Enclosure 4 to DPG-18-114

Rancho Seco ISFSI
License Renewal Application,
Revision 1 (non-proprietary version)

PUBLIC VERSION

Sacramento Municipal Utility District (SMUD)

Rancho Seco ISFSI
License Renewal Application

Docket 72-11

SNM-2510

Revision 1

June 2018

Rancho Seco ISFSI
14440 Twin Cities Road, Herald, CA 95638-9799

The proprietary notice is withheld from this public LRA version.

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Acronym List
(3 pages)

Acronym	Definition
ACHP	Advisory Council on Historic Preservation
ACI	American Concrete Institute
AHSM	Advanced Horizontal Storage Module
ALARA	As Low As Reasonably Achievable
AMA	Aging Management Activity
AMID	Aging Management INPO Database
AMP	Aging Management Program
AMR	Aging Management Review
AR	Action Report
ASME	American Society of Mechanical Engineers
ASR	Alkali-Silica Reaction
ASTM	American Society for Testing and Materials
AWS	Automated Welding System
B&PVC	Boiler and Pressure Vessel Code
CAP	Circular Area Profiling
CAR	Corrective Action Report
CC	Criticality Control
CFR	Code of Federal Regulations
CISCC	Chloride-Induced Stress Corrosion Cracking
CISF	Consolidated Interim Storage Facility
CMTR	Certified Material Test Report
CNDDB	California Natural Diversity Database
CoC	Certificate of Compliance
CPP	Cosumnes Power Plant
CR	Condition Reports
CSAR	Certified Safety Analysis Report
DCS	Dry Cask Storage
DEF	Delayed Ettringite Formation
DOE	Department of Energy
DQ	Deviations from Quality
DSC	Dry Shielded Canister
DSS	Dry Storage System
ECN	Engineering Change Notice
EPRI	Electric Power Research Institute

Acronym List
(3 pages)

Acronym	Definition
ESA	Endangered Species Act
FC	Fuel with Control Components
FC-DSC	Fuel with Control Components DSC
FF	Failed Fuel
FF-DSC	Failed Fuel DSC
FO	Fuel Only
FO-DSC	Fuel Only DSC
FSAR	Final Safety Analysis Report
GALL	Generic Aging Lessons Learned
GEIS	Generic Environmental Impact Statement
GM	General Manager
GTCC	Greater-Than-Class-C (waste)
GW	Underground (below grade level)
HAZ	Heat Affected Zone
HSM	Horizontal Storage Module
HT	Heat Transfer
IN	Information Notice
ISFSI	Independent Spent Fuel Storage Installation
ITS	Important-to-Safety
LRA	License Renewal Application
MAPS	Managing Aging Processes in Storage
MRSA	Manager, Rancho Seco Assets
NCIC	North Central Information Center
NCR	Non-Conformance Report
NITS	Not Important-to-Safety
NMFS	National Marine Fisheries Service
NRC	U.S. Nuclear Regulatory Commission
NSP	Neutron Shield Panels
OD	Outer Diameter
OE	Operating Experience
PB	Pressure Boundary
PCI	Precast/Prestressed Concrete Institute
PDQ	Potential Deviations from Quality
PEO	Period of Extended Operation

Acronym List
(3 pages)

Acronym	Definition
PSDAR	Post-Shutdown Decommissioning Activities Report
PTZ	Pan-Tilt-Zoom
QA	Quality Assurance
RSNGS	Rancho Seco Nuclear Generating Station
RE	Retrieval (of spent fuel canister from storage cask)
SCC	Stress Corrosion Cracking
SFA	Spent Fuel Assembly
SH	Radiation Shielding
SHPO	State Historic Preservation Office
SS	Structural Support
SSCs	Structures, Systems, and Components
SER	Safety Evaluation Report
SMUD	Sacramento Municipal Utility District
TC	Transfer Cask
TLAA	Time Limited Aging Analysis
TMI-2	Three Mile Island, Unit 2
TN	Transnuclear
TNW	Trans Nuclear West
TS	Technical Specifications
UFSAR	Updated Final Safety Analysis Report
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
UT	Ultrasonic Testing
VDS	Vacuum Drying System
WCS	Waste Control Specialists
XRF	X-ray Fluorescence

CHAPTER 1
GENERAL INFORMATION

CONTENTS

1.1 Introduction

Sacramento Municipal Utility District (SMUD) has prepared this application for renewal of the Rancho Seco Independent Spent Fuel Storage Installation License SNM-2510, including Technical Specifications and Safety Evaluation Report, [1-11]. The original 20-year Rancho Seco ISFSI license will expire on June 30, 2020. This application requests renewal of the ISFSI license for an additional 40-year period of extended operation (PEO). This application is submitted in accordance with 10 CFR 72.42 and includes the applicable general, technical, and environmental supporting information. The format and content is also consistent with NEI 14-03, Revision 2, Format, Content and Implementation Guidance for Dry Storage Operations-Based Aging Management, [1-10], which was submitted by NEI to the NRC in December 2016 for review and endorsement. This renewal application is limited in scope to those items required to be addressed for license renewal. No technical changes to the license are being requested; however, two editorial changes are being requested, as explained in Appendix D.

The Rancho Seco ISFSI is designed to provide dry storage capacity for 100% of the Rancho Seco spent fuel assemblies (SFAs) and Greater than Class C (GTCC) waste in order to complete full plant dismantlement. The waste is stored in 21 spent fuel canisters and 1 GTCC canister, which is described in more detail elsewhere in the LRA.

In accordance with NUREG-1927, Rev 1, Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance, [1-2], this renewal application is based "on the continuation of the existing licensing basis throughout the PEO and on the maintenance of the intended safety functions of the structures, systems, and components (SSCs) important to safety." The existing licensing basis consists primarily of the following:

A. The ISFSI Final Safety Analysis Report (ISFSI FSAR), Revision 6, Rancho Seco ISFSI Final Safety Analysis Report [1-7],
B. The ISFSI license, SNM-2510, and associated Technical Specifications (TS), and Safety Evaluation Report (SER) [1-11],
C. Safety Evaluation Reports (SERs) issued for the Rancho Seco Independent Spent Fuel Storage Installation License SNM-2510, original license (denoted as Amendment 0 [1-3], and Amendments 1 through 3 [1-4] [1-5] [1-6],
D. NRC Orders,
E. Exemptions, and
F. Other docketed licensing correspondence.

Section 2.2.2 provides a summary of each amendment and the NRC orders and exemptions.

1.2 Application Format and Content

The format and content of this application includes information required by 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, [1-1] and is consistent with the guidance contained in the Nuclear Regulatory Commission's (NRC's) NUREG-1927 [1-2].

Chapter 1, General Information: This chapter provides: (1) a general description of the Rancho Seco ISFSI; (2) information on the format and content of this application, and; (3) licensee information as required by 10 CFR 72.22.

Chapter 2, Scoping Evaluation: This chapter provides a description of the methodology used to identify the SSCs, and subcomponents of the Rancho Seco ISFSI that are within the scope of the renewal. This methodology is based on the two-step process described in NUREG-1927 [1-2].

Chapter 2 also provides a summary of the results of the scoping evaluation based on Revision 6 of the ISFSI FSAR, Rancho Seco ISFSI Final Safety Analysis Report [1-7] which reflects the current configuration of the Rancho Seco SSCs resulting from Amendments 1 through 4 to the SNM-2510 license and changes implemented under the provisions of 10 CFR 72.48.

Chapter 3, Aging Management Review: This chapter provides the methodology used and the results of the aging management review (AMR) of the SSCs and subcomponents of the Rancho Seco ISFSI, based on the guidance provided in NUREG-1927 [1-2] and NEI 14-03, Format, Content and Implementation Guidance for Dry Storage Operations-Based Aging Management [1-10]. The AMR documented in Chapter 3 identifies the materials and environments for those SSCs and associated subcomponents determined to be within the renewal scope in Chapter 2. This is accomplished by reviewing the drawings and the design basis included in the current ISFSI FSAR [1-7] Rancho Seco Independent Spent Fuel Storage Installation License SNM-2510, including Technical Specifications and Safety Evaluation Report [1-11]. Once the component material/ environment combinations are determined, potential aging effects requiring management are identified and evaluated based on engineering literature, related industry research information, and existing operating experience (OE). Chapter 3 also provides a summary of the OE accumulated over the last 20 years for the Standardized NUHOMS® System. The information gleaned from this OE is used to identify potential aging effects that require management.

After applicable aging effects are identified, it is determined whether they can be addressed by either time-limited aging analysis (TLAA), or if they will require an aging management program (AMP).

Appendix A: This appendix provides a description and results of the TLAAs and other supplemental evaluations prepared for the in-scope SSCs.

Appendix B: This appendix provides a description of the AMPs to be implemented during the PEO.

Appendix C: This appendix provides the recommended changes to the Rancho Seco ISFSI FSAR for SNM-2510 renewal.

Appendix D: This appendix provides the recommended changes to the Rancho Seco ISFSI license and TS.

Appendix E: This appendix provides the supplement to the Rancho Seco ISFSI Environmental Report.

Appendix F: This appendix addresses the Rancho Seco ISFSI Decommissioning Funding Plan Update.

1.3 Facility Description

1.3.1 Facility Description

The Rancho Seco ISFSI is located within the Owner Controlled Area of the Rancho Seco site, which is owned and operated by SMUD. The Rancho Seco site comprises approximately 2480 acres in Sacramento County, California. The Rancho Seco ISFSI pad is approximately 225 feet by 170 feet in size, and contained within an approximately 14 acre licensed area.

The storage technology used at the Rancho Seco ISFSI is a NUHOMS® canister-based system for the dry storage of irradiated SFAs consisting of a dry shielded canister (DSC) and a reinforced concrete horizontal storage module (HSM). Additional SSCs include a transfer cask (TC) and other canister transfer and auxiliary equipment used to support DSC loading and transfer operations.

The Rancho Seco ISFSI provides for three types of DSC design: Fuel Only DSC (FO-DSC), Fuel with Control Components DSC (FC-DSC) and Failed Fuel DSC (FF-DSC). The Rancho Seco FO, FC and FF DSC design are based on the Standardized NUHOMS®-24P DSC design, NUH-003, Certified Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Fuel, Revision 4A [1-8] except that the FO and FC DSCs include fixed neutron absorbers in the design of the DSC basket. Also provided is one canister for storage of Greater than Class C (GTCC) waste consisting of solid, reactor-related waste such as activated reactor internals and in-core instrumentation.

The Rancho Seco HSM design is similar to the Standardized NUHOMS® HSM design [1-8]. The HSM is a low profile, modular, reinforced concrete structure whose primary functions are to provide a means for passively removing spent fuel decay heat, provide structural support and environmental protection to the loaded DSC, and provide radiation shielding protection.

The TC, designated as the NUHOMS®- Transfer Cask (TC), is certified for offsite transport [1-9]. The TC facilitated fuel loading/unloading as well as onsite transfer of a loaded DSC. In addition to these primary components, the ISFSI also made use of auxiliary equipment consisting of a vacuum drying system (VDS), TC lifting yoke, DSC automatic welding system (AWS), hydraulic ram system and a transfer trailer equipped with a TC skid. No more DSCs are to be loaded at the Rancho Seco ISFSI and thus the TC, VDS, AWS and other auxiliary equipment will not be used at the ISFSI for any loading operations. However, to assure canister retrievability, the TC is considered in-scope for license renewal, as discussed in Chapter 2.

A more complete system description, including supporting design basis, is contained in the Rancho Seco ISFSI FSAR, Revision 6 [1-7].

1.4 Information Required by 10 CFR 72.22

1.4.1 Name of the Applicant

Sacramento Municipal Utility District.

1.4.2 Address of the Applicant

6301 S Street, Sacramento, California 95817.

1.4.3 Address of the Rancho Seco ISFSI

14440 Twin Cities Road, Herald, California 95638.

1.4.4 Description of Business or Occupation of the Applicant

SMUD was formed under the provisions of California's Municipal Utility District Act following a vote of the citizens of Sacramento in 1923. SMUD began operations in 1946 and is now the sixth largest community-owned electric utility in the nation. SMUD is responsible for the acquisition, generation, transmission and distribution of electric power to its service area with a population of approximately 1.4 million - most of Sacramento County and small, adjoining portions of Placer and Yolo counties.

1.4.5 Organization and Management of the Applicant

SMUD's Board of Directors is the policy-making body, which has ultimate responsibility for the Rancho Seco ISFSI license.

The Chief Executive Officer and General Manager (GM) reports directly to the Board of Directors. The GM, through the Chief Energy-Delivery Officer, and Director, Power Generation has corporate responsibility for overall safety and management of the facility. The GM shall take any measures needed to ensure acceptable performance of the staff in managing, maintaining, and providing technical support to the facility to ensure nuclear safety.

The Chief Energy-Delivery Officer is responsible for the overall Rancho Seco facility and the Rancho Seco organization. This includes ensuring the safe storage of spent nuclear fuel and GTCC waste, ensuring effective day-to-day management, and maximizing the effectiveness of nuclear policies and procedures.

The Director, Power Generation is responsible for ensuring effective management of the licensed facilities, and ensuring the safe storage of spent nuclear fuel and GTCC waste.

The Manager, Rancho Seco Assets (MRSA) is the lead SMUD representative at the Rancho Seco site and is responsible for all facets of day-to-day management of the licensed facilities. The MRSA is responsible for site security during routine, emergency, and contingency operations. The MRSA is also responsible for the implementation and maintenance of the Physical Protection Plan.

The MRSA is the Radiation Protection Manager and implements the Radiation Protection program. The MRSA is responsible for health physics surveillance, personnel monitoring and record keeping, radwaste management, emergency preparedness and environmental monitoring.

The MRSA utilizes available SMUD and contract personnel to resolve engineering, design, and other technical issues required to support compliance with the 10 CFR Part 72 ISFSI license. The MRSA is responsible for ensuring that management of the Rancho Seco ISFSI is conducted in accordance with Technical Specifications, federal and state regulations, Physical Protection Plan, and plant procedures and has the primary responsibility for cask and canister handling operations.

Staff under the direction of the MRSA are trained and qualified, as described in Volume I, Section 9.3, of [1-7] to ensure that ISFSI operations are conducted in a safe and efficient manner. As required by site procedures, personnel under the direction of the MRSA check, analyze, and log system parameters, and initiate corrective actions when abnormal conditions exist. These personnel perform initial fire response and notifications in accordance with the fire protection program.

Individuals on shift are trained and qualified to implement appropriate radiation protection procedures.

Power Generation Regulatory Compliance Program is responsible for ensuring that the quality assurance program is implemented in accordance with regulatory requirements. The Power Generation Regulatory Compliance organization has the authority to take any issue regarding the quality of program management at Rancho Seco to the General Manager and the Chief Energy-Delivery Officer.

Emergency Preparedness is responsible for maintaining and administering the Emergency Plan under the direction of the Manager, Rancho Seco Assets. The Emergency Preparedness staff trains all personnel implementing the Emergency Plan as well as directing drills and other activities necessary to maintain regulatory compliance. The Emergency Plan is outside the scope of this LRA per NUREG-1927 [1-2].

Rancho Seco ISFSI Security is responsible for providing personnel, as required, to implement the Physical Protection Plan. Security is also responsible for staffing the security functions, as required, during routine, emergency and contingency conditions at the facility. All of the Security functions are staffed by contract personnel under the direction of the Manager, Rancho Seco Assets. Security is outside the scope of LRA in accordance with NUREG-1927 [1-2].

1.4.6 Financial Information

As required by 10 CFR 72.22(e), SMUD will remain financially qualified to carry out the activities associated with spent fuel storage at the Rancho Seco ISFSI throughout the PEO. Governed by an elected board of directors (Board), SMUD has the rights and powers to fix rates and charges for commodities and services it furnishes, incur indebtedness, and issue bonds or other obligations.

The estimated operating costs for the Rancho Seco ISFSI specific license are conservatively estimated to be $200M in 2017 dollars for the duration of the 40-year license PEO, or approximately $5M per year. There are no plans to expand the capacity of the Rancho Seco ISFSI. SMUD has an annual budget in excess of $1.0 billion and maintains an AA- credit rating. This information provides reasonable assurance of SMUD's ability to obtain the necessary funds to cover the operating costs over the PEO.

The Rancho Seco Decommissioning Funding Plan Update is provided in Appendix F. SMUD provides financial assurance for the decommissioning of the Rancho Seco ISFSI using the external sinking fund method. Contributions to the trust fund are based upon a site-specific cost estimate that includes license termination activities including decommissioning of the Part 50 Phase II licensed area and the Part 72 ISFSI licensed area. The Rancho Seco decommissioning trust fund was considered fully funded in 2008. At this time, no future contributions are planned, but SMUD will continue to perform decommissioning cost estimates and compare the results with the available funds in the decommissioning trust. As a municipal utility, SMUD has the ability to recover costs of service, including decommissioning, through rates, thereby providing reasonable assurance that sufficient funding is available for decommissioning.

1.5 References

1-1 U.S. Nuclear Regulatory Commission, 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," Code of Federal Regulations.

1-2 U.S. Nuclear Regulatory Commission, NUREG-1927 Revision 1, "Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance," June 2016.

1-3 Rancho Seco Independent Spent Fuel Storage Installation License SNM-2510, including Technical Specifications and Safety Evaluation Report, Amendment 0, June 2000, (Docket 72-11).

1-4 Rancho Seco Independent Spent Fuel Storage Installation License SNM-2510, including Technical Specifications and Safety Evaluation Report, Amendment 1, April 2005 (Docket 72-11).

1-5 Rancho Seco Independent Spent Fuel Storage Installation License SNM-2510, including Technical Specifications and Safety Evaluation Report, Amendment 2, April 2005 (Docket 72-11).

1-6 Rancho Seco Independent Spent Fuel Storage Installation License SNM-2510, including Technical Specifications and Safety Evaluation Report, Amendment 3, August 2009 (Docket 72-11).

1-7 Rancho Seco ISFSI Final Safety Analysis Report, Revision 6, August 2016 (Docket 72-11).

1-8 Vectra Technologies, Inc., "NUH-003, Certified Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Fuel, Revision 4A," June 1996 (Docket No. 72-1004).

1-9 U.S. Nuclear Regulatory Commission, Certificate of Compliance for Radioactive Material Packages, Certificate Number 9255, Revision 13, issued to TN Americas LLC, NUHOMS® MP187 Multi-Purpose Cask, approved January 30, 2017.

1-10 Nuclear Energy Institute, "Format, Content and Implementation Guidance for Dry Storage Operations-Based Aging Management," NEI 14-03 Revision 2, 2016.

1-11 Rancho Seco Independent Spent Fuel Storage Installation License SNM-2510, including Technical Specifications and Safety Evaluation Report, Amendment No. 4, November 2017 (Docket 72-11).

CHAPTER 2
SCOPING EVALUATION

CONTENTS

LIST OF TABLES

2.1 Introduction

Chapter 2 describes the evaluation process and methodology used to identify the structures, systems, and components (SSCs) and associated subcomponents of the Rancho Seco Independent Spent Fuel Storage Installation (ISFSI) that are within the scope of the Rancho Seco Independent Spent Fuel Storage Installation Materials License SNM-2510, including Technical Specifications and Safety Evaluation Report [2-7] renewal.

In accordance with the guidance contained in NUREG-1927, Rev 1 Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance [2-1], the first step of the renewal process is the performance of a scoping evaluation. The scoping evaluation identifies the ISFSI SSCs that are within the scope of renewal. The second step is the aging management review (AMR), described in Chapter 3, whereby the SSCs that are identified to be within the scope of renewal are subsequently subjected to evaluation for potential degradation due to aging effects.

A description of the scoping evaluation process and methodology is provided in Section 2.2. The results of the scoping evaluation are provided in Section 2.3. A detailed description of the Rancho Seco ISFSI SSCs and associated subcomponents within the scope of renewal is provided in Section 2.4.

2.2 Scoping Evaluation Process and Methodology

This section describes the scoping evaluation process and methodology used to determine the SSCs and associated subcomponents that are within the scope of renewal. The scoping evaluation is performed based on the two-step process described in Section 2.4.2 of NUREG-1927 [2-1].

The first step is a screening evaluation to determine which SSCs are within the scope of the renewal. In accordance with the NUREG-1927 [2-1] guidance, SSCs are considered to be within the scope of the renewal, if they satisfy either of the following two criteria:

Criterion 1: The SSC is classified as important-to-safety (ITS) as it is relied on to perform one of the following functions:

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

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

Criterion 2: The SSC is classified as not important-to-safety (NITS), but according to the licensing basis, its failure could prevent fulfillment of a function that is ITS, or its failure as a support SSC could prevent fulfillment of a function that is ITS.

The second step involves further review of the SSCs that are determined to be within the scope of the renewal to identify and describe the subcomponents and subcomponent parts that support the intended function or functions of the SSCs. The intended functions of the SSC subcomponents (and the corresponding abbreviations used to denote this function) include:

- Providing criticality control of the spent fuel (CC),
- Providing heat transfer (HT),
- Directly or indirectly maintaining a pressure boundary (PB),
- Providing radiation shielding (SH),
- Providing structural support, functional support, or both, to SSCs that are ITS (SS) and
- Providing retrieval of spent fuel canister from the storage cask (RE).

The scoping of the spent fuel assemblies (SFAs) authorized for storage at the Rancho Seco ISFSI has been addressed as specified in Section 2.4.2.1 of NUREG-1927 [2-1].

2.2.1 Licensing Basis for Retrievability of Rancho Seco SFAs

A brief discussion is presented here to clarify the licensing basis for Rancho Seco SFA retrievability. Rancho Seco Independent Spent Fuel Storage Installation Final Safety Analysis Report (ISFSI FSAR) [2-2], Section 4.2.2.1.12, states:

"Retrievability: By using a transportable storage system, the stored fuel can be transferred directly to a DOE facility after DOE acceptance of the fuel. The steps involved in placing a loaded vertical cask on the transfer trailer and transferring the cask from the trailer to a rail car and preparing it for transport are covered in the NUHOMS®-MP187 Multi-Purpose Transportation Package Safety Analysis Report, Document No. NUH-05-151 submitted in accordance with 10 CFR 71."

The NRC accepted this canister-based approach to retrievability as meeting Interim Staff Guidance, ISG-2, Revision 0, Fuel Retrievability [2-14]. It is to be noted that at the time of SNM-2510 approval in June 2000, ISG-2, Revision 0 [2-14] was applicable, while, Interim Staff Guidance, ISG-2, Revision 1, Fuel Retrievability [2-15] was not issued until February 2010. As stated in Section 4.3.7 of the original SNM-2510 SER [2-4]:

> The design criteria with regard to retrieval considerations for SSCs important to safety are governed by 10 CFR 72.122(l). As stated in ISG-2, as long as the design of the storage system has a method to repackage into a transportation cask for shipment offsite for further processing or disposal, a facility meets the requirements of 10 CFR 72.122(l). …therefore, the staff considered that the requirements of 10 CFR 72,122(l) are met by the design of the Rancho Seco ISFSI….The Rancho Seco ISFSI meets the guidance of ISG-2 for fuel retrievability.

2.2.2 Documentation Sources Used for Scoping

In accordance with NUREG-1927 [2-1], the renewal is based on the continuation of the existing licensing bases throughout the period of extended operation (PEO) and on the maintenance of the intended safety functions of the SSCs important to safety. Accordingly, the sources of information reviewed in the scoping evaluation are those that describe the licensing basis and the intended safety functions of the ITS SSCs.

The current Rancho Seco ISFSI licensing bases consists primarily of the following:

- Rancho Seco ISFSI FSAR, Revision 6 [2-2],
- Rancho Seco Independent Spent Fuel Storage Installation Materials License SNM-2510, Amendment 4 including Technical Specifications and Safety Evaluation Report [2-8],

- Safety Evaluation Reports (SERs) issued for the Rancho Seco Independent Spent Fuel Storage Installation Materials License SNM-2510, original license (denoted as Amendment 0) [2-4] and Amendments 1 through 3 [2-5] [2-6] [2-7],
- Exemptions [2-10] [2-11],
- NRC Orders,
- Docketed licensing correspondence, as applicable.

The Rancho Seco License SNM-2510, Amendment 4 [2-8] encompasses the initial approved license (Amendment 0) and subsequently approved amendments (Amendment 1 through Amendment 4).

A brief summary of the contents of each amendment to Rancho Seco license SNM-2510 is presented in Table 2-4 and summarized below:

- Amendment 1 [2-5] deleted annual effluent reporting requirement of Technical Specification 5.5.2,
- Amendment 2 [2-6] authorized storage of greater than class C (GTCC) waste at Rancho Seco ISFSI in a GTCC dry shielded canister (DSC),
- Amendment 3 [2-7] approved the retrospective re-classification of six intact SFAs in five FC DSCs as damaged fuel, and
- Amendment 4 [2-8] authorized possession of a Sr90 source under the Rancho Seco 10 CFR Part 72 license.

Amendment 1 is related to record keeping and reporting. Amendment 4 adds a source to the allowed material to be possessed under the 10 CFR Part 72 license. Therefore, Amendments 1 and 4 do not have any impact on the renewal of Rancho Seco Materials License SNM-2510. Amendments 2 and 3 are addressed in this LRA.

Also listed in Table 2-4 are two active exemptions to Rancho Seco Materials License, SNM-2510. The approved exemptions from 10 CFR 72.72(d) [2-10], and from 10 CFR 72.44(d)(3) [2-11] are related to recordkeeping and reporting, and remain necessary. However, they do not have any impact on the renewal of Rancho Seco Materials License SNM-2510.

The two security-related orders remain in effect and have no impact on license renewal.

In addition, the changes to the Rancho Seco ISFSI components and subcomponents implemented under the provisions of 10 CFR 72.48 are documented in the Rancho Seco ISFSI Biennial Reports for the periods from 2000-2016. The 72.48 changes that impacted the configuration of Rancho Seco ISFSI SSCs are those documented in Rancho Seco ISFSI Biennial Report for the period 2000-2002, [2-13]. These changes are listed in Table 2-5.

The updated Rancho Seco ISFSI FSAR [2-2] is the primary source used in the scoping evaluation. It incorporates the first three approved amendments to Rancho Seco license SNM-2510, as well as the changes implemented to the Rancho Seco ISFSI SSCs under the provisions of 10 CFR 72.48.

As documented in Volume 1, Section 3.4.1 of the Rancho Seco ISFSI FSAR [2-2], the safety classifications of the Rancho Seco SSCs are similar to those of the Standardized NUHOMS® System SSCs listed in Section 3.4 of the CSAR, NUH-003, Certified Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Fuel, Revision 4A [2-3]. Table 3.4-1 of the CSAR summarizes the safety classification of the major Standardized NUHOMS® System components. The HSM, DSC and TC drawings, contained in Volume 4 of the ISFSI FSAR [2-2], list all the associated subcomponents of these SSCs, their quality categories and their materials of construction. The drawings listed in Table 2-10 provide a roadmap to the detailed description of the Rancho Seco ISFSI SSCs presented in Section 2.4.

These documents were reviewed to determine the SSCs and associated subcomponents that meet either Scoping Criterion 1 or 2. Based on this review, those SSCs and subcomponents that perform or support any of the identified intended functions, identified in Section 2.3.1, are determined to require an AMR, which is presented in Chapter 3. Those SSCs and associated subcomponents that do not perform or support one or more of these intended safety functions are excluded from further evaluation in the AMR. Section 2.3.2 identifies those SSCs that are out-of-scope.

2.3 Results of Scoping Evaluation

This section discusses the renewal scoping results. Table 2-1 summarizes the results of the scoping evaluation, listing the SSCs that are identified to be within the scope of renewal and the criterion upon which this determination is based.

Detailed scoping evaluation results for each SSC and associated subcomponents have been generated based on the current revision of the Rancho Seco ISFSI FSAR [2-2]. These detailed scoping evaluation results, along with AMR results, are presented in Table 2-6 (for DSCs), Table 2-7 (for HSMs), Table 2-8 (for TC), and Table 2-9 (for SFAs). The scoping results presented in these tables represent a consolidated scoping evaluation of the storage system as currently designed and licensed. The source drawings, upon which these detailed scoping tables are based, are listed in Table 2-10.

Note: As discussed in Section 2.4.1.4, the external design characteristics of the GTCC waste containing DSC are identical to the fuel-containing DSCs (FO/FC/FF DSCs). Hence, the term “DSC” has been used to address both the fuel and the GTCC DSCs in this application, unless a distinction is necessary to address a specific characteristic of the GTCC DSC.

2.3.1 Structures, Systems, and Components within the Scope of Rancho Seco ISFSI License Renewal

The SSCs determined to be within the scope of Rancho Seco ISFSI license renewal under Criterion 1 are the DSC, HSM, and TC. The subcomponents of the in-scope SSCs and their intended functions are identified in Table 2-6 (DSCs), Table 2-7 (HSMs), and Table 2-8 (TCs). A detailed description of the Criterion 1 in-scope SSCs and associated subcomponents, including their intended functions, is presented in Section 2.4.

At the Rancho Seco ISFSI, all spent fuel and GTCC waste is currently in dry storage and no more DSCs are to be loaded at Rancho Seco ISFSI. Hence, the TC and the auxiliary equipment, described in Sections 2.3.2 and 2.4.3, respectively, will not be used for any loading operations. The only remaining TC safety function during the PEO is retrieval of the DSCs from the HSMs prior to offsite shipment of the DSC.

The SFAs, which are stored in an inert and sealed environment and are supported inside the FO/FC/FF DSC basket assembly, are also determined to be within the scope of renewal consistent with NUREG-1927, Section 2.4.2.1. Table 2-2 provides a summary of the characteristics of the SFAs allowed for storage at the Rancho Seco ISFSI. Table 2-11 provides an overview of the SFAs loaded at Rancho Seco Nuclear Generating Station (RSNGS). Table 2-3 summarizes the radioactive waste contents allowed for storage in the GTCC DSC. The in-scope subcomponents of the SFAs and their intended functions are identified in Table 2-9.

NITS subcomponents that meet Criterion 2 are also within the scope of renewal. For these NITS subcomponents, the intended ITS function that could be prevented from being fulfilled is identified in Table 2-6, Table 2-7, Table 2-8, and Table 2-9. A detailed description of the Criterion 2 in-scope SSCs and associated subcomponents, including their intended functions, is presented in Section 2.4.

The basemat is a NITS structure. Since settlement of the basemat may affect retrievability of the DSC, the basemat is included within the scope of renewal (monitoring for basemat settlement). There are no other credible failure modes of the basemat that could prevent the HSM safety functions from being fulfilled. The accessible above-grade and inaccessible below-grade areas of the storage pad are within the scope of renewal.

2.3.2 SSCs not within the Scope of Rancho Seco ISFSI License Renewal

SSCs that are not in the scope of renewal include the fuel transfer and auxiliary equipment. These components are classified as NITS and do not meet scoping Criterion 2. Also not within the scope are those NITS subcomponents of the DSC, HSM and TC that do not meet Criterion 2 because their failure does not prevent fulfillment of an ITS function. Explanation or justification for these items is provided in Table 2-6, Table 2-7, and Table 2-8 or the DSCs, HSMs, and TCs, respectively. The GTCC waste as described in Section 2.3.2.4 is also not in the scope of renewal.

2.3.2.1 Fuel Transfer and Auxiliary Equipment

Fuel transfer equipment necessary for ISFSI operations includes the lifting yoke, the primary mover and transfer trailer, skid positioning system, hydraulic ram system, ram support assembly, and the cask support skid. Auxiliary equipment used at the Rancho Seco ISFSI to facilitate canister loading, draining, drying, inerting, and sealing operations include the following systems: the vacuum drying system, automatic welding equipment, the waste processing system, the security system, and the temperature monitoring system.

At the Rancho Seco ISFSI, all of the spent fuel and GTCC from plant operations is currently in dry storage and no more DSCs are to be loaded at the Rancho Seco ISFSI. Hence, the fuel transfer and auxiliary equipment listed above will not be used for any loading operations.

The fuel transfer and auxiliary equipment are NITS items and their failure would not prevent fulfilment of any intended function supporting storage operations. The auxiliary equipment used to retrieve the DSCs from the HSMs is subject to standard maintenance and repair prior to use. Hence, the fuel transfer and auxiliary equipment does not meet scoping Criterion 2 and, therefore, are not in the scope of renewal.

2.3.2.2 Approach/Apron Slabs

The approach or apron slab is a NITS reinforced concrete structure, designed and constructed to Rancho Seco site specific conditions. The slab provides access to the HSM but does not support the HSM. It does not provide a safety function, and its failure would not prevent fulfillment of a safety function of the HSM loaded with a DSC.

The transport trailer used to retrieve the DSCs has features that enable adjustment to any credible differential settlement between the basemat and the apron slab. The apron slab can be repaired if needed to maintain access to the HSM during DSC retrieval.

2.3.2.3 Miscellaneous Equipment

ISFSI miscellaneous equipment (e.g., ISFSI security fences and gates, lighting, lightning protection, communications, and monitoring equipment) is NITS and its failure would not prevent fulfillment of any ITS function. Security equipment is excluded from the scope of license renewal consistent with Section 1.2 of NUREG-1927, [2-1].

2.3.2.4 GTCC waste

Table 2-3 summarizes the radioactive waste contents allowed for storage in the GTCC DSC. GTCC waste is non-fuel related material generated as a result of plant operations and decommissioning. This waste includes such items as incore components and instrument tips, activated metal from core support structures, and small reactor-related miscellaneous parts resulting from the reactor vessel internals segmentation/decommissioning process [2-2].

The GTCC DSC provides confinement of radioactive materials, encapsulates the waste in an inert helium environment, and together with a TC or HSM, provides biological shielding during GTCC DSC closure, transfer and storage operations. Since the GTCC waste does not include any spent fuel assemblies or fissionable material, the GTCC DSC basket is entirely NITS. The GTCC waste does not directly perform any safety function associated with criticality, shielding, confinement, heat transfer, structural integrity or retrievability nor would its failure prevent fulfilment of any intended function supporting storage operations. As listed in Table 2-1, the GTCC waste does not meet Scoping Criterion 1 or Scoping Criterion 2 and, therefore, it is not in the scope of renewal.

2.4 Detailed Description of Rancho Seco ISFSI Components and Subcomponents

This section provides a detailed description of the Rancho Seco SSCs and associated subcomponents, including materials of construction and intended functions. A listing of the drawings for the DSCs, HSMs, and the TC is provided in Table 2-10. Volume I, Chapter 1 of [2-2] provides figures depicting the Rancho Seco DSCs, HSMs and TC.

2.4.1 DSCs

The Rancho Seco ISFSI provides for storage of 100% of the Rancho Seco spent fuel assemblies and control components. To fulfill this requirement, three types of DSCs are provided: (1) Fuel Only (FO), (2) Fuel with Control Components (FC), and (3) Failed Fuel (FF). The Rancho Seco DSC designs are based on the Standardized NUHOMS®-24P DSC design [2-3] except that the FO and FC DSCs include fixed neutron absorbers. In addition, modifications have been made to the DSC cavity basket and spacer disc design to qualify the DSCs for offsite transport. The Rancho Seco ISFSI also provides for storage of 100% of Rancho Seco GTCC waste in a GTCC DSC.

All three types of DSCs containing SFAs are SA-240, Type 304 stainless steel, welded pressure vessels that provide confinement of the radioactive materials, encapsulate the fuel in an inert atmosphere, and provide axial biological shielding during DSC closure, transfer operations and long term storage. The Rancho Seco ISFSI configuration consists of eighteen FC DSCs, two FO DSCs and one FF DSC.

All three DSC types have an outside diameter of 67.2 inches (nominal) and are 186.2 inches (nominal) long. The DSC is composed of a 5/8-inch thick austenitic stainless steel shell. The cylindrical shell and the top and bottom cover plate assemblies form the pressure retaining boundary for the spent fuel and cover gas. The DSCs are equipped with two shielded end plugs so that the occupational doses at the ends are minimized for drying, sealing and handling operations. The DSCs have redundant seal welds, which join the shell and the top and bottom shield plug and cover plate assemblies to seal the canister. The bottom-end assembly welds are made during fabrication of the DSC. The top-end closure welds are made after fuel loading. Both top plug penetrations (siphon and vent ports) are redundantly sealed after the DSC drying operations are completed.

The internal basket assembly contains a storage position for each fuel assembly. The basket is composed of circular spacer discs machined from thick carbon steel plates. Axial support for the DSC basket is provided by four high strength stainless steel support rods (FO and FC DSC) or four carbon steel support plates (FF DSC), which extend over the full length of the DSC cavity and bear on the canister top and bottom end assemblies. All DSCs are inerted with helium before being sealed. Carbon steel components of each DSC basket assembly are coated with a thin layer of nickel to provide corrosion resistance for the short time that the DSC is in the spent fuel pool for fuel loading. After the DSC is drained, dried, inerted and sealed for storage or transportation, there is no mechanism available for corrosion of the carbon steel components.

On the bottom of each DSC is a grapple ring that allows the DSC to be transferred in and out of the NUHOMS® storage modules from the TC horizontally. The DSC basket is keyed to the DSC shell and the grapple ring is keyed to the cask bottom closure to maintain the basket-to-cask alignment during all operations. The specific features of the three types of DSCs provided at Rancho Seco ISFSI are as follows:

2.4.1.1 Fuel-Only (FO) DSC

The FO DSC has a cavity length of 167 inches and has solid steel shield plugs at both ends. The FO DSC is capable of storing 24 intact B&W 15x15 Mark B SFAs with characteristics as listed in Table 2-2. The FO DSC basket assembly consists of 24 guide sleeve assemblies with integral borated neutron absorber plates, twenty-six spacer discs and four support rods. The spacer discs have machined openings, which allow the guide sleeves and the fixed borated neutron absorber plates to pass through.

2.4.1.2 Fuel with Control Components (FC) DSC

The FC DSC has an internal cavity length of 173 inches to accommodate fuel with control components. To obtain this increased cavity length the shield plugs are a composite of lead and steel. The use of lead in the shield plugs allows them to be thinner, thus increasing the DSC cavity length. The support rods are six inches longer above the top spacer disc than those in the FO DSC. The FC DSC has a capacity to store 24 intact B&W 15x15 Mark B SFAs with control components (with the exception of six damaged SFAs stored in accordance with footnote 3 in Table 2-2). The SFA characteristics are listed in Table 2-2 while the control component characteristics are listed in Volume 1, Table 3-2 of the Rancho Seco ISFSI FSAR [2-2]. To ensure that guide sleeve displacements during a top end drop do not uncover the active portion of the fuel assemblies, four 6.25-inch lengths of angle, or formed plates, protrude above the top of each guide sleeve. Angles are used to preclude interference of the fuel handling grapple during insertion and removal of fuel assemblies. All other features of the FC DSC are the same as those of the FO DSC.

2.4.1.3 Failed Fuel (FF) DSC

The FF DSC is similar to the FC DSC in most respects with the exception of the basket assembly. The internal cavity length is 173 inches. The FF DSC has a capacity to store 13 damaged fuel assemblies.

The FF DSC shell and top and bottom ends enclose a basket assembly, which serves as the structural support for the fuel assemblies. The fuel assemblies may be intact or damaged fuel assemblies as defined in Section 1.1 of Rancho Seco Technical Specifications [2-8] with characteristics as listed in Table 2-2. Because of the fuel cladding defects, individual (screened) fuel cans are provided to confine any loose material, and facilitate loading and unloading operations.

The FF DSC basket assembly consists of fifteen carbon steel spacer discs, four carbon steel axial support plates, and thirteen stainless steel failed fuel cans. The carbon steel components are coated with electroless nickel. The spacer discs maintain the cross-sectional spacing and provide lateral support for the fuel assemblies and failed fuel cans. The spacer discs are held in place by the support plates, which maintain longitudinal separation. The failed fuel cans are removable and are not permanently attached to the basket assembly or DSC shell.

The spacer discs in the FF DSC have thirteen square cut-outs. Additionally, the four support plates are fitted between cut-outs in the spacer discs. These plates have the same function as the support rods in the FO and FC DSC design. Support plates are welded between the spacer discs at the 45°, 135°, 225°, and 315° azimuthal positions.

The FF DSC failed fuel can consists of a seam-welded stainless steel tube with a welded bottom lid assembly and a welded removable top lid assembly. The cans do not contain any borated neutron absorber materials. They provide for the confinement of the fuel pellets/shards by means of a fixed bottom screen and a removable top screen. The bottom lid and top lid stainless steel screens allow for dewatering of the failed fuel can. The bottom end of the can also include provisions for fuel support. The fuel can lid is fitted with a fuel handling type pintle to interface with the plant fuel handling equipment for placement of the lid and handling of the removable fuel can.

2.4.1.4 Greater Than Class C Waste (GTCC) DSC

The SMUD ISFSI is provided with one GTCC DSC designed to store 100% of Rancho Seco's solid reactor-related waste only, consisting of activated reactor vessel internals and other in-core instrumentation. The radioactive waste contents authorized for storage in this DSC are listed in Table 2-3. The GTCC DSC is an ASTM A-240 stainless steel, welded vessel that provides confinement of radioactive materials, encapsulates the waste in an inert helium atmosphere, and together with a TC or HSM, provides biological shielding during GTCC DSC closure, transfer and storage operations.

The external characteristics of the GTCC DSC are identical to the FO/FC/FF DSCs. The GTCC basket, with an internal cavity length of 167 inches, has been modified to accommodate different waste forms and, therefore, does not contain spacer discs or guide sleeves. The basket, consisting of a perforated metal canister, is designed to accommodate 100% of Rancho Seco's GTCC waste.

2.4.2 HSM

The Rancho Seco HSM is a massive reinforced concrete structure that provides protection for the DSC against tornado missiles and other potentially adverse natural phenomena during storage. The HSM also serves as the principal biological shield for the spent fuel during storage.

The Rancho Seco HSM design is similar to the Standardized NUHOMS® HSM design [2-3]. The Rancho Seco ISFSI includes 22 HSMs, consisting of two HSMs for storing FO DSCs, 18 HSMs for FC DSCs, one HSM for an FF DSC, and one HSM for storing a GTCC DSC.

The HSM contains four shielded air inlet openings in the lower side walls of the structure to admit ambient ventilation air into the HSM. The cooling ventilation air flows around the DSC and exits near the top of the HSM. Air warmed by the DSC is exhausted through four shielded vent openings near the HSM roof slab. Adjacent modules are spaced to provide adequate ventilation flow and shielding. This passive system provides an effective means for spent fuel decay heat removal. Roof and side-wall mounted heat shields are provided between the DSC and HSM concrete to mitigate concrete temperatures.

The DSC rests on a carbon steel frame structure with support rails in the cavity of the HSM. The support structure is anchored to the HSM floor slab, side wall, and the front wall. The steel support rails extend into the HSM front wall access opening, which is slightly larger in diameter than the DSC. The HSM front access opening has a stepped flange sized to facilitate docking of the TC. This configuration minimizes streaming of radiation through the HSM opening during DSC transfer.

The top surfaces of the rails on which the DSC slides are coated with a dry film lubricant that is suitable for a radiation environment. The support rail sliding surfaces consist of hardened stainless steel plates for corrosion protection and added lubricity. Inside the HSM, the heat rejected from the DSC has a drying effect. Decay heat warms the air, which may reduce the accumulation or condensation of moisture inside the HSM.

The DSC is prevented from sliding along the support rails during a postulated seismic event by rail stops attached to the back ends of the DSC support rails and a DSC axial retainer located in the front access door of the HSM.

The HSM wall and roof thicknesses are primarily dictated by shielding requirements. The massive HSM walls, together with the end shield walls, adequately protect the DSC against tornado missiles and other adverse natural phenomena. The HSM wall thickness for individual modules and HSM arrays are specified on the Appendix E drawings of the CSAR [2-3].

The HSM front opening for DSC access is covered by a thick steel and concrete door that provides shielding and protection against tornado missiles. The door assembly includes a solid concrete core that acts as a combined gamma and neutron shield. The door is attached to the front wall using ten bolted clamps.

The HSM gap between modules is covered with a stainless steel wire bird screen to prevent pests or foreign material from entering the HSM. A daily visual inspection of the HSM inlets and outlets is a required surveillance activity per TS [2-8].

The reinforced concrete components of the HSM are constructed of 5,000 psi compressive strength, normal weight concrete.

2.4.3 NUHOMS®- MP187 Transfer Cask

The Rancho Seco ISFSI is provided with one onsite TC, designated as the NUHOMS®-MP 187 cask, which is also certified for transport as a pressure retaining structure under 10 CFR Part 71 [2-12]. The MP187 TC has no remaining function during normal ISFSI storage operations under 10 CFR 72 since all nuclear fuel at Rancho Seco has been placed into interim storage. It was used to load and transfer the DSCs to the HSMs and will not be used again until a DSC is to be retrieved from the HSM for offsite shipment. The TC is currently in storage at the Rancho Seco site.

The cask is fabricated primarily of stainless steel. Non-stainless steel members include the cast lead shielding between the containment boundary inner shell and the structural shell, the O-ring seals, the cementitious neutron shield material and the carbon steel closure bolts. Socket head cap screws (bolts) are used to secure the top closure plate to the cask body and the ram-access closure plate to the bottom of the cask. The body of the cask is constructed of a 1.25-inch, 68-inch inside diameter stainless steel inner (containment) shell and a 2.5-inch thick, 83.5-inch outside diameter stainless steel structural shell, which sandwich the 4-inch thick cast lead shielding material. The cask containment boundary consists of the inner shell, an 8-inch thick bottom plate with a 17-inch diameter, 5-inch thick ram access closure, a top closure plate end forging ring, a 6.5-inch thick top closure plate (lid) and double O-ring seals for each of the lids with closure bolts, and vent and drain port closure bolts. A 68-inch diameter by 187-inch long cavity is provided.

The neutron shield assembly consists of an outer jacket, a series of support angles, top and bottom support rings, and the cementitious neutron shielding material. The neutron shield support angles provide support for the outer jacket, which is the confinement boundary for placement of the neutron shield material. The neutron shield support rings provide closure for the neutron shield and attachment support for the impact limiters.

The overall external dimensions of the cask are 201.5 inches long and 92.5 inches in diameter. The weight of the cask body is approximately 158,500 pounds.

There are four trunnion sockets on the cask (two at the top and two at the bottom). They receive removable trunnions for handling and lifting of the cask. These trunnion sockets are attached to the structural shell. The bottom two trunnion sockets are covered by the lower impact limiter during transport. The upper two trunnions have covers that contain neutron shielding material.

2.4.4 Spent Fuel Assemblies

The FO/FC DSC is designed to store intact 24 B&W 15x15 SFAs with characteristics as listed in Table 2-2. The FF DSC is designed to store 13 intact or damaged B&W 15x15 SFAs with characteristics as listed in Table 2-2. Damaged SFAs are as defined in Section 1.1 of Rancho Seco Technical Specifications [2-8].

Amendment 3 to Rancho Seco ISFSI license [2-7] approved the retrospective re-classification of six intact SFAs previously stored in five FC DSCs as damaged fuel. The reason for this classification change is due to the evolution to a more restrictive definition of damaged fuel (defects greater than hairline cracks or pinhole leaks) from an earlier less stringent definition after these six SFAs had already been loaded. Technical Specification 2.1.1 was amended to allow storage of these six damaged SFAs in FC DSCs.

The intended functions of the SFAs include criticality control, structural integrity, and heat transfer. The geometry of the SFAs is a factor in the proper conduction and convection of heat to the DSC surface and in criticality control. The fuel cladding provides a fission product barrier, and its structural integrity is necessary to maintain a favorable geometry, and for DSC retrieval operations. The following subcomponents are applicable to the SFAs currently in storage at the Rancho Seco ISFSI:

- Fuel Rods (Cladding, End Caps/Plugs)
- Guide tubes
- Instrumentation Tube Assembly
- Spacer Grid Assemblies
- Lower End Fitting (and related subcomponents)
- Upper End Fitting (and related subcomponents

These subcomponents are further described in the following paragraphs:

2.4.4.1 Fuel Rods (Cladding, End Caps/Plugs)

The fuel rods consist of enriched UO2 pellets inserted into the cladding tubes. Plug-type end caps are seal welded to each end. The material of construction for the fuel rods (cladding and end caps) is Zircaloy-4. The cladding and end caps confine the fuel pellets and fission products. Each fuel rod is pressurized with helium during fabrication.

