS components.

The tollgate is an obligation of the licensee (via the CoC holder for general licensees) to perform a safety assessment and take appropriate corrective actions, such as repairs or replacements, and to make adjustments to TLAAs, AMPs, and any other monitoring or inspection programs in place to support dry cask storage operations through the PEO. Licensees are expected to share tollgate assessments with each other and with the DSS CoC holder to factor into future designs and/or future aging management submittals. CoC holders are also expected to share aging-related degradation information they generate or acquire that may have cross-technology applicability. The ISFSI Aging Management INPO Database was designed to provide a centralized repository for aging-related degradation information accessible to licensees and CoC holders. The database should be used as a resource to inform licensee tollgate assessments. See Section 4.5 of this document for additional information on the ISFSI Aging Management INPO Database.

3.6.6 Feedback and Corrective Action (Mitigation, Repair and/or Analysis)

Feedback received during the PEO from OE, research, monitoring, inspections and tollgate assessments should be processed through the licensee and CoC holder OE and corrective action programs, as appropriate. Licensees and CoC holders will determine appropriate corrective actions, including mitigation, prevention and analysis options to assure continued safe operation through the remaining years of the PEO. As discussed further in Section 4.5, sharing of OE and close coordination between licensees (both specific and general) and the cask vendors is required to assure there is a clear understanding of the safety implications of any findings for that site, for that storage technology and for consideration of generic applicability across storage technologies. An important element of feedback and corrective actions is an evaluation of the continued validity of TLAAs and effectiveness of AMPs.

3.7 REPORTING

3.7.1 NRC Reporting

Reporting of events and conditions to the NRC for Part 72 specific licensees, general licensees and CoC holders is governed primarily by the 10 CFR 72 regulations. Specifically, 10 CFR 72.74, 72.75, and 72.242 contain the criteria for determining whether an event or condition is reportable to the NRC. (Additional NRC reporting requirements may also be found in the cask CoCs for the general licenses; e.g., reporting of a mis-loaded canister or cask.) The reporting requirements in 10 CFR 72 provide consistent, well understood criteria for determining reportability, the timing of any verbal notifications, and the requirements for timing and content of follow-up written reports.

Part 72 licensees and CoC holders should use these same 10 CFR 72 regulatory requirements to determine if a particular aging-related degradation condition or event identified via operating experience, research, monitoring or inspection is reportable to the NRC. Likewise, the 10 CFR

72 reporting criteria should be used to determine NRC reportability of any conclusions reached in a tollgate assessment.

The NRC will also be able to request and receive periodic reports from the ISFSI Aging Management Database to see timely information on the state of aging-related degradation pertaining to various ISFSIs, DSS designs, and materials.

3.7.2 Other Reporting

Reporting of individual events and conditions so that other licensees and CoC holders are made aware of the issues in a timely manner is an important element of operations-based aging management. Individual events and conditions not rising to the level of NRC reportability based on the criteria in 10 CFR 72 still should be communicated among licensees and CoC holders in some manner to allow tracking and trending. In fact, an individual event, while not rising to the level of NRC reportability by itself may be indicative of a trend that may be reportable. In addition, while tollgate assessment reports are not required to be submitted to the NRC, they are, of course, subject to NRC inspection.

Operations-based aging management and the use of tollgates will require licensees, CoC holders, and cask vendor users groups to develop a process for controlling OE and other aging-related degradation information. Refer to Section 4.5 for additional guidance pertaining to aggregation, and dissemination of information for licensee use in performing tollgate assessments.

3.8 RECORDS

Records Management requirements under the licensee and CoC holder Quality Assurance programs provides an appropriate set of requirements for operations-based aging management-related records. Aging-related degradation information collected by licensees and CoC holders from operating experience, research, monitoring, inspections and tollgate assessments will be maintained as readily retrievable records in accordance with 10 CFR 72.174 or 10 CFR Appendix B, Criterion XVII, as applicable.