2.4.4.2 Guide Tubes

The guide tubes are mechanically attached and secured to the top and bottom end fittings. The material of construction for the guide tubes is Zircaloy-4.

2.4.4.3 Instrumentation Tube Assembly

The instrumentation tube assembly consists of the instrument tube, a retainer, and seven spacer sleeves. The instrumentation tube is restrained by a sleeve in the lower end fitting. The spacer sleeves fit around the instrument tube between the spacer grid assemblies and position the spacer grid assemblies. The material of construction for the instrument tubes, retainers, and spacer sleeves is Zircaloy-4.

2.4.4.4 Spacer Grid Assemblies

Each SFA includes a spacer grid assembly located at the top and six intermediate locations along the length of the SFA. The spacer grid assemblies provide support for the fuel rods and maintain correct rod-to-rod spacing. The spacer grid assemblies are made of Inconel. The spacer grid assemblies are fabricated from strips that are slotted and fitted together in “egg crate” fashion.

2.4.4.5 Lower End Fitting (and related subcomponents)

The lower end fitting is a square, box-like structure that is mechanically connected to the guide tubes with connectors. It positions the guide tube array and functions as the bottom structural element of a fuel assembly. The material of the lower end fitting and connectors is stainless steel.

2.4.4.6 Upper End Fitting (and related subcomponents)

The upper end fitting is a square, box-like structure that is mechanically connected to the guide tubes with connectors. It maintains the guide tube array and functions as the top structural element of a fuel assembly. It also interfaces with the fuel assembly grapple as the lifting point for the SFA during insertion or removal from the DSC. The material of the upper end fitting and connectors is stainless steel.

The upper end fitting also contains a holddown spring and holddown retainer. The material for the holddown spring is Inconel or Alloy 718. The material for the holddown retainer is stainless steel.

2.4.5 ISFSI Basemat

The HSMs are installed on a reinforced concrete basemat approximately 140 feet long, 40 feet wide, and 2 feet thick. The basemat was built in accordance with applicable commercial grade codes and standards. There are no structural connections or means to transfer shear between the HSM base unit module and the concrete basemat.

The basemat is classified as NITS as it is not relied upon to provide any safety function. However, as discussed in Section 2.3.1, since settlement of the basemat may affect retrievability of the DSC, the basemat is included within the scope of renewal (monitoring for basemat settlement).

2.4.6 Approach Slab

The approach slab is a reinforced concrete slab, designed and constructed to Rancho Seco site conditions. It provides access to the HSM and supports the DSC transfer system.

The approach slab is classified as NITS, as it is not relied upon to provide any safety function.

2.5 References

2-1 U.S. Nuclear Regulatory Commission, NUREG-1927, Revision 1, "Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel," June 2016.

2-2 Rancho Seco Independent Spent Fuel Storage Installation Final Safety Analysis Report (IFSAR), Revision 6, August 2016 (Docket 72-11).

2-3 Vectra Technologies, Inc., "NUH-003, Certified Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Fuel, Revision 4A," Docket No. 72-1004, June 1996.

2-4 Rancho Seco Independent Spent Fuel Storage Installation Materials License SNM-2510, including Technical Specifications and Safety Evaluation Report, Amendment 0, June 2000 (Docket 72-11).

2-5 Rancho Seco Independent Spent Fuel Storage Installation Materials License SNM-2510, including Technical Specifications and Safety Evaluation Report, Amendment 1, March 2005 (Docket 72-11).

2-6 Rancho Seco Independent Spent Fuel Storage Installation Materials License SNM-2510, including Technical Specifications and Safety Evaluation Report, Amendment 2, April 2005 (Docket 72-11).

2-7 Rancho Seco Independent Spent Fuel Storage Installation Materials License SNM-2510, including Technical Specifications and Safety Evaluation Report, Amendment 3, August 2009 (Docket 72-11).

2-8 Rancho Seco Independent Spent Fuel Storage Installation Materials License SNM-2510, including Technical Specifications and Safety Evaluation Report, Amendment 4, November 2017 (Docket 72-11).

2-9 U.S. Nuclear Regulatory Commission, "Certificate of Compliance for Spent Fuel Storage Casks," Certificate No. 1004, Revision 0, January 23, 1995 (Docket 72-1004).

2-10 Exemption from the Requirement of 10 CFR 72.72(d) Regarding the Storage of Spent Fuel Records, March 2001.

2-11 Exemption from the Requirement to Submit an Annual Radioactive Effluent Report Pursuant to 72.44(d)(3), March 2005.

2-12 U.S. Nuclear Regulatory Commission, Certificate of Compliance for Radioactive Material Packages, Certificate Number 9255, Revision 13, issued to TN Americas LLC, NUHOMS® MP187 Multi-Purpose Cask, approved January 30, 2017.

2-13 MPC&D 02-051, Letter from Steve Redeker (SMUD) to U.S. NRC Document Control Desk, "Rancho Seco ISFSI Biennial Report," May 23, 2002 (Docket 72-11).

2-14 Interim Staff Guidance, ISG-2, Revision 0, "Fuel Retrievability," U.S. Nuclear Regulatory Commission, Spent Fuel Project Office, May 1999.

2-15 Interim Staff Guidance, ISG-2, Revision 1, “Fuel Retrievability,” U.S. Nuclear Regulatory Commission, Spent Fuel Project Office, February 2010.

Table 2-1
Scoping Evaluation of Rancho Seco ISFSI SSCs

SSC	Criterion 1	Criterion 2	In-Scope
Dry Shielded Canister (DSC)(1)	Yes	N/A	Yes
HSM(2)	Yes	N/A	Yes
Transfer Cask (TC)(3)	Yes	N/A	Yes
Transfer Cask Lifting Yoke(4)	No	N/A	No
Spent Fuel Assemblies(5)	Yes	N/A	Yes
ISFSI Basemat(6)	No	Yes	Yes
ISFSI Approach Slab	No	No	No
Other Transfer Equipment(7)	No	No	No
Auxiliary Equipment(8)	No	No	No
Miscellaneous Equipment(9)	No	No	No
GTCC Waste	No	No	No

Notes:

(1) The DSC includes (but is not limited to) the DSC shell confinement boundary assembly and the internal basket assembly, siphon and vent block, support ring, lifting lugs. There are three types of DSCs and one GTCC canister licensed for Rancho Seco ISFSI: NUHOMS® FO-DSC, NUHOMS® FC-DSC, NUHOMS® FF-DSC and NUHOMS® GTCC DSC.

(2) The HSM includes (but is not limited to) the HSM reinforced concrete walls, roof, and end/rear shield walls; DSC steel structure support assembly; HSM accessories (DSC seismic retainer, heat shield panels, shielded door assemblies and door supports); associated attachment/installation hardware (tie rods, bolts, nuts, washers, embedment assemblies, mechanical splices); ventilation inlet vent openings and bird screens, ventilation outlet vent openings and bird screens, and outlet vent reinforced concrete covers.

(3) Transfer Cask includes (but is not limited to) the MP187 cask structural shell assembly, cask inner liner, upper and lower trunnion assemblies, lead gamma shielding, neutron shield panel, solid neutron shielding, top cover assembly, ram access penetration, bottom cover assembly.

(4) The TC lifting yoke was used for handling of the TC within the fuel/reactor building and was designed and procured as a “safety-related” component by the licensee under 10 CFR Part 50. The yoke will not be used again since all spent fuel has been transferred into DSCs and, therefore, the yoke is out of scope.

(5) Spent Fuel Assemblies - SFA cladding and assembly hardware listed in Table 2-9 are included in-scope.

(6) ISFSI Basemat - See discussion in Section 2.3.1.

(7) Other transfer equipment includes a hydraulic ram system, a prime mover for towing, a transfer trailer, a ram support assembly, a cask support skid, auxiliary equipment mounted on the skid, and a skid positioning system.

(8) Auxiliary equipment to facilitate canister loading, draining, drying, inerting, and sealing operations includes (but is not limited to) the following five systems: a vacuum drying system, an automatic welding system, the waste processing system, the security system, and the temperature monitoring system.

(9) Miscellaneous equipment includes (but is not limited to) ISFSI security fence and gate(s), lighting, lightning protection, communications, monitoring, and alarm systems.

N/A: Not Applicable.

Table 2-2
B&W 15x15 Mark B SFA Characteristics Allowed for Storage at Rancho Seco ISFSI

DSC Type	DSC Design Basis Heat Load (kW)(1)	Max. Assembly Initial Enrichment (wt % U-235)(2)	Max. Burnup (GWd/MTU)(2)	Total Assembly Only Weight(2)	Cladding Type(2)	Damaged Fuel
FO & FC	13.5	3.43	38.268	1530 lbs	Zircaloy-4	Yes(3)
FF	9.93	3.43	38.268	1530 lbs	Zircaloy-4	Yes

Notes:

(1) The source of this information is Sect. 3.1.1.2 of the Rancho Seco ISFSI FSAR (Reference 2-2).

(2) The source of this information is Table 3-1 of the Rancho Seco ISFSI FSAR (Reference 2-2).

(3) Six fuel assemblies originally classified as “intact fuel” and later reclassified as “damaged fuel” are stored in five FC-DSCs as authorized by Amendment 3 to Materials License SNM-2510.

Table 2-3
Summary of Contents Allowed for Storage in GTCC Canister

Storage System	Canister Design Basis Heat Load (kW)(1)	Design Life (years)(2)	Min/Max Ambient Temperatures (°F)(3)	Payload(1)	Total Payload Weight (lb)(1)
GTCC(1)	≈ 0.725 predicted	50	-20 °F/+117 °F	• In-core support structures; • Misc. RV internal parts; • In-core components and instrumentation	25,000

Notes:

(1) The Greater Than Class C (GTCC) canister with characteristics as defined in Section 3.1.1, Appendix C of the Rancho Seco ISFSI FSAR [2-2].

(2) The source of this information is Section 1.1, Volume I of the Rancho Seco ISFSI FSAR [2-2].

(3) The source of this information is Table 3-12, Volume 1 of the Rancho Seco ISFSI FSAR[2-2].

Table 2-4
Listing of Amendments to Rancho Seco Materials License SNM-2510 and Rancho Seco ISFSI Active Exemptions

Amendment/ Exemption	Approval Date	Amendment/Exemption Summary	Impact on License Renewal
Amendment 1	March 2005	Deleted Technical Specification 5.5.2, Item d to keep Rancho Seco Technical Specifications consistent with issuance of Exemption 72.44(d) (3) listed below.	No impact; affects annual effluent reporting requirement at Rancho Seco site.
Amendment 2	April 2005	Authorized Storage of Greater than Class C (GTCC) Waste at Rancho Seco ISFSI. Appendix C is added to the Rancho Seco ISFSI FSAR to reflect the addition of the GTCC Canister and supporting safety analysis.	Yes; addressed in the renewal scope.
Amendment 3	August 2009	Revised Technical Specification 2.1.1 to add a footnote, which allows six damaged fuel assemblies to be stored in FC DSCs. These six fuel assemblies had been previously loaded in five FC DSCs based on the old definition of intact fuel. However, based on the current definition of intact fuel (defects greater than hairline cracks or pinhole leaks), they are now classified as damaged fuel.	Yes; addressed in the renewal scope.
Amendment 4	November 2017	Revised Part 72 license conditions to transfer one radioactive byproduct source (Sr90) used for calibration and standardization purposes from Part 50 to Part 72 license.	No impact; added a radioactive source to the authorized possession limits.
Exemption 10 CFR 72.72(d)	March 2001	Exemption from the requirement of 10 CFR 72.72(d) regarding duplicate storage of special nuclear material records.	No impact; affects record keeping requirements.
Exemption !0 CFR 72.44(d)(3)	March 2005	Exemption from the requirement to submit an annual radioactive effluent report pursuant to 72.44(d)(3).	No impact (See Amendment 1 above).

Table 2-5
Listing of Rancho Seco ISFSI 10 CFR 72.48 Evaluations for the Period 2000-2002 [2-13]

72.48 Screening/Evaluation Number	Approval Date	Evaluation Summary
72-1593	7/16/2001	This change adds a chamfer to the keyway in the MP187 Cask bottom-end closure to improve the DSC/ Cask shear key interface. The shear key and keyway are not analyzed in the ISFSI FSAR. The addition of chamfer does not affect any load or load cases.
72-1622	8/17/2001	This change revises the Pressure Test for the FO/FC/FF DSC from a range of 11-12 psig to 11-14 psig to prevent violation of the maximum test pressure due to heat up of the test medium. This change does not result in Code allowable stresses.
72-1605	6/7/2001	This change deletes Diamond Note 4 and the dimension from the top of the FO/FC DSC shell to the top of the support ring shown in the SAR drawing NUH-05-4004. This dimension is not analyzed in the ISFSI FSAR and does not affect any load cases. It is irrelevant for fit-up purposes (double dimensioning).
72-1607 Rev. 2	10/22/2001	This change implements several modifications to the FC DSC procurement drawings to enhance the fabricability of the DSC. Supporting calculations were originated, which demonstrate that the change can be implemented without an amendment to Materials License SNM-2510.
72-1641	9/6/2001	For the FO/FC DSC, a note is added to the shear key to grapple ring support weld callout to clarify that no weld is required at the drain hole location. The SAR structural analysis does not take credit for this 0.25-inch weld and, thus, it is acceptable to implement this change.
72-1613	5/8/2002	This change implements several editorial, clarification, fabricability and design changes to the FF DSC. Updated calculations demonstrate that these changes may be implemented without an amendment to Materials License SNM-2510.
72-1659	11/28/2001	This change modifies the design of the top lid of failed fuel can of the FF DSC to improve the interface of the failed fuel can with the fuel handling equipment.

Proprietary Information on Pages 2-26 through 2-37
Withheld Pursuant to 10 CFR 2.390

Table 2-9
Scoping Evaluation Results for SFAs

Subcomponent	Intended Function					
	Confinement	Shielding	Criticality	Structural	Thermal	Retrievability
Fuel Pellets	None					
Fuel Cladding [(2)]	Yes[(1)]	No	Yes	Yes	Yes	Note 3
Spacer Grid Assemblies	No	No	Yes	Yes	No	Note 3
Upper End Fitting/Nozzle (and related subcomponents	No	No	No	Yes	No	Note 3
Lower End Fitting/Nozzle (and related subcomponents)	No	No	No	Yes	No	Note 3
Guide Tubes	No	No	No	Yes	No	Note 3
Hold Down Spring and Upper End Plugs	None					
Control Components	None					

Notes:

(1) Though fuel cladding is the first barrier for confinement of radioactive materials, no credit for confinement of radioactive material is taken for the fuel cladding in the SMUD ISFSI design and licensing basis. The DSC pressure boundary is the only credited confinement boundary.

(2) Zircaloy-4 for Rancho Seco.

(3) The licensing basis for retrievability with respect to the Rancho-Seco ISFSI is defined on a canister basis, consistent with ISG-2 Revision 0, as described in ISFSI FSAR Section 4.2.2.1.12. The NRC has accepted this approach as documented in SER Section 4.3.7.

Table 2-10
List of Rancho Seco ISFSI Drawings

Component	Drawing No./Rev.	Subcomponent
List of Drawings for the NUHOMS® Storage System–DSCs		
NUHOMS®-FO & FC-DSC	NUH-05-4004/R-16	Main Assembly
NUHOMS®-FF DSC	NUH-05-4005/R-14	Main Assembly
GTCC Canister	13302-1005/R-0	Main Assembly
GTCC Canister	13302-1007/R-0	Main Assembly
GTCC Canister	11221-1000/R-1	Basket
GTCC Canister	11221-1002/R-0	Basket
List of Drawings for the NUHOMS® Storage System–HSMs		
HSM80	VEC-NUH-03-6008/R-5	General Arrangement
HSM80	VEC-NUH-03-6009/R-4	Main Assembly
HSM80	VEC-NUH-03-6010/R-1	Base Unit Assembly
HSM80	VEC-NUH-03-6014/R-5	Base Unit
HSM80	VEC-NUH-03-6015/R-4	Roof Slab Assembly
HSM80	VEC-NUH-03-6016/R-3	DSC Support Structure
HSM80	VEC-NUH-03-6017-01/R-4	Module Accessories
HSM80	VEC-NUH-03-6018/R-5	Shield Walls Plans & Details
HSM80	VEC-NUH-03-6024/R-1	Module Erection Hardware
List of Drawings for the NUHOMS® Storage System–TC		
MP187	NUH-05-4001/R-15	Main Assembly
MP187	NUH-05-4003/R-10	On-Site Transfer

Table 2-11
Loading Overview at Rancho Seco Nuclear Generating Station

DSC Serial No.	HSM No.	Date Loaded	Vacuum Drying/ Blow-down Gas Used	Total DSC Heat Load (kW)	Minimum Cooling time (years)	Highest FA Enrichment (wt. % U-235)	Highest FA Burnup at time of loading (GWd/MTU)
FO24P-P01	20	4/19/2001	Helium	9.005	5.0	3.21	35.20
FO24P-P02	12	10/10/2001	Helium	8.774	5.0	3.26	37.55
FC24P-P03	18	7/19/2001	Helium	8.145	5.0	3.43	37.91
FC24P-P04	16	8/28/2001	Helium	8.268	5.0	3.43	36.29
FC24P-P05	14	9/26/2001	Helium	8.149	5.0	3.43	37.91
FC24P-P06	10	11/20/2001	Helium	8.152	5.0	3.43	36.70
FC24P-P07	8	12/12/2001	Helium	8.161	5.0	3.43	37.91
FC24P-P08	6	1/7/2002	Helium	8.151	5.0	3.43	36.70
FC24P-P09	4	1/23/2002	Helium	8.146	5.0	3.43	38.26
FC24P-P10	2	2/6/2002	Helium	8.137	5.0	3.43	38.26
FC24P-P11	1	2/27/2002	Helium	8.139	5.0	3.43	38.26
FC24P-P12	3	3/13/2002	Helium	8.162	5.0	3.43	37.82
FC24P-P13	5	4/3/2002	Helium	8.157	5.0	3.43	37.91
FC24P-P14	7	4/17/2002	Helium	8.139	5.0	3.43	37.91
FC24P-P15	9	5/8/2002	Helium	8.147	5.0	3.43	36.70
FC24P-P16	11	5/22/2002	Helium	8.156	5.0	3.43	36.29
FC24P-P17	13	6/12/2002	Helium	8.132	5.0	3.43	36.29
FC24P-P18	15	6/26/2002	Helium	8.141	5.0	3.43	37.91
FC24P-P19	17	7/17/2002	Helium	8.144	5.0	3.43	37.55
FC24P-P20	19	7/31/2002	Helium	8.127	5.0	3.43	37.82
FF13P-P21	21	8/21/2002	Helium	4.642	5.0	3.43	34.40

CHAPTER 3
AGING MANAGEMENT REVIEW

CONTENTS

LIST OF TABLES

LIST OF FIGURES

3.1 Introduction

This chapter addresses the aging management review (AMR) of the Rancho Seco independent spent fuel storage installation (ISFSI) dry storage system. As stated in NUREG-1927 Revision 1, Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance [3-1], the purpose of the AMR is to assess the proposed aging management activities (AMAs) of structures, systems, and components (SSCs) determined to be within the scope of renewal. The AMR addresses aging mechanisms and effects that could adversely affect the ability of the SSCs (and associated subcomponents) from performing their intended functions during the period of extended operation (PEO).

Section 3.2 presents a summary of the NUHOMS® dry storage system operating experience (OE), representing about 20 years of fabrication, installation, and available OE of the storage system deployed across nineteen sites in the United States. This section also includes relevant U.S. Nuclear Regulatory Commission (NRC) generic communications and research results (e.g., Electric Power Research Institute (EPRI) inspections).

Section 3.3 describes the AMR methodology, which follows the guidance and the processes of NUREG-1927 [3-1]. This section addresses each of the major steps of the AMR process:

Section 3.3.1: Identification of materials and environment,

Section 3.3.2: Identification of aging mechanisms and effects requiring management, and

Section 3.3.3: Identification of time-limited aging analysis (TLAAs), if applicable, supplemental evaluations and aging management programs (AMPs) for managing the effects of aging. Evaluations, which do not meet the six criteria of a TLAA, as specified in NUREG-1927 [3-1], are defined as supplementary evaluations. These supplementary evaluations are used to preclude the need for an AMP.

Sections 3.4, 3.5, 3.6, 3.7 and 3.8, provide the AMR results for the dry shielded canister (DSC), horizontal storage module (HSM) the concrete basemat, transfer cask (TC) and spent fuel assemblies (SFAs), respectively. Each of these sections provides a description of the component, the materials of construction, the environment(s), and the evaluation of the potential aging effects and the associated aging mechanisms.

The aging effects and associated aging mechanisms that could cause degradation resulting in loss of intended function are evaluated for each component. These evaluations result in the identification of all applicable aging effects requiring management, and the required AMAs (either TLAAs or AMPs).

The identified TLAAs and other supplemental/support evaluations are presented in Appendix A. These TLAAs are prepared to assess SSCs that have a time-dependent operating life to demonstrate that the existing licensing basis remains valid and that the intended functions of the SSCs in scope of renewal are maintained during the PEO. Time dependency may entail fatigue life (cycles), change in a mechanical property such as fracture toughness or strength of materials due to irradiation, or time-limited operation of a subcomponent.

As appropriate, an AMP is created and implemented for those in-scope SSCs that do not have a TLAA or a supplementary evaluation. The AMPs credited for managing the effects of aging degradation are presented in Appendix B.

Section 3.9 describes the proposed tollgates for the Rancho Seco ISFSI as recommended in NEI 14-03, Revision 2, Format, Content and Implementation Guidance for Dry Storage Operations-Based Aging Management [3-19]. Sacramento Municipal Utility District (SMUD) will create and implement the tollgate process described in Section 3.9 as part of the overall program for managing the ISFSI throughout the PEO.

3.2 Operating Experience Review

3.2.1 Operating Experience Review Process

This section summarizes the Operating Experience (OE) information for the NUHOMS® storage system installed at the Rancho Seco ISFSI.

As described in Chapter 1 of Rancho Seco Independent Spent Fuel Storage Installation Final Safety Analysis Report (ISFSI FSAR), Revision 6, August 2016 (Docket 72-11), Volume 1 [3-15], the Rancho Seco HSM design is based on the Standardized NUHOMS® HSM Model 80 described in the NUH-003, Certified Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Fuel, Revision 4A [3-7]. The Rancho Seco DSCs and the NUHOMS ® MP187 Transfer Cask (MP187 TC) are a modified version of the NUHOMS® Standardized 24P DSC and Standardized Transfer Cask described in the CSAR [3-7], with design enhancements to meet 10 CFR Part 71 transportation requirements. Accordingly, the OE information described in this section was primarily obtained from documented corrective action reports (CARs) and non-conformance reports (NCRs) databases generated during the NUHOMS® System fabrication and installation, or from licensee condition reports (CRs) or action reports (ARs) generated during in-service operations. These databases comprise approximately 20 years of storage system history and document the identification and resolution of relevant issues encountered during fabrication, installation and operation of the Standardized NUHOMS® System components. Also, a review was performed of the SMUD originated potential deviations from quality (PDQs) and deviations from quality (DQs) that resulted from findings during Rancho Seco ISFSI installation or ISFSI inspections during the last 20 years. This OE is described in Section 3.2.2.2 and summarized in Table 3-1.

Review and evaluation of these sources of information provided insights on the various forms of potential aging-related degradation that could affect the ability of the system components to perform their intended function.

In addition, relevant generic industry information was reviewed, including relevant industry OE of dry cask storage systems, and relevant NRC Information Notices, NRC Inspection Reports, and NRC Bulletins. These reports were reviewed for any conditions that could be analogous to the aging of the Rancho Seco ISFSI and its components. The generic industry OE is discussed in Section 3.2.3.

A pre-application inspection was performed at the Rancho Seco ISFSI in May 2017, Rancho Seco Independent Spent Fuel Storage Installation Pre-Application Inspection Report, [3-8] to document and evaluate the condition of the storage system components since the beginning of storage. A summary discussion of this Rancho Seco ISFSI pre-application inspection is presented in Section 3.2.4.

Finally, information from the pre-application inspection reports from similar NUHOMS®-based specific ISFSI renewal applications, were reviewed as part of the AMR process to identify actual or potential aging effects and associated aging mechanisms applicable to the Rancho Seco ISFSI SSCs. These include the specific renewal application inspection reports for Calvert Cliffs Nuclear Power Plant ISFSI, see references [3-2, 3-37, 3-38]; and Oconee Nuclear Station ISFSI, reference [3-3], and H.B. Robinson Steam Electric Plant ISFSI, reference [3-4 and 3-5]. These pre-application inspection reports and baseline inspections are considered relevant because their ISFSIs are based on similar NUHOMS®-based storage system design. A brief summary of these pre-application inspections is provided in Section 3.2.5.

Proprietary Information on Pages 3-5 and 3-6
Withheld Pursuant to 10 CFR 2.390

3.2.2.2 Rancho Seco ISFSI Operating Experience

A review of Rancho Seco's database of PDQs and DQs was performed to identify issues relevant to aging and age-related degradation. Most of the PDQs/DQs listed below are representative of the non-conformances due to fabrication, construction or operational issues and do not relate to age-related degradation.

PDQ 00-0038

HSM - Grout patches on HSM No. 1 and No. 14 are falling out.

The grout patches are on the bottom corners of the HSMs as they sit on the storage slab. The corners were damaged and repaired during construction. There are no signs that the patch failures were caused by mechanical means. There is no visible sign of rebar corrosion. Most likely cause is from poor bonding between the patch material and the base material.

The accessible grout patches have been repaired and no additional preventative actions were noted to be required.

The applicable aging effect/mechanism for this condition (loss of material/corrosion) is evaluated in the HSM AMR and will be included in the acceptance criteria of the HSM AMP.

PDQ 02-0027

MP187 TC - The Helicoil Backed Out of the MP187 TC.

Helicoils backing out has been documented previously in several additional PDQs. The top lid inserts are the only helicoils that have shown a tendency to back out.

As a part of remedial action, helicoils that have backed out were removed and new coils inserted.

The conditions described herein are event-driven that resulted during handling of the TC. Therefore, there is no applicable aging effect that needs to be evaluated in the AMR.

DQ 01-0052

MP187 TC - Scratches and gouges noticed on TC after inserting DSC into HSM.

After insertion of DSC FO24P-P01 into HSM #20 scratches and a deep gouge were noted at approximately the 180 degree position of the TC. The most likely causes for the interferences were design, foreign material intrusion, and fabrications controls. In addition to the scrape at the bottom of the cask, there is also evidence of light scraping which occurred on the rails. Based on the fabrication records, the clearance for this DSC and the TC was found to be very tight and likely caused the scraping to occur.

Operations provided training to personnel on the importance of cask cleanliness and foreign material for the prevention of reoccurring of scratches and gouging.

The following actions were taken as preventive actions in order to eliminate gouging in the future:

- Remove all raised metal, polish surfaces where contact area is rough,
- Apply lubricant (N-5000 or equivalent) to the bottom of cask for future loadings,
- Carefully review cylindrical measurements from fabrication record for locations of protrusions,
- Accept 0.005-inch weld reinforcement limitations of Engineering Change Notice (ECN) 01-84,
- Remind personnel of the importance of cleanliness and foreign material exclusion.

The extent of the gouge was limited to the TC and the DSC. The work order was listed in the DQ for the repair of the TC.

As part of this investigation, the DSC was remotely inspected to see if any damage was visible on the lower surface of the canister, corresponding to the area of contact with the gouge on the TC and documented findings in the DQ. A video inspection of the DSC bottom revealed comparable scratches on the bottom half of FO24P-P01. This scratch on FO24P-P01 was also confirmed in Rancho Seco ISFSI Pre-Application Inspection results (see Figure 3-4, Section 3.2.4).

The conditions described herein were event-driven that resulted during handling of the DSC. Therefore, there is no applicable aging effect that needs to be evaluated in the AMR.

PDQ 01-0123

Metal deposit and potential raised metal on the MP187 Transfer Cask.

The PDQ concerns gouging of the MP187 TC during transfer operations due to contact between the cask and canister. The probable cause for the issue was that the repeated loading activities at Rancho Seco have produced wear on the rails.

During these loadings, there has been no noticeable effect on the ram operation during transfer, so the mechanism causing gouging does not add significant resistance. Trans Nuclear West (TNW) first evaluated this issue in TNW NCR 01.041, which resulted in minor rework of the cask to remove any gouges. There was no minimum wall thickness violation in either the cask or canister. TNW took mitigating action by issuing a design change, wherein the crowns on certain exterior canister welds are reduced. TNW also recommended that SMUD liberally coat the mating surfaces with an appropriate lubricant to further minimize the potential for scratching.

The conditions described herein are event-driven and resulted during the handling of the DSC. Therefore, there is no applicable aging effect that needs to be evaluated in the AMR.

PDQ 02-0003

Scratch on TC rail after inserting DSC No. 8.

During insertion of DSC No. 8 into HSM No. 6, one of the internal rails of the TC was scratched, leaving material deposited at the end of the rail. A work order was completed to remove the raised material and Quality Control verified the surface finish was sufficient in the worked areas.

PDQ 02-0003 does not list any drawings as being affected, nor does it list any potentially reportable condition or technical specification violation. This was an issue found during loading operations. Therefore, there is reasonable assurance that the DSC shell minimum thickness (0.5 inch) requirements from Drawing NUH05-4004 were not violated as part of this PDQ since it was not mentioned in the disposition and this was considered to be a one-time, event-driven condition. Therefore, there is no applicable aging effect that needs to be evaluated in the AMR.

<u>DQ 06-0004</u>

Greater than Class C (GTCC) basket lid does not fit into the basket

Appropriate corrective actions were implemented to resolve the interference and verify proper GTCC lid and basket fit.

The conditions described herein are event-driven and there is no applicable aging effect that needs to be evaluated in the AMR.

<u>DQ 01-0001</u>

Peeling of Paint from thermal shields on HSM No. 2 and No.6.

Construction of the ISFSI was completed in 1996, but fuel was not placed in storage until 2001. As part of preparation of the HSMs for loading, an inspection was performed in 2001. During this inspection, it was observed that the paint on the heat shields on two of the HSMs, No. 2 and No. 6 had peeled and there was a residue under the peeling paint. The cause of the peeling paint was believed to be either flawed material or faulty workmanship (e.g., the paint was unsatisfactory or the heat shield may not have received adequate preparation). Regardless of the cause, the resolution of the condition (i.e., cleaning off the flaking paint and residue) was unaffected. Note that the condition was bounded by the thermal analysis performed in 1997, which showed that all acceptance criteria were met for all conditions of the paint, including no paint on the heat shield.

Since the condition occurred before any spent fuel was placed in storage and is believed to be caused by flawed material or faulty workmanship, it is considered to be event driven and no applicable aging effect that needs to be evaluated in the AMR.

<u>PDQ 05-0022</u>

GTCC Basket contaminated with organic material.

The GTCC basket was potentially contaminated with organic material due to hydraulic leaks and hose breaks in the fuel transfer canal.

Based on the information evaluated, the metal surfaces of concern to segmentation activities show no visible evidence of oily residue. No oily residue is believed to be present on the metal surfaces associated with the GTCC basket and contents.

This issue has been evaluated for safety concerns and it was concluded that the GTCC DSC is acceptable as-is. Therefore, there is no applicable aging effect that needs to be evaluated in the AMR.

DQ 00-0098

DSC surface defects

The surface defects included arc strikes on the outer surface of the canister, surface porosity defects, linear indication of about 2 inches long on weld, and a linear (crack appearance) indication observed on the base metal surface of the upper shell.

The above-stated conditions were repaired or removed through work orders by plant procedures, as part of the above-listed DQ resolution, and documented under work requests in response to the DQ. This also included verification of the minimum wall thickness of the shell.

Based on the above discussion, these defects have been corrected and there is no applicable aging effect that needs to be evaluated in the AMR.

DQ 00-0111

Rancho Seco Technical Specification (TS) 4.3.4, Rancho Seco Independent Spent Fuel Storage Installation Materials License SNM-2510 including Technical Specifications [3-17] requires that the TC and DSC be fabricated to American Society of Mechanical Engineers (ASME) Code with alternatives as allowed by Appendix A of the ISFSI FSAR [3-15]. Contrary to this, the TC and DSC were fabricated and accepted with additional code exceptions. A DSC pneumatic test was performed in lieu of the hydrostatic test, which contradicts NB-6612.1(a). The other exception was based on 125% of operating pressure rather than design pressure, which contradicts NB-6221. Welding of large attachments was performed on the structural shell after pressure test of the cask which contradicts NB-4436.

These additional exceptions to the American Society of Mechanical Engineers Boiler and Pressure Vessel (ASME B&PV) Code were submitted to the NRC for approval. The NRC approved additional code exceptions in March 2001. Considering the nature of the issue, there is no applicable aging effect that needs to be evaluated in the AMR.

3.2.3 Generic Industry Experience

3.2.3.1 INPO Database

The INPO database was queried to identify reported aging-related OE associated with dry storage systems. The following OE reports were identified:

[ ]

The above OE reports were evaluated for age-related degradation relevance and were determined to be not applicable or event-driven, and therefore not age-related degradation issues [ ] occurred early, but could contribute to later age-related degradation. It is adequately addressed by the HSM AMP for internal and external surfaces, outlined in Appendix B.4.

3.2.3.2 NRC Information Notices

The following NRC information notices (INs) were found to be directly related to the dry fuel storage systems.

NRC Information Notice 2011-20: Concrete Degradation by Alkali-Silica Reaction, [3-9]

This information notice (IN) addresses the occurrence of alkali-silica reaction (ASR)-induced concrete degradation on Seismic Category I structures at a nuclear power plant. Because TN Americas LLC Inc. generates a CAR for INs that have a bearing on the Standardized NUHOMS® System, this IN is summarized and addressed in Table 3-1.

NRC Information Notice 2012-20: Potential Chloride-Induced Stress Corrosion Cracking of Austenitic Stainless Steel and Maintenance of Dry Cask Storage System Canisters [3-10]

Several failures in austenitic stainless steels have been attributed to CISCC. The components that have failed at nuclear power plants because of this failure mechanism are made from the same types of austenitic stainless steels typically used to fabricate dry cask storage system canisters. As described in the IN, this failure mechanism is reproducible in Type 304 and 304L stainless steels, as well as in 316L stainless steels. Accordingly, the NRC expects that all types of austenitic stainless steels typically used to fabricate dry cask storage system canisters (304, 304L, 316 and 316L) are susceptible to this failure mechanism.

All of the failures mentioned in the IN at nuclear power plants occurred in components located near a saltwater body. Section 3.4.4.2 provides justification as to why CISCC of austenitic stainless steel at the Rancho Seco ISFSI is not an applicable aging mechanism.

NRC Information Notice 2013-07: Premature Degradation of Spent Fuel Storage Cask Structures and Components from Environmental Moisture [3-11]

This IN concerns OE on environmental moisture causing premature degradation of structures and components important-to-safety (ITS) during spent nuclear fuel storage operations. The instances described in this IN illustrate how the intrusion of water can potentially decrease the effective life of both the structures and components of a spent fuel storage system.

In one instance, the presence of water not only caused chemical degradation through oxidation of one metal, but it also facilitated the formation of a galvanic cell between two dissimilar metals, which contributed to the degradation of the secondary confinement barrier of the storage system. The specific conditions cited in this case apply only to casks with bolted lids and mechanical seals, but visual inspections of the canister, HSM support structure, HSM interior, and HSM exterior as specified by the AMPs in Appendices B.3 and B.4 would detect signs of water damage or corrosion in the NUHOMS® System as well.

In another instance, water contributed to an accelerated aging process of the concrete structures of the spent fuel storage system at the Three Mile Island, Unit 2 (TMI-2) ISFSI at the Idaho National Laboratory site. Essentially, this began as the same condition as that [ ] discussed above. Water entered roof bolt through-holes in the HSMs and when subjected to freezing temperatures, generated mechanical forces that produced cracks in the concrete. These cracks provided additional and larger pathways for water to enter the interior of the concrete, which resulted in larger cracks from subsequent freezing temperatures and promoted efflorescence. If remedial actions had not been taken, this accelerated aging process could have inhibited the ability of the HSM concrete structure to perform its design function of protecting the canister system containing the radioactive material, as well as protecting personnel from ionizing radiation, during normal and accident conditions. Table 3-1 contains a more detailed description of this second occurrence and the actions taken by the licensee to ensure the HSMs continue to perform their safety function. Lessons learned have been incorporated into the "HSM Aging Management Program for External and Internal Surfaces," described in Appendix B.4.

3.2.3.3 NRC Bulletins

NRC Bulletin 96-04, "Chemical, Galvanic or other Reactions in Spent Fuel Storage and Transportation Casks," [3-73] addresses the generation of hydrogen due to the reaction of internal materials with spent fuel pool water during loading. This does not affect the aging of the DSC since all components are dry within the sealed canister. Therefore, no AMP is required to address this industry experience.

3.2.3.4 NRC Inspections of Rancho Seco ISFSI

NRC INSPECTION REPORT, Region IV; 71-0011/95-01; April 17-21, 1995. Inspection of the horizontal dry spent fuel storage module and the pad for an independent spent fuel storage installation.

There were several observations/deficiencies made as follows:

A review of Concrete Specification NUH-03-114 for the HSMs determined that the minimum field-cured cylinder strength for lifting of the roof slabs was 1000 psi. The inspectors were informed by VECTRA personnel that the form work was removed after 24 hours of curing time. The inspectors questioned whether the concrete had attained the required strength to be lifted within 24 hours. A review of records by the inspectors determined that the concrete test cylinders met the required strength; therefore, the inspectors had no technical concerns. This is considered as a "Testing-Programmatic Issue," not as an aging management issue.

Weaknesses were identified in concrete testing activities involving the failure to perform slump testing prior to concrete placement, and the failure to generate corrective action documentation upon notification of the deficiency, and the failure to record concrete water content. This is considered as a "Programmatic Issue," not as an aging management issue.

The above issues were not related to aging management. Therefore, there is no applicable aging effect that needs to be evaluated in the AMR.

NRC INSPECTION REPORT, Region IV; 50-312/97-01; 72-11/97-01; during February 24-27, 1997

Design change package R91-0001 AC 50.59, Revision 2, "Horizontal Storage Module Temperature Monitoring System," was reviewed and found in compliance with applicable NRC regulations.

There were two issues discussed in the report, which dealt with (a) the thickness of the lead shielding between the inner and outer steel shells of the overpack and, (b) the potential for hydrogen generation in the canister.

The report discusses VECTRA's plan to address all outstanding MP187 TC design issues and submit a revised SAR on the cask to the NRC.

The above issues are not related to aging management. Therefore, there is no applicable aging effect that needs to be evaluated in the AMR.

NRC INSPECTION REPORT, Region IV; 72-11/10-01; 50-312/10-01;dated 05-11-2010; inspection during March 16-17, 2010

There were 32 safety screenings and eleven 72.48/50.59 evaluations performed by SMUD since the last inspection in October 2007. All safety screenings and evaluations had been performed in accordance with plant procedures. This is not an aging-related issue/discussion.

Review of selected 2008 and 2009 records for temperature monitoring and visual inspections of the HSM storage modules demonstrated that temperature levels have remained within required performance limits established in TS. This is not an aging-related issue/discussion.

In 2006, SMUD notified the NRC that six potentially failed fuel assemblies had been loaded in storage canisters during the cask loading campaign in 2001 and 2002 that were not designed for storage of failed fuel. The loading of failed fuel in canisters other than failed fuel canisters in 2001 and 2002 was a violation of the licensee's TS. This issue has been resolved with the issuance of Amendment 3 to SNM-2510 license [3-16] on August 11, 2009. This is not an aging-related issue.

NRC INSPECTION REPORT, Region IV; 50-312/00-05; dated 12-05-2000; inspection during November 13-16, 2000

An NRC inspector attended a commitment management review group meeting during the inspection. The meeting addressed a PDQ that identified a procedure that did not differentiate between the training cask and the MP187 TC multi-purpose cask. The fuel team leaders were briefed and understood the problem. The commitment management review group determined that the item was a PDQ and assigned the disposition to the operations group. This is not an aging-related issue/discussion.

NRC INSPECTION REPORT, Region IV; 50-312/2002-03; 72-11/2002-02; dated 09-18-2002; inspection during August 12-22, 2002

PDQ 02-0068 was initiated to follow up a corrective action that the dose rate at 3 feet from the HSM surface was not the maximum dose rate and the wrong data may have been recorded during loading operation of HSM No. 21. The highest dose rate was observed above the bird screens on the roof of the HSM. This would not create HSM concrete concerns and therefore is not an aging-related issue.

NRC INSPECTION REPORT, Region IV; 50-312/06-001; inspection during Feb 6-9, 2006

During installation, the licensee found that the vendor had not fabricated the basket to the design drawings in that the four lifting lugs were placed 90 degrees apart as opposed to 80/100/80/100 degrees that the design specified.

The licensee modified the basket lid to permit access to the lifting lugs in the basket. The modification of basket lid is not an aging-related issue.

3.2.3.5 NRC Inspections of Other ISFSIs

The most relevant NRC ISFSI inspection, as it relates to aging degradation of ISFSI SSCs, is the NRC inspection of the TMI-2 ISFSI in Idaho. This was covered under NRC Inspection Report (072-020/2011-001) issued to the U.S. Department of Energy (DOE), and is addressed as OE ID Number 1 in Table 3-1.

3.2.4 Rancho Seco ISFSI Pre-Application Inspection

The Rancho Seco pre-application inspection [3-8] was performed on May 24, 2017, which included direct visual inspection of the HSM doors (exterior), roofs and exterior concrete surfaces as well as the above ground basemat concrete surfaces.

The remote visual inspection was performed using a camera mounted on a remote controlled crawler. The scope of the remote visual inspection included:

- DSC shell, lower half,
- HSM heat shields,
- HSM side walls, floor (all interior) and,
- HSM steel support structure.

Note: The HSM roof heat shields prevent access to the upper half of the DSC shell via the air outlet vents; therefore, the upper half of the DSC shell is not addressed in this remote visual inspection.

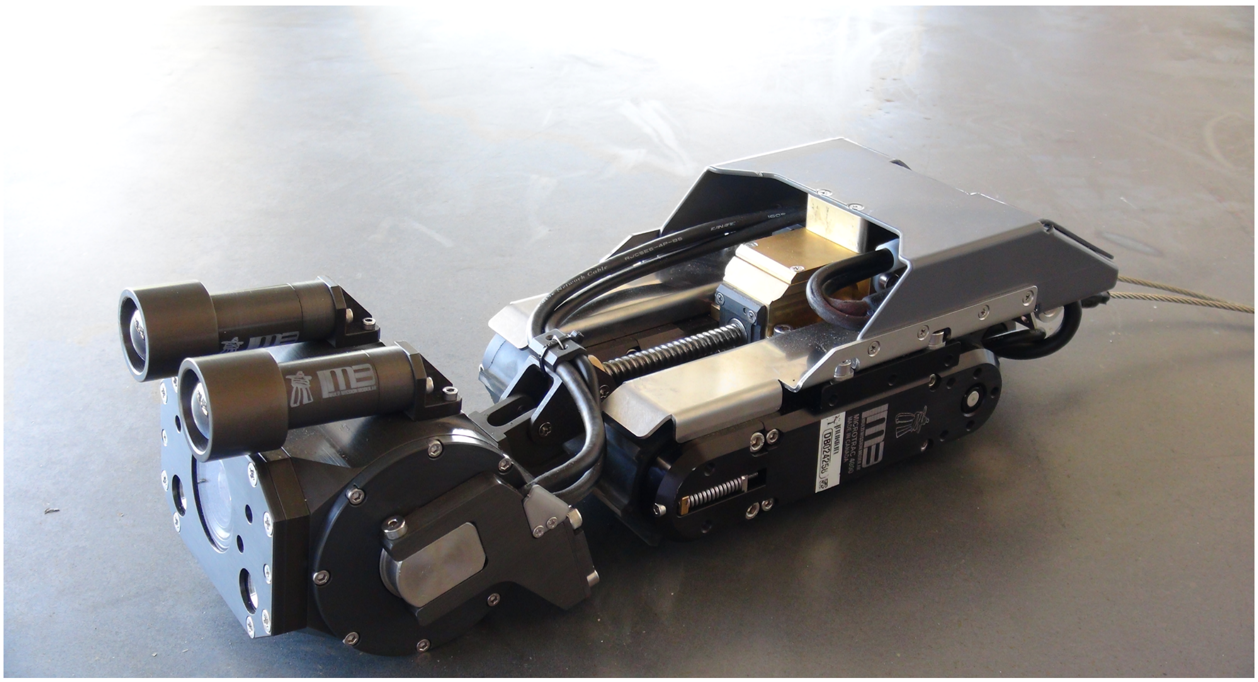
Ranch Seco determined that HSM-20 and DSC- FO24P-P01 are representative and bounding for the remaining HSMs and DSCs at the Rancho Seco ISFSI based on the following:

Table 2-11 provides an overview of the SFAs loaded at Rancho Seco Nuclear Generating Station. The DSC with the longest time in service is DSC Serial No FO24P-P01, which was loaded in HSM No. 20 on April 19, 2001. This DSC has been in service for over 15 years and had an initial decay heat of 9.005 kW. *From the pool of DSCs loaded at the Rancho Seco ISFSI, DSC Serial No. FF13P-P21 has the lowest heat load of 4.642 kW. However, this was the last loaded DSC with a loading date of August 21, 2002. This was about 16 months later from the first loaded DSC at the ISFSI. Although the initial heat load for DSC Serial No. FO24P-P01 was amongst the highest from the pool of DSCs loaded at the ISFSI, the heat load was lower than the design basis for the FO & FC DSC type that have a design basis heat load of 13.5 kW.* This low heat load results in low DSC shell surface temperatures and continues to lower the DSC shell temperatures over the 15-year operating period, thus increasing relative humidity inside the HSM and potentially promoting incubation of ambient contaminants.

3.2.4.1 Inspection Equipment and Methodology

Remote inspection of the HSM-20 interior was performed using a remote controlled MaggHD™ crawler. A tether cable attached the crawler to the controller and transmitted videos, photographs and temperature data to a computer.

The southeast inlet vent was used to access the HSM-20 interior using the crawler. The crawler was equipped with a camera module that is capable of displaying and recording of photographs and videos having VT-3 quality resolution. Four LED lights of adjustable intensity are also mounted on the crawler camera module to provide adequate illumination for the VT-3-level inspection of the interior of HSM-20. An infrared sensor capable of measuring surface temperature was also mounted on the camera module. Thermographic accuracy of the infrared sensor was verified by using a contact pyrometer. A picture of the crawler is shown below:



Crawler with the Camera module

The camera module could be articulated through 120 degrees, which allowed the crawler to record footage in front, directly overhead, and slightly to the rear. The crawler video camera was verified to be VT-3-capable on the day of the inspection just prior to HSM entry.

3.2.4.2 HSM-20 Interior and DSC Exterior Inspection Results

The inspection team included a lead inspector, a VT-3-qualified inspector, and a crawler operator. The lead inspector directed the crawler operator to maneuver the crawler via pre-planned paths and take videos and photographs of the side of HSM-20. Using a secondary monitor (32-inch TV), the inspector monitored the images closely in real-time looking for anomalies. If an anomaly was noted, the inspector informed the operator to zoom in the area in question and record the anomaly via photographs.

Figure 3-1 through Figure 3-6 present a summary of the overall HSM-20 interior inspection results. After more than 15 years of service, the surfaces of the HSM walls, floor, roof, heat shields, DSC support structure, and DSC shell lower half do not show any age-related degradation effects.

As noted in Figure 3-4 and Figure 3-5, a continuous, axial scrape extends along the bottom centerline of the DSC. The scrape extends approximately 6 inches from the south side (HSM door end) to about the middle of the DSC length. This scrape was identified previously in 2001 and documented in DQ 01-0052. DSC P01 had received a scrape along the bottom due to contact with the transfer cask during its dual insertions test performance in 2001. This scrape is clearly evident in these figures. There was no visible rust in the scrape, nor were there any sharp raised metal surfaces along the edges observed.

Figure 3-6 shows discoloration streaks along the DSC that appear to be rail lubricant carried by rainwater intrusion. The streaks appear to be dry with no indication of active water intrusion. *The figure also shows paint blisters on the support rails.*

3.2.4.3 HSM-20 Array Exterior Inspection Results

The HSM array exterior inspection was performed by an HSM fabrication/concrete expert who visually inspected the condition of the HSM exterior walls, roofs, bird screens, fasteners, etc.

The pictures in Figure 3-7 through Figure 3-11 present a summary of the overall exterior HSM array inspection results. After more than 15 years of service, the exterior surfaces of the HSM front walls, side walls, roofs, doors, bird screens, and basemat do not show any age-related degradation effects.

The HSM-16 exterior had a minor spall at the upper left corner as shown in Figure 3-12. The spall likely occurred during transport and assembly of the HSMs. The spall did not appear to be associated with active deterioration.

3.2.4.4 Chloride Sample Analysis Results

As part of the pre-application inspection, SMUD also performed surrogate chloride sampling to determine the susceptibility of chloride aerosols deposition on the horizontal metal surfaces over the PEO at the Rancho Seco site. *The samples were collected in May of 2017 and consist of pieces of metal (one piece was part of a door frame from within the Auxiliary Building and other was a bracket from a structural column from within the Turbine Building). These buildings have been decommissioned and essentially closed to staff since 2008. The buildings have not been sealed and no environmental maintenance has been performed since they were decommissioned. While the Auxiliary Building walls and ceilings are still intact, the Turbine Building walls are very open with the large equipment openings covered with expanded metal grates to restrict access.*

Because the samples were horizontal surfaces, the chloride amounts in the lab report *are expected to* bound the chloride concentrations on the surfaces of the DSCs with different orientations (vertical and lower bottom). Considering the proximity of the Auxiliary Building and the ISFSI and similarity of environmental conditions (i.e. both are open to atmosphere, but not exposed to rain and snow), it is reasonable to conclude that the chloride amounts from the surrogates are representative of the chloride deposition on the DSC surface at the Rancho Seco ISFSI.

Plant	Rancho Seco	Calvert Cliffs [3-66]	Hope Creek [3-67]
Chloride amount (mg/m^2)	18.5	84 (max)	60 on the top (horizontal)

3.2.4.5 Conclusions

- The Rancho Seco ISFSI site is a fundamentally benign environment for potential degradation of metal and concrete since it is not near a source of salt water, or operating cooling towers. It is located in a region of low humidity, with no snow/ice management activities to create airborne chlorides.
- The Rancho Seco pre-inspection confirms that the HSM, DSC Support Structure and DSC subcomponents do not show any age-related degradation and are in very good condition after more than 15 years of service.

3.2.5 Summary of Pre-Application Inspections at Other ISFSIs Using NUHOMS® Storage Technology

Information from the lead canister and baseline inspection reports from similar NUHOMS®-based specific ISFSI license renewal applications were evaluated as part of the AMR process. These include the specific renewal applications inspection reports for Calvert Cliffs Nuclear Power Plant ISFSI [3-2], Oconee Nuclear Station ISFSI, License Renewal Application for the Site-Specific Independent Spent Fuel Storage Installation (ISFSI) - Response to Requests for Additional Information [3-3], and H.B. Robinson Steam Electric Plant ISFSI [3-4, 3-5]. These inspections reports are considered relevant because their ISFSIs are based on NUHOMS®-based storage system design similar to the Rancho Seco ISFSI design.

A summary of the inspections is provided below:

3.2.5.1 Calvert Cliffs Nuclear Power Plant ISFSI, Material License No. SNM-2505

The Calvert Cliffs Nuclear Power Plant ISFSI was originally licensed with the NUHOMS®-24P dry storage system in November 1992. The 20-year license expired on November 30, 2012, was renewed for forty years on October 23, 2014 and expires November 30, 2052. The principal components are an HSM composed of concrete and structural steel, and a stainless steel DSC with an internal basket that holds the spent fuel. The exterior walls and roof of the HSM are 3 feet thick, and the interior walls are 2 feet thick.

On June 27th and 28th, 2012, Calvert Cliffs performed an inspection of the interior of two HSMs, and the exterior of the DSCs contained therein. The inspection was conducted in accordance with Calvert Cliffs Nuclear Power Plant Engineering Test Procedure, “Aging Management and Marine Environment Effects Inspection of ISFSI Horizontal Storage Module and Dry Storage Canisters.” The first module examined was HSM-15, which was loaded in November 1996 and contained the “lead canister” DSC for the purpose of meeting the NUREG-1927 Appendix E guidance. The second module inspected was HSM-1, which was loaded in November 1993 (the first loading) and represents one of the lowest heat load canisters presently loaded (estimated at 4.2 kW). This canister was added as part of the EPRI research efforts on evaluating stress corrosion cracking of stainless steel canisters used for dry storage. This inspection included salt concentration measurements on the upper shell of the DSC, collection of samples of the deposits on the upper shell of the DSC for offsite analysis, and surface temperature measurements via contact thermocouple for the purpose of benchmarking best-estimate thermal models.

The visual inspection was conducted in both HSM-15 and HSM-1 by remote and direct means. The remote inspection was performed by lowering a remote controlled, high definition pan-tilt-zoom (PTZ) camera system with a 100 mm head camera inserted through the rear outlet vent, which allowed viewing of the majority of the DSC, its support structure, and the interior surfaces of the HSM. The direct inspection was performed through the partially open door by mounting the camera on a pole. This allowed for views of the bottom end of the DSC, the seismic restraint, HSM doorway opening, and the backside of the HSM door. Varying levels of camera magnification were utilized to highlight various areas of interest during the inspection.

Based on the visual examinations described above, it was concluded that the Calvert Cliffs baseline inspection of HSM and DSC structures were performing as expected. The inspection did not indicate any aging-related deficiencies with the DSC components. Some minor degradation on HSM external concrete surfaces have been noted. There was evidence of localized water intrusion to the interior of the HSM in the vicinity of the rear outlet vents. A coating of dust and dirt was present on the floors of each HSM but no debris or standing water was observed. There was some general surface corrosion noted on the carbon steel surface and bolting hardware.

Proprietary Information on Pages 3-25 and 3-26
Withheld Pursuant to 10 CFR 2.390

3.2.6 Operating Experience Review Results Summary and Conclusions

The review of available documentation of conditions found in NUHOMS® ISFSIs shows that the aging-related conditions can be classified in three areas of interest. The first is the degradation of the concrete, which is readily monitored visually, and is corrected with proper repair programs. The second area of interest is the degradation of the coatings resulting in some corrosion to the HSM interior steel. The third area of interest is the environment of the DSCs and potential CISCC of the shell surfaces and assembly welds.

Rancho Seco Pre-Application Inspection

The Rancho Seco ISFSI site is a fundamentally benign environment for potential degradation of metal and concrete since it is not near a source of salt water, or operating cooling towers. It is located in a region of low humidity, with no snow/ice management activities to create airborne chlorides.

The Rancho Seco pre-inspection confirms that the HSM, DSC Support Structure and DSC subcomponents do not show any age-related degradation and are in very good condition after more than 15 years of service.

Conclusion

In conclusion, OE from fabrication and installation coupled with the Rancho Seco and other existing site-specific ISFSI inspection results provide a sufficient basis for developing adequate AMPs for the Rancho Seco SNM-2510 renewal application.

Proprietary Information on Pages 3-28 through 3-30
Withheld Pursuant to 10 CFR 2.390

Table 3-1
Operating Experience Documentation of Potential Age-Related Degradation
(16 Pages)

OE ID Number	Brief Description/Cause	Potential Aging Effect & Mechanism	Disposition/LRA Renewal Relevance
4	NRC IN 2011-20 addresses the occurrence of alkali silica reaction (ASR)-induced concrete degradation on seismic Category 1 structures at Seabrook Station. ASR is one type of alkali-aggregate reaction that can degrade concrete structures. ASR is a slow chemical process in which alkalis, usually predominantly from the cement, react with certain types of silica (e.g., chert, quartzite, opal and strained quartz crystals) in the aggregate, when moisture is present. This reaction produces an alkali-silica gel that can absorb water and expand to cause micro-cracking of the concrete. In order for ASR to occur, three conditions must be present: a sufficient amount of reactive silica in the aggregate, adequate alkali content in the concrete and sufficient moisture. To prevent ASR, the American Society for Testing and Materials (ASTM) has issued standards for testing concrete aggregate during construction to verify that only non-reactive aggregates are used. Seabrook used these standards (ASTM C289 and ASTM C295); however, ASR degradation still occurred. Cause: ASR	Loss of compressive strength, modulus of elasticity due to cracking	[ ] Relevance to Rancho Seco LRA renewal: Although the potential for alkali reactivity in the HSM concrete is low, it is considered to potentially exist during the extended storage period. Therefore, signs of ASR are an inspection attribute in the HSM AMP.

Table 3-1
Operating Experience Documentation of Potential Age-Related Degradation
(16 Pages)

OE ID Number	Brief Description/Cause	Potential Aging Effect & Mechanism	Disposition/LRA Renewal Relevance
5	NRC IN 2012-20 addresses the potential chloride induced stress corrosion cracking (CISCC) of austenitic stainless steels typically used to fabricate dry cask storage canisters. As described in the IN, this failure mechanism is reproduced in Type 304, 304L and 316L stainless steels. All of the failures mentioned in the IN occurred in components at nuclear plants located near a saltwater body. Cause: CISCC	Loss of material due to CISCC of austenitic stainless steels.	Initiation of CISCC for austenitic steels is affected by parameters including DSC surface temperature, relative humidity and chloride salt concentration deposited on the DSC surface. Relevance to Rancho Seco LRA renewal: The potential for CISCC at Rancho Seco site is remote due to the location of Rancho Seco ISFSI away from a saltwater body. Additional justification has been provided in Section 3.4.4.2 as to why CISCC of austenitic steel is not a credible aging mechanism at Rancho Seco ISFSI. Rancho Seco evaluation.

Proprietary Information on This Page
Withheld Pursuant to 10 CFR 2.390

Table 3-1
Operating Experience Documentation of Potential Age-Related Degradation
(16 Pages)

OE ID Number	Brief Description/Cause	Potential Aging Effect & Mechanism	Disposition/LRA Renewal Relevance
7	[ ]	[ ]	[ ] Relevance to Rancho Seco LRA renewal: The conditions described herein are event-driven that resulted from improper storage of DSC components. The appropriate corrective actions were taken. They are not related to aging or age-related degradation because the components once installed will be in a sealed and inert environment. Therefore, there is no applicable aging effect that needs to be evaluated in the AMR.

Table 3-1
Operating Experience Documentation of Potential Age-Related Degradation
(16 Pages)

OE ID Number	Brief Description/Cause	Potential Aging Effect & Mechanism	Disposition/LRA Renewal Relevance
8	[ ]	[ ]	[ ] Relevance to Rancho Seco LRA renewal: The settlement of the basemat noted in this OE occurred following the initial placement of the modules during installation. This is distinct from the settlement of a concrete basemat over a long term. The settlement of the basemat over a long term is an applicable aging effect and an inspection attribute in the AMP and monitoring inspections.

Proprietary Information on Pages 3-36 and 3-37
Withheld Pursuant to 10 CFR 2.390

Table 3-1
Operating Experience Documentation of Potential Age-Related Degradation
(16 Pages)

OE ID Number	Brief Description/Cause	Potential Aging Effect & Mechanism	Disposition/LRA Renewal Relevance
11	[ ]	[ ]	[ ] Relevance to Rancho Seco LRA renewal: Leaching of concrete and water stains on metal components are included in the acceptance criteria of the HSM AMP for external and internal surfaces.
12	[ ]	[ ]	[ ] Relevance to Rancho Seco LRA renewal: None, since the vent screens are monitored daily per Rancho Seco Tech Specification 5.5.3.3.

Table 3-1
Operating Experience Documentation of Potential Age-Related Degradation
(16 Pages)

OE ID Number	Brief Description/Cause	Potential Aging Effect & Mechanism	Disposition/LRA Renewal Relevance
13	[ ]	[ ]	[ ] Relevance to Rancho Seco LRA renewal: Inspection for indications of corrosion of the HSM internals is an attribute in the HSM AMP.
14	[ ]	[ ]	[ ]. Relevance to Rancho Seco LRA renewal: Visual inspection of the DSC exterior for corrosion products is included in the DSC AMP

Table 3-1
Operating Experience Documentation of Potential Age-Related Degradation
(16 Pages)

OE ID Number	Brief Description/Cause	Potential Aging Effect & Mechanism	Disposition/LRA Renewal Relevance
15	[ ]	[ ]	[ ] Relevance to Rancho Seco LRA renewal: None for DSC internal parts because of the dry inert internal environment during storage.
16	[ ]	[ ]	[ ] Relevance to Rancho Seco LRA renewal: Indications of concrete flaking, peeling, and indentations (voids) are inspection attributes in the HSM AMP for external and internal surfaces.

Table 3-1
Operating Experience Documentation of Potential Age-Related Degradation
(16 Pages)

OE ID Number	Brief Description/Cause	Potential Aging Effect & Mechanism	Disposition/LRA Renewal Relevance
17	At an operating ISFSI, HSM roof has surface cracking, which appears to align with the underlying reinforcing steel. Other roof modules also have similar surface cracking. See INPO OE27586. Cause: Conditioning of the concrete surface during fabrication.	Loss of material (cracking & spalling); cracking/freeze-thaw	[ ] well above the design requirement of 5,000 psi. The evaluations concluded that the type of crack observed is not structural and is limited to the outer layer of the concrete cover. The overall HSM and HSM array continues to be capable of fully performing the intended function/performance requirements, both structurally and radiologically. As a mitigating measure, TN recommended sealing the concrete surface with concrete sealant to prevent moisture intrusion. Relevance to Rancho Seco LRA renewal: Applicable aging effect included in the HSM AMP for external and internal surfaces.

Table 3-1
Operating Experience Documentation of Potential Age-Related Degradation
(16 Pages)

OE ID Number	Brief Description/Cause	Potential Aging Effect & Mechanism	Disposition/LRA Renewal Relevance
18	[ ]	[ ]	[ ] Relevance to Rancho Seco LRA renewal: Loss of concrete material is addressed by the HSM AMP for external and internal surfaces.
19	[ ]	[ ]	[ ] Relevance to Rancho Seco LRA renewal: Corrosion is addressed by the HSM AMP for external and internal surfaces.
20	Scratch /Gouge on the Rancho Seco MP187 TC. Cause: Event driven during DSC handling.	Loss of material	The scratches/gouges were repaired and evaluated in accordance with Rancho Seco site procedures as part of the resolution. The conditions described herein are event-driven that resulted during handling of the DSC. The appropriate corrective actions were taken. Relevance to Rancho Seco LRA renewal: They are not aging or age-related degradation. Therefore, there is no applicable aging effect that needs to be evaluated in the aging management review.

Table 3-1
Operating Experience Documentation of Potential Age-Related Degradation
(16 Pages)

OE ID Number	Brief Description/Cause	Potential Aging Effect & Mechanism	Disposition/LRA Renewal Relevance
21	Paint peeling off the HSM Heat Shields at Rancho Seco ISFSI. Cause: Poor workmanship.	Loss of Paint	This was discovered during NRC inspection of the Rancho Seco HSMs. Calculation NUH004.0421 *Rev. 3 (1997) bounds* the condition including no paint on the heat shield. The affected area of the HSM # 2 and #6 were cleaned per work order. Relevance to Rancho Seco LRA renewal: This issue was considered as bad workmanship and not aging or age-related degradation. Therefore, there is no applicable aging effect that needs to be evaluated in the aging management review.

Figure 3-1
Floor at HSM Interior Northwest Corner, Looking North

No anomalies noted.

Figure 3-2
Northwest Corner

Shown in the picture are the left and upper heat shields and DSC (dark gray) at right. The DSC support rail is at the far right.

No anomalies noted.

Figure 3-3
Ceiling, South East Corner

The bolts shown in the middle left of the photo are fasteners attached to the east wall. The camera is looking south with support post #1 in view. No degradation of the bolts, supports, support rail, support welds, heat shield, or DSC was observed. There are circular shaped shiny and dark spots on the right of the support rail. The shiny spot is the glare of the crawler's lights. The "dark" spot appears to be a burnish mark on the DSC, which appears to be darker than the surrounding. It does not appear to be a result of degradation.

Figure 3-4
Scrape on DSC Bottom

This photo was taken approximately 4 feet from the south (plug) wall and in the middle of the HSM.

Note: The scrape extends from approximately 6 inches from the south HSM door to the middle of the DSC along an axial line. No indication of deterioration is observed.

As noted in DQ No. 01-0052, DSC P01 had received a scrape along the bottom due to contact with the TC during its insertion test performance in 2001. As shown, this scrape is clearly evident.

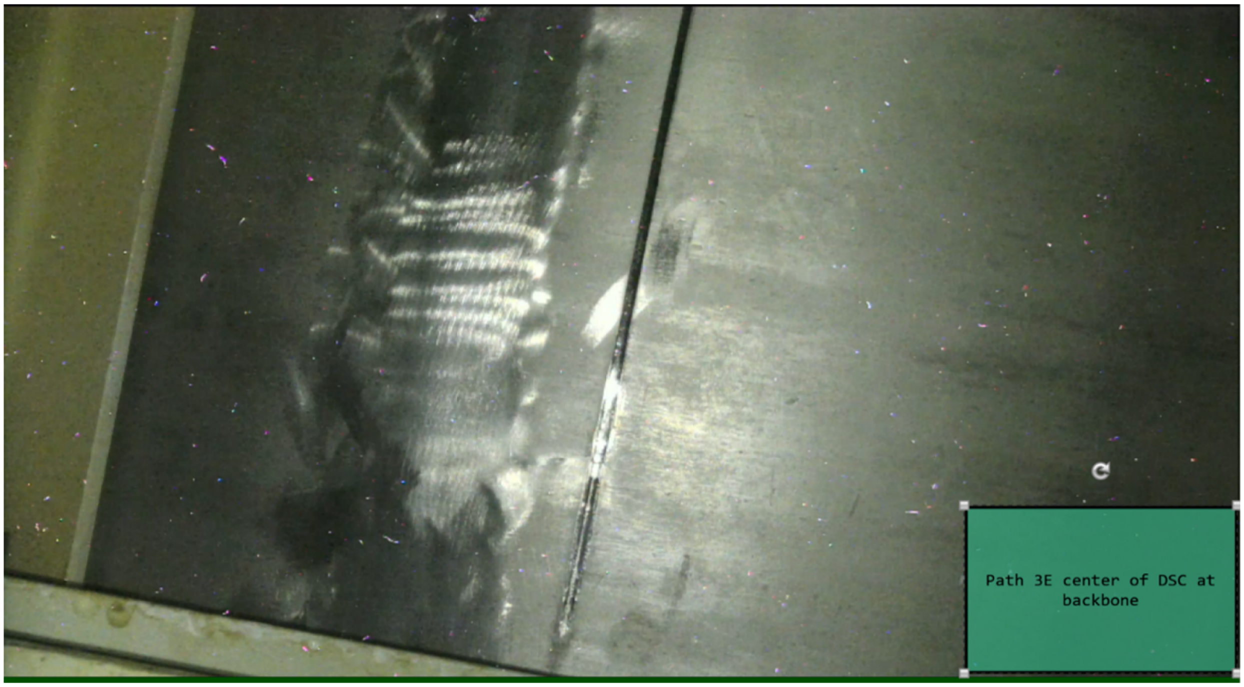


Figure 3-5
DSC Bottom Scrape at Northern Terminus

This picture shows a zoomed-in view of the scrape. There is no visible rust in the scrape observed. There are no sharp raised metal surfaces along the edges observed.

The scrape terminus is about 7 feet north of the interior face of the front wall. The middle crossbeam is at the lower portion of the picture. East rail flange is along the left portion of the picture.

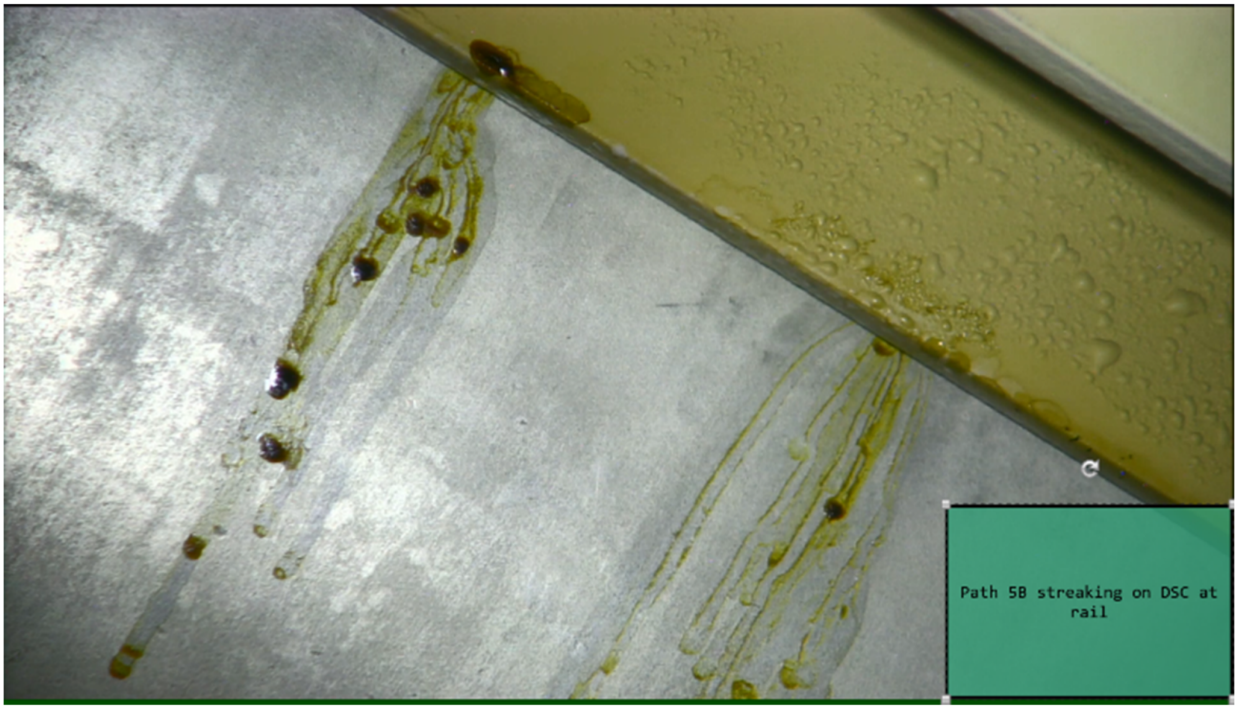


Figure 3-6
DSC Bottom and Support Rail, East Side, between Support #2 and Support #3

Note discoloration streaks can be seen on the DSC that appear to be rail lubricant carried by rainwater intrusion. The streaks appear to be dry with no indication of active water intrusion. *Paint blisters were also observed on the Support Rail*

Figure 3-7
HSM-20 Front Face

Minor cracks in the concrete as defined in this report are crack widths of up to 0.013 inch on exterior surfaces, which is acceptable per ACI 224 [3-40]. Random hairline shrinkage or tensile cracks may occur in the cement film on the surface of modules.

Roof – Front Face

The front face of the roof is attached to the base with shear keys in the interior and through rods. Conduit runs along the top of the array and attaches to the thermocouple at the face of the module. An extra thermowell is plugged with a fastener. The surface is free of spalls or cracks.

Door

The door is comprised of an 8-inch thick hollow steel plate filled with concrete. The door is attached by 10 clamps and four welds at the door ring embed located close to the vertical

centerline of the door. The door is coated with Carbo Zinc 11 primer and Carboguard 890 topcoat. The top coat is intact and protecting the carbon steel.

Base – Roof Side Walls

The module side walls were inspected from the front as observed through the 6-inch gap. The walls appear to have their original finish with no signs of spalls or structural cracks.

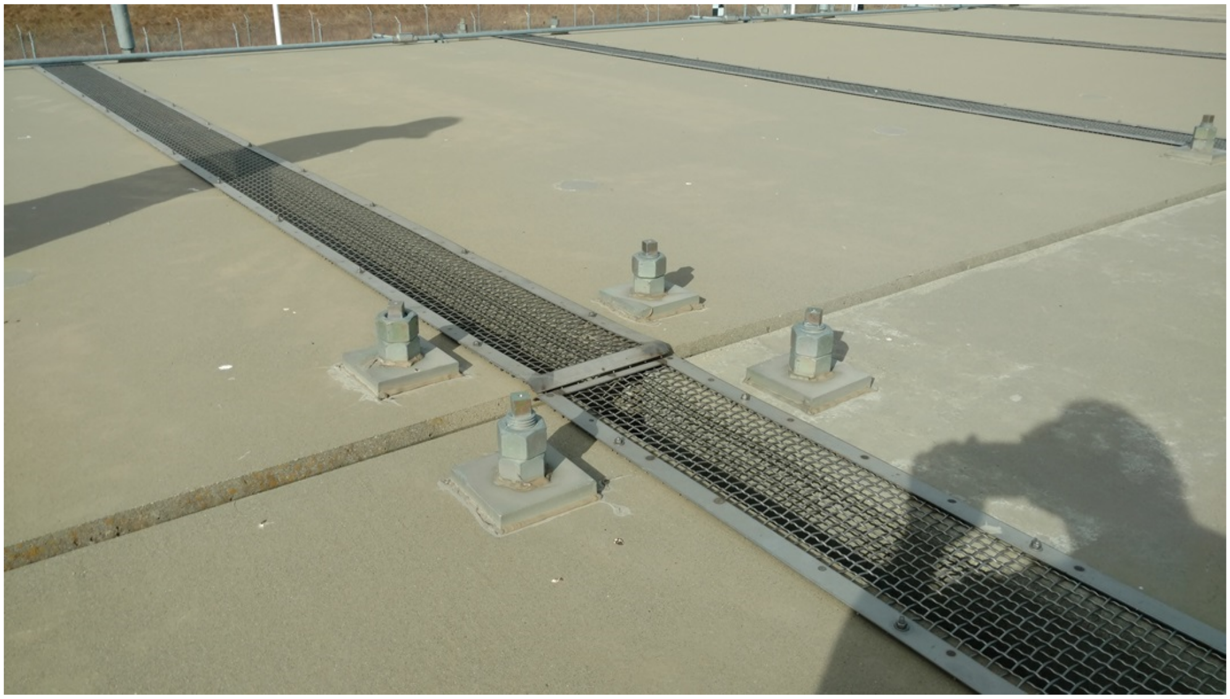


Figure 3-8
HSM-20 Roof

The HSM roof surface has the original finish with no indications of map cracking, scale, or abrasion. The four grout patches that fill the lift embeds are sound and free of deleterious cracks.

<u>Bird Screen</u>

The bird screens are stainless steel mesh and welded frame that is attached to the concrete with Hilti post installed anchors. The bird screens are intact and performing the function as designed. There are no warped sections that would indicate movement. There is no indication of corrosion or deterioration.

Figure 3-9
West End Shield Wall South Panel

The end shield walls consist of four vertical slabs attached to the end modules with through-studs at the bottom and metal straps at the top. The concrete surface has minor superficial map cracking that is not deleterious. There are no spalls. The grout patches for filling the lifting embeds are sound. The light discolorations are superficial and appear to be part of the original construction.

Figure 3-10
End Shield Walls East Side

The east shield walls are identical to the west panels. There are two shear keys reinforced with galvanized angles at the corners. The shear keys are intact. There are no spalls and the visible cracks are typical and minor. The grout patches for filling the lifting embeds are sound. The light discolorations are superficial and appear to be part of the original construction.

The east shield wall has the conduit for the temperature monitoring system. The junction box has corrosion on the outer cover. The temperature system quality class is not important-to-safety (NITS).

Figure 3-11
Basemat East Side Facing South

The basemat is a 2-foot thick slab for the HSM assembly. The basemat extends beyond the front face of the east and west end wall. The basemat has superficial discoloration around the edges. The joint between the basemat and apron is intact. The construction joint between the apron and basemat is level with random wear at the edges.

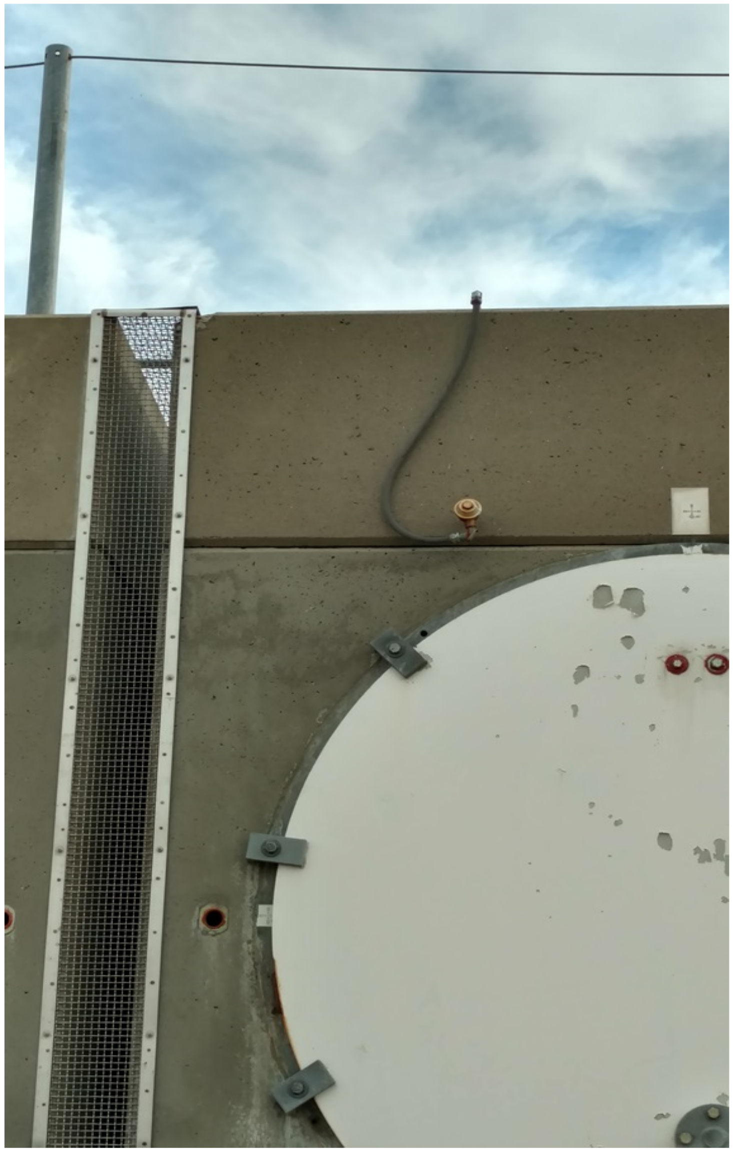


Figure 3-12
HSM-16 Spall at Roof Left Corner

HSM-16 had a spall at the upper left corner. The spall likely occurred during transport and assembly of the HSMs. The spall did not appear to be associated with active deterioration.

3.3 Aging Management Review Methodology

The AMR follows the methodology recommended in NUREG-1927 [3-1] and NEI 14-03 [3-19]. The AMR provides an assessment of the aging effects that could adversely affect the ability of the SSCs to perform their intended functions during the period of extended operation. The guidance in the draft Managing Aging Processes in Storage (MAPS) Report [3-68] was also considered, to the extent possible, given that the LRA was being written concurrent with the development of the draft MAPS Report.

The AMR process involves the following major steps:

- Identification of materials and environments;
- Identification of aging effects and mechanisms requiring management;
- Determination of the activities required to manage the effects and mechanisms of aging. This involves the identification of TLAAs or AMPs for managing the effects of aging;
- Evaluation of spent fuel (canister) retrievability during the period of extended operation.

The scoping evaluation, documented in Chapter 2, identifies the in-scope SSCs for which potential aging effects must be identified and evaluated. The identification of materials and environments for the in-scope SSCs is presented in Section 3.3.1. For each SSC, the material of construction and the environment to which each SSC is exposed are determined. The component environments are determined based on the location of the component within the storage system. Once the component material/environment combinations are determined, potential aging effects requiring management are determined (Section 3.3.2). Engineering literature, related research and industry information, and existing OE are reviewed to identify expected aging degradation mechanisms for different materials and environments. After the *expected* aging effects are identified, it is determined whether the effects can be addressed by TLAA, or will require an AMP (Section 3.3.3).

3.3.1 Identification of Materials and Environments

The first step in the AMR process is to identify the materials of construction for each subcomponent of the in-scope SSCs and the environments to which those materials are exposed during normal storage conditions. The combinations of materials and environments are used to identify the potential aging effects that require management during the PEO, as discussed in Section 3.3.2.

3.3.1.1 Materials

The Rancho Seco ISFSI SSCs and associated subcomponent materials of construction are summarized in tables presented in Chapter 2, Table 2-6 (for DSCs), Table 2-7 (for HSMs), Table 2-8 (for TC) and Table 2-9 (for SFAs) on a component-by-component basis. The materials of construction were identified through a review of the drawings listed in Table 2-10 and included in the ISFSI FSAR along with other pertinent design information.

In this LRA, coatings (or paints) are treated as materials rather than as a separate subcomponent that would otherwise have been subject to scoping evaluation. Various in-scope subcomponents of major components are coated. In all cases, the coatings are considered not-important-to-safety. Coatings are discussed for each in-scope component, as applicable in the AMR discussions that follow under the subsection entitled "Aging Effects Requiring Management." As appropriate, the AMRs evaluate the impact of the failure of coatings on the ability of associated in-scope subcomponents (or those located nearby) to perform their intended functions.

3.3.1.2 Environments

The environments to which SSCs and associated subcomponents are exposed play a critical role in the determination of potential aging effects and mechanisms. The configuration of the Rancho Seco ISFSI, consisting of an array of individual HSM storage modules, provides an effective means of protection against extreme seasonal weather conditions, including heavy precipitation, drifting snow, ice flows, lightning strikes, strong winds, wind driven missiles, and blowing dust [3-15]. The Rancho Seco ISFSI has been designed for a bounding seasonal normal ambient operating temperature range of 0 °F to 101 °F, and an off-normal range of -20 °F to 117 °F with concurrent extreme insolation.

The environments to which the Rancho Seco SSCs are exposed are affected by the characteristics of the ISFSI site environment, as well as by the component location within the storage system. There are five basic environments that apply for the Rancho Seco ISFSI SSCs.

<u>Note:</u> The five environments listed below are consistent with the environments listed in Table 3-1 of the draft MAPS Report [3-68]. (MAPS designations are shown in parentheses).

- Inert Gas (HE) – Inert helium environment inside the DSC cavity. The spent fuel assemblies (SFAs), the DSC internal basket assembly, and the inside surfaces of the DSC shell and interior shell assembly subcomponents (e.g., inner top and bottom cover plates and top shield plugs) are exposed to the inert gas (helium) environment inside the shell assembly cavity. These components are exposed to significant neutron and gamma radiation. See FO/FC/FF DSC cavity helium temperatures

and pressures presented in ISFSI FSAR Volume I [3-15], Tables 8-2a and 8-2b, for normal and off-normal conditions. Both temperature and pressure are expected to continue decreasing over the period of extended operation.

- Sheltered (SH) – Protected environment, such as HSM interior or TC stored indoors in an uncontrolled environment. A sheltered environment is a protected environment with no direct exposure to sun, wind, or precipitation. A sheltered environment may contain moisture and salts or other contaminants from the external ambient air. The temperature inside the HSM depends on the ambient air temperature and the heat load of the loaded canister. It may range from ambient air temperature to about 382 °F at the beginning of storage (from Table 8-4 of ISFSI FSAR Volume II [3-15], based on DSC shell maximum temperature for the maximum design basis heat load of 13.5 kW and 117 °F ambient conditions temperature). The corresponding maximum concrete temperature is about 241 °F (from Table 8-4 of ISFSI FSAR Volume II [3-15]). Components exposed to the HSM sheltered environment (interior side of the HSM walls, HSM steel, and DSC external shell assembly components) are exposed to neutron and gamma radiation to a lesser extent than those of the interior cavity of the DSC. Temperatures and radiation sources are expected to decrease over the PEO.
- Embedded or Encased (E-C, E-M, E-NS, FE) – This environment applies for materials that are embedded or encased (sealed) inside another material (e.g., concrete, metal, or neutron shielding). These include rebar and anchorage embedded in the HSM concrete, DSC bottom shield plug encased between the inner and outer cover plates, NS-3 solid neutron shielding material encased in the TC lids and between the TC neutron shield jacket and the structural shell, and the lead encased between the inner liner and the structural shell of the TC. Embedded or encased environments are exposed to radiation. The radiation source is expected to decrease over the period of extended operation.
- External (OD) – During storage, the exterior surfaces of the HSM are exposed to all weather conditions, including insolation, wind, rain, snow, and plant-specific ambient air conditions, including moist atmospheric air, ambient temperatures, and humidity.
- Underground (GW) – At the Rancho Seco ISFSI, the HSMs are installed on a reinforced concrete basemat, which is constructed on compacted, engineered fill. As discussed in Chapter 2, the concrete basemat accessible areas above-grade and inaccessible areas below-grade are within the scope of Rancho Seco ISFSI renewal. The ISFSI basemat that is located below grade could be exposed to a groundwater/soil environment.

The environments considered in the AMR are the environments that the Rancho Seco SSCs and associated subcomponents normally experience. Environmental stressors that are conditions not normally experienced (such as extreme cold), or that may be caused by a design or fabrication condition, are considered event-driven and are not aging-related. Such event-driven situations would be evaluated and corrective actions, if any, implemented at the time of the event.

3.3.2 Identification of Aging Effects Requiring Management

After the component material/environment combinations are determined, potential aging management effects are determined. Engineering literature is reviewed to identify expected aging degradation mechanisms for different materials and environments.

Aging effects are the manifestation of aging mechanisms. In order to effectively manage an aging effect, it is necessary to determine the aging mechanisms that are potentially at work for a given material and environment combination. Therefore, the AMR process identifies both the aging effects and the associated aging mechanisms that cause them. Some aging mechanisms are only applicable at certain conditions such as high temperature or moisture. Each identified aging mechanism is characterized by a set of applicable conditions that must be met for the mechanism to occur. Given this evaluation process, each subcomponent that was subjected to AMR was evaluated to determine if the potential aging effects and mechanisms were credible considering the various material/environment combinations.

The potential aging effects and mechanisms that were considered for the Rancho Seco ISFSI SSCs were based on analysis tools and reports provided by EPRI reports, NUREG/CRs, Standardized NUHOMS® System-specific operating experience, Rancho Seco specific operating experience and industry operating experience.

3.3.3 Identification of the Activities Required to Manage the Effects of Aging

TLAAs are prepared to assess SSCs that have a time-dependent operating life to demonstrate that the existing licensing basis remains valid and that the intended functions of the SSCs in the scope of renewal are maintained during the period of extended operation. Time dependency may entail fatigue life (cycles), change in a mechanical property such as fracture toughness or strength of materials due to irradiation, or time-limited operation of a subcomponent. The TLAAs and other supplemental evaluations are presented in Appendix A.

AMPs are developed for managing the effects of aging. As appropriate, an AMP was created to summarize the activities or procedures implemented to monitor and manage the aging effects. The AMPs credited for managing the effects of aging degradation are presented in Appendix B.

3.4 Aging Management Review Results — DSCs

This section summarizes the results of the AMR for the in-scope subcomponents of Rancho Seco DSCs (FO, FC, FF and the GTCC DSC). The in-scope DSC subcomponents and their intended functions are summarized in the scoping evaluation Chapter 2, Table 2-6. (MAPS designations in parentheses, if different).

The DSC performs the following intended functions:

- CC (CR) Provides criticality control of spent fuel
- HT (TH) Provides heat transfer
- PB (CO) Directly or indirectly maintains a pressure boundary (confinement)
- SH Provides radiation shielding
- SS (SR) Provides structural support (structural integrity)
- RE Provides retrievability of SFAs

The GTCC DSC is designed to store greater than Class C waste and thus criticality is not an intended function for the GTCC DSC.

3.4.1 Description of DSC Subcomponents

The Rancho Seco DSCs consist of two main subcomponents: the shell assembly and the internal basket assembly. A description of the three DSC types and the GTCC DSC is provided in Section 2.4 of Chapter 2.

The following DSC subcomponents are excluded from further AMR because either they were scoped out or they do not support the intended function of the DSC during the PEO:

- Dry film lubricant on the exterior sliding surfaces of the DSCs/GTCC
- Quick-connect fittings for siphon and vent ports
- Siphon tubing
- Electroless nickel coating on carbon steel subcomponents
- Thread lubricant, tape, or sealant
- Non-structural stainless steel plugs or bolts

3.4.2 DSC Materials Evaluated

The materials of construction for the subcomponents of the DSCs are presented in Chapter 2, Table 2-6 and summarized in Table 3-2.

3.4.3 Environments for the DSC

The environments that affect the DSC subcomponents, both externally and internally, are those that are normally (continuously) experienced and are described below:

External

Each DSC is positioned for long-term storage inside an HSM. As such, the external surfaces of the DSC (shell, top and bottom outer cover plates, grapple assembly, and associated welds) are exposed to the HSM interior (i.e., sheltered) environment. This is a protected environment with no direct exposure to sun, wind, or precipitation. The internal HSM environment may contain moisture and salts or other contaminants from the external ambient air. The maximum initial DSC shell assembly temperatures (at the beginning of storage) for normal conditions of storage inside the HSM are summarized in Rancho Seco ISFSI FSAR, Volume II, Table 8-5 [3-15]. Using 70 °F ambient conditions for the long-term normal conditions, the maximum DSC shell temperature is calculated to be 305 °F in the FO and FC DSC, which bounds the FF DSC and GTCC. These surface temperatures continuously decrease from the beginning of storage into the PEO.

The DSC shell assembly components are exposed to neutron and gamma radiation. Appendix A documents the analyses performed to evaluate the effects of neutron fluence and gamma radiation on the mechanical properties of the DSC subcomponents. The evaluation takes credit for source strength decay over a total service (storage) life of 100 years, and the energy deposition is integrated over the same period. The maximum neutron fluence on the DSC shell assembly is reported in Table A.2 of Appendix A. This maximum value is well below the level of concern for embrittlement of stainless steel of 1 x 10^{18} neutrons/cm^2 per EPRI Report 1015078, Plant Support Engineering: Aging Effects for Structures and Structural Components (Structural Tools) [3-33].

Internal

The internal components of the DSC (basket assembly, other shell assembly subcomponents, such as inner top and bottom cover plates, shield plugs, siphon and vent block and cover plates, and associated welds) are exposed to the inert gas (helium) environment inside the DSC cavity. The average helium temperature in the DSC cavity reaches 524 °F at the beginning of storage (ISFSI FSAR, Volume I, Table 8-2a, [3-15]) for the FO/FC DSC at 70 °F ambient under normal storage conditions. Also, the helium gas pressure is 3.9 psig at the beginning of storage (ISFSI FSAR, Volume I, Table 8-2a, [3-15]) for the FO/FC DSC at 70 °F ambient under normal storage conditions. The FO/FC DSC thermal analysis results bound the FF and GTCC DSC results. The helium gas temperature and pressure decreases over the PEO.

The DSC internal components are exposed to significant neutron and gamma radiation. The maximum neutron fluence in the basket assembly center fuel compartments is reported in Table A.2 of Appendix A. This maximum value is well below the level of concern for embrittlement of stainless steel of 1 x 10^{18} neutrons/cm^2 [3-33].

3.4.4 Aging Effects Requiring Management for the DSCs

3.4.4.1 Materials

The materials of construction for the DSC subcomponents that are subject to further AMR include stainless steel and carbon steel.

This section describes the potential aging effects that could, if left unmanaged, cause degradation of DSC subcomponents and result in loss of the component intended function(s). The potential aging effects that could cause loss of intended function(s) are:

- Loss of Material
- Cracking
- Change in Material Properties

Aging mechanism(s) that could lead to aging effect(s) for steel components were determined using technical publications, NUREG/CRs, and EPRI reports. Aging mechanism(s) were evaluated to determine if the mechanism(s) could lead to an aging effect requiring management.

Loss of Material Aging Effects Assessment

- Loss of Material due to general corrosion – carbon steel
- Loss of Material due to crevice corrosion – carbon steel and stainless steel
- Loss of Material due to pitting corrosion – carbon steel and stainless steel
- Loss of Material due to galvanic corrosion – dissimilar metals

Cracking Aging Effects Assessment

- Cracking due to Stress Corrosion Cracking (SCC) – stainless steel
- Cracking due to thermal fatigue – carbon steel and stainless steel

Change in Material Properties Aging Effects Assessment

- Change in material properties due to *thermal aging* -carbon steel and stainless steel
- Change in material properties due to irradiation embrittlement-carbon steel and stainless steel

3.4.4.2 Discussion of Aging Mechanisms

General Corrosion

Carbon steel surfaces in contact with moist air or water are subject to general corrosion. The rate of general corrosion is governed by several factors, such as the moisture of the air, the salinity level of the air, the temperature of the metal surface.

The carbon steel subcomponents of the DSC include the top and bottom shield plugs and other top shield plug assembly parts (e.g., casing plates, stiffeners, etc., for DSCs with lead-encased shield plugs). These carbon steel parts are completely enclosed within the DSC cavity in an inert gas environment and will, therefore, not be subjected to general corrosion. Thus, loss of material due to general corrosion is not an aging effect requiring management for the DSC.

Crevice Corrosion

Crevice corrosion is localized corrosion within crevices or shielded areas. It occurs most frequently in connections, lap joints, splice plates, bolt threads, under bolt heads, or points of contact between metals and non-metals, and it is associated with a stagnant or low flow solution (an electrolyte). To function as a corrosion site, the crevice must be wide enough to permit liquid entry and narrow enough to maintain a stagnant zone, typically a few thousandths of an inch or less [3-33].

Crevice corrosion is strongly dependent on the presence of dissolved oxygen. Any surface exposed to atmospheric conditions will be saturated in oxygen above the threshold levels for crevice corrosion to occur (0.1 parts per million (ppm)). This form of corrosion, as the name implies, requires a crevice in which contaminants and corrosion products can concentrate. In addition to oxygen, moisture is required for the mechanism to operate. Typically, atmospheric pollutants and contaminants, both indoors and outdoors, are insufficient to concentrate and thereby promote crevice corrosion. Alternating wetting and drying is particularly harmful because this leads to a concentration of atmospheric pollutants and contaminants [3-33].

The DSC is located within the sheltered environment of the HSM interior, and DSC decay heat will heat the air preventing the accumulation or condensation of moisture inside the HSM. However, since the DSC decay heat will progressively decrease during the period of extended operation, the presence of moist air cannot be ruled out. Air with enough moisture can facilitate the loss of material in steel caused by crevice corrosion. Moist air in the absence of condensation also is potentially aggressive. Therefore, this aging mechanism is potentially operative on the external surface of the stainless steel DSC shell assembly around the support rail areas. For this reason, loss of material due to crevice corrosion in stainless steel is an aging effect requiring management. DSC steel subcomponents located inside the DSC cavity are in an inert environment and are not subject to crevice corrosion.