4 SITE IMPLEMENTATION

4.1 SPECIFIC LICENSE

The Part 72 specific license is owned by the licensee and pertains only to the ISFSI at that licensee's site. Implementation of ISFSI license renewal requirements by specific and general licensees, including aging management activities, will have a strong parallel to implementing operating plant aging management activities. In the case of specific licenses, the licensee owns the TLAAs and AMPs, and can set up appropriate controls for revising them as information is returned from OE, research, monitoring and inspection activities as well as tollgate assessments performed during the PEO. Tollgate assessments performed by the specific licensees should consider feedback from other sources, including general licensees and CoC holders.

4.2 GENERAL LICENSE

The Part 72 general license involves two regulated entities, namely the CoC holder and the general licensee. The CoC holder is responsible for renewing the CoC, including appropriate amendments, and defining generic requirements for ensuring the DSS will perform as designed through the PEO. Once a CoC renewal is approved by the NRC, the general licenses for the DSSs operated under that CoC are also renewed. General licensees are responsible for implementing the requirements, including AMPs, once the first DSS at the ISFSI has been in service for its initial license term. For example, a general licensee may have deployed DSSs at its ISFSI over several years in accordance with a single CoC. Aging management requirements must be implemented by the general licensee at the ISFSI when the first DSS begins its PEO, based on the initial term of the CoC. This is typically 20 years after the DSS was place in service at the ISFSI. Aging management requirements for each DSS become applicable when the DSS has been in service for its initial license term.

The CoC holder should carefully consider the appropriate level of detail and use precise wording in the licensing documents for the aging management activities they specify for application at multiple licensee sites. Implementation details should be appropriately segregated between generic requirements applicable to all DSSs, generic requirements that can be met through the use of surrogate monitoring or inspections, and requirements for which applicability is determined by each general licensee based on site-specific conditions, time in service, operating practices, and NRC-approved exemptions. The general licensees should perform an implementation review to determine applicability of the CoC generic programs, exemptions and incorporation into site implementing procedures. That implementation review should be summarized in the site 10 CFR 72.212 report.

In an operations-based aging management scheme, it is expected that information obtained from operating experience, research, monitoring and inspections during the PEO, particularly at the tollgates, may prompt changes, deletions or additions to the AMAs. Therefore, the CoC holder should allow the flexibility for licensees and themselves to modify the AMAs in the cask UFSAR by keeping the AMA information in the CoC limited to programmatic descriptions including key elements of those programs (i.e., tollgates must be established and defined). Implementation details for AMPs, including inspection details and acceptance criteria should be

included in the UFSAR, implementing procedures, or other aging management program document under licensee change control. This flexibility is a fundamental element of a learning approach to aging management. See Section 2.2.5 for additional guidance.

Both CoC holders and general licensees would have the ability to modify the AMAs in the UFSAR or implementation procedures under the provisions of 10 CFR 72.48. Changes to AMAs made by the CoC holder or general licensee pursuant to 10 CFR 72.48 would be shared in accordance with existing requirements in 10 CFR 72.48. Site-specific changes made to AMAs by a particular general licensee should be evaluated by the CoC holder to determine if the AMA change should be implemented on a generic basis.

4.3 Interface with Part 50 Aging Management Programs

The majority of the ISFSIs in the United States are co-located on sites with operating or shutdown reactors where a 10 CFR 50 license remains active, thus allowing the ISFSI to be operated under a 10 CFR 72 general license. Most of the operating reactors are now, or soon will be, operating under a renewed Part 50 license which requires aging management activities to be performed for the power plant. Aging management for the ISFSI and the casks at co-located ISFSIs may be integrated into existing site aging management program or may be controlled as a separate program, at their discretion. Licensees operating ISFSIs at shutdown plant sites should develop their dedicated ISFSI aging management program under an appropriate process for the applicable Part 72 license type.