Pitting Corrosion

Pitting corrosion is a localized corrosive attack in aqueous environments containing dissolved oxygen and chlorides. When passivity breaks down at a spot on a metal surface, an electrolytic cell is formed with the anode at the minute area of active metal and the cathode at the considerable area of passive metal. The large electric potential difference between the two areas accounts for considerable flow of current with rapid corrosion at the anode. The anode does not spread because it is surrounded by passive metal, and as the mechanism continues, it penetrates deeper into the metal, forming a pit. Pitting corrosion is more common with passive materials, such as austenitic (300 Series) stainless steels than with non-passive materials, such as carbon steels [3-33].

Oxygen is required for pitting initiation. Areas in which aggressive species can concentrate, that is, locations of frequent or prolonged wetting or of alternate wetting and drying, are particularly susceptible to pitting. Most pitting is the result of halide contamination, with chlorides, bromides, and hypochlorites being prevalent [3-33].

The DSC is located within the sheltered environment of the HSM interior and DSC decay heat will heat the air, limiting the accumulation or condensation of moisture inside the HSM. However, because the DSC decay heat will progressively decrease during the period of extended operation, the presence of moisture on the DSC service cannot be ruled out. Air with enough moisture can facilitate the loss of material in steel caused by pitting corrosion. Moist air in the absence of condensation also is potentially aggressive. Therefore, this aging mechanism is potentially operative on the external surface of the stainless steel DSC shell assembly; hence, loss of material due to pitting corrosion in stainless steel is an aging effect requiring management. The DSC steel subcomponents located inside the DSC cavity are in an inert environment and are not subject to pitting corrosion.

Galvanic Corrosion

Galvanic corrosion occurs when two or more metals of differing electrochemical potential are in electrical contact in a conductive fluid (the presence of an electrolyte). Under these conditions, an electrolytic cell is formed transmitting an electrical current between an anode and a cathode. Loss of material occurs when ions of the metal with the lower potential, the anode, are being depleted and deposited onto the more noble metal, the cathode. Galvanic corrosion will not occur in a dry environment; an electrolyte must be present and remain liquid. The ratio between surface areas of the metals in contact is of significant importance. Corrosion rates increase when the more noble metal has a greater surface area than the more active metal in the presence of moisture and water [3-33].

One instance of the DSC components coming in contact with dissimilar materials that are exposed to the sheltered environment inside the HSM is the graphite lubricant used on the DSC support structure rail faces. Because the graphite lubricant is noble relative to the rail face and the canister shell, this could induce galvanic corrosion of the DSC shell. Even though there is no reported operating experience of stainless steel degradation where a graphite lubricant film causes galvanic corrosion, loss of material due to galvanic corrosion of the DSC stainless steel shell is an aging effect requiring management in a sheltered environment.

Stress Corrosion Cracking

SCC is a localized non-ductile cracking failure resulting from an unfavorable combination of sustained tensile stresses, material condition, and the presence of a corrosive environment. SCC is a phenomenon that occurs in austenitic stainless steels, but becomes significant only if tensile stress and a corrosive environment exist. In most cases, SCC involves crack initiation, subcritical crack growth, and failure when the crack reaches a critical size and the tensile strength of the remaining material is exceeded. In terms of corrosive environment, dissolved oxygen, sulfates, fluorides, and chlorides can provide the necessary environment for SCC to occur [3-33].

Based on the NUHOMS® System OE history and other generic industry experience presented in Section 3.2, objective evidence does not exist to exclude SCC as an active aging mechanism. Therefore, this aging mechanism is potentially operative on the external surface of the stainless steel DSC shell assembly; hence, loss of material due to SCC in stainless steel is an aging effect requiring management.

Note: SCC, when initiated by chlorides as the corrosive environment, or CISCC, is a site-specific aging mechanism, which has been evaluated separately for the Rancho Seco ISFSI in the next section.

Chloride Induced Stress Corrosion Cracking

Operating experience, documented in NRC Information Notice 2012-20 [3-10], has shown that austenitic stainless steels under tensile stresses are known to be susceptible to SCC when exposed to chlorides in the environment. A literature survey revealed failures attributed to CISCC in the types of austenitic stainless steels typically used in dry cask storage canisters when these materials are exposed to atmospheric conditions near saltwater bodies. This phenomenon is of concern at temperature and relative humidity combinations that allow the chloride compounds to deliquesce. It is understood that airborne salts could deposit on the material surface, then form chloride-rich deliquescent brines in conditions of high relative humidity. Laboratory data suggest that CISCC is of particular concern as the canister surface temperature decreases to the level where salt will deliquesce.

Airborne chloride salts (from the seawater or other chloride sources, such as salted-roads due to use of deicing salts or effluents from cooling tower water) may enter the HSM interior, via the HSM external vents, and deposit and accumulate on the canister surface. The moisture or aqueous environment required to support the electrochemical reactions associated with CISCC can result from deliquescence of the salts, wherein dry salt absorbs moisture from the air to form a saturated solution. ISFSIs located in coastal regions near the ocean may be subjected to airborne chloride salts generated by the surf action (splashing water) on the sea shore and/or by the whitecaps on the open sea and transported inland by wind action.

Initiation of CISCC for austenitic stainless steels is affected by three major environmental parameters, including canister surface temperature, relative humidity, and chloride salt concentration deposited on the canister surface.

A susceptibility evaluation, Calculation 502917-AMR03, Revision 0, “Rancho Seco ISFSI Site Chloride-Induced Stress Corrosion Cracking Susceptibility Ranking” [3-63], has been performed for the Rancho Seco ISFSI in accordance with the methodology described in EPRI Report 3002005371, Susceptibility Assessment Criteria for Chloride-Induced Stress Corrosion Cracking (CISCC) of Welded Stainless Steel Canisters for Dry Cask Storage Systems [3-62] to determine the CISCC susceptibility ranking at the Rancho Seco site.

The results of this susceptibility evaluation show that the Rancho Seco ISFSI has a CISCC susceptibility ranking of “2.” This is a relatively low ranking on the scale of 1-10, with “10” being the most susceptible to CISCC affects. This low ranking means that the potential for deposition of chloride aerosols on the DSC surface at the Rancho Seco ISFSI is very low. This conclusion is further supported by the laboratory results of surrogate Cl^- samples taken from the Auxiliary and Turbine buildings described in Section 3.2.4.4. In addition, no evidence of aging-related degradation was observed during the pre-application inspection of a HSM interior as discussed in Section 3.2.4.2.

Based on the results of the susceptibility evaluation [3-63], the potential for CISCC on the external surface of the Rancho Seco DSC shell assembly is minimal. Therefore, cracking due to CISCC is *not an aging effect requiring management*.

Gamma Radiation Effects on Canister Corrosion

The interaction of gamma radiation with the water adsorbed in the hygroscopic salts on the canister surface can generate radiolytic oxidizing products (e.g., hydrogen peroxide, nitric acid) via radiolysis of the water and moisture. As radiolytic products are generally oxidizing in electrochemistry, the corrosion process of the stainless steel canister could be affected by gamma radiation. Of more importance with stainless steel could be the possibility of radiation-induced localized corrosion including pitting corrosion, crevice corrosion, and SCC of the stainless steel canister during storage. [

] As a result, gamma radiolysis of water on the canister surface and its effect on canister SCC and crevice corrosion will be managed by managing the aging effects due to pitting corrosion, crevice corrosion, and SCC.

Thermal Fatigue

Thermal fatigue is the progressive and localized structural damage that occurs when a material is subjected to cyclic loading associated with thermal cycling. The only source of potential thermal fatigue of the DSC is ambient seasonal and daily temperature fluctuation. The DSC does not experience the full amplitude of ambient temperature cycles, and a gradual, long-term temperature decrease occurs during the course of storage. The seasonal and daily variations in ambient conditions are ameliorated by the thermal mass of the HSM.

Appendix A documents the evaluation of the DSC *pressure boundary subcomponents* for pressure and temperature fluctuations in accordance with the provisions of NB 3222.4(d) of the ASME B&PV Code, Section III, Division 1, 1992 Edition, with Addenda through 1993 [3-14]. As provided by NB 3222.4(d) of the ASME B&PV Code, fatigue effects need not be specifically evaluated provided the six criteria in NB 3222.4(d) are met. This TLAA is performed considering a 60-year service life using maximum initial DSC pressures (bounding for all DSC types) and temperatures at the beginning of storage, and assumes that the maximum pressures and temperatures do not decrease over time, but may fluctuate due to ambient condition changes. The TLAA shows that all the six criteria of NB 3222.4(d) are met. Therefore, cracking *of the DSC pressure boundary subcomponents due to thermal fatigue is an aging effect managed via a TLAA*.

Thermal Aging

The maximum temperatures of the DSC internals (basket components) are limited by the cladding temperature limit at the beginning of storage (e.g., 379 °C (714 °F) [3-15]). The DSC subcomponent initial material temperatures for normal conditions of storage were shown to be within the temperature limits allowed by the ASME B&PV Code (for Code materials) or were evaluated to show they can perform their safety function (for non-Code materials, such as neutron absorber materials).

[ ]

The maximum basket temperature in the Rancho Seco ISFSI FSAR, at the beginning of storage, for normal conditions of storage is 714 °F (379 °C) [3-15, Volume II, Table 8-5). [

] the basket stainless steel welds have adequate fracture toughness with sufficient margin and remain within the range required for ferritic materials by the ASME B&PV Code. Furthermore, basket component stresses are not affected by thermal aging because, as reported in the above references, thermal aging has little or no change on tensile strength properties.

NUREG/CR-6745, Dry Cask Storage Characterization Project-Phase 1: CASTOR V/21 Cask Opening and Examination [3-42] provides additional substantiation of the performance of stainless steel welds subjected to thermal aging. NUREG/CR-6745 [3-42] documents results of inspection of the CASTOR V/21 cask interior, including the internal basket. The CASTOR V/21 basket is fabricated from welded stainless steel. The purpose of the examination was to inspect for evidence of basket degradation caused by long-term storage (from 1985 to 1999). The peak cladding temperature at the beginning of long-term storage was 344 °C (651 °F) and reached 415 °C (779 °F) for a short time period during the initial heat transfer performance tests. The 1999 inspections performed after long-term storage found no evidence of welds degradation due to thermal aging.

Based on the above justifications, thermal aging embrittlement of the fuel basket welds is not expected to affect the safety function or performance of the basket structure.

As noted in the table below, the bounding maximum temperature of the DSC shell is 423 °F (217 °C) at the beginning of storage.

DSC Type	Ambient Temp (°F)	DSC Shell Temp (°F)	ISFSI FSAR, Volume II [3-15]
24P (FO & FC-DSCs)(1)	70	305	Table 8-5
	117	423	Table 8-5

(1) The FF-DSC and the GTCC DSC have much lower decay heats than FO/FC DSCs and will therefore have lower temperatures than the values shown above.

This temperature is significantly below the embrittlement saturation temperature of 400 °C (752 °F) in NUREG/CR-6428 [3-46]. It is also below the lower 335 °C (635 °F) temperature in the “Low temperature thermal aging embrittlement of austenitic stainless steel welds and its electrochemical assessment,” [3-47] and “Low temperature thermal aging embrittlement of austenitic stainless steel welds,” [3-48] tests. Also, in accordance with NUREG-1801, Revision 2, Final Report – Generic Aging Lessons Learned (GALL) [3-12], austenitic steels with service temperature below 482 °F (250 °C) are not susceptible to thermal aging embrittlement. This threshold essentially corresponds to the maximum DSC shell temperature of 423 °F (217 °C).

Therefore, change in material properties due to *thermal aging* (loss of fracture toughness due to thermal aging embrittlement) is not an aging effect requiring management in the PEO for the DSC shell steel components.

Irradiation Embrittlement

High neutron radiation can cause loss of fracture toughness in steel (i.e., increases in the nil-ductility temperature). However, as demonstrated in *the supplemental analysis in* Appendix A, the neutron fluence seen by the metal components of dry fuel storage systems is generally orders of magnitude lower than that required to produce any significant effect. Hence, neutron radiation is unlikely to be a significant aging effect for the steel components. Gamma radiation does not have any significant impact on the properties of steel. *Therefore, change in material properties due to irradiation embrittlement is not an aging effect requiring management in the PEO for the DSC carbon and stainless steel components.*

Creep

Creep is a time-dependent strain (deformation) in metals occurring under constant load at constant temperature. There are three stages of creep during which the shear and elastic moduli of the material decrease and the Poisson ratio increases. An increase in either stress or temperature accelerates creep. If stress or temperature is increased beyond certain levels, the increased deformation can eventually result in failure.

Metallic materials are generally considered to be subject to creep under conditions of extended exposure to stress and temperature in excess of a homologous temperature of $0.4T_m$, where T_m is melting point in degree Kelvin. For steel, with a melting point of 1516 °C (2760 °F) or 1789 K, temperatures of at least 716 K or 443 °C (829 °F) are required to initiate creep. For austenitic stainless steel, with a melting point of 1425 °C (2597 °F) or 1698 K, temperatures of at least 679 K or 406 °C (763 °F) are required to initiate creep. The maximum temperatures of the DSC basket components are limited by the cladding temperature limit at the beginning of storage (e.g., 379 °C (714 °F) [3-1]. Hence, creep is not an aging mechanism requiring management for the steel and stainless steel subcomponents in the DSC during the PEO.

For aluminum (Al) alloys, this translates to a temperature of approximately 100 °C (212 °F). Hence, the only material of interest for assessment of degradation due to creep is aluminum. The DSC assembly does not contain any aluminum subcomponents, other than BORAL® neutron absorber plates, which are provided for criticality control. BORAL® consists of a core of uniformly distributed boron carbide and aluminum alloy particles sandwiched between a surface cladding of aluminum alloy on both sides of the core. As discussed in Section 3.4.2.5 of the MAPS Report [3-68], since the neutron poison plates do not serve a structural function and are not expected to be under loads other than their own weight. Hence, the impact of creep on the criticality control function of BORAL® is not credible, so creep is not an aging effect requiring management for the DSC.

3.4.4.3 Neutron Absorber Materials Evaluation

Only the Rancho Seco FO and FC DSCs contain fixed BORAL® neutron absorber plates, per Rancho Seco ISFSI FSAR, Volume I, Chapter 3 [3-15]. The safety analyses do not rely upon the mechanical strength of the neutron absorber materials. The performance of the neutron absorber's design function is ensured only by the presence of B-10 and the uniformity of its distribution, which are verified with testing requirements specific to each material.

Appendix A determines the amount of B-10 depleted in the poison plates due to neutron irradiation during 100 years of storage. Although the license renewal period is 40 years, this evaluation takes into account the initial 20 years and an additional 80 years of storage, for a total of 100 years. The evaluation considers a bounding neutron irradiation rate with the least amount of B-10 content available in poison plates and computes the reaction rate density. The evaluation shows that a negligible amount of B-10 in the poison plates is depleted after 100 years of irradiation. The result of this TLAA demonstrates that the ability of the BORAL® neutron absorber plates to maintain sub-criticality remains unaffected over the desired duration of storage. *Therefore, loss of criticality control due to boron depletion is an aging effect managed via a TLAA*.

3.4.4.4 Coating Evaluation

There are no coatings applied to the DSC shell assembly external surfaces (exposed to the HSM sheltered environment). Carbon steel subcomponents that are part of the DSC shell assembly (e.g., A36 shield plugs, lead shield plug casing plates and the spacer discs) that are not sealed by other materials are coated with electroless nickel. This coating was intended to mitigate corrosion during loading/unloading operations when the DSC is in the spent fuel pool. The nickel coating limited rust contamination of the pool water, but does not perform any important to safety dry storage function. *While the DSC is in storage within an HSM, the electroless nickel coatings are not exposed to water. Therefore, the* nickel *is* not subject to a corrosive environment during the PEO and no aging management is required for the electroless nickel coatings within the DSC.

3.4.4.5 Temporary Attachment Evaluation

DSC fabrication is in accordance with ASME B&PV Code Section III NB-4000 [3-14]. Welding of any temporary attachments and their removal is per NB-4435, which requires examination of the base metal by liquid penetrant or magnetic particle method in accordance with NB-5110 after the temporary attachment is removed. The acceptance criteria of NB-5340 or NB-5350, whichever is applicable, ensure that the restored surface is free of any relevant indications.

The concern about temporary attachment welds is attributed to thermal sensitization and residual stresses resulting from initial welding of the temporary attachment and high local surface temperatures that can occur at the abrasive-to-surface interface during removal of the temporary attachments via grinding. Although the local temperature can be above the sensitization range at the location of the weld, the heat affected zone (HAZ) is limited to approximately a 0.125-inch depth, which is much less than the seam welds that extend through the thickness. Thus, when the seam welds are determined to be acceptable, the suitability of all temporary attachments also is demonstrated.

Regarding the effects of grinding as compared to welding, the relatively low peak heat input limits the opportunity for carbide precipitation to occur. The depth of the grinding HAZ, generally less than 0.03 inch [3-55] is substantially less than the temporary attachment weld and relative to the nominal thickness of the DSC shell (0.625 inch). The tensile stress field required to promote SCC would result from the heat of welding and/or grinding, causing brief local compressive yielding of the substrate at and immediately beneath the component's surface, which would revert to tensile stress once the material returns to ambient temperature. These tensile stresses would be confined to a very narrow near-surface region of the DSC shell thickness. Even considering that crack initiation could occur, any local cracking would be arrested at a very shallow depth.

Since the welding and removal of temporary attachments is performed per the provisions of the ASME B&PV Code, which includes examinations to demonstrate no relevant indications on the shell surface, and because such cracking, if it did occur, would not propagate to sufficient depth to compromise the performance of the confinement boundary, there is a low risk that SCC of significant depth will occur at these locations. Furthermore, ASME B&PV Code, Section XI excludes temporary attachments from periodic inspection, as specified in Table IWE-2500-1. Therefore, it is not necessary to search for temporary attachment locations specifically for inspection.

3.4.4.6 Summary of Applicable Aging Effects Requiring Management for DSCs

The following aging effects and mechanisms are applicable for DSC steel components:

Loss of Material

- Loss of material due to crevice corrosion – stainless steel
- Loss of material due to pitting corrosion – stainless steel
- Loss of material due to galvanic corrosion – Nitronic® 60 rail plate and graphite lubricant

Cracking

- Cracking due to radiation induced stress corrosion cracking – stainless steel
- *Cracking due to thermal fatigue – stainless steel DSC pressure boundary*

Loss of Criticality Control

- *Loss of criticality control due to boron depletion – Boral*

3.4.5 Aging Management Activities for DSCs

This section describes the AMAs resulting from the AMR. Those areas of the AMR that can be addressed by TLAAs are addressed in Section 3.4.5.1. Section 3.4.5.2 describes the AMPs that are focused on the examination of the external surfaces of the DSC. The basket internal components are not subject to degradation as they are maintained in an inert gas environment. This was confirmed by a demonstration project documented in NUREG/CR-6745 [3-42] and EPRI Report 1002882, Dry Cask Storage Characterization Project, Final Report, Electric Power Research Institute [3-34], which was conducted to provide the basis for ensuring that the internals are not degrading to unacceptable levels during the extended storage period.

3.4.5.1 DSC TLAAs

The following are summary descriptions of the TLAAs that were identified and prepared based on the AMR of the DSC:

A. Fatigue Evaluation of the DSCs (see Appendix A)

This TLAA documents the evaluation of the DSC *pressure boundary subcomponents* for pressure and temperature fluctuations in accordance with the provisions of NB 3222.4(d) of the ASME B&PV Code [3-14]. As provided by NB 3222.4(d) of the ASME B&PV Code, fatigue effects need not be specifically evaluated provided the six criteria in NB 3222.4(d) are met. This evaluation is performed considering a 60-year service life using maximum bounding initial DSC pressures and temperatures (at the beginning of storage). This evaluation shows that the six criteria of NB 3222.4(d) are met.

B. Boron Depletion

This TLAA is performed to determine the amount of boron depletion in the FO and FC DSC poison plates during the PEO. Although the license renewal period is for 40 years, this evaluation takes into account the initial 20 years of storage period and an additional 80 years of storage period, for a total of 100 years.

The evaluation considers a bounding neutron irradiation rate with the least amount of B-10 content available in the poison plates and computes the reaction rate density. The evaluation shows that the depleted amount of B-10 is negligible.

3.4.5.2 DSC Aging Management Programs

The DSC External Surfaces AMP, described in Appendix B.3, is employed to manage the aging effects and mechanisms for the DSC.

The scope of the DSC AMP, parameters to be monitored and the criteria for selecting a DSC for the AMP are described in Appendix B.3, Section B.3.5. Rancho Seco will implement the first (baseline) DSC inspections under this AMP on the selected DSCs in accordance with the program schedule as described in Appendix B.3, Section B.3.5.

3.4.6 Summary of the AMR Results for the DSCs

Table 3-3, Table 3-4, Table 3-5 and Table 3-6 summarize the results of the AMR for the FO, FC, FF and GTCC DSC respectively.

Table 3-2
FO, FC FF and GTCC DSC Materials

SSC	DSC Shell Assembly Subcomponents	Material
FO, FC and FF DSC	Cylindrical shell, inner and outer top cover plates, inner and outer bottom cover plates, grapple ring, grapple ring support, siphon and vent block, siphon and vent cover plates, support ring, lifting lugs, reinforcing pads, and other miscellaneous parts.	Stainless steel
FO DSC	Top and bottom shield plugs	Carbon steel (coated with electroless nickel, unless encased)
FC DSC	Top and bottom shield plug assemblies	Lead shield plug with stainless steel casing (bottom shield plug assembly) Lead shield plug with carbon steel casing (top shield plug assembly)
SSC	**Basket Assembly Subcomponents**	**Material**
FO, FC, and FF DSC	Spacer discs, support rods, support plates	Carbon steel coated with electroless nickel
	Guidesleeves, oversleeves, spacer sleeves, FF Can	Stainless steel
	Neutron absorber plates	Boral® (Except FF-DSC)

SSC	GTCC Shell Assembly Subcomponents	Material
GTCC DSC	Cylindrical shell, outer top and bottom cover plate, bottom shield plug, grapple ring and grapple ring support.	Stainless steel
	siphon and vent port cover plates, top shield plug	Carbon steel (coated with electroless nickel)
	Basket Assembly Subcomponents	**Material**
	Perforated basket shell, lifting lugs, siphon tube	Carbon steel (coated with electroless nickel)

Table 3-3
Rancho Seco FO-DSC Intended Functions and AMR Results
(2 pages)

Subcomponent(2)	Subcomponent Parts(2)	Intended Function(1)(2)	Environment	Aging Effects Requiring Management	Aging Management Activity
Main Assembly	Cylindrical Shell	PB, SH, SS, HT, RE	Inert Gas / Sheltered	Loss of Material, Cracking	AMP, *TLAA*
Main Assembly	Outer Bottom Cover	SH, SS, RE	Sheltered / Embedded	Loss of Material, Cracking	AMP
Main Assembly	Grapple Ring	SS, RE	Sheltered	Loss of Material, Cracking	AMP
Main Assembly	Grapple Ring Support	SS, RE	Sheltered	Loss of Material, Cracking	AMP
Main Assembly	Inner Bottom Cover	PB, SH, SS	Inert Gas / Embedded	*Cracking*	*TLAA*
Main Assembly	Spacer Discs (Type “A” “B” and Type “C”)	CC, SS	Inert Gas	None Identified	None Required
Main Assembly	Guide sleeve	CC, SS, HT	Inert Gas	None Identified	None Required
Main Assembly	Oversleeve	CC, SS, HT	Inert Gas	None Identified	None Required
Main Assembly	Neutron Absorber Sheet	CC, HT	Inert Gas	*Loss of Criticality Control*	*TLAA*
Main Assembly	Support Rod	CC, SS	Inert Gas	None Identified	None Required
Main Assembly	Shear Key	SS, RE	Inert Gas	None Identified	None Required
Main Assembly	Extension Plate	CC, SS, HT	Inert Gas	None Identified	None Required
Main Assembly	Key	SS	Inert Gas	None Identified	None Required
Main Assembly	Siphon & Vent Block	PB, SH, SS	Inert Gas	*Cracking*	*TLAA*
Main Assembly	Lifting Lug	SS	Inert Gas	None Identified	None Required
Main Assembly	Support Ring	SS	Inert Gas	None Identified	None Required

Table 3-3
Rancho Seco FO-DSC Intended Functions and AMR Results
(2 pages)

Subcomponent[(2)]	Subcomponent Parts[(2)]			Intended Function[(1)(2)]	Environment	Aging Effects Requiring Management	Aging Management Activity
Main Assembly	Top Shield Plug			SH, SS	Inert Gas	None Identified	None Required
Main Assembly	Bottom Shield Plug			SH, SS	Embedded	None Identified	None Required
Main Assembly	Inner Top Cover Plate			PB, SH, SS	Embedded / Inert Gas	*Cracking*	*TLAA*
Main Assembly	Outer Top Cover Plate			PB, SH, SS, RE	Embedded / Sheltered	Loss of Material, Cracking	AMP, *TLAA*
Main Assembly	Siphon & Vent Port Cover Plate			PB, SH, SS, HT	Inert Gas / Embedded	*Cracking*	*TLAA*
Main Assembly	Top and Bottom End Spacer Sleeve			CC, SS	Inert Gas	None Identified	None Required
Main Assembly	Spacer Sleeves (Type 1, 2, 3, 4, 5, 6)			CC, SS	Inert Gas	None Identified	None Required
Main Assembly	Stop Plate			SS	Inert Gas	None Identified	None Required
Main Assembly	Plate 0.085 Thk			SS	Inert Gas	None Identified	None Required

Notes:

(1) Abbreviations for Intended Function Column:

PB - Directly or indirectly maintains a pressure boundary (confinement)
SH - Provides radiation shielding
CC - Provides criticality control of spent fuel
SS - Provides structural support
HT - Provides heat transfer
RE - Retrievability

(2) Only in-scope subcomponents from Chapter 2, Table 2-6 are listed in this table.

Table 3-4
Rancho Seco FC-DSC Intended Functions and AMR Results
(3 pages)

Subcomponent[(2)]	Subcomponent Parts[(2)]	Intended Function[(1)(2)]	Environment	Aging Effects Requiring Management	Aging Management Activity
Main Assembly	Cylindrical Shell	PB, SH, SS, HT, RE	Inert Gas / Sheltered	Loss of Material, Cracking	AMP, *TLAA*
Main Assembly	Outer Bottom Cover	SH, SS, RE	Sheltered / Embedded	Loss of Material, Cracking	AMP
Main Assembly	Lead Shielding	SH	Embedded / Encased	None Identified	None Required
Main Assembly	Grapple Ring	SS, RE	Sheltered	Loss of Material, Cracking	AMP
Main Assembly	Grapple Ring Support	SS, RE	Sheltered	Loss of Material, Cracking	AMP
Main Assembly	Inner Bottom Cover	PB, SH, SS	Inert Gas / Embedded	*Cracking*	*TLAA*
Main Assembly	Bottom Plug Post	SS	Inert Gas	None Identified	None Required
Main Assembly	Spacer Discs (Type “A” “B” and Type “C”)	CC, SS	Inert Gas	None Identified	None Required
Main Assembly	Guide sleeve	CC, SS, HT	Inert Gas	None Identified	None Required
Main Assembly	Oversleeve	CC, SS, HT	Inert Gas	None Identified	None Required
Main Assembly	Neutron Absorber Sheet	CC, HT	Inert Gas	*Loss of Criticality Control*	*TLAA*
Main Assembly	Support Rod	CC, SS	Inert Gas	None Identified	None Required
Main Assembly	Shear Key	SS, RE	Inert Gas	None Identified	None Required
Main Assembly	Extension Plate	CC, SS, HT	Inert Gas	None Identified	None Required
Main Assembly	Key	SS	Inert Gas	None Identified	None Required
Main Assembly	Siphon & Vent Block	PB, SH, SS	Inert Gas	*Cracking*	*TLAA*

Table 3-4
Rancho Seco FC-DSC Intended Functions and AMR Results
(3 pages)

Subcomponent[2]	Subcomponent Parts[2]			Intended Function[1] [2]	Environment	Aging Effects Requiring Management	Aging Management Activity
Main Assembly	Lifting Lug			SS	Inert Gas	None Identified	None Required
Main Assembly	Support Ring			SS	Inert Gas	None Identified	None Required
Main Assembly	Inner Top Cover Plate			PB, SH, SS	Embedded / Inert Gas	*Cracking*	*TLAA*
Main Assembly	Outer Top Cover Plate			PB, SH, SS, RE	Embedded / Sheltered	Loss of Material, Cracking	AMP, *TLAA*
Main Assembly	Siphon & Vent Port Cover Plate			PB, SH, SS, HT	Inert Gas / Embedded	*Cracking*	*TLAA*
Main Assembly	Top Shield Plug Casing			SH, SS	Inert Gas / Embedded	None Identified	None Required
Main Assembly	Top Shield Plug Post			SS	Embedded	None Identified	None Required
Main Assembly	Plate Stiffening			SS	Embedded	None Identified	None Required
Main Assembly	Top and Bottom End Spacer Sleeve			CC, SS	Inert Gas	None Identified	None Required
Main Assembly	Spacer Sleeves (Type 1, 2, 3, 4, 5, 6)			CC, SS	Inert Gas	None Identified	None Required
Main Assembly	Angle, 1-1/4 x 1-1/4 x ¼			SS	Inert Gas	None Identified	None Required
Main Assembly	Plate 1.25x1.25 x ¼			SS	Inert Gas	None Identified	None Required
Main Assembly	Stop Plate			SS	Inert Gas	None Identified	None Required
Main Assembly	Plate 0.085 Thk			SS	Inert Gas	None Identified	None Required

Table 3-4
Rancho Seco FC-DSC Intended Functions and AMR Results
(3 pages)

Subcomponent[2]	**Subcomponent Parts**[2]		**Intended Function**[1][2]	**Environment**	**Aging Effects Requiring Management**	**Aging Management Activity**
Main Assembly	Bottom Plug Top and Side Casing		SH, SS	Embedded	None Identified	None Required
Main Assembly	Plate Stiffening		SS	Embedded	None Identified	None Required

Notes:

(1) Abbreviations for Intended Function Column:

PB - Directly or indirectly maintains a pressure boundary (confinement)
SH - Provides radiation shielding
CC - Provides criticality control of spent fuel
SS - Provides structural support
HT - Provides heat transfer
RE - Retrievability

(2) Only in-scope subcomponents from Chapter 2, Table 2-6 are listed in this table.

Table 3-5
Rancho Seco FF-DSC Intended Functions and AMR Results
(3 pages)

Subcomponent[2]	Subcomponent Parts[2]	Intended Function[1] [2]	Environment	Aging Effects Requiring Management	Aging Management Activity
Main Assembly	Cylindrical Shell	PB, SH, SS, HT, RE	Inert Gas / Sheltered	Loss of Material, Cracking	AMP, *TLAA*
Main Assembly	Outer Bottom Cover	SH, SS, RE	Sheltered / Embedded	Loss of Material, Cracking	AMP
Main Assembly	Key	SS	Inert Gas	None Identified	None Required
Main Assembly	Grapple Ring	SS, RE	Sheltered	Loss of Material, Cracking	AMP
Main Assembly	Grapple Ring Support	SS, RE	Sheltered	Loss of Material, Cracking	AMP
Main Assembly	Inner Bottom Cover	PB, SH, SS	Inert Gas / Embedded	*Cracking*	*TLAA*
Main Assembly	Spacer Discs	CC, SS	Inert Gas	None Identified	None Required
Main Assembly	Inner and Outer Support Plate	SS	Inert Gas	None Identified	None Required
Main Assembly	Lead Shielding	SH	Embedded / Encased	None Identified	None Required
Main Assembly	Bottom Plug Post	SS	Embedded	None Identified	None Required
Main Assembly	Siphon & Vent Block	PB, SH, SS, HT	Inert Gas	*Cracking*	*TLAA*
Main Assembly	Lifting Lug	SS	Inert Gas	None Identified	None Required
Main Assembly	Support Ring	SS	Inert Gas	None Identified	None Required
Main Assembly	Inner Top Cover Plate	PB, SH, SS	Embedded / Inert Gas	*Cracking*	*TLAA*
Main Assembly	Outer Top Cover Plate	PB, SH, SS, RE	Embedded / Sheltered	Loss of Material, Cracking	AMP, *TLAA*

Table 3-5
Rancho Seco FF-DSC Intended Functions and AMR Results
(3 pages)

Subcomponent[2]	Subcomponent Parts[2]	Intended Function[1] [2]	Environment	Aging Effects Requiring Management	Aging Management Activity
Main Assembly	Siphon & Vent Port Cover Plate	PB, SH, SS, HT	Inert Gas / Embedded	*Cracking*	*TLAA*
Main Assembly	Top Shield Plug Casing	SH, SS	Inert Gas Embedded	None Identified	None Required
Main Assembly	Top Shield Plug Post	SS	Embedded	None Identified	None Required
Main Assembly	Liner	PB, SS	Inert Gas	None Identified	None Required
Main Assembly	Flange Plate	PB, SS	Inert Gas	None Identified	None Required
Main Assembly	Shear Key	SS, RE	Sheltered	Loss of Material, Cracking	AMP
Main Assembly	Top Lid Cover Plate	PB, SS	Inert Gas	None Identified	None Required
Main Assembly	Bottom Lid Adapter Plate	PB, SS	Inert Gas	None Identified	None Required
Main Assembly	Top Lid Lifting Pintle	SS	Inert Gas	None Identified	None Required
Main Assembly	Mesh, 6x6	SS	Inert Gas	None Identified	None Required
Main Assembly	Washer Plate	SS	Inert Gas	None Identified	None Required
Main Assembly	Spacer Bar	SS	Inert Gas	None Identified	None Required
Main Assembly	Cover Plate	SS	Inert Gas	None Identified	None Required
Main Assembly	Side Lid Plate	SS	Inert Gas	None Identified	None Required
Main Assembly	Bottom Plug Top and Side Casing	SH, SS	Embedded	None Identified	None Required
Main Assembly	Plate Stiffening	SS	Embedded	None Identified	None Required

Table 3-5
Rancho Seco FF-DSC Intended Functions and AMR Results
(3 pages)

Subcomponent(2)	Subcomponent Parts(2)	[	]	Intended Function(1)(2)	Environment	Aging Effects Requiring Management	Aging Management Activity
Main Assembly	Plate Stiffening			SS	Embedded	None Identified	None Required

Notes:

(1) Abbreviations for Intended Function Column:

PB - Directly or indirectly maintains a pressure boundary (confinement)
SH - Provides radiation shielding
CC - Provides criticality control of spent fuel
SS - Provides structural support
HT - Provides heat transfer
RE - Retrievability

(2) Only in-scope subcomponents from Chapter 2, Table 2-6 are listed in this table.

Table 3-6
Rancho Seco GTCC DSC Intended Functions and AMR Results

Subcomponent[2]	Subcomponent Parts[2]	Intended Function[1] [2]	Environment	Aging Effects Requiring Management	Aging Management Activity
Main Assembly	Cylindrical Shell	PB, SH, SS, RE	Inert Gas / Sheltered	Loss of Material, Cracking	AMP, *TLAA*
Main Assembly	Bottom Shield Plug	SH	Embedded / Inert Gas / Sheltered	Loss of Material, Cracking	AMP
Main Assembly	Grapple Ring	SS, RE	Sheltered	Loss of Material, Cracking	AMP
Main Assembly	Grapple Ring Support	SS, RE	Sheltered	Loss of Material, Cracking	AMP
Main Assembly	Top Shield Plug	SH	Embedded (Inert Gas	None Identified	None Required
Main Assembly	Outer Top Cover Plate	PB, SH, SS, RE	Sheltered / Embedded	Loss of Material, Cracking	AMP
Main Assembly	Outer Bottom Cover Plate	SH, SS, RE	Sheltered / Embedded	Loss of Material, Cracking	AMP
Main Assembly	Siphon & Vent Port Cover Plate	PB, SH, SS	Inert Gas / Embedded	*Cracking*	*TLAA*

Notes:

(1) Abbreviations for Intended Function Column:

PB - Directly or indirectly maintains a pressure boundary (confinement)
SH - Provides radiation shielding
CC - Provides criticality control of spent fuel
SS - Provides structural support
HT - Provides heat transfer
RE - Retrievability

(2) Only in-scope subcomponents from Chapter 2, Table 2-6 are listed in this table.

3.5 Aging Management Review Results – HSM

This section summarizes the results of the AMR of the in-scope subcomponents of the Rancho Seco HSMs. The in-scope HSM subcomponents and their intended functions are summarized in the scoping evaluation Table 2-7, Chapter 2.

The evaluation boundary for the HSM includes the entire HSM concrete structure and the steel support structure for the DSCs which perform the following intended functions (MAPS designations in parentheses, if different):

- HT (TH) Provides heat transfer
- SH Provides radiation shielding
- SS (SR) Provides structural support (structural integrity)
- RE Provides retrievability of the DSCs

3.5.1 Description of HSM Subcomponents

The HSM is a prefabricated, modular, reinforced concrete structure whose primary functions are to provide a means for spent fuel decay heat removal, to provide structural support and environmental protection to the loaded DSC, and to provide radiation shielding protection.

At the Rancho Seco ISFSI, the HSMs are installed in a double side-by-side and back-to-back array, which eliminates the need for the rear shield walls. The HSM consists of two separate reinforced concrete units (a base and roof), and an internal steel structure assembly that is used to slide the DSC into and out of the HSM, which also supports the DSC during storage. Other HSM subcomponents include the door, heat shields, axial retainer, and the vent screens. Thick shield walls placed at the end of the HSM array for additional shielding and environmental protection complete the HSM installed configuration.

The base of the HSM has a bottom floor integral with walls to form the base unit. The DSC support structure is a steel frame structure anchored to the side walls and to the bottom floor of the HSM. The inlet and outlet vents are located in each side of the HSM, at the bottom and top of the base unit, respectively. The HSMs are installed adjacent to each other with a 6-inch space between them to permit ventilation air flow. The HSM is licensed to store DSCs with heat loads up to 13.5 kW.

A general description of the HSM subcomponents follows:

Concrete Walls and Roof

The HSM is a reinforced concrete structure consisting of a base unit and a roof unit. The base unit, which resists loads by frame and shear wall action, and the roof, which is keyed to and connected to the base unit, form the load-resisting structural system. The end shield walls provide additional impact resistance. The HSM walls, roof slab, and end shield wall thicknesses are established on the basis of radiological shielding requirements.

DSC Support Structure Assembly

Structural support of the loaded DSC is provided by a DSC support structure assembly composed of two longitudinal support beams that extend approximately the full length of the HSM module. For the HSM, the longitudinal beams are supported on the front, rear and mid-span by a steel frame structure that includes three crossbeams and six support legs anchored to the floor slab and to the side walls of the HSM. The steel support structure is made of ASTM A36 and ASTM A500 Grade B carbon steel coated with an inorganic zinc-rich primer and a high build epoxy enamel finish.

Stainless steel rail faces (Nitronic® 60) are welded to the longitudinal support beams to provide a sliding surface for the DSC. Nitronic® 60 is selected for its galvanic compatibility with the DSC shell material, and for its resistance to galling. The sliding surface of the DSC support rails is coated with a dry film graphite lubricant.

Heat Shields

Metal sheets are provided between the DSC and the HSM concrete to mitigate high concrete temperatures and prevent concrete degradation due to design basis thermal conditions. The heat shields are anchored to the HSM ceiling and interior side walls.

The heat shields are fabricated from hot-dipped galvanized carbon steel. The heat shield is composed of formed and slotted sheets, which are mounted to the ceiling and interior side walls with stand-off embedment anchors.

Ventilation System

Heat removal is achieved by a combination of radiation, conduction and convection. Ambient air enters the interior of the HSM through two ventilation inlet openings located in the lower region of each side wall and circulates in the interior HSM cavity around the DSC. Air exits through two outlet openings located in the top regions of each HSM side wall. The HSM gap between the adjacent modules is covered with stainless steel wire screens to prevent pests or other foreign material from entering the HSM. This passive system provides an effective means for spent fuel decay heat removal. Thermal monitoring and visual inspection is used to provide indication of a blocked vent condition.

HSM Door

Each HSM has an access opening in the front wall to accommodate transfer of DSCs from and into the TC. The access opening is covered by a thick shielded access door.

Cask Restraint System

Cask restraint attachment threads are embedded in the front face of each HSM to provide restraint of the TC during DSC insertion and retrieval operations.

DSC Axial Retainer Assembly

A DSC Axial Retainer Assembly restricts axial sliding of the DSC during seismic events. After insertion of the DSC, a removable DSC Axial Retainer Assembly consisting of a rod is installed through a hole in the HSM door. The rod is welded to a plate, which is bolted onto the HSM door exterior.

Anchorage and Embedments

Anchorages and embedments are the steel members, studs, etc., that are embedded in concrete. These anchors also have an exposed surface above the concrete.

3.5.1.1 Excluded Subcomponents

Dry Lubricant

The DSC support rails are coated with a dry film graphite lubricant. A low coefficient of friction minimizes the amount of force applied to the DSC, thus minimizing the possibility of damage to the DSC during insertion and withdrawal. During storage, the lubricant performs no function. The dry film lubricant (categorized as a consumable) is NITS and is not within the scope of renewal.

Thermowells and Temperature Monitoring System

Pursuant to Rancho Seco Technical Specifications 5.5.3 [3-17], the licensee must monitor the HSM to identify and correct blockage of the vents that would affect the convective removal of heat from the DSC. For Rancho Seco ISFSI, this is accomplished by visual surveillance and by monitoring the temperature at thermowells embedded in the lower portion of the roof. The calibration and functional verification of the temperature sensors, readouts, and alarms is part of the routine maintenance, and is not in the scope of the renewal.

Lightning Protection Systems

Section 8.2.6 of the CSAR [3-7] demonstrates that lightning strike on the HSM would have no effect on the performance of the Standardized NUHOMS® System. Therefore, any lightning protection embedments in the HSM, or lightning protection equipment installed by the licensee, is out of the scope of renewal. This applies to the Rancho Seco ISFSI as well.

Cask Alignment Targets

Before sliding a DSC into or out of an HSM, the TC must be aligned with the DSC support structure rails. This alignment is accomplished by sights on the TC and alignment targets on the front face of the HSM, and on the ground in front of the HSM. The alignment targets are NITS, and perform no function during storage. They are, therefore, out of the scope of the renewal.

Bird Screen Assemblies

These assemblies consist of a stainless steel screen supported by a stainless steel frame, which is attached to the HSM concrete. The assemblies prevent the entry of debris and animals into the HSM interior. They are installed to bridge the space between adjacent HSMs. These items are part of routine surveillance by the licensee in accordance with Technical Specification 5.5.3.3 [3-17], and are, therefore, out of scope of the renewal.

3.5.2 HSM Materials Evaluated

The materials of construction for the subcomponents of the HSM are presented in Chapter 2, Table 2-7 and summarized in Table 3-7.

3.5.3 Environments for the HSMs

The environments that are experienced by HSM subcomponents are described as follows:

The HSMs are located outdoors. Therefore, the exterior surfaces of the HSM are exposed to all weather conditions, including insolation, wind, rain, snow, and plant-specific ambient temperature, humidity, and airborne contamination. The Rancho Seco ISFSI is located in an environment that is considered as dry and remote from chloride sources, industrial areas, or areas near the seashore.

The temperature environment for the HSMs is bounded by the temperatures due to design basis heat load of 13.5 kW at the normal ambient temperature range of 0 °F to 101 °F and the off-normal ambient temperature range of -20 °F to 117 °F.

Inside each HSM, considered to be a sheltered environment, subcomponents are protected from outdoor effects (e.g., precipitation), but experience higher temperatures and radiation in an air environment.

The HSM interior components are exposed to neutron fluence and gamma radiation. Appendix A documents the analyses performed to evaluate the effects of neutron fluence and gamma exposure on the mechanical properties of reinforced concrete components. Appendix A determines the neutron and gamma fluence on the HSM concrete walls.

The maximum predicted temperatures in the HSM concrete at the beginning of storage, presented in Table 8-4, ISFSI FSAR Volume II [3-15], are 164 °F and 241 °F for normal and off-normal conditions, respectively. These initial temperatures are below the temperature limit of 300 °F per Section 3.0 of "Safety Evaluation Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," [3-39] and Section 3.5.1.2 (i)(2)(b) of NUREG-1801 [3-12].

3.5.4 Aging Effects Requiring Management for the HSMs

3.5.4.1 Concrete

This section describes the potential aging effects that could, if left unmanaged, cause degradation of HSM concrete components including reinforcing steel and could result in loss of the HSM concrete component intended functions. The potential aging effects that could cause loss of intended functions are:

- Loss of Material
- Cracking
- Change in Material Properties

Aging mechanism(s) that could lead to aging effect(s) for concrete components were determined using technical literature, related industry research, and existing OE. Aging mechanism(s) were evaluated to determine if the mechanism(s) could lead to an aging effect requiring management.

Loss of Material Aging Effects Assessment

Loss of material in concrete components is manifested as scaling, spalling, pitting, and erosion. Scaling, spalling, pitting, and erosion are described in ACI 201.1, Guide for Conducting a Visual Inspection of Concrete in Service [3-22]. Potential aging mechanisms that can lead to loss of material include:

- Freeze-thaw
- Abrasion and cavitation
- *Thermal aging*
- Aggressive chemical attack, including microbiological chemical attack
- Corrosion of embedded steel (embedments, rebar)

- Delayed ettringite formation (DEF)

Cracking Aging Effects Assessment

Cracking is manifested in concrete components as a complete or incomplete separation of the concrete into two or more parts. ACI 201.1 [3-22] provides a description and illustrations of cracking. Potential aging mechanisms that can lead to concrete cracking are:

- Freeze-thaw
- Reactions with aggregates
- Shrinkage
- *Thermal aging*
- Fatigue
- Irradiation embrittlement
- Creep
- Corrosion of embedded steel (embedments, rebar)

Change in Material Properties Aging Effects Assessment

The change in material properties aging effect is manifested in concrete components as increased permeability, increased porosity, reduction in pH, reduction in tensile strength, reduction in compressive strength, reduction in modulus of elasticity, and reduction in bond strength. Potential aging mechanisms that can lead to changes in material properties include:

- Leaching of calcium hydroxide
- *Thermal aging*
- Aggressive chemical attack, including microbiological chemical attack
- Irradiation embrittlement
- Fatigue

3.5.4.2 Discussion of Aging Mechanisms

Freeze-thaw

Repeated freezing and thawing can cause degradation of concrete, characterized by scaling, cracking, and spalling. The cause is water freezing within the pores of the concrete, creating hydraulic pressure resulting in freeze-thaw degradation.

Concrete structures or components located in areas that experience numerous freeze-thaw cycles with significant winter rainfall are more likely to exhibit damage than areas in milder climates.

American Society for Testing and Materials (ASTM) C216, Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale) [3-18] provides a quantitative measure of the weathering index for various regions of the USA. For Northern California region, the weathering index is less than 50 day-in/yr. Consistent with Section 3.5.1.1 of the MAPS Report [3-68], for regions with weathering index less than 100 day-in/yr, freeze-thaw degradation is not considered to be significant. Furthermore, Rancho Seco pre-application inspection results show that that even after 15 years of service, the HSM concrete surfaces do not show any visible degradation from freeze-thaw aging effects. Therefore, freeze-thaw of HSM concrete is not an applicable aging mechanism at Rancho Seco ISFSI.

Abrasion and Cavitation

HSM concrete is not subjected to flowing water, which is a requirement for this aging mechanism. Therefore, abrasion and cavitation are not applicable concrete aging mechanisms.

Thermal Aging

The following temperature criteria are used for the HSM concrete per the Safety Evaluation Report for the Standardized NUHOMS® Horizontal Modular Storage System [3-39].

- If concrete temperatures of general or local areas do not exceed 93.3 °C (200 °F) in normal or off-normal conditions or occurrences, no tests or reduction of concrete strength in the design analysis are required.
- If concrete temperatures of general or local areas exceed 93.3 °C (200 °F) but would not exceed 149 °C (300 °F), no tests or reduction of concrete strength are required if Type II cement is used and aggregates are selected that are acceptable for concrete in this temperature range. The staff has accepted the following criteria for aggregates (fine and coarse), which are considered suitable:
  - Satisfy ASTM C33, Standard Specification for Concrete Aggregates [3-27] requirements and other requirements as referenced in ACI 349, Evaluation of Existing Nuclear Safety-Related Concrete Structures [3-20] for aggregates.
  - Have demonstrated a coefficient of thermal expansion (tangent in temperature range of 21 °C to 37.8 °C (70 °F to 100 °F)) no greater than 1×10^{-5} cm/cm/°C (6×10^{-6} in/in/°F) or be one of the following minerals: limestone, dolomite, marble, basalt, granite, gabbro or rhyolite.

The above criteria do not extend above 149 °C (300 °F) for normal or off-normal temperatures and do not modify the ACI requirements for accident situations. Use of any Portland cement concrete, where normal or off-normal temperatures may exceed 149 °C (300 °F), or where “accident” temperatures may exceed 177 °C (350 °F), requires tests on the exact concrete mix (cement type, additives, water-cement ratio, aggregates, proportions), which is to be used. The above temperature criteria are consistent with the thermal criteria described in NUREG-1536, Section 3.5.1.2(i), Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility – Final Report, [3-13].

Under normal conditions of storage, the concrete temperatures will experience a gradual decrease over the service life of the HSM with only daily or seasonal fluctuations due to the ambient conditions. Therefore, *thermal aging* is not an applicable concrete aging mechanism.

Aggressive Chemicals

Continued or frequent cyclic exposure to the following aggressive chemical environments is necessary to cause significant degradation: [3-12]

- Acidic solutions with pH < 5.5
- Chloride solutions > 500 ppm
- Sulfate solutions > 1500 ppm

Because the HSMs are installed above-grade on a concrete basemat, the HSM concrete is not normally subject to aggressive chemical attack due to prolonged wetting. ISFSI basemats are designed to preclude flooding and are installed above the site’s design flood elevation. However, ISFSIs may be located in areas where the exposed surfaces of HSM can be subject to sulfur-based acid-rain degradation. No explicit acid rain data are available for the Rancho Seco ISFSI from the National Atmospheric Deposition Program/National Trends Network. Therefore, as noted in Section 3.5.1.5 of the MAPS Report [3-68], aggressive chemical attack is an applicable concrete aging mechanism.

Corrosion of Embedded Steel

Corrosion is an electrochemical process involving metal, oxygen, and an electrolyte that results in the formation of ferric oxide, that is, rust. The oxide product, which has a significantly greater volume than the original metal can result in tensile stresses and eventually cause hairline cracking, followed by rust staining, spalling and more cracking in the concrete surrounding the embedded steel. Typically, the high alkalinity (pH > 12.5) nature of concrete provides an environment around embedded steel and steel reinforcement that protects them from corrosion. If the pH is lowered (for example, pH < 10) due to leaching of alkaline products through cracks, intrusion of acidic materials, or carbonation, corrosion may occur, ASTM C1562-10, Standard Guide for Evaluation of Materials Used in Extended Service of Interim Spent Nuclear Fuel Dry Storage Systems [3-32]. Carbonation results from the chemical reaction between the hydrated cement components (mainly calcium hydroxide and calcium-silicate hydrate) and atmospheric carbon dioxide. The reaction lowers the pH of the concrete pore water to a level where passivity of the embedded steel surface is no longer supported, leading to initiation of rebar corrosion and subsequent concrete degradation, NUREG/CR-7116, Materials Aging Issues and Aging Management for Extended Storage and Transportation of Spent Nuclear Fuel [3-50]. Chlorides could also be present in constituent materials of the concrete mix (that is, cement, aggregates, admixtures, and water), or they may be introduced environmentally, ASTM C1562-10 [3-32].

Corrosion of embedded steel can be an aging degradation mechanism for concrete structures. If the concrete is degraded by other aging mechanisms, which may reduce the protective cover of the steel, corrosion may occur at a significantly higher rate.

The HSMs installed at the Rancho Seco ISFSI are placed contiguous to each other, separated by a 6-inch gap. The HSM side walls are protected by a 2 feet-thick end shield walls, which are installed at both ends of the HSM array. These shield walls provide environmental protection to the HSMs proper. The HSM rear walls are also protected since the Rancho Seco ISFSI is configured in two back to back HSM rows. Thus, only the external surface of the roof and the front wall are directly exposed to ambient weather conditions. The front wall and roof are designed as very thick components due to shielding considerations. Roof thickness is 3 feet, front wall thickness is 2.5 feet, and the minimum rebar cover is approximately 1 inch. These design features mitigate cracking, and thereby provide enhanced corrosion protection.

Furthermore, the HSM concrete mix design is in accordance with Section 4.3 of ACI 318-83, Building Code Requirements for Reinforced Concrete [3-21] (or Section 5.3 of ACI 318-95 [3-21]). [

] These stringent requirements ensure good-quality concrete that is resistant to chemical attack and, together with adequate concrete cover, makes the reinforcing steel less susceptible to corrosion.

The OE described in Section 3.2 contains cases where spalling of concrete cover with exposed rebar was observed. Although all observed cases were repaired, environmental degradation of the HSM concrete due to rebar corrosion is considered an aging effect requiring management for the HSM. Therefore, corrosion of embedded steel including reinforcing steel is an applicable concrete aging mechanism.

<u>Reactions with Aggregates</u>

Chemical reactions may develop between certain mineral constituents of aggregates and alkalis that compose the Portland cement. These alkalis are largely introduced in the concrete by cement, but may also be present from improper admixtures and salt-contaminated aggregates. Seawater and solutions of deicing salt can also inject alkalis into concrete by action of penetration. Three types of chemical reactions may occur depending upon the composition of the aggregates: alkali-aggregate reaction, cement-aggregate reaction, and alkali-carbonate reaction. The alkali-silica reaction (ASR) can occur when aggregate containing silica is exposed to alkaline solutions. It can cause expansion and cracking of concrete structures. The degree of vulnerability of the concrete to this effect is primarily a function of the aggregate that is used. The cement-aggregate reaction occurs between alkalis in the cement and silicates in the aggregates. It mainly occurs in environments that promote concrete shrinkage and alkali concentrations in the surface due to drying. The alkali carbonate reaction (between carbonate aggregates and alkalis) may produce expansion and cracking of the concrete. It often results in map cracking on the concrete surface. It has been known to occur for certain limestone aggregates.

The aging effect of the aggregate reaction degradation mechanisms is generally map or pattern cracking on the concrete surface (more or less uniform spacing of cracks over the entire concrete surface) and possible presence of alkali-silica gel on the concrete surface, as discussed in ACI 221.1, State-of-the-Art Report on Alkali-Aggregate Reactivity [3-24] and NRC Information Notice 2011-20 [3-9].

Shrinkage

Most of the concrete shrinkage has already occurred (91% in first year, 98% in five years and 100% in 20 years – ACI 209R-92 [3-23]). Twenty years will have occurred by the end of the current license. Therefore, concrete shrinkage is not an applicable concrete aging mechanism.

Leaching of Calcium Hydroxide

Leaching of calcium hydroxide ($Ca(OH)_2$) due to water penetration can result in loss of concrete material, converting the cement into gels that have no strength. The significance of the effect is governed by water temperature and salt content as described in NUREG/CR-7116, Materials Aging Issues and Aging Management for Extended Storage and Transportation of Spent Nuclear Fuel [3-6]. Leaching over long periods of time can increase the permeability of concrete, making it more susceptible to other forms of aggressive attack and reducing strength. Leaching can also lower the pH of the concrete and affect the integrity of the protective oxide film of reinforcement steel.

There is some OE indicating occurrences of leaching in the HSM concrete. The most likely cause of $Ca(OH)_2$ leaching in the HSM concrete would be rainwater penetrating the surface layer. Therefore, leaching of $Ca(OH)_2$ is an applicable ISFSI concrete aging mechanism.

Irradiation Embrittlement

In dry storage systems, the level of irradiation over the extended operation is not expected to reach a level that is sufficient to cause strength reduction of concrete; therefore, the irradiation effect is not considered to be a significant aging degradation mechanism as described in ASTM C1562-10 [3-32].

The HSM interior components are exposed to neutron fluence and gamma exposure radiation. *The supplemental analysis in* Appendix A determines that there is no credible degradation in the strength of the HSM components due to the neutron fluence and gamma exposure. Therefore, irradiation embrittlement is not an applicable concrete aging mechanism.

Creep

Creep is the time-dependent increase of strain in hardened concrete that has been subjected to sustained stress, primarily compressive. The sustained stress results from dead load, live load, pre-stress on the structure and from temperature effects. Creep deformation is a function of loading history, environment, and material properties of the concrete. The time-dependent creep deformation of concrete under compressive load consists of cumulative strain resulting from progressive cracking at the aggregate-cement paste interface, from moisture exchange with the atmosphere, and from moisture movement within the concrete.

Creep-induced concrete cracks are typically not large enough to result in concrete deterioration or in exposure of the reinforcing steel to environmental stressors. Cracks of this magnitude do not reduce the concrete’s compressive strength. Creep is significant when new concrete is subjected to load and decreases exponentially with time, and therefore, any degradation is noticeable in the first few years. According to ACI 209R-92, Prediction of Creep, Shrinkage, and Temperature Effects in Concrete Structures [3-23], 78% of creep occurs within the first year, 93% within 10 years, 95% within 20 years, and 96% within 30 years. Creep is not a significant aging degradation mechanism and was not identified during the OE review. Therefore, creep is not an applicable concrete aging mechanism.

Fatigue

The only source of thermal fatigue is daily and seasonal environmental temperature fluctuations. The maximum average daily fluctuation is 47 °F per Section 8.1.1.9 of the ISFSI FSAR [3-15]. The high thermal mass of the HSM and low conductivity of the concrete material limit the magnitude of the thermal forces that could be developed due to this temperature difference. Therefore, thermal fatigue is not an aging effect requiring management for the HSM.

Delayed Ettringite Formation

Ettringite is the mineral name for calcium sulfoaluminate, which is normally found in Portland cement concretes. Calcium sulfate sources (e.g., gypsum) are intentionally added to the cement to regulate early hydration reactions, improve strength development, and reduce drying shrinkage. Sulfate and aluminate are also present in supplementary cementitious materials and admixtures. These compounds react in the cement to form primary ettringite within the first few hours after mixing with water.

Delayed ettringite formation (DEF) is the potential deleterious reformation of ettringite in moist concrete after destruction of primary ettringite by high early-age temperatures from heat treatment, or in extreme cases, from internal heat of hydration. Heat treatment temperatures above about 70 °C (158 °F) are most often cited to cause deleterious volume expansion due to DEF, "Ettringite Formation and the Performance of Concrete [3-56]. The conditions necessary for the occurrence of DEF are excessive temperatures (above about 70 °C (158 °F)) during concrete casting and curing, the presence of internal sulfates, and a moist environment. The principal effect of DEF is volume expansion, which leads to cracking and spalling. It can also increase other forms of degradation such as freeze/thaw and reinforcement corrosion. The use of supplementary cementitious materials and air entrainment has been shown to reduce the potential for deleterious expansion due to DEF as described in "Expert Panel Workshop on Concrete Degradation in Spent Nuclear Fuel Dry Cask storage Systems –Summary Report" [3-57].

The HSM fabrication specification requires the concrete temperature of plastic concrete, as placed during casting, to be limited [ ] Cement type is Type II meeting the requirements of ASTM C150 [3-28] with moderate heat of hydration and moderate sulfate resistance. Specified air content of the concrete, determined in accordance with ASTM C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Test Method [3-71], is 4% to 7%. Supplementary cementitious materials (e.g., slag) conforming to the requirements of ASTM C989, Standard Specification for Slag Cement for Use in Concrete and Mortars [3-72] may be used for blending with cement up to 50% by weight of total cementitious material. The HSMs are fabricated in accordance with the ACI 318 Code [3-21]. The HSM fabrication specification requires the concrete to be cured and protected in accordance with the curing provisions of Section 5.5 of the ACI 318 Code [3-21]. Thus, concrete degradation of the HSMs due to DEF is not likely during the period of extended operation.

Microbiological Degradation or Microbiological Chemical Attack

Microbiological degradation or microbiological chemical attack of concrete structures is a potential aging mechanism caused by live organisms that grow in environments that offer favorable conditions (e.g., available moisture, neutral pH, presence of nutrients, etc.), which facilitate the colonization of microbes on concrete surfaces. Conducive environments may have elevated relative humidity (i.e., between 60% and 98%), long cycles of humidification and drying, freezing and defrosting, high carbon dioxide concentrations (e.g., carbonation), high concentrations of chloride ions or other salts or high concentrations of sulfates and small amounts of acids, "Microbiologically Induced Deterioration of Concrete – A Review," [3-58]. Under these conditions, microorganisms can affect the concrete mainly by contributing to the deterioration of the exposed concrete surface, reducing the protective cover depth, increasing concrete porosity, and increasing the transport of degrading substances into the concrete that can accelerate cracking and spalling, [3-58]. Corrosion of the steel reinforcement from microbiological chemical attack is also possible where moisture stagnates on concrete surfaces for an extended period of time, ACI 349.3R-02 [3-20]. Consistent with the guidance provided in the MAPS Report [3-68], microbiological chemical attack is an applicable concrete aging mechanism for Rancho Seco ISFSI.

3.5.4.3 Steels and Other Metals

This section describes the potential aging effects that could, if left unmanaged, cause degradation of carbon steel and stainless steel HSM subcomponents and could result in loss of the component's intended function(s). The potential aging effects that could cause loss of design function(s) are:

- Loss of material
- Cracking
- Change in material properties

Aging mechanism(s) that could lead to aging effect(s) for steel and other metal components were determined by technical literature review. Aging mechanism(s) were evaluated to determine if the mechanism(s) could lead to an aging effect requiring management.

Loss of Material Aging Effects Assessment

- Loss of material due to general corrosion – carbon steel
- Loss of material due to crevice corrosion – carbon steel and stainless steel
- Loss of material due to pitting corrosion – carbon steel and stainless steel
- Loss of material due to galvanic corrosion – dissimilar metals

Cracking Aging Effects Assessment

- Cracking due to stress corrosion cracking – stainless steel
- Cracking due to stress corrosion cracking – bolting
- Cracking due to thermal fatigue – carbon steel and stainless steel

Change in Material Properties Aging Effects Assessment

- Change in material properties due to elevated temperature - carbon steel and stainless steel
- Change in material properties due to irradiation embrittlement - carbon steel and stainless steel

3.5.4.4 Discussion of Aging Mechanisms

General Corrosion

Metal surfaces in contact with moist air or water are subject to general corrosion. The rate of general corrosion is governed by several factors, such as the moisture of the air, the salinity level of the air, the temperature of the metal surface, and the specific type of metal involved. The atmosphere will be dependent on the site location and environment, typically benign in terms of corrosion inside the HSM modules. Although DSC decay heat will heat the air preventing the accumulation or condensation of moisture inside the HSM, the decay heat will decline during the PEO. Thus, the presence of moist air cannot be ruled out. Therefore, loss of material due to general corrosion is an aging effect requiring management for carbon steel and low alloy steel in outdoor and sheltered environments. Stainless steel is not susceptible to general corrosion.

Crevice Corrosion

Crevice corrosion is localized corrosion within crevices or shielded areas. It most frequently occurs in connections, lap joints, splice plates, bolt threads, under bolt heads, or points of contact between metals and non-metals, and it is associated with a stagnant or low flow solution (an electrolyte). Per EPRI Report 1015078 [3-33], to function as a corrosion site, the crevice must be wide enough to permit liquid entry and narrow enough to maintain a stagnant zone, typically a few thousandths of an inch or less.

Crevice corrosion is strongly dependent on the presence of dissolved oxygen. Any surface exposed to atmospheric conditions will be saturated in oxygen above the threshold levels for crevice corrosion to occur (0.1 ppm). This form of corrosion, as the name implies, requires a crevice in which contaminants and corrosion products can concentrate. In addition to oxygen, moisture is required for the mechanism to operate. Typically, atmospheric pollutants and contaminants, both indoors and outdoors, are insufficient to concentrate and thereby promote crevice corrosion. Per EPRI Report 1015078 [3-33], alternating wetting and drying is particularly harmful because this leads to a concentration of atmospheric pollutants and contaminants.

Air with enough moisture can facilitate the loss of material in steel caused by crevice corrosion. Moist air in the absence of condensation is potentially aggressive (e.g., coastal locations, near salted roads and in the path of cooling tower drift). Although DSC decay heat will heat the air preventing the accumulation or condensation of moisture inside the HSM, the decay heat will decline during the PEO, thus the presence of moist air cannot be ruled out. Carbon steel, low alloy steel and stainless steel are all susceptible to crevice corrosion. Therefore, loss of material due to crevice corrosion is an aging effect requiring management for these HSM metals.

Pitting Corrosion

Pitting corrosion is a localized corrosive attack in aqueous environments containing dissolved oxygen and chlorides. When passivity breaks down at a spot on a metal surface, an electrolytic cell is formed with the anode at the minute area of active metal and the cathode at the considerable area of passive metal. The large electric potential difference between the two areas accounts for considerable flow of current with rapid corrosion at the anode. The anode does not spread because it is surrounded by passive metal, and as the mechanism continues, it penetrates deeper into the metal, forming a pit. Pitting corrosion is more common with passive materials such as austenitic (300 Series) stainless steels than with non-passive materials, such as carbon steels. However, all materials of interest are susceptible to pitting corrosion under certain conditions, per EPRI Report 1015078 [3-33].

Oxygen is required for pitting initiation. Areas in which aggressive species can concentrate, that is, locations of frequent or prolonged wetting or of alternate wetting and drying, are particularly susceptible to pitting. Per EPRI Report 1015078 [3-33], most pitting is the result of halide contamination, with chlorides, bromides, and hypochlorites being prevalent.

Therefore, loss of material due to pitting corrosion is an aging effect requiring management for all HSM metals.

Galvanic Corrosion

Galvanic corrosion occurs when two or more metals of differing electrochemical potential are in electrical contact in a conducting environment (the presence of an electrolyte). Under these conditions an electrolytic cell is formed transmitting an electrical current between an anode and a cathode. Loss of material occurs when ions of the metal with the lower potential, the anode, are being depleted and deposited onto the more noble metal, the cathode. Galvanic corrosion will not occur in a dry environment; an electrolyte must be present and remain liquid. The ratio between surface areas of the metals in contact is of significant importance. Per EPRI Report 1015078 [3-33], corrosion rates increase when the more noble metal has a greater surface area than the more active metal in the presence of moisture and water. An instance in the HSM where dissimilar materials are in contact and, therefore, vulnerable to galvanic corrosion is at the contact area where graphite lubricant is used at the DSC support structure rail faces. Since the graphite lubricant used is noble relative to the rail face, it could induce galvanic corrosion of the Nitronic® 60 support structure rail plate. This loss of material due to galvanic corrosion of Nitronic® 60 DSC support structure rail plate is an aging effect previously addressed in Section 3.4.4.2.

Stress Corrosion Cracking

SCC is a localized, non-ductile cracking failure resulting from the combination of a corrosive environment, a susceptible material, and tensile stresses. In most cases, SCC involves crack initiation, subcritical crack growth, and failure when the crack reaches a critical size and the tensile strength of the remaining material is exceeded. Per EPRI Report 1015078 [3-33], in terms of corrosive environment, dissolved oxygen, sulfates, fluorides, and chlorides can provide the necessary environment for SCC to occur. Austenitic stainless steels are susceptible to SCC.

Residual stresses at the welds are likely to be sufficient to initiate SCC at storage sites with sufficient chloride aerosols. There are no weld joints in the heat shields. Therefore, SCC at the welds and heat affected zones of the welds of the Nitronic® 60 rail face to carbon steel support structures is subject to aging management.

Stress Corrosion Cracking Of High Strength Bolting

Bolting fabricated from high-strength (measured yield strength, Sy, ≥ 150 ksi) low-alloy steel is susceptible to stress corrosion cracking. Examples of high-strength alloy steels that comprise this category include ASTM A193 Grade B7, A540 Grade B23/24, A193 Grade B8, and Grade L43.

Structural component anchorage applications in the HSM include bolted joints and threaded connections, collectively referred to as bolted connections. Bolted connections include bolts, studs, screws, nuts, washers, and member faying surfaces (i.e., mating surfaces) of a bolted joint. Structural bolting materials used with Rancho Seco HSMs include ASTM A36, A193 Grade B7, A194 Grade 2H, A307, A325, A490, and A563 Grade A.

HSM structural component anchorages are installed snug-tight per HSM installation specifications. This is true for the installation of HSM shield wall connections, rail extensions, door attachments, roof attachments, and heat shields. These HSM structural component anchorages do not have sufficiently high tensile stress to initiate SCC; therefore cracking of high strength bolts due to SCC is not an aging effect requiring management for HSM subcomponents.

Thermal Fatigue

The only source of thermal fatigue is environmental temperature fluctuation. For HSM steel subcomponents located inside the HSM, i.e., in a sheltered environment, the thermal fluctuations due to external ambient temperature fluctuations are significantly dampened by the HSM walls and roof and the DSC decay heat. Thermal cycling fatigue due to fluctuations in the ambient conditions is not an aging effect requiring management for HSM subcomponents.

Thermal Aging

The maximum temperature of the HSM steel subcomponents is 241 °F at the beginning of storage (ISFSI FSAR, Volume II, Table 8-4 [3-15]) for the off-normal conditions of storage (117 °F ambient temperature). This temperature is well within allowed temperature limits for the structural metal components of the HSMs (e.g., maximum temperature limit is 700 °F and 800 °F, for carbon and stainless steels, respectively, per the ASME code).

Carbon steels are not susceptible to embrittlement due to thermal aging, per EPRI Report 1015078 [3-33]. The maximum temperature of 241 °F is well below the embrittlement saturation temperature of 752 °F (400 °C) in, NUREG/CR-6428 [3-46]. It is also below the lower 635 °F (335 °C) temperature in the tests reported in [3-47] and [3-48] where embrittlement was observed for stainless steel welds. Also, per NUREG-1801 [3-12], austenitic steels with service temperature below 482 °F (250 °C) are not susceptible to thermal aging embrittlement. Therefore, change in material properties due to

thermal aging is not an aging effect requiring management for HSM metal subcomponents.

Irradiation Embrittlement

High neutron radiation can cause loss of fracture toughness in steel. Previously, as addressed in Appendix 3E of CoC 1004 Renewal Application RAI Response [3-59], the neutron radiation seen by the metal components of dry fuel storage systems is orders of magnitude lower than that required to produce any effect, so neutron radiation is not a significant aging effect for the HSM steel subcomponents. Gamma radiation does not have any significant impact on the properties of steel. Therefore, irradiation embrittlement is not an aging effect requiring management for HSM steel subcomponents.

3.5.4.5 Coatings Evaluation

For the carbon steel subcomponents, no credit is taken for coatings for the performance of intended functions. *C*oatings are *treated as a "material" rather than a "subcomponent"; therefore,* an AMR was performed on coating failure to determine if it could adversely affect the safety function of a safety-related SSC.

Metallic subcomponents within the HSM are carbon steel. Carbon steel subcomponents are coated with inorganic coatings or are galvanized. Hence, all metallic materials are protected against corrosion. The coated steel within the HSM is in a warm, sheltered environment.

Table 3-7 lists the coated HSM subcomponents.

The NUHOMS® HSM fabrication specifications require **[**

] These coating systems have excellent adhesion to carbon steel and resistance to alkalis, and are intended to provide protection for the carbon steel against corrosion in the harshest environments.

Hot-dip galvanizing is performed in accordance with the requirements of ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products [3-26] with a minimum thickness Coating Grade of 100.

The amount of applied coating within an HSM is limited; coating failure (e.g., blistering, cracking, flaking, peeling) adversely affecting the thermal performance of the HSM is not credible because the HSM thermal analysis does not take credit for the coating emissivity. Therefore, coating failure does not prevent the HSM or the DSC from satisfactorily accomplishing its intended functions. Based on the evaluation provided above and the guidance provided in the MAPS Report [3-68], it is concluded that coatings are not relied upon to manage the effects of aging for the HSM subcomponents at the Rancho Seco ISFSI. Therefore coating failure is not included as an inspection attribute within the HSM AMP.

The sliding surfaces of the DSC support rails of the HSM are coated with a dry film lubricant to minimize friction during insertion and retrieval of the DSC. The dry film lubricant provides a thin, clean, dry layer of lubricating solids to reduce wear and prevent galling. Graphite lubricants are suitable for very high and cryogenic temperature applications. The lubricant is not affected by water and is designed to be highly resistant to aggressive chemicals. The lubricant suffers no radiation effects because it consists entirely of graphite. *The dry lubricants are treated as a “material” rather than a “subcomponent.” The coefficient of friction associated with these lubricants is below 0.05, while the design basis calculations employed a coefficient of friction of 0.25. The mechanical system used for DSC transfer is capable of exerting an extraction force equal to the loaded weight of a DSC. An effective coefficient of friction of 100% (assuming no lubrication) has been used for these “jammed DSC analyses.” The support structure is also designed for this loading. Therefore, dry lubricant deterioration is not an aging effect requiring aging management since the dry film lubricant is not relied upon for DSC retrievability.*

3.5.4.6 Summary of Aging Effects Requiring Management

The following aging effects and mechanisms for HSM concrete components are applicable:

Loss of Material

- Aggressive chemical attack, including microbiological chemical attack
- Corrosion of embedded steel

Cracking

- Reactions with aggregates
- Corrosion of embedded steel

Change in Material *Properties*

- Leaching of $Ca(OH)_2$
- Aggressive chemical attack

The following aging effects/mechanisms for HSM steel components are applicable:

Loss of Material

- Loss of material due to general corrosion – carbon steel
- Loss of material due to crevice corrosion – carbon steel and stainless steel
- Loss of material due to pitting corrosion – carbon steel and stainless steel
- Loss of material due to galvanic corrosion – Nitronic® 60 DSC support rail plates

Cracking

- Stress Corrosion Cracking – welds attaching Nitronic® 60 rail plate

3.5.5 Aging Management Activities for the HSMs

3.5.5.1 *HSM TLAAs*

No TLAAs are used to manage any expected aging effects of HSM components.

3.5.5.2 HSM Aging Management Programs

The following program is employed to manage the aging effects and mechanisms for the HSM concrete and steel components:

- HSM Aging Management Program for External and Internal Surfaces (applicable to HSM, DSC support structures)

The scope of the HSM AMP, parameters to be monitored and the criteria for selecting an HSM for the AMP are described in Section B.4.5 of Appendix B.4. Rancho Seco will implement the first (baseline) HSM inspections under this AMP on the selected HSM in accordance with the program schedule as described in Appendix B.4, Section B.4.5.

3.5.5.3 Summary of the AMR Results for the HSMs

Table 3-8 summarizes the results of the AMR for the HSMs.

3.6 Aging Management Review Results – Concrete Basemat (Storage Pad)

This section summarizes the results of the AMR for the Rancho Seco ISFSI concrete basemat. The basemat is a NITS reinforced concrete structure designed to support the HSMs and constructed to plant-specific site conditions.

As discussed in Section 3.5.4.2, long-term settlement of the ISFSI basemat is a credible aging mechanism. There are no other credible failure modes of the basemat that could prevent the HSM intended functions from being fulfilled. The basemat is evaluated in support of the following intended function:

- Provides HSM structural/functional support

3.6.1 Description

The basemat is designed and constructed in accordance with codes and standards set by the site licensee. It is subject to site-specific foundation analyses and design considerations, including licensee-specific HSM loading configurations. The basemat and underlying foundation are engineered, designed, and constructed to meet the requirements for a heavy industrial facility (Section 2.6 of the Standardized NUHOMS® CSAR [3-7]).

3.6.2 Basemat Materials Evaluated

The material of construction for the basemat is reinforced concrete.

3.6.3 Environments for the Basemat

The basemat is located in an external environment; the exposed exterior surfaces of the basemat are exposed to all weather conditions, including insolation, wind, rain, snow, and plant-specific ambient temperature, humidity, and airborne contamination. The Rancho Seco HSM module is provided with its own concrete floor and the entire HSM assembly sits on the basemat. The areas of the concrete floor within the footprint of the installed HSM array are in a sheltered environment. These areas are protected from outdoor effects (e.g. direct sunlight, precipitation, etc.) and experience temperatures and radiation exposure levels that are bounded by those of the HSM concrete components discussed in Section 3.5.3.

The below-grade portions of the basemat are in an underground environment and could be exposed to a groundwater/soil environment.

3.6.4 Summary of Aging Effects Requiring Management

Based on the evaluations in Sections 3.5.4.1and 3.5.4.2, the following aging effects and mechanisms are applicable for the concrete basemat:

Loss of Material

- Aggressive chemical attack, including microbiological chemical attack
- Corrosion of embedded steel
- Delayed Ettringite Formation (DEF)

Cracking

- Reactions with aggregates

Settlement (aging mechanism described below)
Settlement of a structure may be due to changes in the site conditions (e.g., water table, soil). As noted in Section 3.5.1.4 of the MAPS Report [3-68], differential settlement of concrete structures involves a combination of immediate settlement and progressive long-term settlement. Because of the potential aging effects that long-term settlement of the basemat may have on the HSM intended functions, settlement is an applicable concrete aging mechanism for the basemat.

Change in Material *Properties*

- Leaching of $Ca(OH)_2$
- Aggressive chemical attack, including microbiological chemical attack

3.6.5 Aging Management Activities for the Rancho Seco ISFSI Basemat

The Rancho Seco ISFSI Basemat AMP, described in Appendix B.6, is employed to manage the aging effects and mechanisms for the basemat concrete.

The scope of the basemat AMP and the parameters to be monitored are described in Section B.6.5 of Appendix B.6. Rancho Seco will implement the first (baseline) basemat inspections under this AMP in accordance with the program schedule as described in Section B.6.5, Appendix B.6.

Table 3-7
HSM Materials

HSM Subcomponents	Material
HSM walls, roof, floor, end shield walls, rear shield walls and floor	Reinforced concrete
DSC support structure: structural beams and frames	Carbon steel (coated)
DSC support rail plate	Nitronic® 60 stainless steel
Shielded access door encased core	Plain Concrete
Shielded access door: door steel plates	Carbon steel (coated)
Axial retainer assembly: tube steel, plate embedment, DSC axial retainer	Carbon steel (coated)
HSM Heat Shields	Carbon steel (coated)
HSM cask docking ring	Carbon steel (coated)
HSM roof attachment angles and stiffener plates	Carbon steel (coated)
Support frames for HSM inlet and outlet vent bird screens	Stainless steel
Anchorages (threaded fasteners include bolts, studs, screws, nuts, washers, and embedments)	Carbon steel (coated) Stainless steel
End shield walls-to-module connecting hardware	Carbon steel (coated)

Table 3-8
Rancho Seco HSM Intended Functions and AMR Results
(3 pages)

Subcomponent[(2)]	Subcomponent Parts[(2)]	Intended Function [(1)] [(2)]	Environment	Aging Effects Requiring Management	Aging Management Activity
Base Unit Assembly	HSM Base Walls & Floor Slab	SH, SS, HT, RE	External / Sheltered	Loss of Material, Cracking, Change in Material Properties	AMP
Roof Slab Assembly	HSM Roof Slab	SH, SS, HT	External / Sheltered	Loss of Material, Cracking, Change in Material Properties	AMP
End/Rear Shield Walls	End and Rear Shield Walls	SH, SS, HT	External / Sheltered	Loss of Material, Cracking, Change in Material Properties	AMP
DSC Support Structure Assembly	Support Rail Beams and Cross Beams	SS, RE	Sheltered	Loss of Material	AMP
DSC Support Structure Assembly	Support Rail Plate	RE	Sheltered	Loss of Material / Cracking	AMP
DSC Support Structure Assembly	Support Structure Steel (Rail Extension Plate, DSC Stop Plates, Stiffener Plates, Gussets, Mounting Plates, Base Plates, Support Plate, Wall Attachment Channel and Angles	SS, RE	Sheltered	Loss of Material	AMP
DSC Support Structure Assembly	Tube Steel Leg Column	SS	Sheltered	Loss of Material	AMP
DSC Support Structure Assembly	Bolts	SS	Sheltered	Loss of Material	AMP
DSC Support Structure Assembly	Nuts	SS	Sheltered	Loss of Material	AMP
DSC Support Structure Assembly	Wall Attachment Hardware (Heavy Hex Bolt/Hardened Washer)	SS	Sheltered	Loss of Material	AMP
HSM Shielded Door Assembly	Steel Plates (Various)	SH, SS, RE	External	Loss of Material	AMP

Table 3-8
Rancho Seco HSM Intended Functions and AMR Results
(3 pages)

Subcomponent[2]	Subcomponent Parts[2]	Intended Function [1] [2]	Environment	Aging Effects Requiring Management	Aging Management Activity
HSM Shielded Door Assembly	Encased Concrete Core	SH, RE	Embedded / Encased	None Identified	None Required
HSM Shielded Door Assembly	Door Bolt	SS, RE	External	Loss of Material	AMP
Canister Axial Retainer Assembly	Axial Retainer Rod/Mounting Plate /Bolts /Hardened Washer	SS	External	Loss of Material	AMP
Cask Docking Ring Assembly	Rings /Plates /Nelson Studs / Door Clamps /Hex Bolts	SS, RE	Embedded / Encased / External	Loss of Material	AMP
Heat Shield Assemblies	Roof and Side Wall Mounted Heat Shields	HT	Sheltered	Loss of Material	AMP
Heat Shield Assemblies	ZEE Brackets (for the Roof Mounted Heat Shields)	SS	Sheltered	Loss of Material	AMP
Heat Shield Assemblies	Heat Shield Attachment Hardware (Rods, Nuts)	SS	Sheltered	Loss of Material	AMP
Heat Shield Assemblies	Heat Shield Embedment Assemblies (Bolts/Sleeve Nuts)	SS	Embedded / Encased	Loss of Material	AMP
Cask Restraint Embedment Assembly	Rods/Sleeve Nuts/Hexagonal Nuts	SS, RE	Embedded / Encased / Sheltered	Loss of Material	AMP
Wall & Floor Mounted Canister Support Structure Embedment Assembly	Bolt/Sleeve Nut	SS	Embedded / Encased / Sheltered	Loss of Material	AMP
Roof Attachment Assembly	Roof Attachment Angle/Stiffener Plate	SS	Sheltered	Loss of Material	AMP

Table 3-8
Rancho Seco HSM Intended Functions and AMR Results
(3 pages)

Subcomponent[(2)]	Subcomponent Parts[(2)]		Intended Function [(1)] [(2)]	Environment	Aging Effects Requiring Management	Aging Management Activity
Roof Attachment Assembly	Roof Mounted/Wall Mounted Attachment Assemblies (Sleeve Nut)		SS	Sheltered	Loss of Material	AMP
End and Rear Shield Wall Attachment Hardware	Embedment Bolts/Sleeve Nuts		SS	Embedded / Encased / Sheltered	Loss of Material	AMP
End Shield Wall Attachment Hardware	Embedment Bolts/Sleeve Nuts		SS	Embedded / Encased / Sheltered	Loss of Material	AMP
End and Rear Shield Wall Attachment Hardware	Cast-In Place Bolts/Nuts		SS	External	Loss of Material	AMP
End & Rear Shield Wall Attachment Hardware	Tie Plate		SS	External	Loss of Material	AMP
HSM-to-HSM Spacer Channels	Spacer Channels		SS	External	Loss of Material	AMP
End and Rear Shield Wall Support Bolt Assembly	Shield Wall Support Bolt Assembly (Bolts, and Nuts)		SS	External	Loss of Material	AMP

Notes:

(1) Abbreviations for Intended Function Column:

PB - Directly or indirectly maintains a pressure boundary (confinement)
SH - Provides radiation shielding
CC - Provides criticality control of spent fuel
SS - Provides structural support
HT - Provides heat transfer
RE - Retrievability

(2) Only in-scope subcomponents from Chapter 2, Table 2-7 are listed in this table.

3.7 Aging Management Review Results – Transfer Cask

This section summarizes the results of the AMR for the in-scope subcomponents of the MP187 TC. The in-scope TC subcomponents and their intended functions are summarized in the scoping evaluation Table 2-8, Chapter 2.

The evaluation boundary for the TC includes the TC subcomponents, which perform the following intended functions (MAPS designations in parentheses, if different):

- HT (TH) Provides heat transfer
- SH Provides radiation shielding
- SS (SR) Provides structural support (impact resistance, lifting, etc.)
- RE Provides retrievability of DSC

3.7.1 Description of Transfer Cask Subcomponents

Note: All of the Rancho Seco SFAs and GTCC waste have been loaded and placed into the HSMs for interim storage. The MP187 TC is currently stored in a sheltered environment and the only remaining MP187 TC function is to retrieve the DSCs when they are to be shipped offsite. The following discussion, excerpted from the Rancho Seco ISFSI FSAR, discusses the MP187 TC functions, including those for transferring fuel from the spent fuel pool to the ISFSI. The activities are not functions required for the PEO.

As described in the ISFSI SAR [3-15], the MP187 TC is a cylindrical vessel with a welded bottom assembly and a bolted top cover plate. The TC is designed for onsite transfer of the DSC to and from the plant's spent fuel pool and the ISFSI. The TC provides radiological shielding and heat rejection during handling in the fuel or reactor building, DSC closure operations, and transfer to the HSM at the ISFSI. In addition, the TC provides physical protection for the loaded DSC during off-normal and drop accident events postulated to occur during the transfer operations. The TC also provides protection of the DSC against potential natural and operational hazards during transfer of the DSC to the ISFSI.

The TC is constructed from three concentric cylindrical shells to form an inner and outer annulus. The inner annulus is filled with cast lead to provide gamma shielding. The outer annulus forms a steel jacket, which is filled with NS-3, a hydrogen rich castable solid material, manufactured by BISCO Products, Inc. See "NS-3 Specification Sheet," by BISCO Products Inc., [3-45] for neutron shielding. The two inner shells are welded to heavy forged ring assemblies at the top and bottom ends of the cask. The TC structural shell and the bolted top cover plate are fabricated from stainless steel. A stainless steel cover plate equipped with an O-ring is provided to seal the bottom hydraulic ram access penetration of the cask during fuel loading. All surfaces exposed to fuel pool water are stainless steel.

Two trunnion assemblies are provided in the upper region of the cask for lifting of the TC inside the plant's spent fuel building, and for supporting the cask on the skid for transfer to and from the ISFSI. An additional pair of trunnion assemblies, provided in the lower end of the cask, used to position the cask on the support skid, serve as the rotation axis during down-ending of the cask, and provide support for the bottom end of the cask during transfer operations. The trunnion assemblies are fabricated from a stainless steel trunnion sleeve welded into the structural shell. A removable trunnion, machined from a stainless steel bar, is bolted to the trunnion sleeve. In the trunnions, a machined hollow space is formed and this is filled with NS-3 neutron shielding material to provide shielding during transfer operations. The TC is provided with a set of internal rails, fabricated from a non-galling, wear resistant stainless steel material coated with a high contact pressure dry film lubricant *(containing graphite)* to facilitate DSC transfer into and out of the HSM.

The ram access penetration ring located on the bottom plate allows access to the DSC for transfer operations. The annulus drain valve is located within the bottom support ring and the annulus fill valve is located in the top flange.

The neutron shield jacket, which surrounds the cask structural shell, extends axially from the bottom ring to the top flange, and is composed of an outer stainless steel jacket, top and bottom support rings, and axial support angles. The neutron shielding material is NS-3.

The cask is provided with a top cover assembly, which is bolted to the cask body during transfer of a fuel-loaded or GTCC DSC from the fuel building to the HSM. Lifting eyes are provided to allow removal of the cover from the TC when it is in either a horizontal or vertical orientation.

The following TC subcomponents are excluded from further aging management review because they do not support or impact the intended function of the TC during the period of extended operation:

- Coatings, lubricants, sealants, Teflon tape
- Eyebolts for bottom access plate and top cover plate and associated thread inserts
- Cover plates, gaskets, and screws for annulus fill and drain ports
- Quick-connect fittings for annulus and neutron shield fill and drain ports
- Alignment pins for top cover plate
- Stick-on alignment targets

3.7.2 Transfer Cask Materials Evaluated

The materials of construction for the TC and its subcomponents are listed in Table 3-9.

3.7.3 Environments for the Transfer Cask

The TC is normally stored in a sheltered environment between uses and during staging activities prior to each use. The TC was last used in August 2002 for fuel loading and transfer operations except for the loading and transfer of GTCC waste, which concluded in 2006. All of the Rancho Seco fuel is currently in storage in the HSMs and the TC will only be used when the DSCs are to be retrieved from the HSMs for offsite shipment.

The total time exposure of the TC to the spent fuel pool environment (during the historic loading operations) and to the external environment (during transfer operations) represents a negligible fraction of its total life span, including PEO. Hence, the only environment considered for the TC AMR is the sheltered environment.

3.7.4 Aging Effects Requiring Management for the Transfer Cask

3.7.4.1 Steels and Other Metals

This section describes the potential aging effects that could, if left unmanaged, cause degradation of steel TC subcomponents and result in loss of the component's intended function(s). The potential aging effects that could cause loss of intended function(s) are:

- Loss of material
- Cracking
- Change in material properties

Loss of Material Aging Effects Assessment

- Loss of material due to general corrosion – carbon steel
- Loss of material due to crevice corrosion – carbon steel and stainless steel
- Loss of material due to pitting corrosion – carbon steel and stainless steel
- Loss of material due to galvanic corrosion – dissimilar metals
- Loss of material due to wear

Cracking Aging Effects Assessment

- Cracking due to stress corrosion cracking – stainless steel
- Cracking due to thermal fatigue - carbon steel and stainless steel

Change in Material Properties Aging Effects Assessment

- Change in material properties due to *thermal aging* - carbon steel and stainless steel
- Change in material properties due to irradiation embrittlement - carbon steel and stainless steel

3.7.4.2 Discussion of Aging Mechanisms

General Corrosion

Carbon steel surfaces in contact with moist air or water are subject to general corrosion. Therefore, loss of material due to general corrosion is an aging effect requiring management for carbon and low alloy steel in outdoor and sheltered environments. Stainless steel is not susceptible to general corrosion.

Crevice Corrosion

Crevice corrosion is localized corrosion within crevices or shielded areas. It most frequently occurs in connections, lap joints, splice plates, bolt threads, under bolt heads, or points of contact between metals and non-metals, and it is associated with a stagnant or low flow solution (an electrolyte). Per EPRI Report 1015078 [3-33], to function as a corrosion site, the crevice must be wide enough to permit liquid entry and narrow enough to maintain a stagnant zone, typically a few thousandths of an inch or less.

Crevice corrosion is strongly dependent on the presence of dissolved oxygen. Any surface exposed to atmospheric conditions will be saturated in oxygen above the threshold levels for crevice corrosion to occur (0.1 ppm). This form of corrosion, as the name implies, requires a crevice in which contaminants and corrosion products can concentrate. In addition to oxygen, moisture is required for the mechanism to operate. Typically, atmospheric pollutants and contaminants, both indoors and outdoors, are insufficient to concentrate and thereby promote crevice corrosion. Per EPRI Report 1015078 [3-33], alternating wetting and drying is particularly harmful because this leads to a concentration of atmospheric pollutants and contaminants.

Air with enough moisture can facilitate the loss of material in steel caused by crevice corrosion. Therefore, loss of material due to crevice corrosion is an aging effect requiring management for carbon steel, low alloy steel, and stainless steel in outdoor, and sheltered environments.

Pitting Corrosion

Pitting corrosion is a localized corrosive attack in aqueous environments containing dissolved oxygen and chlorides. When passivity breaks down at a spot on a metal surface, an electrolytic cell is formed with the anode at the minute area of active metal and the cathode at the considerable area of passive metal. The large electric potential difference between the two areas accounts for considerable flow of current with rapid corrosion at the anode. The anode does not spread because it is surrounded by passive metal, and as the mechanism continues, it penetrates deeper into the metal, forming a pit. Pitting corrosion is more common with passive materials such as austenitic (300 Series) stainless steels than with non-passive materials, such as carbon steels. However, all materials of interest are susceptible to pitting corrosion under certain conditions. See EPRI Report 1015078 [3-33].

Oxygen is required for pitting initiation. Areas in which aggressive species can concentrate, that is, locations of frequent or prolonged wetting or of alternate wetting and drying, are particularly susceptible to pitting. Per EPRI Report 1015078 [3-33], most pitting is the result of halide contamination, with chlorides, bromides, and hypochlorites being prevalent.

Loss of material due to pitting corrosion is an aging effect requiring management for carbon steel, low alloy steel, and stainless steel in outdoor and sheltered environments.

Galvanic Corrosion

Galvanic corrosion occurs when two or more metals of differing electrochemical potential are in electrical contact in a conducting environment (the presence of an electrolyte). Under these conditions, an electrolytic cell is formed transmitting an electrical current between an anode and a cathode. Loss of material occurs when ions of the metal with the lower potential, the anode, are being depleted and deposited onto the more noble metal, the cathode. Galvanic corrosion will not occur in a dry environment; an electrolyte must be present and remain liquid. The ratio between surface areas of the metals in contact is of significant importance. Per EPRI Report 1015078 [3-33], corrosion rates increase when the more noble metal has a greater surface area than the more active metal in the presence of moisture and water.

One instance of the TC components coming in contact with dissimilar metals is where the graphite lubricant is in contact with the TC rails, inner shell, and bottom end closure (due to the potential for the lubricant to flow off the rails and onto the inner shell or bottom end closure). Because the graphite lubricant is noble relative to the stainless steel components, there is the potential for galvanic corrosion of the TC rails, inner shell, and bottom end closure. Therefore, loss of material due to galvanic corrosion of the rail face, inner shell, and bottom end closure is an aging effect requiring management in a sheltered environment.

Wear

General wear may occur as a result of movement of one material with respect to another. One type of wear applicable to the external portions of equipment is the result of relative motion between components called fretting. Fretting is the loss of material that occurs as a result of relative motion between two materials.

The DSC is designed to slide from the TC into the HSM and back without undue galling, scratching, gouging, or other damage to the sliding surfaces. This is accomplished by the addition of Nitronic® 60 austenitic stainless steel sliding rails to the TC. Furthermore, there is OE with scratching of the cask liner and trunnions. The MP187 TC is in storage at the Rancho Seco site and is not in routine use. Therefore, loss of material due to wear is not an aging effect requiring management for the TC Nitronic® 60 rails, the TC inner shell, and the trunnions.

Stress Corrosion Cracking

SCC is a localized non-ductile cracking failure resulting from an unfavorable combination of sustained tensile stresses either applied (external) or residual (internal), material condition, and the presence of a corrosive environment. SCC is a phenomenon that occurs in austenitic stainless steels, but becomes significant only if tensile stress and a corrosive environment exist. In most cases, SCC involves crack initiation, subcritical crack growth, and failure when the crack reaches a critical size and the tensile strength of the remaining material is exceeded. According to EPRI Report 015078 [3-33], dissolved oxygen, sulfates, fluorides, and chlorides can provide the necessary environment for SCC to occur.