Nearly all of the materials and aging mechanisms associated with ISFSIs and DSSs are also part of aging management programs for operating nuclear plants. Thus, Part 72 aging management programs should be very similar in structure to Part 50 aging management programs to allow efficient integration with the Part 50 program. With this in mind, this guidance has been developed in a manner that is similar to the guidance provided in NEI 03-08 [21], while at the same time recognizing the unique aspects of dry cask storage aging management. The key differences between dry cask storage aging management and operating plant aging management are:

- The use of tollgates.
- The lower risks associated with dry cask storage relative to operating reactors.
- As entirely passive, low-pressure systems, DSSs are unlike reactor plant systems and failures do not have the potential to result in rapid thermodynamic responses or significant public health and safety consequences. The reaction of DSS SSCs to failures are slow-developing, giving licensees significantly more time to take a deliberative approach to addressing any identified DSS aging-related degradation.
- The fact that the PEO for ISFSI licenses may extend to timeframes beyond the licensed life of their associated reactors.
- Direct accessibility to canister exterior surfaces in ventilated DSSs is problematic due to very high radiation fields and the inability to readily re-locate the radioactive source for canister inspections or mitigation access.

- Small clearances between the canisters and the storage overpacks or modules make in-situ inspections difficult for DSS in operation.

- The condition of the stored contents and cask internals cannot, with currently-available technology, be directly assessed without opening the canister or cask. Opening a welded canister or bolted cask is not desirable from an operational risk perspective and would be inconsistent with sound ALARA principles. In addition, opening a cask or canister for no other reason than to inspect the contents and internals was not anticipated in original cask design or licensing; such an activity would likely require a license or CoC amendment as a test or experiment in accordance with 10 CFR 72.48.

The above differences give rise to the concept of more extensive use of surrogate inspections for dry cask storage aging management than have been historically used for operating reactor aging management. Nevertheless, the AMPs, inspection techniques and acceptance criteria described in certain operating plant-related documents should be considered first by licensees and CoC holders. Thus, there are several aging management resources that should be considered in developing dry cask storage renewal applications and aging management programs for dry cask storage. See Section 5.4 for a partial listing of these documents.

Except for the shutdown plant sites, licensees may choose to integrate their Part 72 aging management program into their existing (or future) Part 50 aging management program for the operating plant. This approach would be consistent with how Part 72 general licenses use Part 50 programs (e.g., quality assurance, emergency response, etc.) to govern Part 72 activities. Experience from Part 50 license renewals and specific Part 72 license renewals shows a consistency in the location of aging management information in licensing documents and the associated change control processes. This consistency should be maintained for future Part 72 specific license renewals and CoC renewals for general licensees. See Section 2.2.5 for additional guidance.

4.4 Implementation Examples

4.4.1 Chloride-Induced Stress Corrosion Cracking (CISCC) of Storage Canisters

The types of stainless steel used in most dry storage canister designs and the welding techniques used to fabricate and seal the canisters make them susceptible to a loss of confinement due to CISCC if: 1) the canister is deployed in a ventilated storage cask and 2) the conditions for CISCC are present on the canister surface. The latter requirement depends on the canister initial heat load, time in storage, and ISFSI location. This issue has been identified by the NRC and EPRI as an area in need of additional research to fully understand the susceptibility of canisters under actual storage conditions [12-16].

Recognizing the potential applicability of this phenomenon to DSS operations after decades of operation, the industry and the NRC initiated Regulatory Issue Resolution Protocol (RIRP) N-10-01 in 2010 to drive resolution of this issue in a cost-effective manner on a schedule that reflects its safety significance [20]. This effort has produced CISCC susceptibility criteria [28]. Beyond the RIRP, EPRI plans to develop specific CISCC management guidance for addressing this issue through the period of extended operation. Licensees and CoC holders will review the

EPRI CISCC aging management program guidance, including susceptibility criteria, when it becomes available and implement the criteria, as applicable.

4.4.2 Fuel Performance and Internals

The performance of the stored fuel and the condition of cask internals after the initial license period and through the PEO is an issue that should be addressed in the renewal application. Continued performance of the fuel and cask internals, as relied on in the safety analysis for the DSS, is necessary to ensure the DSS's ability to allow retrieval of individual SNF assemblies (if required) and to continue to provide adequate shielding, heat removal and criticality control through the PEO. The specific license renewals approved to date relied upon a previous inspection of fuel and internals from a storage cask that had been in service for some time. That inspection [16, 17] provided the technical basis for the NRC to conclude that reasonable assurance exists that cask internals and low burnup spent fuel (average assembly burnup less than 45,000 MWd/MTU) will perform as expected through the PEO with no aging management action required. However, today's specific license and CoC renewals include spent fuel that is burned above 45,000 MWd/MTU (known as high burnup (HBU) fuel).

Reasonable assurance exists that HBU fuel can be safely stored and meet applicable regulatory requirements through the initial license period and for some period of time thereafter. Similar assurance exists for canister or cask internals (i.e., the fuel basket and supports). This has been confirmed by the NRC's approval of the storage of HBU fuel and cask designs in the initial licensing process, and the approval of amendments to those licenses and CoCs. Based on the current state of knowledge, it is expected that HBU fuel can also be stored safely and the canister or cask internals will be essentially unchanged through a 60-year period of operation [25].[10] However, there are postulated physical phenomena unique to HBU fuel cladding in dry storage for which additional data are needed to assess whether or not the postulated phenomena could actually occur and if these phenomena do occur, what effect they might have on the integrity of the fuel cladding.

The DOE and EPRI are currently conducting a research project [19] to inspect HBU fuel from a cask in storage to confirm that it can be safely stored through the PEO. Some of the results of this research are planned to become available later this decade. In addition, hot cell examinations of HBU fuel have taken place over approximately two decades. Many of these hot cell examinations used HBU fuel cladding subjected to more extreme conditions than those expected for HBU fuel in dry storage, which have led to some postulated phenomena that could degrade the physical properties of the HBU fuel cladding. Additional experiments using more realistic conditions pertaining to the fuel-cladding interface are either under way or planned for the future. Licensees and CoC holders are expected to include consideration of the relevant HBU fuel R&D project when results of the research become available and in tollgate assessments if they are storing HBU fuel.

[10] An initial term of 20 years plus a renewed term of 40 years.

4.5 AGGREGATION AND DISSEMINATION OF AGING-RELATED OPERATING EXPERIENCE AND OTHER INFORMATION

4.5.1 Overview

The cornerstone of the operations-based aging management idea in general, and the tollgate concept in particular, is the collection and assessment of dry cask storage aging-related operating experience, research results, monitoring feedback and inspection data. This information is being generated on a continual basis across the various dry storage technologies and at a wide variety of geographic locations nationwide. It will be collected and made accessible to the appropriate parties via the ISFSI Aging Management INPO Database (ISFSI AMID) to support tollgate assessments being performed by the licensees for their specific ISFSI sites and storage technologies. See Subsection 4.5.3 for a description of the ISFSI AMID.

The key objectives for collecting this information in the ISFSI AMID are:

- Licensees and CoC holders should identify, evaluate and take appropriate actions pertaining to OE and other dry cask storage aging management-related information at the time of its discovery, in a time frame commensurate with its safety significance. The database does not replace or duplicate the licensee or CoC holder corrective action program (CAP) and operating experience (OE) review process. Thus, actions planned or taken in response to an event or finding are not included in the database.

- Information in the ISFSI AMID should be available to the ISFSI licensees and CoC holders (with due consideration of proprietary information).

- Use of the ISFSI AMID should be governed by a users' guide to screen information so that its applicability to dry cask storage aging management can be determined and to ensure consistency in the level of detail of records added to the ISFSI AMID. Dry cask storage operating experience that is not aging management-related would continue to be reported separately according to current practice.

- Both ISFSI licensees and CoC holders should be able to add records to the ISFSI AMID. However, CoC holders have the final approval on the information being added to the database that involves their product line, no matter who initiates the record.

- Both positive and negative information should be included in the database.

NEI 14-13, *Use of Industry Operating Experience for Aging-related Degradation and Aging Management Programs* [27] provides useful insights from Part 50 aging management program implementation that can be applied to dry cask storage aging management programs as well. Inclusion of both positive and negative information in the ISFSI AMID allows licensees and CoC holders to perform trending, prepare tollgate assessments, and adjust aging management programs, if appropriate.