Chloride Induced Stress Corrosion Cracking (CISCC)

Operating experience documented in NRC Information Notice 2012-20 [3-10], has shown that austenitic stainless steels under tensile stresses are known to be susceptible to CISCC when exposed to chlorides in the environment. This phenomenon is of concern at temperature and relative humidity combinations that allow the chloride compounds to deliquesce. Airborne salts could deposit

on the material surface, then form chloride-rich deliquescent brines in conditions of high relative humidity. Operating experience showed that through wall cracking attributed to CISCC in austenitic stainless steel piping exposed to atmospheric conditions near saltwater bodies occurred at three plants in the United States at service lives of 16, 25, and 33 years.

It is possible for airborne chloride salts to deposit on the TC stainless steel surfaces, particularly if the TC is in service at locations with significant chloride aerosols. However, it is highly unlikely that CISCC will occur for the MP187 TC since all of the Rancho Seco SFAs and GTCC waste have been loaded and placed into the HSMs for interim storage. The MP187 TC is currently stored in a sheltered environment at the Rancho Seco site and is not exposed to external ambient environmental conditions (rain, wind or snow). More importantly, the Rancho Seco ISFSI is far away from salt water bodies and thus it is unlikely that TC surface salt concentrations reach concentration levels that might be conducive to CISCC.

Based on the above discussion, the conditions for deposition of chloride-containing salts to reach concentration levels necessary for CISCC to occur on the TC external surfaces are not present. This is confirmed by the Rancho Seco Pre-Inspection [3-8] conducted after 15 years of exposure of the MP187 TC to the sheltered environment at the Rancho Seco ISFSI. Therefore, cracking due to CISCC is not an aging effect requiring management.

Thermal Fatigue

Thermal fatigue is the progressive and localized structural damage that occurs when a material is subjected to cyclic loading associated with thermal cycling. Potential thermal fatigue of the TC may be due to temperature fluctuations associated with transfer operations of a loaded DSC from the time fuel is loaded into the DSC until the DSC is pushed from the cask and loaded into the HSM.

Appendix A documents the TLAA performed to evaluate the effects of pressure and temperature fluctuations in accordance with the provisions of NB 3222.4(d) of the ASME B&PV Code [3-14]. As provided by NB 3222.4(d) of the ASME B&PV Code, fatigue effects need not be specifically evaluated provided the six criteria in NB 3222.4(d) are met.

The number of loading cycles used is based on a conservative average of 20 uses per year of a TC, for a service life of 60 years, or 1,200 uses per loaded TC. The evaluation demonstrates that the six criteria, (a) through (f), contained in NB 3222.4(d) are satisfied for all components of the TCs. Therefore, cracking *of the TC subcomponents due to the thermal fatigue is an aging effect managed via a TLAA*.

Thermal Aging

Steels in the TC are used in the annealed condition, except for the precipitation hardened trunnions and optionally cold-worked Nitronic® 60 rails. Maximum TC temperatures are well below the levels that would permanently affect the trunnion mechanical properties. Therefore, *change in material properties due to* thermal aging is not an aging effect requiring management for TC subcomponents.

Irradiation Embrittlement

High neutron radiation can cause loss of fracture toughness in steel. However, the neutron radiation seen by the metal components of dry fuel storage systems are orders of magnitude lower than that required to produce any significant effect, so neutron radiation is not a significant aging effect for the steel components. Gamma radiation does not have any significant impact on the properties of steel.

The TC, no longer in routine operation, was subjected to neutron fluence and gamma exposure only when a loaded DSC was in the cask during loading and transfer operations. Since the exposure of the TC to neutron fluence was limited to a very short duration, the *supplemental* evaluation presented in Appendix A for radiation exposure on DSC steel materials bounds radiation exposure for the TC.

Neutron irradiation may also result in generation of combustible gases in the neutron shielding material of the TC which is discussed in the next section.

3.7.4.3 Other Materials

This section describes the aging effects that could, if left unmanaged, cause degradation of TC shielding material (lead and NS-3) and result in loss of the component intended function(s).

The TC is constructed from three concentric cylindrical shells to form an inner and outer annulus. The inner annulus is filled with cast lead. The outer annulus is filled with a solid neutron shielding material, NS-3. The two inner shells are welded to heavy forged ring assemblies at the top and bottom ends of the cask.

Two trunnion assemblies, located in the upper region of the transfer cask the TC are fabricated as a hollow assembly, which is filled with NS-3.

The aging effects that could cause loss of intended function(s) are:

- Change in Material Properties

The lead shielding material of the TC is completely encased in the inner annulus. Shrinkage gaps formed as the lead is cooled from the bottom up are filled by a pool of molten lead maintained above the solidified bottom until the lead pour is complete. Therefore, the lead is in full surface contact with the inner shell. No electrolyte is present for galvanic corrosion of lead in contact with stainless steel. The dry conditions preclude general or pitting corrosion as well. Lead creep, which could result in local shielding reduction, is not a concern due to the full and tight encasement of the lead.

The MP187 TC outer annulus is filled with NS-3, a neutron shielding material. NUREG/ CR-7116 “Materials Aging Issues and Aging Management for Extended Storage and Transportation of Spent Nuclear Fuel” [3-6] indicates that neutron shielding degradation is primarily applicable to polymeric materials. These materials are subject to degradation and reduced shielding effectiveness as a result of thermal and radiation exposure. In addition, radiolytic decomposition of polymeric materials may result in generation of combustible gases.

A *supplemental* evaluation has been performed (see Appendix A). This evaluation shows that the amount of combustible gases generated due to radiolysis is statistically insignificant.

Therefore, there is no degradation of the solid neutron shield or the lead during the period of extended operation that requires aging management.

3.7.4.4 Coating Evaluation

The DSC support rails of the TC are coated with a dry film lubricant, a NITS component, to minimize friction during insertion and retrieval of the DSC. The dry film lubricant provides a thin, clean, dry layer of lubricating solids to reduce wear and prevent galling. It is applied before each loading campaign. Graphite lubricants are suitable from very high to cryogenic temperature applications. The lubricant is not affected by water and is designed to be highly resistant to aggressive chemicals. The lubricant suffers no radiation effects because it consists entirely of graphite. *The coefficient of friction associated with these lubricants is below 0.05, while the design basis calculations employed a coefficient of friction of 0.25. The mechanical system used for DSC transfer is capable of exerting an extraction force equal to the loaded weight of a DSC. An effective coefficient of friction of 100% (assuming no lubrication) has been used for these “jammed DSC analyses.” The support structure is also designed for this loading. Therefore, dry lubricant deterioration is not an aging effect requiring aging management since the dry film lubricant is not relied upon for DSC retrievability.*

3.7.4.5 Summary of Aging Effects Requiring Management

The following aging effects and mechanisms for steel components are applicable:

Loss of Material

- Loss of material due to general corrosion – carbon steel
- Loss of material due to crevice corrosion – carbon steel and stainless steel
- Loss of material due to pitting corrosion – carbon steel and stainless steel
- *Loss of material due to galvanic corrosion - stainless steel rail, inner shell, and bottom end closure*

Cracking

- *Cracking due to thermal fatigue – carbon steel and stainless steel*

3.7.5 Aging Management Activities for the NUHOMS® MP187 Transfer Cask (TC)

3.7.5.1 TC Time-Limited Aging Analysis

Appendix A documents the thermal fatigue analysis of the TC for pressure and temperature fluctuations in accordance with the provisions of NB 3222.4(d) of the ASME B&PV Code [3-14]. As provided by NB 3222.4(d) of the ASME B&PV Code, fatigue effects need not be specifically evaluated provided the six criteria in NB 3222.4(d) are met. This evaluation is performed considering a 60-year service life using maximum bounding initial TC pressures and temperatures (at the beginning of storage). This evaluation shows that all the six criteria of NB 3222.4(d) are met.

3.7.5.2 TC Aging Management Programs

The MP187 TC has not been in-service for more than 11 years since all the Rancho Seco SFAs and GTCC waste have been placed into the ISFSI in 2006. However, the only remaining TC safety function during the PEO is retrieval of the DSCs from the HSMs prior to offsite shipment of the DSCs.

The TC AMP, described in Appendix B.5, is employed to manage the aging effects and mechanisms for the DSC:

Rancho Seco will perform the inspections and monitoring activities described in this AMP prior to use to identify areas of degradation. Evaluation of this information during preparations for DSC retrieval and transfer provides adequate predictability and allows time for corrective action, if required, in order for the TC to perform its intended functions.

3.7.5.3 Summary of the AMR Results for the TC

Table 3-10 summarizes the results of the AMR for the TC.

Table 3-9
Transfer Cask Materials

TC Subcomponents	Material
Cask Top Cover Assembly	Stainless steel Elastomeric O-ring
Shell Assembly (Top Flange, Bottom End Forging, Bottom End Plate, Bottom Support Plate, Ram Access Penetration Forging, Inner Liner)	Stainless steel
Structural Shell Assembly (Structural Shell)	Stainless steel
Upper Trunnion Assemblies (Trunnion Sleeves, Trunnions)	Stainless steel NS-3
Lower Trunnion Assemblies (Trunnion Sleeves, Trunnions)	Stainless steel
Gamma Shielding	Lead
Neutron Shielding	NS-3
Neutron Shield Assembly (Neutron Shield Panels (NSP), NSP Top and Bottom Support Rings, NSP Support Angles)	Stainless steel
Canister Rails	Nitronic® 60
Cask Bottom Ram Penetration cover plate	Stainless steel Elastomer O-ring
Fasteners (Cask Top Cover Closure Screws, Bottom Ram Plate Closure Screws)	Carbon steel, Stainless steel

Table 3-10
MP187 TC Intended Functions and AMR Results
(4 pages)

Subcomponent(2)	Subcomponent Parts(2)	Intended Function(1) (2)	Storage Environment (3)	Aging Effects Requiring Management (4)	Aging Management Activity (4)
Main Assembly	Inner Shell	SH, SS, HT, RE	Sheltered / Encased	Loss of Material, Cracking	AMP
Main Assembly	Bottom End Closure	SH, SS	Sheltered	Loss of Material	AMP
Main Assembly	Bottom Structural Shell	SH, SS, HT, RE	Encased / Sheltered	Loss of Material, Cracking	AMP
Main Assembly	Top Structural Shell	SH, SS, HT, RE	Encased / Sheltered	Loss of Material	AMP
Main Assembly	Top Flange	SH, SS	Sheltered	Loss of Material	AMP
Main Assembly	Gamma Shielding	SH, HT	Encased	None Identified	None Required
Main Assembly	Upper Trunnion Plug Cover & Side Plate	SS	Encased / Sheltered	Loss of Material	AMP
Main Assembly	Upper Trunnion Sleeve	SH, SS, RE	Encased / Sheltered	Loss of Material	AMP
Main Assembly	Lower Trunnion Sleeve	SH, SS	Encased / Sheltered	Loss of Material	AMP
Main Assembly	Pad Plate	SS	Encased	None Identified	None Required
Main Assembly	Bearing Block	SS	Encased / Sheltered	Loss of Material	AMP
Main Assembly	Tie Bar	SS	Encased / Sheltered	Loss of Material	AMP
Main Assembly	NSP Top & Bottom Support Ring	SH, SS, HT	Encased / Sheltered	Loss of Material, Cracking	AMP
Main Assembly	NSP Support Angle, Outer	SH, SS, HT	Encased	None Identified	None Required

Table 3-10
MP187 TC Intended Functions and AMR Results
(4 pages)

Subcomponent[(2)]	Subcomponent Parts[(2)]	Intended Function[(1) (2)]	Storage Environment [(3)]	Aging Effects Requiring Management *(4)*	Aging Management Activity *(4)*
Main Assembly	Rupture Plug	SH	Encased / Sheltered	Loss of Material	AMP
Main Assembly	Plugs	SH		Loss of Material, Cracking	AMP
Main Assembly	Neutron Shield Shell	SH, SS, HT	Sheltered	Loss of Material, Cracking	AMP
Main Assembly	Upper Trunnion Plug Bottom Plate	SH, SS	Encased / Sheltered	Loss of Material,	AMP
Main Assembly	Rails	SS, RE	Sheltered	Loss of Material, Cracking	AMP
Main Assembly / On-Site Transfer	Castable Neutron Shielding Material	SH	Encased	None Identified	None Required
Main Assembly	Ram Closure Plate	SH, SS, RE	Sheltered	Loss of Material	AMP
Main Assembly	Top Closure Plate	SH, SS, RE	Sheltered	Loss of Material	AMP
Main Assembly	Screw, Cap Hd. Soc.	SS, RE	Sheltered	Loss of Material	AMP
Main Assembly	Filler Plate	SH, SS	Encased / Sheltered	Loss of Material	AMP
Main Assembly	Hardened Washer (3" & 1.5" OD)	SS	Sheltered	Loss of Material	AMP
Main Assembly	Test Port Screw	SS	Sheltered	Loss of Material	AMP
Main Assembly	Vent/Drain Port Screw	SS	Sheltered	Loss of Material	AMP
Main Assembly	Lower Trunnion Plug Cover Plate	SS	Encased / Sheltered	Loss of Material	AMP
Main Assembly	Lower Trunnion Plug Shield Block	SH, SS, RE	Encased / Sheltered	Loss of Material	AMP

Table 3-10
MP187 TC Intended Functions and AMR Results
(4 pages)

Subcomponent[2]	Subcomponent Parts[2]		Intended Function[1] [2]	Storage Environment [3]	Aging Effects Requiring Management [4]	Aging Management Activity [4]
Main Assembly	Screw, Flat Hd. Cap		SS	Sheltered	Loss of Material	AMP
Main Assembly	NSP Support Angle, Inner		SH, SS, HT	Sheltered	Loss of Material	AMP
Main Assembly	Screw Thread Insert (1” and 2”)		SS, RE	Encased / Sheltered	Loss of Material	AMP
Main Assembly	10 Gage Sheet		SS	Encased / Sheltered	Loss of Material	AMP
On-Site Transfer	Outer Plug Cover Plate		SH	Encased / Sheltered	Loss of Material	AMP
On-Site Transfer	Outer Plug Sleeve		SS	Encased / Sheltered	Loss of Material	AMP
On-Site Transfer	Nut, 1/2-13UNC-2B		SS	Encased / Sheltered	Loss of Material	AMP
On-Site Transfer	Inner Plug Cover Plate		SH	Encased / Sheltered	Loss of Material	AMP
On-Site Transfer	Inner Plug Sleeve		SS	Encased / Sheltered	Loss of Material	AMP
On-Site Transfer	Inner Plug Inside Sleeve		SS	Encased / Sheltered	Loss of Material[6]	AMP
On-Site Transfer	Bolt, 1-8UNC-2A		SS	Sheltered	Loss of Material	AMP
On-Site Transfer	Outer Plug Support Bracket		SS	Sheltered	Loss of Material	AMP

Table 3-10
MP187 TC Intended Functions and AMR Results
(4 pages)

Subcomponent(2)	Subcomponent Parts(2)		Intended Function(1) (2)	Storage Environment (3)	Aging Effects Requiring Management (4)	Aging Management Activity (4)
On-Site Transfer	Key Plug Cover Plate		SS	Encased / Sheltered	Loss of Material	AMP
On-Site Transfer	Flat Hd Socket Cap Screw		SS	Sheltered	Loss of Material	AMP
On-Site Transfer	Socket Hd Cap Screw		SS	Sheltered	Loss of Material	AMP
On-Site Transfer	Lower Trunnion		SH, SS	Sheltered	Loss of Material	AMP
On-Site Transfer	Upper Trunnion		SH, SS, RE	Sheltered	Loss of Material	AMP
On-Site Transfer	Trunnion Back		SS	Encased / Sheltered	Loss of Material	AMP
On-Site Transfer	Key Plug Side Plate		SS	Encased / Sheltered	Loss of Material	AMP
On-Site Transfer	Key Plug Bottom Plate		SS	Encased / Sheltered	Loss of Material	AMP

Notes:

(1) Abbreviations for Intended Function Column:

PB Directly or indirectly maintains a pressure boundary (confinement)
SH Provides radiation shielding
CC Provides criticality control of spent fuel
SS Provides structural support
HT Provides heat transfer
RE Retrievability

(2) Only in-scope subcomponents from Chapter 2, Table 2-8 are listed in this table.

(3) The TC operations are intermittent and following the completion of each fuel loading campaign all exposed cask surfaces are thoroughly cleaned to remove potential contamination. Therefore, the Aging Management Results are based on the Encased / Sheltered environments.

(4) Cracking due to thermal fatigue of the transfer cask subcomponents has been addressed by performing a TLAA that bounds all subcomponents.

3.8 Aging Management Review Results – Spent Fuel Assemblies

The intended functions of the SFAs include criticality control, confinement, structural integrity, and heat transfer. The geometry of the SFA is a factor in the proper conduction and convection of heat to the DSC surface and in the criticality model. The fuel cladding provides a confinement barrier, and its structural integrity is necessary to maintain a favorable geometry and for retrieval. After fuel loading and DSC drying, the SFAs are not moderated, ensuring subcriticality during subsequent operations and configurations. The SFA principal function during dry storage is to maintain proper geometry and position of radioactive material through confinement. No credit is taken in the safety analysis for the fuel cladding as a confinement boundary.

The evaluation boundary for the SFA includes the fuel cladding and end plugs, guide tubes, grid assemblies, upper nozzle, and bottom nozzle, which perform the following intended functions (MAPS designations in parentheses, if different):

- CC (CR) Provides criticality control
- HT (TH) Provides heat transfer
- PB (CO) Directly or indirectly maintains a pressure boundary (confinement)
- SS (SR) Provides structural support (structural integrity)

3.8.1 Description of Spent Fuel Assembly Subcomponents

Chapter 2, Section 2.4.4, provides a general description of the B&W 15x15 SFA subcomponents. The characteristics of the SFAs and GTCC waste stored at the Rancho Seco ISFSI are listed in Chapter 2, Tables 2-2 and 2-3, respectively. The in-scope SFA subcomponents and their intended functions are listed in Chapter 2, Table 2-9.

3.8.2 Spent Fuel Assemblies Materials Evaluated

The materials of construction of the SFA hardware consist of Zirconium-based alloys, stainless steel and nickel-based alloys.

The AMR for the SFAs focuses primarily on the fuel rod cladding as it is considered the limiting component of the FA hardware because it serves as a barrier to fission products, provides defense-in-depth, and maintenance of its structural integrity ensures its retrievability from the DSC (See Section 2.2.1 for the canister based licensing basis for retrievability for the Rancho Seco ISFSI.) Though fuel cladding is the first barrier for confinement of radioactive materials, no credit for confinement of radioactive material is taken for the fuel cladding in the SMUD ISFSI design and licensing basis. The DSC pressure boundary is the only credited confinement boundary. As stated in EPRI TR-108757, Data Needs for Long-Term Dry Storage of LWR Fuel [3-35], the impact of irradiation on stainless steel and nickel-based superalloys during storage is less than in the reactor environment. Furthermore, annealing temperatures are bounded by that of zircaloy. According to EPRI TR-108757 [3-35], "storage temperatures are too low to anneal out the radiation damage in stainless steel or nickel-based alloys [and] no significant changes are expected to occur in stainless steels and nickel-based superalloys during dry storage."

3.8.3 Environments for the Spent Fuel Assemblies

The environments that affect the subcomponents of each SFA, both externally and internally, are those that are normally (continuously) experienced and are described below:

External

For SFAs, external environment refers to the internal DSC atmosphere. The storage atmosphere is predominantly helium with trace amounts of water vapor and air.

Additionally, boric acid residue may coat the PWR SFA surfaces, since they were exposed to a borated water environment in the spent fuel pool prior to storage. Any boric acid residue remaining on the SFAs will have no deleterious effects due to the absence of water and due to the materials of construction for the SFAs.

In dry storage, the SFA subcomponents that are subject to aging management review are stored in an inert helium environment.

The maximum cladding temperature at the beginning of storage for SFAs loaded in the FO/FC DSCs is 746 °F (397 °C) for off-normal conditions as presented in Volume II, Table 8-5 of the ISFSI FSAR [3-15]. *This is greater than the normal temperature of 714 °F (379 °C), but less than the fuel cladding acceptance criteria of 1058 °F (570 °C).* The FF and GTCC DSC thermal analysis results are bounded by the FO/FC DSC thermal analysis results.

Internal

For SFAs, internal environment refers to the fuel rod interior. The fuel rods were pressurized with helium during manufacturing. For purposes of this evaluation, the fuel rod internal environment is assumed to be a combination of the original helium fill gas and fission products produced during reactor operation.

3.8.4 Aging Effects Requiring Management for the Spent Fuel Assemblies

This section identifies the possible effects of storage on SFA. Relevant EPRI, ASTM, and NRC documents were used to identify the possible aging effects. The following sections discuss those documents. Only creep, and hydrogen embrittlement are considered potential degradation mechanisms for SFAs.

EPRI Report on Data Needs for Storage

EPRI contracted with Battelle's Pacific Northwest Division to prepare a report (EPRI TR-108757 [3-35]) on data needs for long-term dry storage. The report discusses available data and its usefulness in treating some degradation mechanisms. The emphasis of this report is on fuel performance during the period from 20 to 100 years after the fuel is placed into dry storage.

The report's summary section provides an assessment of the durability of spent fuel: "The results obtained so far lead to the view that any concerns about long-term dry storage, in all likelihood, do not lie with the behavior of the SFAs - at least for those with burnups lower than ~50,000 MWd/MTU." The remainder of the report provides details to support this conclusion.

EPRI Report on Bases for Extended Dry Storage

EPRI produced a second report EPRI 1003416, Technical Bases for Extended Dry Storage of Spent Nuclear Fuel [3-36], which to some extent, is a supplement to EPRI TR-108757 [3-35]. The report reviews possible fuel and cladding degradation mechanisms. As discussed, only hydrogen embrittlement was considered applicable to extended dry storage under normal conditions.

ASTM Standard on Extended Dry Storage

The ASTM produced a consensus standard, which discusses possible fuel and cladding degradation mechanisms. This standard also views embrittlement as a degradation mechanism applicable to extended dry storage, ASTM C1562-10 [3-32].

Dry Cask Storage Characterization Project

In the mid-1980s, DOE sponsored a program to evaluate the thermal performance of a CASTOR dry storage cask, EPRI Report 1002882 [3-34]. Surry PWR fuel was placed in it and exposed to six thermal cycles (referred to as “benchmark testing”); the two hottest cycles reached fuel cladding temperatures of 415 °C (779 °F) and 398 °C (748 °F). After the last thermal test, the cask was stored on a concrete pad for about 15 years.

As part of an EPRI and NRC program to evaluate dry storage facility license renewal, fuel from this cask was then removed and examined. The FA was a Westinghouse 15x15 assembly with an assembly-averaged burnup of 35.7 GWd/MTU. The fuel was 3.11% enriched and 95% dense. The cladding was cold-worked/stressed relieved Zircaloy-4.

Detailed examination showed that the fuel was suitable for extended storage. No deleterious effects, such as fission gas release, cladding creep, cladding hydride reorientation, or cladding property degradation, was observed.

In terms of cladding material, assembly burnup, and pellet enrichment, this fuel is similar to that being stored at the Rancho Seco ISFSI. Therefore, the report’s observations are also applicable to Rancho Seco SFAs:

- The rods experienced very little thermal creep during benchmark testing and storage. Little additional creep would be expected for additional storage duration because of the low temperature.
- No additional fission gas appears to have been released. This means further pressurization of the cask is not expected.
- No evidence of hydrogen pickup or hydride reorientation was observed. A small amount of axial migration of hydrogen to cooler sections might have occurred.
- Little or no cladding annealing occurred during either the benchmark testing or long-term storage.
- Creep tests on post-storage samples showed residual creep strains exceeding 1% with the 400 °C sample exceeding 6%. The cladding retains significant creep ductility.
- The fuel was suitable for extended storage.
- No deleterious effects from 15 years of dry cask storage were observed.

Cladding Considerations for the Transportation and Storage of Spent Fuel

Interim Staff Guidance ISG-11 Revision 3, Cladding Considerations for the Transportation and Storage of Spent Fuel [3-44] defines the acceptance criteria needed to provide reasonable assurance that commercial spent fuel is maintained in the configuration that is analyzed by a licensee.

The NRC discussed the applicability of this ISG to storage of fuel with burnups less than 45 GWd/MTU. “Based on staff’s evaluation, it is expected that FAs with burnups less than 45 GWd/MTU are not likely to have a significant amount of hydride reorientation due to limited hydride content. Even if hydride reorientation occurred during storage, the network of reoriented hydrides is not expected to be extensive enough in low burnup fuel to cause fuel rod failures.”

Creep is a potentially active degradation mechanism during the period of extended operation. The relatively high initial temperatures, differential pressures, and corresponding hoop stress on the cladding could potentially result in permanent creep deformation of the cladding over time.

Tests to assess creep performance of cladding under long-term storage are documented in NUREG/CR-6831, Examination of Spent PWR Fuel Rods after 15 Years in Dry Storage [3-43]. Fuel rods were stored for 15 years at an initial temperature of 350 °C (662 °F) (and reached as high as 415 °C (779 °F) for up to 72 hours during the performance testing at the beginning of storage). Pre- and post-storage creep tests results show that the spent fuel cladding has significant creep capacity even after 15 years of dry cask storage. The creep tests of fuel rods indicated that the creep deformation was uniform around the circumference of the cladding with no signs of localized bulging, which can be a precursor to rupture. In general, the data and analyses support the conclusions that:

- deformation caused by creep will proceed slowly over time and will decrease the rod pressure,
- the decreasing cladding temperature also decreases the hoop stress, which also slows the creep rate so that during later stages of dry storage, further creep deformation will become exceedingly small, and
- in the unlikely event that a breach of the cladding due to creep occurs, it is believed that this will not result in gross rupture.

Conclusions

Creep is identified as a potentially active degradation mechanism during the period of extended operation. The extensive work of creep, documented in NUREG/CR-6831 [3-43], generally supports the conclusions that creep deformation is a slow process. Under long-term storage, creep deformations will be exceedingly small because the creep rate will slow down due to decreasing temperatures in the period of extended operation.

This section also identified that low to moderate burnup fuel is not impacted by either of these mechanisms as documented in EPRI Report TR-108757 [3-35] and EPRI Report 1003416 [3-36]. The results of the Dry Cask Storage Characterization Project [3-34] support the conclusion that low burnup SFAs will not degrade under extended storage.

3.8.5 Aging Management Activities for the Spent Fuel Assemblies

The materials inside the DSC, including the SFAs, cannot practically be inspected in-situ due to radiation levels and accessibility (i.e., DSC is seal welded). In preparation for dry storage, the DSC internals are vacuum dried and backfilled with helium to establish an inert gas environment in the DSC cavity. The DSC is leak tested to ensure that the inert gas environment is maintained so that the SFAs will not become subject to age-related degradation mechanisms during the storage period. A demonstration project provides the basis for the assertion that the SFAs will not degrade to unacceptable levels during the period of extended operation, NUREG/CR-6831 [3-43] and EPRI Report 1002882 [3-34].

3.8.5.1 Aging Management Program

There are no aging effects that require management for low to moderate burnup fuel (≤ 45 GWd/MTU) that is stored in an inert environment. Safe storage of low to moderate burnup fuel has been demonstrated in NUREG/CR-6831 [3-43] and EPRI Report 1002882 [3-34]. Therefore, reasonable assurance is provided that the intended functions of the SFAs will be maintained under current licensing basis conditions during the PEO.

Therefore, no aging management program or activities are credited during the PEO for the Rancho Seco low burnup SFAs and associated subcomponents.

3.9 Periodic Tollgate Assessment

Industry guidance on the preparation of ISFSI LRAs is contained in NEI 14-03, "Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management," [3-19]. This NEI document introduces the concept of "tollgates" and "tollgate assessments" and provides specific guidance in Section 3.6.5 and Appendix C. SMUD will perform tollgate assessments during the PEO of the Rancho Seco ISFSI, spanning the period from June 30, 2020 through June 30, 2060 or the date the last licensed material is removed from the Rancho Seco ISFSI, whichever occurs sooner.

SMUD may choose to integrate the tollgate assessment into existing Rancho Seco ISFSI assessment programs, while continuing to meet the underlying intent of the tollgate concept. Tollgate assessments for the Rancho Seco ISFSI will be performed in accordance with Table 3-11.

In order to prepare the tollgate assessments effectively, SMUD will participate in, and have access to the Industry's Aging Management Institute of Nuclear Power Operation Database (AMID) via the NUHOMS® Dry Storage System (DSS) vendor, TN Americas. SMUD will review the AMID for relevant information to support the preparation of the tollgates assessments and will prepare those assessments as recommended in NEI 14-03 [3-19].

It is important to note that the tollgate process is not a substitute for the other SMUD OE reviews or the SMUD corrective action program. Operating Experience and other information or events pertaining to ISFSI aging-related issues that SMUD becomes aware of will be reviewed for relevance to the Rancho Seco ISFSI. As a result, actions will be taken in a timeframe commensurate with the safety significance of the issue. Relevant items will be addressed in the SMUD corrective action program, as appropriate.

The preparation of tollgate assessments during the PEO will be an administratively controlled by procedure.

Table 3-11
Rancho Seco ISFSI Tollgates

TOLL GATE	DUE DATE	ASSESSMENT
1	6/30/2025	Evaluate information from the following sources and perform a written assessment of the aggregate impact of the information, including but not limited to applicable and relevant 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 DSS ISFSIs; – Relevant domestic and international OE including research results on aging effects/mechanisms (including non-nuclear on an opportunistic basis); – Relevant results of domestic and international ISFSI and DSS performance monitoring; – Relevant results of domestic and international ISFSI and DSS inspections Topics of particular interest for the Rancho Seco ISFSI tollgate assessment should include the following: – Reinforced concrete degradation in general, and degradation of NUHOMS® HSMs in particular – Deterioration of carbon steel and coatings
2	6/30/2030	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 and later	No more than five years after completion of the previous tollgate assessment	Same as Tollgate 1, as informed by the results of Tollgates 1 and 2

3.10 Conclusions

The AMR was conducted using the guidance in NUREG-1927 [3-1], NEI 14-03 [3-19], and, to the extent possible, the draft MAPS Report [3-68]. The SSCs determined to be within the scope of renewal are evaluated for aging effects and mechanisms that could adversely affect their ability to perform their intended safety function during the PEO. For each SSC, the aging effects and associated aging mechanism that could cause degradation, or could result in loss of intended function, are evaluated. These evaluations result in TLAAs or AMPs.

TLAAs, described in Appendix A, are prepared to assess SSCs that have a time-dependent operating life to demonstrate that the existing licensing basis remains valid, and that the intended functions of the SSCs in scope of renewal are maintained during the period of extended operation. The following TLAAs have been developed for the Rancho Seco SSCs:

- Fatigue Analysis of NUHOMS® DSC Shell Assembly (Appendix A)
- Fatigue Analysis of NUHOMS® MP187 Transfer Cask (TC) (Appendix A)
- Boron Depletion (Appendix A)

In addition, supplemental evaluation*s (Appendix A) were* performed to *show that* the *following aging mechanisms did not require aging management:*

- *Irradiation embrittlement*
- *Combustible gas generation*

AMPs, described in Appendix B, are developed for managing the effects of aging for those components and aging effects where a TLAA cannot be performed. The following AMPs describe the activities that need to be implemented to monitor and manage the aging effects.

- DSC External Surfaces Aging Management Program (Appendix B.3)
- HSM Aging Management Program (Appendix B.4)
- Transfer Cask, MP187 Aging Management Program (Appendix B.5)
- Basemat Aging Management Program (Appendix B.6)

The results of the AMR and the implementation of the associated AMAs described in this chapter provide reasonable assurance that the intended functions of the Rancho Seco ISFSI in-scope SSCs will be maintained during the requested 40-year period of extended operation.

3.11 References

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3-22 ACI 201.1-08, “Guide for Conducting a Visual Inspection of Concrete in Service.”

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APPENDIX A
TIME-LIMITED AGING ANALYSIS (TLAA) AND OTHER SUPPORTING ANALYSES FOR THE RANCHO SECO ISFSI

CONTENTS

LIST OF TABLES

A.1 Summary Description

This appendix discusses the results for each of the Time-Limited Aging Analyses (TLAAs) evaluated for license renewal. The analyses were evaluated for a time period of 60 years, which covers the entirety of the original and renewed license period. The basis for these TLAAs is the system design documented in The Topical Report for the NUTECH Horizontal Modular Storage System for Irradiated Nuclear Fuel, NUHOMS®- 24P, [A-4] and the Safety Analysis Report for Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel, [A-5].

A.2 Analyses

A.2.1 Fatigue Analysis of the NUHOMS® DSC Shell Assembly

The AREVA TN Calculation 502917-0201 Rancho Seco License Renewal Dry Storage Canister (DSC) Thermal Fatigue Analysis, Rev 1, [A-7] evaluated the effects of cyclic loading (fatigue) for 60 years on the mechanical properties of the Dry Shielded Canister (DSC) shell assembly, i.e., pressure boundary subcomponents, for the Rancho Seco ISFSI. The evaluation was performed in accordance with the provisions of NB 3222.4(d) ("Rules to Determine Need for Fatigue Analysis of Integral Parts of Vessels") of the applicable ASME B&PV Code, Section III, Division 1, Subsections NB, NF, NG and Appendix I, 1992 Edition through 1993 Addenda, [A-1]. Fatigue effects need not be specifically evaluated provided the six criteria contained in NB 3222.4(d) are met.

An evaluation using these six criteria was performed to show that the ASME B&PV Code fatigue exemption requirements are satisfied for the DSCs at the Rancho Seco ISFSI.

A.2.1.1 Atmospheric To Service Pressure Cycle

The first criterion states that the DSC is adequate for fatigue effects provided that the total number of atmospheric-to-operating pressure cycles during normal operation (including startup and shutdown) does not exceed the number of cycles on the applicable fatigue curve corresponding to an S_a value of three times the S_m value of the material at operating temperatures.

This condition is satisfied for the DSC since the pressure is not cycled during its design life. Apart from minor fluctuations due to seasonal temperature variations, the pressure established at the time that the DSC is sealed following fuel loading and DSC closure operations is constant during normal storage in the Horizontal Storage Module (HSM).

A.2.1.2 Normal Service Pressure Fluctuation

The second criterion states that the DSC is adequate for fatigue effects provided that the specified full range of pressure fluctuations (ΔP) during normal operation does not exceed the quantity:

$$\Delta P \leq \frac{1}{3} \times P_d \times \frac{S_a}{S_m} \qquad \text{(Eq. 1)}$$

Where P_d is the design pressure, S_a is the value obtained from the applicable fatigue curve for the total specified number of significant pressure fluctuations, and S_m is the allowable stress intensity for the material at operating temperatures. Significant pressure fluctuations (ΔP_s) are those for which the total excursion exceeds Equation 1, using a value for S_a corresponding to 10^6 cycles.

Ambient temperature cycles that are significant enough to cause measurable pressure fluctuation are assumed to occur five times per year for 60 years. The number of fluctuations with this pressure range is expected to be 300 for the DSC. Hence, for an S_a value associated with 300 cycles, Equation 1 is equal to 21.6 psig.

For a DSC the total range for a significant pressure fluctuation was calculated to equal 3.5 psig. This small pressure fluctuation may occur during normal storage as a result of seasonal ambient temperature changes.

Since the threshold value of 21.6 psig will not be exceeded during the pressure fluctuation of the DSC, the second criterion is satisfied for the DSC.

A.2.1.3 Temperature Difference – Startup and Shutdown

The third criterion states that the DSC is adequate for fatigue effects provided that the temperature differences between any two adjacent points on the DSC during normal operation do not exceed:

$$\Delta T < \left(\frac{S_a}{2E\alpha}\right) \quad \text{(Eq. 2)}$$

Where S_a is the value obtained from the applicable fatigue curve for the specified number of startup-shutdown cycles, α is the instantaneous coefficient of thermal expansion at the mean value of the temperatures at the two points, and E is the modulus of elasticity at the mean value of the temperatures at the two points.

For an operational cycle of the DSC, thermal gradients occur during fuel loading, DSC closure, transport to the HSM, and transfer of the DSC to the HSM. This half-cycle is approximately reversed for DSC unloading operations.

This normal operational cycle occurs only once in the 60 year design service life of a DSC at Rancho Seco. Since there is only one startup-shutdown cycle associated with the DSC, the value of S_a and, thus the value of (S_a /2Eα), are very large. This is far greater than the temperature difference between any two adjacent points on the canister. Thus, the third criterion is satisfied for the DSC.

A.2.1.4 Temperature Difference – Normal Service

The fourth criterion states that the DSC is adequate for fatigue effects provided that the temperature difference between any two adjacent points on the DSC does not change during normal operation by more than the quantity described in Equation 2.

Small fluctuations in the DSC thermal gradients during normal storage in the HSM occur as a result of seasonal ambient temperature changes. Ambient temperature cycles significant enough to cause a measurable thermal gradient fluctuation are assumed to occur five times per year for 60 years.

For normal service operations, the maximum stress allowed equates to a maximum temperature of 58°F (Equation 2). The most significant fluctuation in normal operating temperature occurs during a maximum change in ambient temperature. This fluctuation results in an estimated change of temperature difference for the DSC of 20°F. The effects of this temperature difference is below the threshold set by Equation 2 under normal service conditions, therefore the fourth condition is satisfied for the DSC.

A.2.1.5 Temperature Difference – Dissimilar Materials

The fifth criterion states that for components fabricated from materials of differing moduli of elasticity or coefficients of thermal expansion, the total algebraic range of temperature fluctuation experienced by the component during normal operation must not exceed the magnitude $S_a/2(E_1\alpha_1 - E_2\alpha_2)$, where S_a is the value obtained from the applicable fatigue curve for the total specified number of significant temperature fluctuations, E_1 and E_2 are the moduli of elasticity, and α_1 and α_2 are the values of the instantaneous coefficients of thermal expansion at the mean temperature value involved for the two materials of construction.

Since the structural material used to construct the DSC is homogeneous (all materials are stainless steel), this fifth condition is not applicable.

A.2.1.6 Mechanical Loads

The sixth criterion states that the DSC is adequate for fatigue effects provided that the specified full range of mechanical loads do not result in a stress range which exceeds the S_a value obtained from the applicable fatigue curve for the total specified number of significant load fluctuations. If the total specified number of significant load fluctuations exceeds 10^6, the S_a value at $N = 10^6$ may be used. A load fluctuation is considered to be significant if the total excursion of stresses exceeds the value of S_a obtained from the applicable fatigue curve for 10^6 cycles.

The only mechanical loads which affect the DSC are those associated with handling loads and a seismic event. One handling load cycle and a major seismic event are postulated during the design life of the DSC. The DSC stresses resulting from these mechanical load fluctuations are small since the structural capacity of the DSC is designed for extreme accident loads such as a postulated cask drop. The number of significant cycles associated with mechanical load fluctuations is conservatively assumed to be 1,000. The value of S_a associated with this number of cycles is 119 ksi. Since the maximum stress range intensity permitted by the code is $3.0S_m$ or 56.1 ksi for SA-240, Type 304 stainless steel at 400°F, this sixth condition is satisfied for the DSC.

A.2.1.7 Conclusion

With the six criteria satisfied for all components of the DSC, per NB-3222.4 (a), "no analysis for cyclic service is required, and it may be assumed that the limits on peak stress intensities as governed by fatigue have been satisfied by compliance with the applicable requirements for material, design, fabrication, examination, and testing" of NB-3222.4 of the ASME B&PV Code.

A.2.2 Fatigue Analysis of the NUHOMS® MP187 Transfer Cask (MP187 TC)

The AREVA TN Calculation 502917-0200 Rancho Seco License Renewal MP187 Multi-Purpose Cask Thermal Fatigue Analysis, Rev 0, [A-6] evaluated the integrity of the MP187 TC due to fatigue loading. As with the fatigue evaluation for the DSC, fatigue effects on the transfer cask are governed by the same six criteria described Section NB 3222.4(d), ASME B&PV Code, Section III, Division 1, Subsections NB, NF, NG and Appendix I, 1992 Edition through 1993 Addenda, [A-1] of the ASME B&PV Code that were used to evaluate the DSC. On-site vertical storage conditions are mentioned in the case that the DSCs are transported to off-site permanent storage and the Transfer Cask moves from the horizontal to vertical condition during the process.

A.2.2.1 Atmospheric To Service Pressure Cycle

For on-site transfer conditions (from the fuel building to the on-site HSM location) the TC is not a pressure retaining boundary; hence this first criterion is not applicable.

For on-site vertical storage conditions the cask is designed to serve as a pressure boundary during vertical storage of a leaking DSC. The pressure established at the time that the cask is sealed, following loading of a leaking DSC and cask closure operations, is maintained during storage operations. Therefore, the cask will experience only one atmospheric-to-operating pressure cycle per vertical storage. As described in Section A.2.1.1, the most limiting S_m is approximately 1,800 psig. This value is far greater than the unlikely DSC leaking event, and thus the first criterion is satisfied.

A.2.2.2 Normal Service Pressure Fluctuation

For on-site transfer conditions the TC is not a pressure retaining boundary; hence the second criterion is not applicable.

For on-site vertical storage conditions, the cask serves as a pressure boundary. In these conditions, the total range of significant pressure fluctuations as described by Equation 1 is 14.1 psig. The most significant fluctuation for normal operating pressure occurs during a maximum change in ambient temperature. This fluctuation results in a maximum pressure change for the TC of approximately 4.5 psig at the maximum total accident pressure case. This value will not be exceeded for on-site vertical storage conditions, and thus the second criterion is satisfied.

A.2.2.3 Temperature Difference – Startup and Shutdown

For on-site transfer conditions, during an operational cycle of the cask, thermal gradients occur during fuel loading, cask closure, transportation, and unloading of the DSC. Conservatively assuming the TC will be used 1,200 times, for the most limiting case, Equation 2 is equal to 210˚F. This is greater than the temperature difference between any adjacent points on the cask, and thus the third criterion is satisfied.

For on-site vertical storage conditions, the cask thermal gradient differences during this one-time accident scenario are bounded by on-site transfer conditions. Therefore, the third criterion is satisfied for the cask.

A.2.2.4 Temperature Difference – Normal Service

For on-site transfer conditions, the TC is not affected by the significant temperature difference fluctuations; hence, this fourth criterion is not applicable.

For on-site vertical storage conditions, small fluctuations in the cask thermal gradients during vertical storage occur as a result of seasonal ambient temperature changes. Ambient temperature cycles significant enough to cause a measurable thermal gradient fluctuation are conservatively assumed to occur five times per year for 60 years. The cask stresses resulting from thermal gradient fluctuations are small compared to the structural capacity as the cask is designed for extreme accident loads, such as cask drop loads, which are postulated to be a one-time occurrence.

Using very conservative values, for on-site vertical storage conditions Equation 2 equals 49˚F. The most significant fluctuation in normal operating temperature occurs during a maximum change in ambient temperature from -20°F to 100°F. This fluctuation results in a maximum temperature difference for the cask of approximately 47°F at the cask bottom end closure. The effects of this temperature difference are below the 49˚F threshold obtained through Equation 2; therefore, the fourth condition is satisfied for the cask.

A.2.2.5 Temperature Difference – Dissimilar Materials

The structural components of the cask consist entirely of ASME SA-240, Type 304 and XM-19 stainless steels, which have identical modulus of elasticity and slightly different coefficients of thermal expansion. Inconel weld material (UNS N06625) is used for the longitudinal welds in the XM-19 cask shells and the stainless steel lifting trunnion sleeve to XM-19 cask shell welds.

For these materials the magnitude of $S_a/2(E_1\alpha_1 – E_2\alpha_2)$ is equal to 302°F. The most significant fluctuation in normal operating temperature occurs during a maximum change in ambient temperature. This fluctuation results in a maximum temperature difference of approximately for the cask of 47°F at the cask bottom end closure. The effects of this maximum temperature difference are not significant since the calculated 47°F temperature difference in the TC is less than the 302°F temperature fluctuation associated with the maximum allowed thermal stress of 28.2 ksi. As a result, the fifth condition is satisfied for the cask for both on-site transfer and vertical storage conditions.

A.2.2.6 Mechanical Loads

A load fluctuation is considered significant if the total excursion of stresses exceed the value of S_a, obtained from applicable fatigue curve for 10^6 cycles, S = 28.2 psi. The only mechanical loads which affect the cask are those associated with handling loads, normal drop and shock, and seismic loads. The cask stresses resulting from these mechanical load fluctuations are small since the structural capacity of the cask is designed for extreme accident loads such as postulated cask side drop. The number of significant cycles associated with mechanical load fluctuations is associated with the numbers of lifts of the cask with the trunnions. The maximum stress intensity at upper trunnion/cask shell location due to lifting of the cask is 17.7 ksi, which is less than the allowed 28.2 ksi. Since the effects of the loads are not significant for this criterion, the sixth condition is satisfied for the cask on–site transfer conditions and vertical storage conditions.

A.2.2.7 Conclusion

The evaluation performed demonstrated that the six criteria contained in NB-3222.4(d) are satisfied for all components of the transfer cask and fatigue analysis need not be specifically performed.

Having determined that the six criteria contained in NB-3222.4 (d) are satisfied for all components of the transfer cask, “no analysis for cyclic service is required, and it may be assumed that the limits on peak stress intensities as governed by fatigue have been satisfied by compliance with the applicable requirements for material, design, fabrication, examination, and testing” of NB-3222.4 of the ASME B&PV Code.

A.2.3 Boron Depletion, Gamma Irradiation, and Neutron Fluence Analysis

The AREVA TN Calculation 502917-0500 Rancho Seco License Renewal Boron Depletion and Fluence Analysis, Rev 0, [A-8] performed an analysis to determine the amount of boron depletion of the poison plate material for the Fuel Only (FO) and Fuel with Control Components (FC) DSC types at the Rancho Seco site. This analysis also determined the effect on ISFSI equipment materials from gamma exposure and neutron radiation fluence. The analysis was done using MCNP5, MCNP/MCNPX – Monte Carlo N-Particle Transport Code System Including MCNP5 1.40 and MCNPX 2.5.0 and Data Libraries, [A-2] a general purpose Monte Carlo N-Particle computer code, and SCALE 5.0: Modular Code System for Performing Standardized Computer Analysis for Licensing Evaluations for Workstations and Personal Computers, [A-3] a comprehensive modeling and simulation package of codes to perform reactor physics, criticality safety, radiation shielding, and spent fuel characterization for nuclear facilities and transportation/storage package designs.

A.2.3.1 Boron-10 Depletion

The results indicate that a negligible amount of boron-10 is depleted over 100 years as shown on Table A-1.

Additionally, for a given areal density of boron-10, the depletion increases with decreasing poison plate thickness. An additional sensitivity calculation using half as much boron-10, or [ ] demonstrated similar results. Conservative hand calculations, assuming every source neutron is absorbed by B-10, give a fraction depleted of [ ] B-10 content plates. More importantly, it is evident that for any poison plate thickness, the depleted amount is negligible compared to the initial concentration of boron-10.

A.2.3.2 Neutron Fluence and Gamma Exposure

The summarized results of the maximum neutron fluence and gamma exposure integrated over 100 years of storage are presented in Table A-2 and Table A-3, respectively. The results are for a 32-assembly DSC (32PTH1), which is a more conservative model and thus bounds the 24P DSCs (24P-FO, FC, and FF) stored at Rancho Seco.

The results indicate that there is no credible mechanical degradation occurring in compressive strength and tensile strength of the DSC shell, shield plug and HSM components due to neutron fluence and gamma exposure levels. Note that neutron fluence in the HSM steel is bounded by neutron fluence of the DSC shell. All radiation levels are below the applicable acceptance criteria. The results also indicate that embrittlement due to neutron irradiation will not occur in the stainless steel compartment over 100 years of total HSM service life.

A.2.4 Combustible Gas Generation

This supporting analysis, AREVA TN Calculation 502917-0501 Rancho Seco License Renewal Combustible Gas Generation Analysis, Rev 0, [A-9] was performed to determine the amount of combustible gases generated as a result of irradiation of neutron shield material for the MP187 TC during its function as a TC during the assumed transport scenario at the Rancho Seco ISFSI site.