4.5.2 Screening of Operating Experience

When event-based, dry cask storage aging-related OE is identified, a determination needs to be made as to whether the event or condition is aging-related degradation. The first step of this determination is to assess whether the event or condition is *aging-related* and *in-scope* for dry cask storage aging management:

a. Is the cause of the condition due to aging-related degradation (such as loss of material, cracking, etc.)?
b. Is the component or structure passive?
c. Is the component or structure long lived (i.e., not subject to replacement based on a qualified life or specific time period)?

If the answers to all three questions above are yes, then Step 2 is implemented to determine if the event or condition should be identified as aging-related *degradation* using the following criteria:

a. New and unexpected aging effect is identified.
b. New or unexpected trend in aging effects is identified.
c. Unexpected inspection results (positive and negative) are identified though AMP implementation.
d. Aging mechanism and effects are identified through the use of new or improved test or inspection methods or equipment.
e. Deficiencies are found that are indicative of aging management program ineffectiveness.

If the response to any of the criteria in Step 2 is yes, the event or condition and meets the threshold for external OE sharing and should be entered into the ISFSI AMID.

4.5.3 ISFSI Aging Management INPO Database

The ISFSI AMID is a clearinghouse of aging-related information relevant to dry cask storage SSCs facilitated by INPO through agreements with the 10 CFR 72 CoC holders. Through separate agreements between the CoC holders and ISFSI licensees (including shutdown plant ISFSI licensees), the ISFSI AMID provides a centralized location where the ISFSI licensees and CoC holders can store, access, search and create reports. Periodic reports will be provided to the NRC upon request.

ISFSI licensees and CoC holders may add records to the database in accordance with a users' guide. CoC holders approve any new records pertaining to their product lines for entry into the database and control changes once a record is approved. Records proposed to be added to the database that are not DSS-specific (e.g., material testing, research, non-nuclear information, etc.) are approved for entry into the database and owned thereafter by NEI. NEI will communicate with the appropriate industry entities, as necessary, before approving such a record.

In order to keep the data in the ISFSI AMID current, licensees should develop processes within their aging management programs to input records to the database in a timely manner after

results are acquired from inspections, monitoring, events, or other activities that may generate relevant information as described in the users' guide. This includes positive as well as negative information. While there is no requirement to do so, relevant aging-related information discovered from activities outside the domestic nuclear power industry and from non-nuclear sources may be added to the ISFSI AMID as well.

Licensees operating ISFSIs under a renewed license or CoC that includes a commitment to perform tollgate assessments should use the ISFSI AMID as a resource for preparing those assessments for their sites.

4.6 License and CoC Amendments during Review of the Renewal Application and After Renewal Approval

It is likely that during the NRC review of a license or CoC renewal application and after the renewal is approved that the license or CoC will need to be amended. Section 1.4.6 of NUREG-1927 provides guidance to the NRC reviewers for this situation. If a CoC amendment is submitted concurrent with, or after the renewal application is submitted for NRC review, there are two options:

1. The amendment application should include a scoping evaluation and an AMR for that amendment to document the evaluation of the amendment's SSCs for extended operation, or

2. The renewal application should be supplemented to address the proposed amendment to document the evaluation of the amendment's SSCs for extended operation.

For CoC amendment applications submitted after the CoC renewal has been approved, the amendment application should include a scoping evaluation and AMR for that amendment. For post-renewal amendment applications or concurrent amendment applications, the application should either (1) show that the in-scope SSCs 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 proposed in the amendment application. The amendment application should contain the following information pertaining to aging management:

- a scoping evaluation that identifies any new SSCs included in the amendment request and discusses whether the SSCs are included or excluded from the scope of renewal, following the guidance in Chapter 2 of NUREG-1927

- an aging management review that identifies any applicable aging mechanisms and effects for the new SSCs or changes to aging mechanisms and effects for existing SSCs within the scope of renewal

- Changes to the UFSAR, 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

- identification of the approved AMPs (or the AMPs included in the renewal application, for concurrent amendments) that encompass the new in-scope SSCs or a summary of proposed changes to approved AMPs or new AMPs that will apply to the new in-scope SSCs.

5 REFERENCES

5.1 REGULATIONS

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

2. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

3. 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

4. 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

5. 10 CFR Part 71, "Packaging and Transportation of Radioactive Material."

5.2 STANDARDS

6. ANSI N 14.6, "Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4,500 kg) or More."

7. ASME *Boiler and Pressure Vessel Code*, Section XI, "Inservice Inspection."

5.3 NUREGS

8. NUREG-1536, "Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility, Revision 1.

9. NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities," Revision 0.

10. NUREG-1927, "Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel," Revision 1.

11. NUREG/CR-6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Important to Safety."

5.4 OTHER

12. *Managing Aging Effects on Dry Cask Storage Systems for Extended Long-Term Storage and Transportation of Used Fuel*, Report No. FCRD-UFD-2014-000476, Revision 2, U.S. Department of Energy, Used Fuel Disposition Campaign, September, 2014.

13. *Annual Status Report: Activities Related to Extended Storage and Transportation*, USNRC, SECY-13-0057, dated May 31, 2013.

14. *Identification and Prioritization of the Technical Information Needs Affecting Potential Regulation of Extended Storage and Transportation of Spent Nuclear Fuel*, USNRC, May 2014.

15. *Failure Modes and Effects Analysis (FMEA) of Welded Stainless Steel Canisters for Dry Cask Storage Systems*, Electric Power Research Institute Technical Report 3002000815, December 2013.

16. *International Perspectives on Technical Data Gaps Associated with Extended Storage and Transportation of Used Nuclear Fuel,* Electric Power Research Institute Extended Storage Collaboration Program International Subcommittee Report 1026481, November 2012.

17. *Needs for Extending Dry Storage of Spent Nuclear Fuel*, K. Waldrop and J. Kessler, Electric Power Research Institute, paper for the 2012 International Youth Nuclear Congress.

18. *Climactic Corrosion Considerations for Independent Spent Fuel Storage Installations in Marine Environments,* EPRI Report 1013524, 2006.

19. *High Burn-up Dry Storage Cask Research and Development Project*, Final Test Plan, EPRI, Revision 0.

20. Regulatory Issue Resolution Protocol (RIRP) N-10-01*, Chloride-Induced Stress Corrosion Cracking.* Nuclear Energy Institute.

21. NEI 03-08*, Guideline for the Management of Material Issues*, Nuclear Energy Institute, Revision 1, January 2010.

22. *Examination of Spent Fuel Rods after 15 Years in Dry Storage*, NUREG CR-6831, U.S. Nuclear Regulatory Commission, September. 2003.

23. *Dry Cask Storage Characterization Project,* Electric Power Research Institute Report 1002882, 2002.

24. *Gap Analysis to Support Extended Storage of Used Nuclear Fuel,* DOE FCRD-USED-2011-000136, U.S. Department of Energy, Used Fuel Disposition Campaign, January, 2012.

25. Letter from R. McCullum, NEI, to Mark Lombard, NRC, "Industry Analysis and Confirmatory Information Gathering Program to Support the Long-Term Storage of High Burnup Fuel (HBF)," dated March 22, 2013.

26. Management Directive 6.4, *Generic Issues Program,* U.S. Nuclear Regulatory Commission.

27. NEI 14-13, *Use of Industry Operating Experience for Aging-related Degradation and Aging Management Programs*, Revision 1, June 2015.

28. *Susceptibility Assessment Criteria for Chloride-Induced Stress Corrosion Cracking (CISCC) of Welded Stainless Steel Canisters for Dry Cask Storage Systems,* Electric Power Research Institute Report 3002005371, September 2015.

29. *Flaw Growth and Flaw Tolerance Assessment for Dry Cask Storage Canisters*, Electric Power Research Institute Report 3002002785, 2015.