To estimate the combustible gas generation in the neutron shield material of the TC due to radiolysis, the analysis:

[ ]

Step 3: Given the energy deposit rate in the neutron shield materials, the combustible gas generation can be determined using the method described in Reference, NUREG/CR-6673, Hydrogen Generation in TRU Waste Transportation Packages, [A-10].

It is determined in this analysis that the maximum amount of hydrogen, total combustible gases, and all gases generated due to radiolysis of NS-3 is [ ] moles respectively. Considering that the total hydrogen mass originally present in the neutron shield material is ~209 kg, the fraction of hydrogen liberated from the neutron shield material over the service period of the cask is [ ] by weight, which is statistically insignificant. This very small fractional loss of hydrogen will have an insignificant impact on the ability of the TC neutron shield material to perform its design shielding function over the Period of Extended Operations (PEO).

A.3 Conclusion

The analyses described in Sections A.2.1 and A.2.2 demonstrate that the Rancho Seco DSC Shell Assembly, i.e., pressure boundary subcomponents, and the NUHOMS® MP187 TC meet the six criteria contained in NB-3222.4(d), [A-1] and thus "*no analysis for cyclic service is required, and it may be assumed that the limits on peak stress intensities as governed by fatigue have been satisfied by compliance with the applicable requirements for material, design, fabrication, examination, and testing"* of NB-3222.4 of the ASME B&PV Code, [A-1].

The analysis in Section A.2.3 demonstrates that a negligible amount of boron-10 is depleted over 100 years of service. In addition, there is no credible mechanical degradation occurring in compressive strength and tensile strength of the DSC shell, shielding plug and HSM components due to neutron fluence and gamma exposure levels.

The analysis in Section A.2.4 determined that the hydrogen liberated from the neutron shield material over the service period of the cask is statistically insignificant, and thus will have an insignificant impact on the ability of the neutron shield materials of the TC to perform its design function over the PEO.

A.4 References

A-1 ASME B&PV Code, Section III, Division 1, Subsections NB, NF, NG and Appendix I, 1992 Edition through 1993 Addenda.

A-2 "MCNP/MCNPX – Monte Carlo N-Particle Transport Code System Including MCNP5 1.40 and MCNPX 2.5.0 and Data Libraries," Radiation Shielding Information Center Code Package CCC-730, Oak Ridge National Laboratory, January 2006.

A-3 "SCALE 5.0: Modular Code System for Performing Standardized Computer Analysis for Licensing Evaluations for Workstations and Personal Computers," Radiation Shielding Information Center Code Package CCC-725, Oak Ridge National Laboratory, June 2004.

A-4 "The Topical Report for the NUTECH Horizontal Modular Storage System for Irradiated Nuclear Fuel, NUHOMS®- 24P," Document Number NUH002.0103, Revision 2A, VECTRA File Number NUH002.0103.

A-5 "Safety Analysis Report for Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," NUH-003, Revision 3A, Pacific Nuclear Fuel Services, VECTRA File No. NUH003.0103.

A-6 AREVA TN Calculation 502917-0200 Rancho Seco License Renewal MP187 Multi-Purpose Cask Thermal Fatigue Analysis, Revision 0.

A-7 AREVA TN Calculation 502917-0201 Rancho Seco License Renewal Dry Storage Canister (DSC) Thermal Fatigue Analysis, Revision 1.

A-8 AREVA TN Calculation 502917-0500 Rancho Seco License Renewal Boron Depletion and Fluence Analysis, Revision 0.

A-9 AREVA TN Calculation 502917-0501 Rancho Seco License Renewal Combustible Gas Generation Analysis, Revision 0.

A-10 NUREG/CR-6673, "Hydrogen Generation in TRU Waste Transportation Packages," May 2000.

Table A-1
Boron-10 Depletion Results

B-10 Areal Density (g/cm^2)	Poison Plate Thickness (inches)	Initial B-10 Number Density (#/barn-cm)	Basket Component Variations	Depleted Amount (#/barn-cm)	Percentage B-10 Remaining
				1.780E-10	99.999
				1.072E-10	99.999
				5.405E-11	99.999
				1.838E-10	99.999
				1.797E-10	99.999
				1.898E-10	99.999
				1.990E-10	99.999
				9.581E-11	99.999

Proprietary Information on Pages A-13 and A-14
Withheld Pursuant to 10 CFR 2.390

APPENDIX B
AGING MANAGEMENT PROGRAMS

CONTENTS

CONTENTS

B.1 Purpose

The application for the renewal of the Rancho Seco 10 CFR Part 72-specific storage license SNM-2510 must demonstrate that the effects and mechanisms of aging on structures, systems, and components (SSCs) subject to aging management review (AMR) will be managed in a manner that is consistent with the licensing basis for the proposed period of extended operation (PEO). Based on the results of the AMR, the in-scope SSCs and subcomponents will be subject to an appropriate Aging Management Program (AMP) for managing these aging effects.

B.2 Methodology

B.2.1 Scope

The AMPs included in this evaluation are:

- DSC External Surfaces AMP.
- HSM AMP for External and Internal Surfaces.
- Transfer Cask AMP.
- Basemat AMP.

B.2.2 Aging Management Program Elements

The structure of each AMP is consistent with the ten program elements described in NUREG-1927 Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel, [B-11] and input from the draft MAPS Report Managing Aging Process in Storage (MAPS) Report, [B-12] as applicable and identified below. The elements for each AMP are as follows:

1. **Scope of the Program:** The scope of the program includes specific SSCs and subcomponents covered by the AMP and the intended functions to be maintained.
2. **Preventive Actions:** Preventive actions will either prevent aging or mitigate the rate of aging for SSCs by following the activities in the AMP.
3. **Parameters Monitored or Inspected:** Parameters monitored or inspected will identify the specific parameters that will be monitored or inspected and describe how those parameters will be capable of identifying degradation or potential degradation before a loss of intended function.
4. **Detection of Aging Effects:** It is intended that detection of aging effects will occur before there is a loss of intended function for any SSC identified within the scope of the program. This includes aspects such as method or technique (i.e., visual, volumetric, surface inspection), frequency, sample size, data collection, and timing of new or one-time inspections to ensure timely detection of aging effects.

   “Accessible areas” are defined as surfaces of in-scope SSCs and subcomponents that can be visually inspected by direct means without disassembly.

   “Normally non-accessible areas” are defined as surfaces of in-scope SSCs and subcomponents that can be visually inspected by remote means without significant disassembly (such as removal of HSM door).

   “Inaccessible areas” are defined as surfaces of in-scope SSCs and subcomponents that cannot be visually inspected by direct or remote means.

5. **Monitoring and Trending:** Monitoring and trending shall provide for an evaluation of the extent of the effects of aging and the need for timely corrective or mitigating actions.
6. **Acceptance Criteria:** Acceptance criteria, against which the need for corrective action will be evaluated, will ensure that the particular structure and component intended functions and the approved design bases are maintained during the period of extended operation. Proposed acceptance criteria will be appropriately justified.
7. **Corrective Actions:** Corrective actions are the measures to be taken when the acceptance criteria are not met. Timely corrective actions, including root cause determination and prevention of recurrence for significant conditions adverse to quality, are critical for maintaining the intended functions of the SSCs during the initial storage period, as well as the PEO.
8. **Confirmation Process:** The confirmation process will ensure that preventive actions are adequate and appropriate corrective actions have been completed and are effective.
9. **Administrative Controls:** Administrative controls for the AMPs and implementing procedures will provide a formal review and approval process.
10. **Operating Experience**: Operating experience (OE) involving the AMP, including past corrective actions resulting in program enhancements or additional programs, is intended to provide objective evidence to support a determination that the effects of aging will be adequately managed so that the structure and component intended functions will be maintained during the period of extended operation.

Note that this is a learning AMP process. Inspections and associated precursors for the monitoring of aging effects will be updated as necessary to incorporate new information as it becomes available.

B.3 DSC External Surfaces Aging Management Program

The materials, environments and aging effects requiring management for the external surfaces of the DSC are as follows:

NOTE: For the purpose of this AMP, 1) all references to “DSC” also include the “GTCC” canister unless otherwise stated; and 2) the DSC external surfaces of the shell assembly also include the external surfaces of the outer bottom cover plate, grapple ring and outer top cover plate.

B.3.1 Materials

The DSC shell assembly components subject to AMR are constructed of the following material:

- Stainless Steel

B.3.2 Environment

The DSC shell assembly components subject to AMR are exposed to the following environment:

- Sheltered

B.3.3 Aging Effects Requiring Management

The following aging effects associated with the DSC shell assembly components require monitoring:

- Loss of material due to crevice and pitting corrosion for stainless steel components.
- Loss of material due to galvanic corrosion for the DSC shell contacting graphite lubricant at the sliding rail surface.
- Cracking due to stress corrosion cracking (SCC) – reference to Section 6.5 and Table 6-2 of MAPS, [B-12] as it points out recent industry information by Electric Power Research Institute (EPRI) Aging Management Guidance to Address Potential Chloride-Induced Stress Corrosion Cracking of Welded Stainless Steel Canisters, [B-5].

Note that an analysis was performed in accordance with current EPRI guidance for ranking susceptibility for loss of material due to chloride-induced stress corrosion cracking (CISCC), [B-5]. The analysis determined that the susceptibility ranking for the Rancho Seco Independent Spent Fuel Storage Installation (ISFSI) site is “2” on a 1 to 10 scale (“10” being the most susceptible to CISCC). This low ranking, along with the favorable environmental conditions, points to the conclusion that the potential for chloride aerosols leading to chloride accumulation on ISFSI components at Rancho Seco is very low and that enhanced monitoring for CISCC is not warranted.

B.3.4 Program Description

The objective of the program is to manage the effects of aging mechanisms on the external surfaces of the DSC shell assembly subject to aging during the PEO. The program manages aging effects through inspection of external surfaces for evidence of the following: 1) loss of material due to corrosion; and 2) cracking due to SCC.

B.3.5 Evaluation and Technical Basis

1) Scope of Program

This program visually inspects and monitors the external surfaces of the DSC that may be subject to loss of material and cracking. The program scope includes external surfaces of the DSC shell assembly. The areas of DSC inspection are:

- Fabrication welds of the confinement boundary and the associated heat affected zone (HAZ), i.e., longitudinal and circumferential welds on the cylindrical shell.
- Crevice locations, i.e., where the shell sits on the support rail
- The upper surface of the cylindrical shell, where atmospheric particulates would settle.
- The top and bottom ends of the cylinder, which are cooler than the center.
- Outer bottom cover plate, grapple assembly, their welds and HAZ.
- Outer top cover plate, welds and HAZ.

The last two areas are not part of the confinement boundary, but their condition must be ascertained prior to retrieval and transport. As vertical surfaces out of the main path of air flow, they are the least susceptible to the effect of atmospheric deposits. Accessibility to the outer top cover plate is limited during storage due to tight clearance with the end wall of the horizontal storage module (HSM) and no access to the top of the HSM. Accessibility to the outer bottom cover plate and grapple ring will be through the 2-inch diameter seismic restraint port of the HSM access door.

Based on industry experience, the HAZ is considered to extend approximately ½ inch away from the edge of a weld on both sides. To be conservative, the inspections of the HAZ will extend to a distance of at least 2 inches on either side of the welds.

Locations of temporary fabrication welds are not likely to result in through-thickness sensitization or tensile stress, so they are not included as areas for inspection.

2) Preventive Actions

This is a condition monitoring program. It does not include preventive actions.

3) Parameters Monitored or Inspected

The DSC External Surfaces AMP consists of visual inspections to monitor for material degradation. There are no “accessible” areas of the DSC available for direct visual inspections since it is sheltered inside the HSM.

The following “normally non-accessible” areas will undergo remote visual inspection for loss of material and cracking:

- DSC surfaces, welds and HAZs, and crevice locations near the DSC support rails are inspected for discontinuities and imperfections. Localized corrosion (e.g., pitting and crevice corrosion), cracking and stains (caused by leaking rainwater) or discolorations are documented, if any. Appearance and location of atmospheric deposits on the DSC surfaces are recorded. No additional action is required for rainwater stains or discoloration unless evidence of corrosion is exhibited.
- Portions of the outer top cover plate, closure weld and HAZ.
- Outer bottom cover plate, grapple ring assembly and their welds and HAZs.
- Portions of the DSC Shell bottom surface (including edge of DSC support rails and HAZ).

The “inaccessible” areas of the DSC include:

- The upper surface of the DSC Shell (i.e., where atmospheric particulates may settle)
- The majority of outer top cover plate, welds and HAZ
- The DSC Shell crevice locations (i.e. where the shell rests on DSC support rail)

4) Detection of Aging Effects

This program manages aging effects for loss of material due to crevice, pitting, and galvanic corrosion, and cracking due to SCC of stainless steel using visual inspection. Visual examinations follow procedures consistent with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PVC), Section XI, Rules for Inservice Inspection of Nuclear Power Plants and Fuel Processing Plants, [B-4] Subsection IWA-2200.

4.1) Selection of DSC(s) for Inspection

One DSC was selected for the baseline and any subsequent inspections; it was the same DSC inspected during the pre-application inspection. The DSC selected for inspection was based on the following considerations/criteria and the benign environment at the Rancho Seco ISFSI site:

A) Time in service: Storage duration (time in service) is related to surface temperature and deposition of contaminants. The DSC selected for inspection was from the pool of DSCs with longest time in service.

B) Initial heat load: The DSC selected for inspection was from a pool of DSCs with low initial heat loading that result in low DSC shell surface temperatures, thus increasing relative humidity inside the HSM and promoting incubation of ambient contaminants.

C) DSC Fabrication and Design Considerations: A review of the design drawings and DSC fabrication package was performed to further “screen-in” the DSC from the pool of candidates selected based on (A) and (B). Fabrication weld maps were reviewed to identity locations of the circumferential and longitudinal welds; location and disposition of welded attachments, and external configurations of the inner bottom cover-to-shell weld.

D) HSM array configuration relative to climatological and geographical features: Per Volume I, Rancho Seco ISFSI Final Safety Analysis Report (FSAR), Rancho Seco Independent Spent Fuel Storage Installation Final Safety Analysis Report Rev. 6, dated August 2016 (Docket 72-11), [B-1] the HSM back-to-back arrays are installed on the Rancho Seco ISFSI pad with a North-South exposure. The vents of the HSMs are oriented in an east-west direction. Per Section 2.3.1.1 of the ISFSI FSAR, the wind direction at Rancho Seco generally follows a north to northwest direction or south to southeast direction. Therefore, the vent openings do not face the prevalent wind direction. However, the potential to bring ambient contaminants (if any) to the DSC external surfaces was still considered.

The considerations/criteria described above provide the basis for selection of the bounding DSC for inspection. This is a learning AMP. The selection criteria described above will be updated as necessary to incorporate new information.

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4.3) Inspection Timing and Frequency

The baseline AMP visual inspection will be no later than two years after entering the PEO, with follow-on inspections at a 10 ± 2-year interval. If the preceding inspection identified a major corrosion indication (see Acceptance Criteria section below for definition), the interval between inspections is decreased to 5 years ± 1 year (or when an engineering evaluation calculates an identified crack will reach 75% through-wall (whichever is less). The inspection interval of 10 years is consistent with ASME, B&PV Code, Section XI, [B-4] Subarticle IWA-2430 optional inspection program B (Paragraph IWA-2432).

5) Monitoring and Trending

The inspections and monitoring activities in this AMP are performed periodically in order to identify areas of degradation. Conditions adverse to quality noted during the inspection and monitoring activities, such as non-conformances, failures, malfunctions, deficiencies and deviations are entered into the SMUD Corrective Action Program. Visual inspections appropriately consider cumulative OE from previous inspections and assessments, in order to monitor and trend the progression of aging effects over time. Data taken for these inspections are to be monitored by comparison to past site data taken as well as comparison to industry OE, including data gathered by the Aging Management INPO Database (AMID) as discussed in NEI 14-03 Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management" Revision 2, 2016, [B-13].

6) Acceptance Criteria

The acceptance criteria for this AMP follows the guidance provided in EPRI Report 3002008193, [B-5] which focuses on CISCC. This report states that CISCC has been identified as the most likely and limiting degradation mechanism that could lead to through-wall penetration of the austenitic stainless steel canister during storage. Thus, other atmospheric corrosion mechanisms (e.g. pitting) are conservatively addressed by these acceptance criteria. There are three tiers of acceptance criteria:

(i) Visual examination criteria – Visual examination results are evaluated using this criteria
(ii) Augmented Examination criteria – Surface or volumetric examination is evaluated using this criteria
(iii) Flaw Evaluation criteria – Used if cracking is detected

6.1) Visual Examination criteria:

Criteria are provided below to classify the indication as a major, minor, or an insignificant corrosion indication.

The presence of a major corrosion indication anywhere on the DSC, or a minor corrosion indication within 2 inches of a weld, will result in performance of a supplemental surface or volumetric examination for the presence of cracking. This will also be entered into SMUD's Corrective Action Program.

A minor corrosion indication more than 2 inches from a weld will receive a supplemental VT-1 exam to demonstrate that there is no attack of the metal under the corrosion indication. If it is determined there is an attack of the metal under the corrosion indication, then the condition will be entered into SMUD's Corrective Action Program.

Major corrosion indications:

If a corrosion indication meets any of the following, it will be considered a major indication:

- Cracking of any size.
- Corrosion products having a linear appearance, except light corrosion indicative of iron contamination.
- Corrosion products having a branching appearance.
- Evidence of pitting corrosion, under-deposit corrosion, or etching with measurable depth (removal/attack of material by corrosion).
- In a 10 cm x 10 cm region, corrosion product is present in 25% or more of the surface with evidence of attack into the DSC.
- Evidence of water intrusion into a crevice location with rust staining at the edge of the crevice.
- Corrosion product deposit present at the mouth of an occluded region that includes a portion of the DSC shell weld.

Minor corrosion indications:

If a corrosion indication is not a major indication and it meets any of the following, it will be considered a minor indication:

- Evidence of water intrusion via staining in the color of normal corrosion products.
- Areas of light corrosion that follow a fabrication feature or anomaly (e.g. scratch or gouge) - such indications are indicative of iron contamination.
- In a 10 cm x 10 cm region, corrosion product is present in 10% to 25% of the canister surface.
- Corrosion product greater than 2 mm in diameter.

Insignificant corrosion indications:

Corrosion indications that do not meet the criteria for being either a major or minor corrosion indication are considered insignificant corrosion indications. Insignificant corrosion indications are acceptable without further action.

6.2) Augmented Examination:

If a surface examination is performed, no further actions are required if any of the following apply:

- If a surface examination confirms the absence of flaws.
- If the detected flaw is a rounded indication, and if no corrosion products or masking deposits are present.
- If the detected flaw is a linear indication, if no corrosion products or masking deposits are present, and if the linear indication is determined not to have a crack-like morphology.

If a volumetric examination is performed no further actions are required if any of the following apply:

- If a volumetric examination confirms the absence of planar flaws.
- If the detected indication is determined to not be connected to the exterior of the DSC (i.e., not associated with the outside surface).
- If the entirety of the detected flaw is in an area that is confirmed to have no corrosion products present, and if the indication is determined to not have a crack-like morphology.
- If the detected indication was recorded prior to being mitigated or remediated and there has been no measurable increase in the flaw size after being remediated.

If none of the above volumetric examination bullets apply, the detected indication is associated with the outside surface connected planar flaw and is considered material cracking. In this case, an engineering evaluation is performed to demonstrate the acceptability of the cracking indication using Flaw Evaluation.

6.3) Flaw Evaluation

If a crack is identified, an engineering evaluation is performed to determine when the flaw will reach 75% of through-wall thickness.

If the flaw is measured to be greater than 75%, or if it is not feasible to perform a supplemental inspection prior to when the engineering evaluation determined the flaw will reach 75% through-wall, the condition will be addressed in accordance with SMUD's Corrective Action Program. Industry OE will be reviewed to identify any consequences of through-wall CISCC with an appropriate limiting length.

7) Corrective Actions

Sacramento Municipal Utility District quality assurance (QA) procedures, review and approval processes, and administrative controls are implemented according to the requirements of the Rancho Seco Quality Manual (latest revision), [B-2]. Sacramento Municipal Utility District's Corrective Action Program ensures that conditions adverse to quality are promptly identified and

corrected, including root cause determinations and prevention of recurrence. Deficiencies are either corrected, or are evaluated as acceptable for continued service through engineering analysis, which provides reasonable assurance that the intended function is maintained consistent with current licensing basis conditions. Evaluations performed to assess conditions associated with aging should utilize the same methodology used in the licensing and design basis calculations for SMUD as much as practical to ensure intended functions are maintained through the PEO. Extent of condition investigation may trigger additional inspections via a different method, increased inspection frequency or expanded inspection sample size. Identification of major corrosion requires an expansion of the sample size to determine the extent of condition at the site. A subject DSC with major corrosion that does not meet the prescribed evaluation criteria must be evaluated for continued service.

8) Confirmation Process

Conditions adverse to quality noted during the inspection and monitoring activities are entered into SMUD's Corrective Action Program. Procedural controls are in place to ensure the responses to corrective action assignments are reviewed and to verify the response adequacy. Condition reports are also reviewed for trending purposes. A tollgate will be established to assess effectiveness of corrective actions and update the AMP as necessary on a periodic basis.

9) Administrative Controls

Administrative controls are based on and implemented in accordance with the requirements of a 10 CFR Part 72, Subpart G quality program and will continue for the PEO. The Rancho Seco Quality Manual, [B-2] meets this requirement.

10) Operating Experience

Operating Experience for DSCs is as evaluated in the AMR. The OE consisting of Industry OE, TN-specific OE and SMUD-specific OE supports a conclusion that no other actions will be necessary to adequately detect aging effects and mechanisms other than those prescribed above.

B.4 HSM Aging Management Program

The materials, environments, and aging effects requiring management for the HSM internal, external and structural components are as follows:

B.4.1 Materials

The HSM subcomponents subject to aging management review are constructed of the following materials:

- Reinforced concrete – base, roof and walls and reinforcing bar (rebar).
- Carbon Steel – support structures, heat shields, and bolting.
- Stainless steel (Nitronic® 60) – DSC support rail plate.

B.4.2 Environment

The HSM subcomponents that are subject to aging management are exposed to the following environments:

- Sheltered
- Outdoors
- Embedded

B.4.3 Aging Effects Requiring Management

The following aging effects associated with the HSMs require management:

- Cracking; loss of material (spalling, scaling) due to corrosion of embedded steel for reinforced concrete.
- Cracking due to expansion from reaction with aggregates, such as alkali silica reaction (ASR) for reinforced concrete).
- Change in material properties - increase in porosity and permeability due to aggressive chemical attack and leaching for reinforced concrete.
- Loss of material due to general, pitting, and crevice corrosion for carbon steel components.
- Loss of material due to crevice, pitting and galvanic corrosion of Nitronic® 60 DSC support rail plates.
- Cracking due to SCC – welds attaching Nitronic® 60 rail face - reference to Section 6.6 and Table 6-3 of MAPS, [B-12] as it points out recent industry information by EPRI, [B-5].
- Loss of material due to aggressive chemical attack.

B.4.4 Program Description

The objective of the program is to manage the aging effects on the internal and external surfaces of the HSMs during the PEO. This is accomplished by inspection for evidence of cracking due to aggressive chemical attack, and ASR for reinforced concrete structures; loss of material due to aggressive chemical attack and corrosion of embedded steel; and increase in porosity and permeability, and loss of strength due to aggressive chemical attack and leaching of calcium hydroxide and carbonation. The inspections will also look for evidence of cracking of the welds on the Nitronic® 60 rail face due to SCC. It also manages loss of material due to general, pitting, and crevice corrosion of steel components (e.g., access door, DSC support structure, heat shields, connecting hardware and embedments).

B.4.5 Evaluation and Technical Basis

1) Scope of Program

The scope of the HSM AMP includes visual inspection of accessible concrete and steel components including HSM walls, roof, and floor slab, HSM access door, DSC support structure and rail assembly, heat shields, embedments and anchorages (including bolts and mounting hardware).

The program consists of periodic visual inspections by personnel qualified to monitor structures and components for applicable aging effects and mechanisms, such as those described in the American Concrete Institute (ACI) 201.1R ACI-201.1R, Guide for Conducting a Visual Inspection of Concrete in Service, 2008, [B-6] and ACI 349.3R, Evaluation of Existing Nuclear Safety Related Concrete Structures, [B-8].

2) Preventive Actions

The program is a condition-monitoring program that does not include preventive actions.

3) Parameters Monitored

The accessible areas of the HSMs under direct visual inspection include:

- The external concrete surfaces of the HSM roof and walls.
- External surfaces of the HSM access door.
- Attachment hardware.

The normally non-accessible areas of HSM under remote visual inspection for loss of material and cracking include:

- Portions of the concrete floor slab, and visible areas of front, back and side walls.
- Portions of the DSC support structure and attachment hardware.

The inaccessible areas of the HSM include:

- The internal surface of the HSM roof blocked from view due to the upper heat shield.
- Heat shields at internal surface of the roof and side walls.

  For each material/aging effect combination, the specific parameters monitored or inspected depend on the particular HSM subcomponent as described below. Parameters monitored or inspected are commensurate with industry codes, standards, and guidelines and consider industry OE as well as SMUD-specific OE.

- Reinforced Concrete

  For concrete structures, parameters monitored include: (1) cracking, and loss of material (spalling and scaling) due to corrosion of embedded steel, or aggressive chemical attack; (2) cracking due to expansion from reaction with aggregates from ASR; and (3) increase in porosity and permeability due to leaching.

- Steel

  Carbon steel and stainless steel components are monitored for loss of material due to general, pitting, crevice corrosion and galvanic corrosion. Other conditions, such as loose or missing anchors, and missing or degraded grout are also part of the inspection.

  Stainless Steel (Nitronic® 60) components are monitored for loss of material due to general, pitting, and crevice corrosion.

  The welds attaching the Nitronic® 60 rail face are inspected for cracking due to SCC.

4) Detection of Aging Effects

   As appropriate, direct or remote visual inspections utilizing ACI-349.3R, [B-8], Section 3.5.1 are conducted for HSM concrete in both Outdoor and Sheltered environments, allowing for detection of aging effects from Section B.4.5(3). Consistent with ASME B&PV Code, Section XI, [B-4] on visual examination techniques, VT-3 direct or remote visual inspections are utilized for general inspections for HSM steel components depending on whether these components are accessible or normally non-accessible, respectively. VT-3 visual examinations are performed for steel surfaces, detecting aging effects while identifying and assessing discontinuities and imperfections on the surface of components. As much of the HSM steel surfaces as can be reasonably accessed, are examined by VT-3 to ascertain their general condition.

Inspection of the normally non-accessible internal surfaces of the HSM concrete may be performed using a video camera, fiber-optic scope, or other remote inspection technology via existing access points of the HSM. The remote inspection system is qualified and demonstrated to have sufficient resolution capability and enhanced lighting to resolve the acceptance criteria identified in Section B.4.5(6).

For HSM concrete, crack maps with a photographic record and physical dimensions are developed using ACI-224.4R guidance, Guide to Design Detailing to Mitigate Cracking, [B-7] and are monitored and trended as a means of identifying progressive growth of defects that may indicate degradation due to specific aging effects, such as rebar corrosion. Crack maps and photographic records are compared with those from previous inspections to identify accelerated degradation of the concrete during the PEO. Similarly, dimensioning is documented in photographic records by inclusion of a tape measure/crack gauge, a comparator, or both.

Within the HSM cavity, certain surface areas may be inaccessible for direct visual and remote inspection. This AMP addresses detection of aging effects for inaccessible areas indirectly by monitoring the inspection findings within accessible and normally non-accessible areas. Therefore, inaccessible area inspections may only be required because of the SMUD ISFSI Corrective Action Program to ensure the aging effect is adequately managed and that the component's intended function is maintained during the PEO.

Performance of the baseline AMP visual inspection will be no later than two years after PEO commencement, with follow-on inspections at a 10± 2-year interval. The inspection interval of 10 years is consistent with ASME, B&PV Code, Section XI, [B-4] Subarticle IWA-2430 optional inspection program B (Paragraph IWA-2432). Furthermore, a 10-year inspection frequency for both inside and outside HSM surfaces is justified based on the benign environmental conditions observed during the pre-application inspection. If preceding inspection acceptance criteria have been exceeded or the trending from previous inspections is unclear, the interval between the sheltered environment HSM component inspections is decreased to 5 years ±1 year.

5) Monitoring and Trending

Inspection and monitoring activities in this AMP are performed periodically in order to identify areas of degradation. Conditions adverse to quality noted during the inspection and monitoring activities, such as non-conformances, failures, malfunctions, deficiencies, and deviations are entered into the SMUD Corrective Action Program. Visual inspections appropriately consider cumulative OE from previous inspections and assessments, in order to monitor and trend the progression of aging effects over time. Data taken for these inspections are to be monitored by comparison to past site data taken as well as comparison to industry OE, including data gathered by the AMID, as discussed in NEI 14-03, [B-13].

In addition, for sheltered environment SCCs, confirmed aging effects within accessible locations require expanded remote visual inspections within accessible or normally non-accessible locations and may also require expanded remote visual inspections within inaccessible locations.

6) Acceptance Criteria

For the HSM AMP for External and Internal Surfaces, inspection results will be evaluated by qualified engineering personnel based on acceptance criteria selected for each structure and aging effect to ensure that the need for corrective actions is identified before loss of intended function occurs. The criteria are derived from design basis codes and standards that include ACI 349.3R, [B-8] ACI 318, Building Code Requirements for Reinforced Concrete, [B-9] ANSI/ASCE 11-99, Guideline for Structural Condition Assessment of Existing Buildings, [B-10] and ASME B&PV Code, Section XI, [B-4]. The criteria are directed at the identification and evaluation of degradation that may affect the ability of the HSM to perform its intended function. Should the inspection acceptance criteria be exceeded, the identified issue requires further evaluation and is entered into SMUD's corrective action program. Loose bolts and nuts and cracked bolts are not acceptable unless approved by an engineering evaluation.

Metallic Components of the HSM:

Consistent with Subarticle IWA-2210 of the ASME B&PV Code, Section XI, [B-4] on visual examination techniques, VT-3 inspections in accordance with IWF-3400 are utilized for general inspections for HSM steel components. For metallic surfaces, any of the following indications of relevant degradation detected require further evaluation:

- Corrosion and material wastage (loss of material)
- Crevice, pitting and galvanic corrosion (loss of material)
- Corrosion stains on adjacent components and structures (loss of material)
- Surface cracks (cracking)

– Stains caused by leaking rainwater if evidence of corrosion is exhibited (stains alone do not require action beyond documenting the condition)

If any of the above items are identified by the VT-3 inspection, these items are to be considered exceeding the second-tier criteria (ACI 349.3R), requiring further evaluation through the SMUD Corrective Action Program. (Though the ACI applies to concrete structures, the reason for providing this as acceptance criteria for metallic components is that individual metallic component degradations are given the same level of corrective actions as the parent HSM material code. Note that it says "**above identified items are considered as exceeding second tier criteria of ACI 349.3R requiring further evaluation**"). This may include performing a more detailed VT-1 visual examination of the flaws.

Concrete HSM structure:

Concrete acceptance criteria from ACI 349.3R, [B-8] provide acceptable conditions for observed degradation that has been determined to be inactive. These criteria are termed second-tier for structures possessing a concrete cover in excess of the minimum requirements of ACI 349. Inactive degradation can be determined by the quantitative comparison of current observed conditions with that of prior inspections. If there is a high potential for progressive degradation or propagation to occur at its present or an accelerated rate, the disposition should consider more frequent evaluations of the specific structure or initiation of repair planning.

The following findings from a visual inspection are considered acceptable without requiring any further evaluation:

– Absence of leaching and chemical attack, including microbiological chemical attack.
– Absence of signs of corrosion in the steel reinforcement.
– Absence of drummy areas (poorly consolidated concrete, air void with paste deficiencies per ACI 201.1R, [B-6]).
– Popouts and voids less than 50 mm (2 in.) in diameter or equivalent surface area.
– Scaling less than 30 mm (1-1/8 in.) in depth.
– Spalling less than 20 mm (3/4 in.) in depth and 200 mm (8 in.) in any dimension.
– Absence of corrosion staining of undefined source on concrete surfaces.
– Passive cracks less than 1 mm (0.04 in.) in maximum width ("passive cracks" are defined as those having an absence of recent growth and absence of other degradation mechanisms at the crack).
– Passive deflections within the original design limits.

7) Corrective Actions

Sacramento Municipal Utility District QA procedures, review and approval processes, and administrative controls are implemented according to the requirements of the Rancho Seco Quality Manual, [B-2]. Sacramento Municipal Utility District's Corrective Action Program ensures that conditions adverse to quality are promptly identified and corrected, including root cause determinations and prevention of recurrence. Deficiencies are either corrected, or are evaluated as acceptable for continued service through engineering analysis, which provides reasonable assurance that the intended function is maintained consistent with current licensing basis conditions. Evaluations performed to assess conditions associated with aging should utilize the same methodology used in the licensing and design basis calculations for SMUD as much as practical to insure intended functions are maintained throughout the PEO. Extent of condition investigation may trigger additional inspections via a different method, increased inspection frequency or expanded inspection sample size.

In addition, for sheltered environment SSCs, confirmed aging effects within accessible locations require expanded remote visual inspections within inaccessible locations. More frequent inspections would remain in effect until reasonable assurance is attained that indicates deterioration is adequately detected, appropriately addressed, and that the current material condition complies with the acceptance criteria.

Repair, restoration or corrective action of an unacceptable condition should be performed consistent with ACI-224.4R, [B-7] and article IWA-4000 of the ASME B&PV Code, Section XI, [B-4].

8) Confirmation Process

Conditions adverse to quality noted during the inspection and monitoring activities are entered into SMUD's Corrective Action Program. Procedural controls are in place to ensure the responses to corrective action assignments are reviewed and to verify the response adequacy. Condition reports are also reviewed for trending purposes. A tollgate will be established to assess effectiveness of corrective actions and update the AMP as necessary on a periodic basis.

9) Administrative Controls

Administrative controls in accordance with SMUD's QA procedures and Corrective Action Program provide a formal review and approval process. Administrative controls are based on and implemented in accordance with the requirements of a 10 CFR Part 72, Subpart G quality program and will continue for the PEO. The Rancho Seco Quality Manual, [B-2] meets this requirement.

10) Operating Experience

Operating Experience for the HSMs is as evaluated in the AMR. The OE supports an assessment that the effects of aging are adequately managed to the extent that the HSM design functions are maintained during the PEO. No other actions are necessary to adequately detect aging effects other than those prescribed above.

B.5 Transfer Cask Aging Management Program

The NUHOMS® MP187 Transfer Cask has not been needed for on-site transfer of spent nuclear fuel or Greater-Than-Class C (GTCC) waste at Rancho Seco since 2006 because all of the fuel and GTCC waste had been placed into storage at the ISFSI at that time. However, materials, environments, and aging effects still require management for the exposed surfaces of the TC as follows:

B.5.1 Materials

The TC is constructed of the following materials:

- Stainless Steel – shell assembly and rails
- Carbon Steel – attachment hardware
- Lead – inner annulus shielding material (internal/inaccessible)
- NS-3 resin – outer annulus shielding

B.5.2 Environment

The TC is exposed to the following environment:

- Sheltered

B.5.3 Aging Effects Requiring Management

The following aging effects associated with the TC assembly require management:

- Loss of material due to general corrosion – carbon steel
- Loss of material due to crevice and pitting corrosion for carbon steel and stainless steel components
- Loss of material due to wear
- Cracking due to SCC
- Loss of Material due to galvanic corrosion - stainless steel rail, inner shell, bottom end closure

B.5.4 Program Description

The objective of the program is to manage the aging effects on the surfaces of the TC shell requiring management during the PEO. The program manages aging effects through visual inspection of external surfaces of the TC subcomponents for evidence of the following: 1) loss of material due to corrosion (e.g., general, crevice, galvanic corrosion and pitting), 2) loss of material due to wear, and cracking due to SCC.

B.5.5 Evaluation and Technical Basis

1) Scope of Program

This program visually inspects and monitors all the accessible TC subcomponents surfaces to ensure that they are intact and free from loss of material due to general, crevice, galvanic, or pitting corrosion, loss of material due to wear, and cracking due to SCC.

The program performs ASME B&PV Code, Section XI, [B-4] VT-3 visual inspections on all TC accessible surfaces. An ASME B&PV Code, Section XI VT-1 visual inspection will also be performed on any area of the TC where the VT-3 inspections detect signs of degradation.

2) Preventive Actions

The program is a condition-monitoring program that does not include preventive actions.

3) Parameters Monitored

The parameters inspected by this AMP are visual evidence of degradation of accessible surfaces of the TC, including the trunnions. The surfaces of the cask cavity inner liner are examined for surface conditions and for indications of corrosion, cracking or excessive wear. Fasteners are examined for surface conditions and for indications of damage or excessive wear.

Visual inspections of the external surfaces of the TC, bearing surfaces of the upper and lower trunnion assemblies, fasteners, and cask lid surfaces are performed prior to use. Visual inspections look for signs of degradation (corrosion and wear).

The TC rails, which provide the sliding surface for the DSC, are fabricated from a non-galling, wear resistant Nitronic® 60 material. They are visually inspected for indications of corrosion, cracking, or excessive wear.

4) Detection of Aging Effects

This program manages aging effects for loss of material due to crevice, galvanic, pitting, and general corrosion, cracking and loss of material due to wear. Inspections in this AMP are all performed “prior to use” for a loading/unloading campaign in order to identify areas of degradation. Visual inspections are performed to determine the physical condition of accessible surfaces of the TC, including the upper and lower trunnion assemblies and cask lid. VT-3 examinations are in accordance with the ASME B&PV Code, Section XI, [B-4] Subsection IWA-2213. These inspections check for loss of material (corrosion and wear). Any area of the TC where the VT-3 inspections detect degradation, with respect to corrosion and wear, will also be subjected to a VT-1 examination per ASME B&PV Code, Section XI, [B-4] IWA-2211. Fasteners are inspected for condition of threaded parts, corrosion, and signs of wear or degradation.

The TC cask was used at SMUD during fuel loading and transfer operations that concluded in August 2002 for all DSCs except the GTCC canister, which concluded in 2006. All of the DSCs are in storage in the HSMs and the TC will only be used when the DSCs are to be retrieved from the HSMs for offsite shipment. Therefore, pre-service inspections are more appropriate for the TC at SMUD.

5) Monitoring and Trending

Monitoring activities in this AMP are performed in order to identify areas of degradation. Conditions adverse to quality noted during the monitoring activities, such as non-conformances, failures, malfunctions, deficiencies, and deviations are entered into the SMUD Corrective Action Program. Visual inspections appropriately consider cumulative OE from previous inspections and assessments, in order to monitor and trend the progression of aging effects over time. Evaluation of this information during preparations for DSC retrieval and offsite shipment provides adequate time for corrective action to be taken, if necessary, in order to ensure that the TC is able to perform its intended functions. Data taken for these inspections are to be monitored by comparison to past site data taken as well as comparison to industry OE, including data gathered by the AMID, as discussed in NEI 14-03, [B-13].

6) Acceptance Criteria

The acceptance criteria for the TC AMP are:

– The TC AMP includes VT-3 and VT-1 examinations in accordance with Section XI IWA-2213 and IWA-2211, respectively. If corrosion on any of the TC subcomponents or wear of the inner liner thickness are detected, the finding is entered in SMUD’s Corrective Action Program

to determine, based on engineering evaluation, the extent and impact of the corrosion on the ability of the TC to perform its intended function.

7) Corrective Actions

SMUD QA procedures, review and approval processes, and administrative controls are implemented according to the requirements of the Rancho Seco Quality Manual, [B-2]. SMUD's Corrective Action Program ensures that conditions adverse to quality are promptly identified and corrected, including root cause determinations and prevention of recurrence. Deficiencies are either corrected, or are evaluated as acceptable for continued service through engineering analysis, which provides reasonable assurance that the intended function is maintained consistent with current licensing basis conditions. Evaluations performed to assess conditions associated with aging need to follow the same methodology used in the licensing and design basis calculations for SMUD as much as practical to ensure intended functions are maintained throughout the PEO.

8) Confirmation Process

Conditions adverse to quality noted during the inspection and monitoring activities are entered into SMUD's Corrective Action Program. Procedural controls are in place to ensure the responses to corrective action assignments are reviewed and to verify the response adequacy. Condition reports are also reviewed for trending purposes. A tollgate will be established to assess effectiveness of corrective actions and update the AMP as necessary on a periodic basis.

9) Administrative Controls

Administrative controls in accordance with SMUD's QA procedures and corrective action program provide a formal review and approval process. Administrative controls are based on and implemented in accordance with the requirements of a 10 CFR Part 72, Subpart G quality program and will continue for the PEO. The Rancho Seco Quality Manual, [B-2] meets this requirement.

10) Operating Experience

Operating Experience for the TC is as evaluated in the AMR. The OE consisting of Industry OE, TN-specific OE and SMUD-specific OE supports a conclusion that no other actions will be necessary to adequately detect aging effects other than those prescribed above.

B.6 Basemat Aging Management Program

The ISFSI basemat is a reinforced concrete structure designed to support the HSMs. Settlement or deflection of the basemat beyond design limits could affect the ability to retrieve the DSCs containing the spent nuclear fuel or GTCC waste; therefore, it is within the scope of the AMP in accordance with NUREG-1927, [B-11]. The basemat is evaluated to support the following intended function:

- Provides support for DSC retrievability

B.6.1 Materials

The basemat is constructed of the following materials:

- Reinforced concrete
- Carbon steel (embedded rebar)

B.6.2 Environments

The basemat is exposed to the following environments:

- Sheltered
- Outdoors
- Embedded
- Below-grade

B.6.3 Aging Effects Requiring Management

The following aging effects associated with the basemat require management:

- Cracking and loss of material (spalling, scaling) due to corrosion of embedded steel for reinforced concrete.
- Cracking due to expansion from reaction with aggregates for reinforced concrete.
- Change in material properties - increase in porosity and permeability due to aggressive chemical attack and leaching for reinforced concrete
- Cracking due to increased stress levels from settlement for reinforced concrete.
- Loss of material due to general, pitting, and crevice corrosion for carbon steel components.
- Loss of material due to delayed ettringite formation or aggressive chemical attack.

B.6.4 Program Description

The objective of the program is to manage the aging effects on the basemat during the PEO. This is accomplished by inspection for evidence of cracking due to ettringite formation, aggressive chemical attack, and ASR for reinforced concrete structures; loss of material due to corrosion of embedded steel; increase in porosity and permeability; and loss of strength due to aggressive chemical attack and leaching of calcium hydroxide and carbonation. Section 3.5.1.3 of the MAPS Report, [B-12] indicates that reduction of concrete strength due to ASR can be mitigated by minimizing moisture from a water source and by keeping wet-dry cycles to a minimum (e.g. providing good drainage from around the basemat).

B.6.5 Evaluation and Technical Basis

1) Scope of Program

The scope of the ISFSI Basemat AMP includes visual inspection of the accessible above-grade portions of the basemat within the HSM array and the basemat extending around the perimeter of the HSM that is exposed to the outdoor environment.

The program consists of periodic visual inspections to manage the aging effects on the above-grade portions of the basemat.

2) Preventive Actions

The program is a condition-monitoring program that does not include preventive actions.

3) Parameters Monitored

This AMP describes periodic visual monitoring, which is performed to determine the surface condition of the ISFSI basemat. The surface condition is a leading indicator for the overall integrity of the basemat. For the ISFSI basemat surface, parameters monitored include: (1) cracking and loss of material (spalling and scaling) due to corrosion of embedded steel, ettringite formation or aggressive chemical attack; (2) cracking due to expansion from reaction with aggregates from ASR; (3) increase in porosity and permeability due to leaching of calcium hydroxide and carbonation or aggressive chemical attack; and (4) reduction of concrete anchorage capacity due to local concrete degradation.

Changes in site conditions (e.g., water table, soil consolidation, construction) may cause settlement of the ISFSI pad. Therefore, cracking and distortion due to settlement is also a monitored parameter.

4) Detection of Aging Effects

The above-grade portion of the concrete basemat is monitored using periodic visual inspection by a qualified inspector to ensure that aging degradation will be detected and quantified before loss of intended functions. These visual inspections check for irregularities such as cracking, loss of material on the concrete surface and effects from change in material properties (due to leaching). As appropriate, direct visual inspections utilizing ACI 349.3R Section 3.5.1, [B-8] are conducted for basemat concrete in the outdoor environment allowing for detection of aging effects and mechanisms from Section B.6.5(3), above. Performance of the baseline AMP visual inspection will be no later than two years after PEO commencement, with follow-on inspections at a frequency of 10± 2-years. The inspection interval of 10 years is consistent with ASME, B&PV Code, Section XI, [B-4] Subarticle IWA-2430 optional inspection program B (Paragraph IWA-2432). If preceding inspection acceptance criteria have been exceeded or the trending from previous inspections is indeterminate, the interval between inspections is decreased to 5 +/- 1 year.

5) Monitoring and Trending

The inspections and monitoring activities in this AMP are performed periodically in order to identify areas of degradation. Conditions adverse to quality noted during the inspection and monitoring activities, such as non-conformances, failures, malfunctions, deficiencies, and deviations are entered into the SMUD corrective action program. Visual inspections appropriately consider cumulative OE from previous inspections and assessments, in order to monitor and trend the progression of aging effects and mechanisms over time. Data taken for these inspections are to be monitored by comparison to past site data taken as well as comparison to industry OE, including data gathered by the AMID as discussed in NEI 14-03, [B-13].

6) Acceptance Criteria

Observed degradation can be determined to be inactive (i.e. no longer degrading) using criteria from ACI 349.3R, [B-8]. These criteria are termed second-tier for structures possessing concrete cover in excess of the minimum requirements of ACI 349. Inactive degradation can be assessed by comparison of current observed conditions with deterioration noted from prior inspections. If there is a high potential for progressive degradation to occur at its present or at an accelerated rate, the disposition should consider more frequent evaluations of the specific structure or initiation of repair planning.

The following findings from a visual inspection are considered acceptable without requiring any further evaluation:

- Absence of leaching and chemical attack, including microbiological chemical attack
- Absence of signs of corrosion in the steel reinforcement
- Absence of drummy areas (poorly consolidated concrete, air void with paste deficiencies per ACI 201.1R, [B-6])
- Popouts and voids less than 50 mm (2 in.) in diameter or equivalent surface area
- Scaling less than 30 mm (1-1/8 in.) in depth
- Spalling less than 20 mm (3/4 in.) in depth and 200 mm (8 in.) in any dimension
- Absence of corrosion staining of undefined source on concrete surfaces
- Passive cracks less than 1 mm (0.04 in.) in maximum width ("passive cracks" are defined as those having an absence of recent growth and absence of other degradation mechanisms at the crack)
- Passive settlements or deflections within the original design limits

7) Corrective Actions

Sacramento Municipal Utility District QA procedures, review and approval processes, and administrative controls are implemented according to the requirements of the Rancho Seco Quality Manual, [B-2]. SMUD's Corrective Action Program ensures that conditions adverse to quality are promptly identified and corrected, including root cause determinations and prevention of recurrence. Deficiencies are either corrected, or are evaluated as acceptable for continued service through engineering analysis, which provides reasonable assurance that the intended function is maintained consistent with current licensing basis conditions. Evaluations performed to assess conditions associated with aging should utilize the same methodology used in the licensing and design basis calculations for SMUD as much as practical to ensure intended functions are maintained throughout the PEO. Extent of condition investigation may trigger additional inspections via a different method, increased inspection frequency or expanded inspection sample size.

Repair, restoration or corrective action of an unacceptable condition should be performed consistent with ACI-224.4R, [B-7] and article IWA-4000 of the ASME B&PV Code, Section XI, [B-4].