30. NEI 14-12, "Aging Management Program Effectiveness," December 2014.

APPENDIX A: PERFORMANCE CRITERIA FOR TOLLGATE ASSESSMENTS

1. **Scope of Program** – Ensure that the scope still adequately addresses specific structures and components subject to AMR in the renewal period.

    a. Procedures and work orders contain appropriate components.
    b. For programs that require sample selection, the sample bases are applied consistent with that outlined in the ISFSI license or CoC renewal application and associated SER.
    c. Implementing procedures and work orders address commitments.
    d. Additions or deletions to program scope are proper with respect to commitments.

2. **Preventive Actions –** Assess the effectiveness of any preventive actions that are taken to prevent aging degradation.

    a. Identified program enhancements are instituted in implementing procedures.
    b. Specific commitments are verified to be in place (and changes, if any, approved per commitment management procedures).
    c. Implementing activities are completed as scheduled and not deferred without adequate technical justification.
    d. Preventive measures are appropriate for the applicable degradation mechanisms.

3. **Parameters Monitored or Inspected** – Evaluate parameters monitored or inspected to ensure that they are appropriate for assessing a particular structure or component to ensure loss of intended function(s) does not occur.

    a. Implementing procedures identify parameters the program monitors.
    b. Parameters monitored should be those being controlled to achieve prevention or mitigation of aging effects.
    c. When evidence of an aging effect or mechanism is observed, document the extent of the condition.

4. **Detection of Aging Effects** – Review the results of inspection activities to ensure that aging effects are being detected before a specific structure or component loses its intended safety function(s). This includes aspects such as the appropriateness of the methods of detection, frequency and sample size of any AMP inspections.

    a. Inspections and examinations are conducted at appropriate intervals.
    b. Aging effects are identified and actions are implemented before loss of intended function.
    c. Samples are biased toward locations most susceptible to aging effect of concern and the sample size is expanded when degradation is detected in the initial sample that may lead to loss of intended function during the period of renewed operation.
    d. Unexpected results are evaluated and program adjustments are made as warranted.

e. Operating experience is considered in evaluating the appropriateness of technique and frequency and adoption of new (enhanced) techniques as they become available.

5. **Monitoring and Trending** – Assess the effectiveness of required monitoring and trending to predict extent of degradation to ensure the timely implementation of corrective or mitigating actions.

    a. Aging effects are monitored and trended such that no loss of intended function occurs during the period of renewed operation.
    b. Results are used to establish a rate of degradation in order to confirm that timing of the next scheduled inspection will occur before a loss of intended function.
    c. Inspection frequencies are adjusted when warranted.

6. **Acceptance Criteria –** Ensure that specified acceptance criteria, which define the need for corrective action, are appropriate to ensure that the intended function(s) of the structure or component is maintained under all required conditions during the period of extended storage operations.

    a. Implementing procedures contain acceptance criteria for each parameter monitored or inspected.
    b. Acceptance criteria should anticipate *rates* of change and margin to loss of function.
    c. Unexpected or new aging mechanisms trigger actions to address extent of condition.

7. **Corrective Actions –** Review the corrective action process to ensure that dry cask storage aging-related issues are being appropriately identified, evaluated in a timely fashion using proper techniques, and generating suitable corrective actions. Proper techniques include simple evaluations, apparent-cause, common-cause and root-cause evaluations.

    a. Condition reports are generated when program results fail to meet acceptance criteria and upon detection of aging-related degradation that potentially affects the ability of a DSS SSC to perform its intended function.
    b. Root-cause evaluations are performed per site procedures.
    c. Appropriate extent of condition is applied.
    d. Prediction of the extent of degradation is used to effect timely preventive actions.
    e. Additional preventive actions, monitoring and inspections are stipulated and instituted as necessary.

8. **Confirmation Process –** Review the effectiveness of corrective actions with respect to aging-related degradation.

    a. Measures to prevent loss of intended function.
    b. Immediate and long-term corrective actions to address a condition found.
    c. Actions to prevent recurrence of a condition.

9. **Administrative Controls** – Assess administrative controls to ensure that they continue to provide a formal review and approval process and provide for developing proper documentation that is generated, retained and retrievable.

    a. Recommendations or deficiencies from external assessments are being addressed.
    b. Commitments are managed in accordance with site procedures.
    c. Changes in commitments should be flagged and administrative controls employed.
    d. Appropriate documentation is verified in accordance with existing procedures.

10. **Operating Experience** - Ensure that relevant operating experience for the aging management activity, including past corrective actions is reviewed to ensure a particular structure or component does not lose its intended function(s).

    a. Industry operating experience is evaluated and program adjustments are made as necessary.
    b. Plant-specific operating experience is used to adjust programs as necessary.

APPENDIX B: SAMPLE AMR TABLE

Sub-Component	Intended Function(s)	Material	Environment	Aging Effect	Aging Mechanism	AMP Required	Aging Management Program	Notes
Shell	HT, PB, SH, SS	Carbon Steel	Air/Gas (Internal)	None	N/A	No	N/A	
			Air/Gas (External)	None	N/A	No	N/A	
			Atmosphere/ Weather (External)	Loss of Material	General, Pitting, and Crevice Corrosion	Yes	ISFSI Inspection and Monitoring Activities Program (AMP No. XX)	
Lid	HT, PB, SH, SS	Carbon Steel	Atmosphere/ Weather (External)	Loss of Material	General, Pitting, Crevice, and Galvanic Corrosion	Yes	ISFSI Inspection and Monitoring Activities Program (AMP No. XX)	
Attachments – Upper Trunnions	SS	Stainless Steel	Air/Gas (Internal)	None	N/A	No	N/A	
			Air/Gas (External)	None	N/A	No	N/A	
Bottom Cover O-Ring Seals	HT, SH	Polymer	Air/Gas (External)	Change in Material Property	Hardening and Loss of Strength	No – periodically replaced	N/A	
Drain and Vent Port Cover Bolts	PB, SS	Carbon Steel	Atmosphere/ Weather (External)	Loss of Material	General, Pitting, Crevice, and Galvanic Corrosion	Yes	ISFSI Inspection and Monitoring Activities Program (AMP No. XX)	
Aluminum Plate	HT	Aluminum	Air/Gas (External)	None	N/A	No	N/A	(1)

CC Provides criticality control of spent fuel
HT Provides heat transfer
PB Directly or indirectly maintains pressure boundary (confinement)
SS Provides structural support and/or functional support of ITS equipment (structural)
SH Shielding
N/A Not Applicable
(1) This is an aluminum enclosure, plate, or shell encasing borated polyester.

APPENDIX C: SAMPLE TOLLGATES

TOLLGATE	YEAR*	ASSESSMENT
1	A**	Evaluate information from the following sources and perform a written assessment of the aggregate impact of the information, including but not limited to trends, corrective actions required, and the effectiveness of the AMPs with which they are associated: • Results, if any, of research and development programs focused specifically on aging-related degradation mechanisms identified as potentially affecting the storage system and ISFSI site, such as: o DOE/EPRI High Burnup Dry Storage Cask Research and Development Project" (HDRP) o EPRI Chloride-Induced Stress Corrosion Cracking (CISCC) research; • Relevant results of other domestic and international research (including non-nuclear); • Relevant domestic and international operating experience (including non-nuclear); • Relevant results of domestic and international ISFSI and DSS performance monitoring; and/or • Relevant results of domestic and international ISFSI and DSS inspections. NOTE: Feedback on any of the above should be assessed at the time the
2	B	Evaluate additional information gained from the sources listed in Tollgate 1 along with any new relevant sources and perform a written assessment of the aggregate impact of the information. This evaluation should be informed by the results of Tollgate 1. The aging effects and mechanisms evaluated at this Tollgate and the time at which it is conducted may be adjusted based on the results of the Tollgate 1 assessment.
3	C	Same as Tollgate 1 as informed by the results of Tollgates 1 and 2
4	D	Same as Tollgate 1 as informed by the results of Tollgates 1, 2, and 3

* Based on the year first cask at the ISFSI reaches initial term of service and aging management activities are required.
** Timing of initial tollgate (A), tollgate frequency (B, C, etc.), and total number of tollgates to be determined by specific licensee/CoC holder in the renewal application.