8) Confirmation Process

Conditions adverse to quality noted during the inspection and monitoring activities are entered into SMUD's Corrective Action Program. Procedural controls are in place to ensure the responses to corrective action assignments are reviewed and to verify the response adequacy. Condition reports are also reviewed for trending purposes. A tollgate will be established to assess effectiveness of corrective actions and update the AMP as necessary on a periodic basis.

9) Administrative Controls

Administrative controls in accordance with SMUD's QA procedures and corrective action program provide a formal review and approval process. Administrative controls are based on and implemented in accordance with the requirements of a 10 CFR Part 72, Subpart G quality program and will continue for the PEO. The Rancho Seco Quality Manual, [B-2] meets this requirement.

10) Operating Experience

Operating Experience for the ISFSI basemat (pad) is as evaluated in the AMR. The OE consisting of Industry OE, TN-specific OE and SMUD-specific OE supports a conclusion that no other actions will be necessary to adequately detect and manage aging effects other than those prescribed above.

Per Rancho Seco ISFSI SAR, Volume I, [B-1] Section 2.4.6, it is indicated that there may be groundwater present underlying the site approximately 150 feet below the original ground surface. The water table has receded over recent years and is expected to recede further due to the grape vineyards adjacent to the site. The ISFSI pad is only 2 feet thick, and per Section 3.4.2.2 of Volume I of the Rancho Seco ISFSI SAR, it is stated that soil liquefaction generally occurs in areas where groundwater is not deeper than 50 ft below grade. As a result, it is concluded that soil liquefaction at the SMUD ISFSI site is highly unlikely.

B.7 Conclusion

The AMPs described in Sections B.3 through B.6 above provide reasonable assurance that potentially detrimental aging effects can be adequately managed to the extent that the intended functions of SSCs are maintained consistent with the Rancho Seco ISFSI licensing basis for the PEO.

B.8 References

B-1 Rancho Seco Independent Spent Fuel Storage Installation Final Safety Analysis Report Rev. 6, dated August 2016 (Docket 72-11).

B-2 Rancho Seco Quality Manual (latest revision).

B-3 ASME B&PV Code, Section III, Division 1, Subsections NB, NF, NG and Appendix I, 1992 Edition through 1993 Addenda.

B-4 ASME B&PV Code, Section XI, “Rules for Inservice Inspection of Nuclear Power Plants and Fuel Processing Plants,” 2013 edition.

B-5 EPRI Report 3002008193, March 2017, “Aging Management Guidance to Address Potential Chloride-Induced Stress Corrosion Cracking of Welded Stainless Steel Canisters.”

B-6 ACI-201.1R, “Guide for Conducting a Visual Inspection of Concrete in Service,” 2008.

B-7 ACI-224.4R, “Guide to Design Detailing to Mitigate Cracking,” 2013.

B-8 ACI-349.3R, “Evaluation of Existing Nuclear Safety Related Concrete Structures,” 2002.

B-9 ACI-318, “Building Code Requirements for Reinforced Concrete,” 1983, 1995.

B-10 ANSI/ASCE 11-99, “Guideline for Structural Condition Assessment of Existing Buildings.”

B-11 NUREG-1927 Rev. 1, “Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel,” June 2016.

B-12 NUREG-2214 Rev. 0, “Managing Aging Process in Storage (MAPS) Report” (draft report for comment, October 2017).

B-13 NEI 14-03, “Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management” Revision 2, 2016.

Table B-1 - DSC AMP Inspections
(2 Sheets)

Subcomponents	Number Inspected	Environment	Inspection Type	Frequency	Trending	Acceptance Criteria	Corrective Action
DSC Shell External Surfaces (normally non-accessible areas) • portions of the outer top cover plate, closure welds and HAZ; • portions of the DSC shell bottom surface • DSC surfaces, welds and HAZ, crevice locations near DSC support rails, inspected for discontinuities and imperfections; localized corrosion (e.g. general, pitting and crevice corrosion); cracking and stains caused by leaking rainwater; appearance and location of atmospheric deposits on DSC surfaces are recorded; no additional action for rainwater stains or discoloration unless corrosion is exhibited • outer bottom cover plate, grapple ring assembly, closure welds and HAZ	1	Sheltered	Remote Visual	Baseline no later than 2 years after PEO begins; 10 +/- 2 yrs thereafter. If "major" corrosion is identified, Increase frequency to 5 yrs +/- 1 yr	Data taken from the inspections are to be monitored by comparison to past site data taken as well as comparison to industry OE.	Visual Exams: The presence of a major corrosion indication anywhere on the DSC, or a minor corrosion indication within 2" of a weld, will receive a supplemental surface or volumetric examination. A minor corrosion indication more than 2" from a weld will receive a supplemental VT-1 exam. Augmented Exams: absence of flaws, or flaw is a round indication, or does not have corrosion products present, or does not have crack-like morphology. Flaw Evaluation: Determine when 75% through-wall is reached.	Conditions adverse to quality are evaluated in accordance with SMUD's Corrective Action Program. Evaluations should use the same methodology used in licensing and design basis as much as practical. Identification of major corrosion requires an expansion of the sample. Extent of condition may trigger additional inspections, increased inspection frequency or expanded inspection sample size.

Table B-1 - DSC AMP Inspections
(2 Sheets)

Subcomponents	Number Inspected	Environment	Inspection Type	Frequency	Trending	Acceptance Criteria	Corrective Action
DSC Shell (inaccessible areas) • upper surface of DSC shell where atmospheric particulate may settle • majority of the outer top cover plate, welds and HAZ • DSC shell crevice locations where shell rests on support rails	As required by inspection findings	Sheltered	In accordance with Corrective Actions AMP Section B.3.5(7)	In accordance with Corrective Actions AMP Section B.3.5(7).	In accordance with Corrective Actions AMP Section B.3.5(7).	Via the SMUD corrective action program to ensure the aging effect is adequately managed and that the intended function is maintained during the PEO.	Further evaluation and disposition per SMUD corrective action program (See AMP Section B.3.5(7), including more frequent inspections.

Table B-2 - HSM AMP Inspections
(4 Sheets)

Subcomponents	Number Inspected	Environment	Inspection Type	Frequency	Trending	Acceptance Criteria	Corrective Action
HSM Concrete - External • front, back, and side walls & rebar • roof exterior • HSM access door	1	Outdoors/ Embedded	Direct Visual (accessible areas)	Baseline no later than 2 years after PEO begins; 10 +/- 2 yrs thereafter. Increase frequency to 5 yrs +/- 1 yr if acceptance criteria exceeded.	Data taken for these inspections are to be monitored by comparison to past site data taken as well as comparison to industry OE, including data gathered by the AMID, as discussed in NEI 14-03	Cracking, spalling, scaling, loss of material and other anomalies do not exceed ACI-349.3R. The following anomalies are considered acceptable: • absence of leaching and chemical attack (including microbiological chemical attack) • absence of signs of corrosion of steel reinforcement • absence of Drummy areas (poorly consolidated concrete, air voids with paste deficiencies per ACI-201.1R) • popouts and voids less than 2" in dia or equal surface area • scaling less than 1-1/8" in depth • spalling less than 3/4" in depth and less than 8" for any dimension • absence of corrosion staining of undefined source on concrete • passive cracks less than 0.04" in maximum width	Conditions adverse to quality are evaluated in accordance with SMUD's Corrective Action Program. Evaluations should use the same methodology used in licensing and design basis as much as practical. Extent of condition may trigger additional inspections, increased inspection frequency or expanded inspection sample size.

Table B-2 - HSM AMP Inspections
(4 Sheets)

Subcomponents	Number Inspected	Environment	Inspection Type	Frequency	Trending	Acceptance Criteria	Corrective Action
HSM Concrete - Internal • visible portions of front, back, and side walls • portions of the HSM concrete floor (base)	1	Sheltered/ Embedded	Remote Visual (normally non-accessible)	Baseline no later than 2 years after PEO begins; 10 +/- 2 yrs thereafter. Increase frequency to 5 yrs +/- 1 yr if acceptance criteria exceeded.	Data taken for these inspections are to be monitored by comparison to past site data taken as well as comparison to industry OE, including data gathered by the AMID, as discussed in NEI 14-03.	Cracking, spalling, scaling, loss of material and other anomalies do not exceed ACI-349.3R. The following anomalies are considered acceptable: • absence of leaching and chemical attack (including microbiological chemical attack) • absence of signs of corrosion of steel reinforcement • absence of Drummy areas (poorly consolidated concrete, air voids with paste deficiencies per ACI-201.1R) • popouts and voids less than 2" in dia or equal surface area • scaling less than 1-1/8" in depth • spalling less than 3/4" in depth and less than 8" for any dimension • absence of corrosion staining of undefined source on concrete • passive cracks less than 0.04" in maximum width	Conditions adverse to quality are evaluated in accordance with SMUD's Corrective Action Program. Evaluations should use the same methodology used in licensing and design basis as much as practical. Extent of condition may trigger additional inspections, increased inspection frequency or expanded inspection sample size.

Table B-2 - HSM AMP Inspections
(4 Sheets)

Subcomponents	Number Inspected	Environment	Inspection Type	Frequency	Trending	Acceptance Criteria	Corrective Action
HSM Concrete & Steel Internal (inaccessible areas) • internal surface of the HSM roof due to the upper heat shield • heat shields at internal surface of the roof and side walls	As required by inspection findings	Sheltered/ Embedded	In accordance with Corrective Actions AMP Section B.4.5(7)	In accordance with Corrective Actions AMP Section B.4.5(7).	In accordance with Corrective Actions AMP Section 5 B.4.5(7).	Via the SMUD corrective action program to ensure the aging effect is adequately managed and that the HSMs intended function is maintained during the PEO.	Conditions adverse to quality are evaluated in accordance with SMUD's Corrective Action Program. Evaluations should use the same methodology used in licensing and design basis as much as practical. Extent of condition may trigger additional inspections, increased inspection frequency or expanded inspection sample size.
HSM Steel - External • HSM access door • attachment hardware	1	Outdoors/Embedd ed	Direct Visual (accessible areas)	Baseline no later than 2 years after PEO begins; 10 +/- 2 yrs thereafter. Increase frequency to 5 yrs +/- 1 yr if acceptance criteria exceeded.	Data taken for these inspections are to be monitored by comparison to past site data taken as well as comparison to industry OE, including data gathered by the AMID, as discussed in NEI 14-03.	VT-3: ASME Section XI, Subarticle IWF-3400 and any indications of the following are evaluated: • corrosion and material loss • crevice, pitting, and galvanic corrosion • corrosion stains on adjacent components and structures • surface cracks • stains caused by leaking rainwater if evidence of corrosion exhibited • loose bolts and nuts and cracked bolts are not acceptable unless approved by the Engineering evaluation.	Conditions adverse to quality are evaluated in accordance with SMUD's Corrective Action Program. Evaluations should use the same methodology used in licensing and design basis as much as practical. Extent of condition may trigger additional inspections, increased inspection frequency or expanded inspection sample size.

Table B-2 - HSM AMP Inspections
(4 Sheets)

Subcomponents	Number Inspected	Environment	Inspection Type	Frequency	Trending	Acceptance Criteria	Corrective Action
HSM Steel - Internal • DSC support structure including Nitronic® 60 rail plates and welds • attachment hardware	1	Sheltered/ Embedded	Remote Visual (normally non-accessible)	Baseline no later than 2 years after PEO begins; 10 +/- 2 yrs thereafter. Increase frequency to 5 yrs +/- 1 yr if acceptance criteria exceeded.	Data taken for these inspections are to be monitored by comparison to past site data taken as well as comparison to industry OE, including data gathered by the AMID, as discussed in NEI 14-03.	VT-3: ASME Section XI, Subarticle IWF-3400 and any indications of the following are evaluated: • corrosion and material loss • crevice, pitting, and galvanic corrosion • corrosion stains on adjacent components and structures • surface cracks • Stains caused by leaking rainwater if evidence of corrosion exhibited • loose bolts and nuts and cracked bolts are not acceptable unless approved by the engineering evaluation.	Conditions adverse to quality are evaluated in accordance with SMUD's Corrective Action Program. Evaluations should use the same methodology used in licensing and design basis as much as practical. Extent of condition may trigger additional inspections, increased inspection frequency or expanded inspection sample size.

Table B-3 - Transfer Cask AMP Inspections

Subcomponents	Number Inspected	Environment	Inspection Type	Frequency	Trending	Acceptance Criteria	Corrective Action
MP187 External Surfaces • Cask lid surfaces • bearing surfaces of upper and lower trunnions • attachment fasteners • exterior cask surfaces	1	Sheltered	Direct Visual of external surfaces accessible areas	Prior to use	Data taken from the inspections are to be monitored by comparison to past site data taken as well as comparison to industry OE.	VT-3:ASME Section XI, IWA-2213 VT-1 (if req'd): ASME Section XI, IWA-2211 with • No indications of corrosion or wear on TC external surfaces	Conditions adverse to quality are evaluated in accordance with SMUD's Corrective Action Program. Evaluations should use the same methodology used in licensing and design basis as much as practical. Extent of condition may trigger additional inspections, increased inspection frequency or expanded inspection sample size.
MP187 Internal Surfaces • Cask cavity inner liner • Nitronic 60 rails	1	Sheltered	Direct Visual, Remote Visual or both of accessible areas	Prior to use	Data taken from the inspections are to be monitored by comparison to past site data taken as well as comparison to industry OE.	VT-3:ASME Section XI, IWA-2213 VT-1 (if req'd): ASME Section XI, IWA-2211 with • No indications of corrosion or cracking on TC internal surfaces • No wear of inner liner thickness	Conditions adverse to quality are evaluated in accordance with SMUD's Corrective Action Program. Evaluations should use the same methodology used in licensing and design basis as much as practical. Extent of condition may trigger additional inspections, increased inspection frequency or expanded inspection sample size.

Table B-4 - Basemat AMP Inspections

Subcomponents	Number Inspected	Environment	Inspection Type	Frequency	Trending	Acceptance Criteria	Corrective Action
Basemat Concrete	1	Outdoors/ Embedded/ Sheltered/ Below-grade	Direct Visual of the accessible above-grade surfaces.	Baseline no later than 2 years after PEO begins; 10 +/- 2 yrs thereafter. If acceptance criteria is exceeded, increase frequency to 5 yrs +/- 1 yr.	Data taken from the inspections are to be monitored by comparison to past site data taken as well as comparison to industry OE.	Cracking, spalling, scaling, loss of material and other anomalies do not exceed ACI-349.3R and ACI-201.1R. The following anomalies are considered acceptable: • absence of leaching and chemical attack (including microbiological attack) • absence of signs of corrosion of steel reinforcement • absence of Drummy areas (poorly consolidated concrete, air voids with paste deficiencies per ACI-201.1R) • popouts and voids less than 2" in dia or equal surface area • scaling less than 1-1/8" in depth • spalling less than 3/4" in depth and less than 8" for any dimension • absence of corrosion staining of undefined source on concrete • passive cracks less than 0.04" in maximum width • passive settlement or deflection within original design limits	Conditions adverse to quality are evaluated in accordance with SMUD's Corrective Action Program. Evaluations should use the same methodology used in licensing and design basis as much as practical. Extent of condition may trigger additional inspections, increased inspection frequency or expanded inspection sample size. Repair, restoration meets ACI-224.4R and ASME Sect. XI, IWA-4000.

APPENDIX C
CHANGES TO THE RANCHO SECO ISFSI FSAR FINAL SAFETY ANALYSIS REPORT

CONTENTS

LIST OF TABLES

C.1 Introduction

The proposed supplement to the Rancho Seco Independent Spent Fuel Storage Installation (ISFSI) Final Safety Analysis Report (FSAR) to support the specific Rancho Seco ISFSI license renewal application is discussed and described in this appendix. These proposed ISFSI FSAR changes summarize the aging management activities and programs planned for the period of extended operation (PEO) for the Rancho Seco ISFSI.

Section C.2 of this appendix provides a proposed new section to address aging management during the PEO for the Rancho Seco ISFSI FSAR to be added in existing Volume I, Chapter 9, "Conduct of Operations." Section C.3 of this appendix identifies changes to the existing ISFSI FSAR that are necessary to reflect this PEO.

Proposed new FSAR Section 9.8, "Aging Management," contains subsections that summarize the following aging management elements:

- Scoping evaluation and results
- Aging management review (AMR) and results
- Time-limited aging analyses (TLAAs)
- Aging management programs (AMPs)
- Tollgate assessments

For efficiency and in order to avoid repetition, many tables proposed for inclusion in the Rancho Seco ISFSI FSAR that reside elsewhere in this license renewal application (LRA) are cross-referenced in the new Section C.2 Aging Management subsections below.

Upon issuance of the renewed license (SNM-2510) for the Rancho Seco ISFSI, Sacramento Municipal Utility District (SMUD) will provide an update to the Rancho Seco ISFSI FSAR incorporating the provisions in this supplement, with any modifications resulting from U.S. Nuclear Regulatory Commission (NRC) review, in accordance with the provisions of 10 CFR 72.70(c).

C.2 Proposed New Rancho Seco ISFSI FSAR Sections

The following aging management information to be included in new Rancho Seco ISFSI FSAR, Section 9.8, is based on Chapters 2 and 3, and Appendices A and B of this LRA, and any applicable reference documents. Further details can be found in those sections/appendices and reference documents. References to chapter and section numbers in the proposed FSAR sections below refer to current FSAR chapters and sections unless otherwise noted. Specific FSAR subsection numbers may differ from those presented here. References herein are in the form “[C-x].” These will be translated to the form “[9.8-x]” when the FSAR is updated.

C.2.1 FSAR Section 9.8 – Aging Management

Aging management activities (AMAs) have been undertaken in order to identify the structures, systems, and components (SSCs) and associated subcomponents of the Rancho Seco ISFSI that are within the scope of the Rancho Seco Independent Spent Fuel Storage Installation Materials License SNM-2510 Amendment 4, November 2017, [C-1] renewal. The methodology used to perform this scoping evaluation is based on the guidance contained in NUREG-1927 Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel, [C-2]. The scoping evaluation identifies the ISFSI SSCs that are within the scope of renewal, and therefore require an AMR. The AMR identifies the materials and environment for the SSCs and associated subcomponents determined to be within the renewal scope. These SSCs within the scope of renewal are further subjected to evaluation for potential degradation due to aging effects. After potential aging effects are identified, it is determined for each in-scope SSC whether they can be addressed by a TLAA, or if they will require an AMP. Additional details of the AMR can be found in Chapter 3. Listed in the subsections below are a description of the scoping evaluation methodology and the results of the scoping evaluation, the results of the AMR, TLAAs and the AMPs selected to manage the effects of aging over the PEO.

C.2.2 FSAR Section 9.8.1 – Scoping Evaluation Methodology

The scoping evaluation is performed based on the two-step process described in Section 2.4.2 of NUREG-1927, [C-2]. SSCs are considered to be within the scope of renewal if they satisfy either of the following two criteria:

Criterion 1: The SSC is classified as important-to-safety (ITS) as it is relied on to perform one of the following functions:

A. Maintain the conditions required by the regulations, specific license or certificate of compliance (CoC) to store spent fuel safely.
B. Prevent damage to the spent fuel during handling and storage.

C. Provide reasonable assurance that spent fuel can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public.

These SSCs ensure that important safety functions are met for (1) criticality, (2) shielding, (3) confinement, (4) heat transfer, (5) structural integrity, and (6) spent fuel canister retrievability.

Criterion 2: The SSC is classified as not important-to-safety (NITS), but according to the licensing basis, its failure could prevent fulfillment of a function that is ITS, or its failure as a support SSC could prevent fulfillment of a function that is ITS.

The second step of the scoping evaluation includes a more detailed review of the SSCs that are determined to be within the scope of the renewal to identify and describe the subcomponents and subcomponent parts that support the intended function or functions of the SSCs. The intended functions of the SSC subcomponents (and the corresponding abbreviations used to denote this function) include:

- Providing criticality control of the spent fuel (CC),
- Providing heat transfer (HT),
- Directly or indirectly maintaining a pressure boundary (PB),
- Providing radiation shielding (SH),
- Providing structural support, functional support, or both, to SSCs that are ITS (SS) and
- Providing retrieval of spent fuel canister from the storage cask (RE).

The scoping of the spent fuel assemblies (SFAs) authorized for storage at the Rancho Seco ISFSI has been addressed as specified in Section 2.4.2.1 of NUREG-1927, [C-2].

The HSM, DSC, and transfer cask (TC) drawings list the associated subcomponents of the major SSCs, their quality categories and their materials of construction. The drawings and other licensing basis documents were reviewed to determine the SSCs and associated subcomponents that meet either Scoping Criterion 1 or 2. Based on this review, those SSCs and subcomponents that perform or support any of the identified intended functions are determined to require an AMR. Those SSCs and associated subcomponents that do not perform or support one or more of these intended safety functions are excluded from further evaluation.

C.2.3 FSAR Section 9.8.2 – Results of Scoping Evaluation

Table C-1 (new ISFSI FSAR Table 9.8-1) summarizes the results of the scoping evaluation, listing the SSCs that are identified to be within the scope of renewal and the criterion upon which this determination is based. The SSCs determined to be within the scope of Rancho Seco ISFSI license renewal are the DSC (containing SFAs and GTCC waste), HSM, TC and ISFSI basemat. Detailed scoping evaluation results for each SSC and associated subcomponents have been generated. These results are included in AMR Table C-3 to Table C-8 (new ISFSI FSAR Tables 9.8-3 to 9.8-8).

At the Rancho Seco ISFSI, all fuel is currently in dry storage and no more fuel or new canisters are to be loaded. Hence, the TC and the auxiliary equipment will not be used for any loading operations. The only remaining TC safety function during the PEO is retrieval of the DSCs from the HSMs directly into a transport package for offsite shipment of the DSC.

The SFAs, which are stored in an inert and sealed environment and are supported inside the FO/FC/FF DSC basket assembly, are also determined to be within the scope of renewal. The in-scope subcomponents of the SFAs and their intended functions are identified in Table C-2 (new ISFSI FSAR Table 9.8-2).

Note: The external design characteristics of the greater than class C (GTCC) waste containing DSC are identical to the fuel-containing DSCs (FO/FC/FF DSCs). Hence, the term “DSC” has been used to address both DSC types in this application, unless a distinction is necessary to address a specific characteristic of the GTCC DSC.

The storage pad (also referred to as the basemat) is a NITS structure. Since settlement of the basemat may affect retrievability of the DSC, the basemat is included within the scope of renewal (monitoring for basemat settlement). The accessible above-grade and inaccessible below-grade areas of the storage pad are within the scope of renewal.

Structures, systems, and components that are not in the scope of renewal include the fuel transfer and auxiliary equipment. These components are classified as NITS and do not meet scoping Criterion 2. Also not within the scope are those NITS subcomponents of the DSC, HSM and TC that do not meet Criterion 2 because their failure does not prevent fulfillment of an ITS function.

The approach or apron slab is a NITS reinforced concrete structure, designed and constructed to Rancho Seco specific conditions. The slab provides access to the HSM but does not support the HSM. It does not provide a safety function, and its failure would not prevent fulfillment of a safety function of the HSM loaded with a DSC

C.2.4 FSAR Section 9.8.3 – Aging Management Review

The purpose of the AMR is to assess the proposed aging management activities of SSCs determined to be within the scope of renewal for the Rancho Seco ISFSI. The AMR addresses aging mechanisms and effects that could adversely affect the ability of the SSCs (and associated subcomponents) from performing their intended functions during the PEO.

The AMR process involves the following major steps:

- Identification of materials and environments;
- Identification of aging effects and mechanisms requiring management;
- Determination of the activities required to manage the effects and mechanisms of aging. This involves the identification of TLAAs or AMPs for managing the effects of aging;
- Evaluation of spent fuel (canister) retrievability during the period of extended operation.

For each SSC, the material of construction and the environment to which each SSC is exposed are determined. The component environments are determined based on the location of the component within the storage system. Once the component material/environment combinations are determined, potential aging effects requiring management are determined. Engineering literature, related research and industry information, and existing operating experience (OE) are reviewed to identify expected aging degradation mechanisms for different materials and environments. After the expected aging effects are identified, it is determined whether the effects can be addressed by analysis (TLAA), or will require an AMP.

The environments to which SSCs and associated subcomponents are exposed play a critical role in the determination of potential aging effects and mechanisms. The environments to which the Rancho Seco SSCs are exposed are affected by the characteristics of the ISFSI site environment, as well as by the component location within the storage system. There are five basic environments that apply for the Rancho Seco ISFSI SSCs.

- Inert Gas – Inert environment inside the DSC cavity. The spent fuel assemblies (SFAs), the DSC internal basket assembly, and the inside surfaces of the DSC shell and interior shell assembly subcomponents (e.g., inner top and bottom cover plates and top shield plugs) are exposed to the inert gas (helium) environment inside the shell assembly cavity. These components are exposed to significant neutron and gamma radiation. Refer to DSC cavity helium temperatures and pressures presented in Volume I, Tables 8-2a and 8-2b, for normal and off-normal conditions. Both temperature and pressure are expected to continuously decrease over the period of extended operation.
- Sheltered – Protected environment, such as HSM interior or TC stored indoors in an uncontrolled environment. A sheltered environment is a

protected environment with no direct exposure to sun, wind, or precipitation. A sheltered environment may contain moisture and salts or other contaminants from the external ambient air. The temperature inside the HSM depends on the ambient air temperature and the heat load of the loaded canister. Components exposed to the HSM sheltered environment (interior side of the HSM walls, HSM steel, and DSC external shell assembly components) are exposed to neutron and gamma radiation to a lesser extent than those of the interior cavity of the DSC. Temperatures and radiation sources are expected to decrease over the PEO.

- Embedded or Encased – This environment applies for materials that are embedded or encased (sealed) inside another material. These include rebar and anchorage embedded in the HSM concrete, DSC bottom shield plug encased between the inner and outer cover plates, NS-3 solid neutron shielding material encased in the TC lids and between the TC neutron shield jacket and the structural shell, and the lead encased between the inner liner and the structural shell of the TC. Embedded or encased environments are exposed to radiation. The radiation source is expected to decrease over the period of extended operation.
- External (Yard and Outdoor) – During storage, the exterior surfaces of the HSM are exposed to all weather conditions, including insolation, wind, rain, snow, and plant-specific ambient air conditions, including moist atmospheric air, ambient temperatures, and humidity.
- Underground – At the Rancho Seco ISFSI, the HSMs are installed on a reinforced concrete basemat, which is constructed on compacted, engineered fill. The concrete basemat accessible areas above-grade and inaccessible areas below-grade are within the scope of Rancho Seco ISFSI renewal. The ISFSI basemat that is located below grade could be exposed to a groundwater/soil environment.

After the component material/environment combinations are determined, potential aging management effects are determined. Aging effects are the manifestation of aging mechanisms. The AMR process identifies both the aging effects and the associated aging mechanisms that cause them. Each subcomponent that was subjected to AMR was evaluated to determine if the potential aging effects and mechanisms were credible considering the various material/environment combinations.

Supplemental Evaluations

For the following aging mechanisms, supplemental evaluations were performed to show that the aging mechanisms did not require aging management:

A. Irradiation Embrittlement

This supplemental evaluation assessed the effect of neutron and gamma radiation on the DSC and HSM structural materials. Although the license renewal period is for 40 years, this evaluation takes into account the initial 20 years of storage period and an additional 80 years of storage period, for a total of 100 years. The maximum fluence is calculated as 7.57 E+15 neutrons/cm^2 for the DSC fuel compartment and the total gamma exposure is calculated as 3.58 E+09 rad. The neutron fluence and gamma exposure are below the threshold levels of concern for the DSC and HSM materials. The results indicate that there is no credible mechanical degradation occurring in compressive strength and tensile strength of the DSC shell, shield plug, and HSM components due to neutron fluence and gamma exposure levels. Therefore, irradiation embrittlement is not an aging effect requiring management for the DSC and HSM components.

B. Combustible Gas Generation

This supplemental evaluation documents an analysis performed to determine the quantity of combustible gases generated as a result of irradiation of the NS-3 neutron shield material for the MP187 TC during its function as a transfer cask. The combustible gas generation in the neutron shield material of the transfer cask was calculated based on the design basis radiological fuel loaded in a DSC inside the transfer cask. Considering that the total hydrogen mass originally present in the neutron shield material is approximately 209 kg, the fraction of hydrogen liberated from the neutron shield material over the service period of the cask is [ ] by weight, which is statistically insignificant. Therefore, generation of combustible gases is not an aging mechanism requiring management for the NS-3 neutron shield material.

C.2.4.1 FSAR Section 9.8.3.1 – Results of Aging Management Review - DSC

The DSC performs the following intended functions:

- CC Provides criticality control of spent fuel
- HT Provides heat transfer
- PB Directly or indirectly maintains a pressure boundary (confinement)
- RE Provides retrievability of SFAs
- SH Provides radiation shielding
- SS Provides structural support (structural integrity)

The GTCC DSC is designed to store greater than Class C waste and, thus, criticality is not an intended function for the GTCC DSC.

The Rancho Seco DSCs consist of two main subcomponents: the shell assembly and the internal basket assembly. The materials of construction for the DSC subcomponents that are subject to further AMR include stainless steel and carbon steel. The following aging effects and mechanisms are applicable for DSC steel components:

Loss of Material

- Loss of material due to crevice corrosion – stainless steel
- Loss of material due to pitting corrosion – stainless steel
- Loss of material due to galvanic corrosion – Nitronic® 60 rail plate and graphite lubricant

Cracking

- Cracking due to stress corrosion cracking – stainless steel
- Cracking due thermal fatigue - stainless steel DSC pressure boundary

Loss of Criticality Control

- Loss of criticality control due to boron depletion - Boral

Tables C-3, C-4, C-5 and C-6 (new ISFSI FSAR Tables 9.8-3 through 9.8-6) summarize the results of the AMR for the FO, FC, FF and GTCC DSCs, respectively. These tables include for each in-scope subcomponent the material, intended function, the environment, the associated aging effects requiring management, and the resulting aging management activity.

C.2.4.2 FSAR Section 9.8.3.2 – Results of Aging Management Review – HSM

The evaluation boundary for the HSM includes the entire HSM concrete structure and the steel support structure for the DSCs, which perform the following intended functions:

HT Provides heat transfer

RE Provides retrievability of DSC

SH Provides radiation shielding

SS Provides structural support (structural integrity)

The materials of construction for the subcomponents of the HSM are presented in the AMR tables listed in this section, and consist of reinforced concrete, carbon steel, Nitronic® 60 stainless steel, plain concrete and stainless steel.

The following aging effects and mechanisms for HSM concrete components are applicable:

Loss of Material

- Aggressive chemical attack, including microbiological chemical attack
- Corrosion of embedded steel

Cracking

- Corrosion of embedded steel
- Reactions with aggregates

Change in Material Properties

- Leaching of $Ca(OH)_2$
- Aggressive chemical attack

The following aging effects/mechanisms for HSM steel and other metal components are applicable:

Loss of Material

- Loss of material due to general corrosion – carbon steel
- Loss of material due to galvanic corrosion – Nitronic® 60 DSC support rail plates
- Loss of material due to crevice corrosion – carbon steel and stainless steel
- Loss of material due to pitting corrosion – carbon steel and stainless steel

Cracking

- Stress Corrosion Cracking - welds attaching Nitronic® 60 rail plate.

Table C-7 (new ISFSI FSAR Table 9.8-7) summarizes the results of the AMR for the RS HSMs.

C.2.4.3 FSAR Section 9.8.3.3 – Results of Aging Management Review – Concrete Basemat

The basemat is a NITS reinforced concrete structure designed to support the HSMs and constructed to plant-specific site conditions. Long-term settlement of the ISFSI basemat is a credible aging mechanism that may affect retrievability of the DSC. Therefore, the basemat is within scope of renewal for monitoring for pad settlement. There are no other credible failure modes of the basemat that could prevent the HSM safety functions from being fulfilled. The basemat is evaluated in support of the following intended function:

- Provides HSM structural/functional support.

The material of construction for the basemat is reinforced concrete.

The following aging effects and mechanisms are applicable for the concrete basemat:

Loss of Material

- Delayed Ettringite Formation (DEF)
- Aggressive chemical attack, including microbiological chemical attack
- Corrosion of embedded steel

Cracking

- Reactions with aggregates
- Settlement

Change in Material Properties

- Leaching of $Ca(OH)_2$
- Aggressive chemical attack, including microbiological chemical attack

The portion of the AMR associated with the concrete in Table C-7 (new ISFSI FSAR Table 9.8-7) is also applicable to the concrete basemat.

C.2.4.4 FSAR Section 9.8.3.4 – Results of Aging Management Review – Transfer Cask

This section summarizes the results of the AMR for the in-scope subcomponents of the NUHOMS® MP187 Transfer Cask (MP187 TC). The evaluation boundary for the TC includes the TC subcomponents, which perform the following intended functions:

HT Provides heat transfer

RE Provides retrievability of DSC

SH Provides radiation shielding

SS Provides structural support (impact resistance, lifting, etc.)

The materials of construction for the subcomponents of the TC are presented in the AMR tables listed in this section, and consist of stainless steel, carbon steel, Elastomer O-rings, NS-3 neutron shielding, lead gamma shielding, and Nitronic® 60 canister rails.

Note: All of the Rancho Seco SFAs and GTCC waste have been loaded and placed into the HSMs for interim storage. The MP187 TC is currently stored in a sheltered environment and the only remaining MP187 TC function is to retrieve the DSCs when they are to be shipped offsite.

The MP187 TC is a cylindrical vessel with a welded bottom assembly and a bolted top cover plate. The TC is constructed from three concentric cylindrical shells to form an inner and outer annulus. The TC is normally stored in a

sheltered environment between uses and during staging activities prior to each use. The total time exposure of the TC to the spent fuel pool environment (during prior loading operations) and to the external environment (during transfer operations) represents a negligible fraction of its total life span, including PEO. Hence, the only environment considered for the TC AMR is the sheltered environment.

The following aging effects and mechanisms for steel components are applicable:

Loss of Material

- Loss of material due to general corrosion – carbon steel
- Loss of material due to crevice corrosion – carbon steel and stainless steel
- Loss of material due to pitting corrosion – carbon steel and stainless steel
- Loss of material due to galvanic corrosion - stainless steel rail, inner shell, and bottom end closure.

Cracking

- Cracking due to thermal fatigue - carbon steel and stainless steel

Table C-8 (new ISFSI FSAR Table 9.8-8) summarizes the results of the AMR for the TC.

C.2.4.5 FSAR Section 9.8.3.5 – Results of Aging Management Review – Spent Fuel Assemblies

The SFA principal function during dry storage is to maintain proper geometry and position of radioactive material through confinement. Although fuel cladding provides a confinement barrier, no credit is taken in the safety analysis for the fuel cladding as a confinement boundary. The evaluation boundary for the SFA includes the fuel cladding and end plugs, guide tubes, grid assemblies, upper nozzle, and bottom nozzle, which perform the following intended functions:

CC Provides criticality control

HT Provides heat transfer

PB Directly or indirectly maintains a pressure boundary (confinement)

SS Provides structural support (structural integrity)

The materials of construction of the SFA hardware consist of zirconium-based alloys, stainless steel and nickel-based alloys.

The AMR for the SFAs focuses primarily on the fuel rod cladding as it is considered the limiting component of the fuel assembly hardware because it serves as a barrier to fission products, provides defense-in-depth, and maintenance of its structural integrity ensures its retrievability from the DSC.

The environments that affect the subcomponents of each DSC, both externally and internally, are those that are normally (continuously) experienced as described below:

External

For SFAs, external environment refers to the internal DSC atmosphere. The storage atmosphere is predominantly helium with trace amounts of water vapor and air.

Internal

For SFAs, internal environment refers to the fuel rod interior. The fuel rod internal environment is assumed to be a combination of the original helium fill gas (during manufacturing) and fission products produced during reactor operation.

The materials inside the DSC, including the SFAs, cannot practically be inspected in-situ due to radiation levels and accessibility (i.e., DSC is seal welded). In preparation for dry storage, the DSC internals are vacuum dried and backfilled with helium to establish an inert gas environment in the DSC cavity. The DSC is leak tested to ensure that the inert gas environment is maintained so that the SFAs will not become subject to age-related degradation mechanisms during the storage period. A demonstration project provides the basis for the assertion that the SFAs will not degrade to unacceptable levels during the PEO. Therefore, no aging management program or activities are credited during the PEO for the Rancho Seco low burnup SFAs and associated subcomponents.

C.2.5 FSAR Section 9.8.4 – Summary of Time-Limited Aging Analyses

Time-limited aging analyses are prepared to assess SSCs that have a time-dependent operating life to demonstrate that the existing licensing basis remains valid and that the intended functions of the SSCs in scope of renewal are maintained during the PEO. Time dependency may entail fatigue life (cycles), change in a mechanical property, such as fracture toughness or strength of materials due to irradiation, or time-limited operation of a subcomponent.

C.2.5.1 FSAR Section 9.8.4.1 – DSC Time-Limited Aging Analyses

The following are summary descriptions of the TLAAs that were identified and prepared based on the AMR of the DSC.

A. Fatigue Evaluation of the DSCs

This TLAA documents the evaluation of the DSC pressure boundary subcomponents for pressure and temperature fluctuations in accordance with the provisions of NB 3222.4(d) of the ASME B&PV Code, Section III, Division 1, 1992 Edition, with Addenda through 1993, [C-3]. As provided by NB 3222.4(d) of the ASME B&PV Code, fatigue effects need not be specifically evaluated provided the six criteria in NB 3222.4(d) are met. This evaluation is performed considering a 60-year service life using maximum bounding initial DSC pressures and temperatures (at the beginning of storage). This evaluation shows that the six criteria of NB 3222.4(d) are met.

B. Boron Depletion

This TLAA performs an analysis to determine the amount of boron depletion in the FO and FC DSC poison plates during the PEO. Although the license renewal period is for 40 years, this evaluation takes into account the initial 20 years of storage period and an additional 80 years of storage period, for a total of 100 years.

Over a period of 100 years, the evaluation considers a bounding neutron irradiation rate, and indicates that the amount of B-10 depleted is negligible.

C.2.5.2 FSAR Section 9.8.4.2 – HSM Time-Limited Aging Analyses

No TLAAs are used to manage any expected aging effects of HSM components.

C.2.5.3 FSAR Section 9.8.4.3 – Transfer Cask Time-Limited Aging Analyses

The following are summary descriptions of the TLAAs that were identified and prepared based on the AMR of the TC.

Fatigue Evaluation of the TC

This TLAA documents the thermal fatigue analysis of the TC for pressure and temperature fluctuations in accordance with the provisions of NB 3222.4(d) of the ASME BP&V Code. As provided by NB 3222.4(d), fatigue effects need not be specifically evaluated provided the six criteria in NB 3222.4(d) are met. This evaluation is performed considering a 60-year service life using maximum bounding initial TC pressures and temperatures (at the beginning of storage). This evaluation shows that all the six criteria of NB 3222.4(d) are met.

C.2.5.4 FSAR Section 9.8.4.4 – ISFSI Basemat Time-Limited Aging Analyses

No TLAAs are used to manage any expected aging effects of the basemat components.

C.2.6 FSAR Section 9.8.5 – Summary of Aging Management Programs

Aging management programs are developed for managing the effects of aging. As appropriate, an AMP was created to summarize the activities or procedures implemented to monitor and manage the aging effects.

C.2.6.1 FSAR Section 9.8.5.1 – DSC Aging Management Program

The DSC External Surfaces AMP is employed to manage the aging effects and mechanisms for the DSC. The scope of the DSC AMP, parameters to be monitored, the criteria for selecting a DSC for the AMP, the detection of aging effects and the acceptance criteria are described in Table C-9 (new ISFSI FSAR Table 9.8-9). Rancho Seco will implement the first (baseline) DSC inspections under this AMP on the selected DSCs in accordance with the program schedule as described in the table.

C.2.6.2 FSAR Section 9.8.5.2 – HSM Aging Management Program

The following program is employed to manage the aging effects and mechanisms for the HSM concrete and steel components:

- HSM Aging Management Program for External and Internal Surfaces (applicable to HSM, DSC support structures)

The scope of the HSM AMP, parameters to be monitored, the criteria for selecting an HSM for the AMP, the detection of aging effects and the acceptance criteria are described in Table C-10 (new ISFSI FSAR Table 9.8-10). Rancho Seco will implement the first (baseline) HSM inspections under this AMP on the selected HSM in accordance with the program schedule as described in the table.

C.2.6.3 FSAR Section 9.8.5.3 – TC Aging Management Program

The TC AMP is employed to manage the aging effects and mechanisms for the TC components. The scope of the TC AMP, parameters to be monitored, the detection of aging effects and the acceptance criteria are described in Table C-11 (new ISFSI FSAR Table 9.8-11). Rancho Seco will perform the inspections and monitoring activities described in this AMP prior to use to identify areas of degradation. Evaluation of this information during preparations for DSC retrieval and transfer provides adequate predictability and allows time for corrective action, if required, in order for the TC to perform its intended functions.

C.2.6.4 FSAR Section 9.8.5.4 – ISFSI Basemat Aging Management Program

The Rancho Seco ISFSI Basemat AMP is employed to manage the aging effects and mechanisms for the basemat concrete. The scope of the ISFSI basemat AMP, the detection of aging effects, and the acceptance criteria are described in Table C-12 (new ISFSI FSAR Table 9.8-12). Rancho Seco will implement the first (baseline) basemat inspections under this AMP in accordance with the program schedule as described in the table.

C.2.7 FSAR Section 9.8.6 –Aging Management Tollgates

The AMPs listed in Section 9.8.5 are subject to modification under 10 CFR 72.48 as new OE accumulates. For these AMPs, Rancho Seco will implement a program that is consistent with the guidelines of a generic AMP tollgate process described below.

The following definitions are reproduced from NEI 14-03, Format, Content and Implementation Guidance for Dry Storage Operations-Based Aging Management, [C-4]:

Tollgate: A requirement included in a renewed ISFSI license and associated UFSAR for the licensee to perform and document an assessment of the aggregate impact of aging-related dry cask storage (DCS) OE, research, monitoring, and inspections at specific points in time during the renewed operating period.

Tollgate Assessment: A written evaluation, performed by licensees at each tollgate, of the aggregate impact of aging-related DCS OE, research, monitoring, and inspections on the intended functions of in-scope DCS SSCs. Tollgate assessments are intended to 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 programs of the licensee, the certificate holder, or both.

Corrective actions may include

- Modification of TLAAs
- Adjustment of the scope, frequency, or both of AMPs
- Repair or replacement of SSCs

Rancho Seco will assess new information relevant to aging management, as it becomes available, in accordance with normal corrective action and OE programs. Tollgates are an opportunity to seek out other information that may be available and perform an aggregate assessment.

Tollgate assessments are not stopping points. No action other than performing an assessment is required to continue NUHOMS® dry storage system operation.

SMUD will perform tollgate assessments during the PEO of the Rancho Seco ISFSI, spanning the period from June 30, 2020 through June 30, 2060 or the date the last licensed material is removed from the Rancho Seco ISFSI, whichever occurs sooner. Tollgate assessments for the Rancho Seco ISFSI will be performed as shown in Table C-13 (new ISFSI FSAR Table 9.8-13).

C.3 Proposed Revised Rancho Seco ISFSI FSAR Sections

The Rancho Seco ISFSI FSAR was reviewed for proposed changes required to reflect the change in the license term from the original 20 years to 60 years as a result of the additional 40 years of the PEO, plus some revised analyses to address this extended license term.

C.3.1 FSAR Volume I, Section 1.1 – Introduction

Revise the second paragraph to reflect renewal of the ISFSI license for an additional 40 years:

> Consistent with Rancho Seco PSDAR, the Independent Spent Fuel Storage Installation (ISFSI) is intended to provide dry storage capacity for Rancho Seco spent nuclear fuel and Greater than Class C (GTCC) radioactive waste. The storage system was designed for 50 year service, and *initially* licensed for 20 years in accordance with 10 CFR 72. *On [mm/dd/yy], the NRC approved renewal of the ISFSI license (SNM-2510) for an additional 40 years. The aging management activities associated with this renewal applies to Amendment 4. Any future amendments will include an aging management review (AMR) and any associated required aging management activities. The current aging management results are detailed in Chapter 9, Section 9.8.*
>
> *The original ISFSI FSAR chapters indicate design life and service life values of 50 years[1]. The new design life is 60 years. Time-limited aging-analyses (TLAAs) to assess SSCs that have a time-dependent operating life to demonstrate that the existing licensing basis remains valid and that the intended functions of the SSCs in scope of renewal are maintained during the period of extended operation (PEO) to 60 years are detailed in Chapter 9, Section 9.8.4.*
>
> Construction of the Rancho Seco ISFSI was completed during 1996 and the initial license was received on June 30, 2000. All fuel was in dry storage at the ISFSI in August 2002 and the single GTCC waste canister was loaded at the ISFSI in August 2006.
>
> [1]*The terms design life and service life are equivalent and interchangeable.*

C.3.2 FSAR Volume I, Section 1.2 –General Description of the Installation

Revise the principal ISFSI design criteria summary for design life in the 5th paragraph to reflect a design life of 60 years for the DSC:

> The efficacy of the neutron absorber panels throughout the ~~50~~*60*-year design life of the DSC is demonstrated in the following manner:

C.3.3 FSAR Volume I, Section 3.3.4.1.1 –Fuel-Only (FO) DSC Design Features

Revise the design life of the DSC for the neutron absorber panels used for nuclear criticality safety and the boron depletion results in the fifth paragraph to reflect a design life of 60 years:

> The efficacy of the neutron absorber panels throughout the ~~50~~*60*-year design life of the DSC is demonstrated in the following manner:
>
> 1. Acceptance tests are performed on the panels during fabrication as described below and in compliance with Section 8.1.8 of the NUHOMS®-MP187 TC transportation SAR [3.6]. The neutron absorber plates are verified to have the minimum total B^{10} per unit area (areal density) of the sandwiched material as specified on the drawings in Volume IV. Samples from each sheet of the neutron absorber are retained for testing and record purposes. The minimum areal B^{10} content and the uniformity of dispersion within a panel are verified by wet chemical analysis and/or neutron attenuation testing. All material certifications, lot control records, and test records are maintained to assure material traceability.
>
> 2. Depletion of the poison material over the storage period is negligible. Using the results of the canister shielding models described in Volume III, Chapter 7 and in Reference Calculation 2069.0503, the maximum neutron flux in the DSC during storage is 2.6×10^{5} neutrons/sec/cm^{2}. ~~Conservatively applying the thermal neutron capture cross-section for B^{10} of 3837 barns and using a B^{10} number density in the absorber panels of 6.634×10^{-3} atoms/b-cm, the total B^{10} depletion over the 50-year DSC design life is then 1.0×10^{8} atoms B^{10}/b-cm. This represents less than 0.0002% of the total B^{10} inventory in the absorber panels.~~ *A new calculation was performed using the Monte Carlo N-Particle computer code. The maximum B^{10} depletion ratio calculated is* [ ] *This represents a* [ ] *depletion over a period of 100 years, which envelops the 60-yr total storage period with the additional PEO.*

C.3.4 FSAR Volume I, Section 8.1.1.9 –Thermal Cycling of the Cask

Add an additional paragraph after the 1st paragraph for the thermal cycling of the cask to reflect a design life of 60 years:

The largest mean daily change of temperature at the Rancho Seco site is conservatively assumed equal to the largest mean daily change of temperature in the United States of 47°F, occurring in Reno, Nevada. Because of the large thermal mass of the cask, a period of approximately 1 day is needed to obtain steady state temperatures and a steady state thermal gradient. For conservatism, it is assumed that the 47°F maximum daily change could produce a steady state gradient every day for 50 years, for a total of 18,250 thermal cycles. From the S-N curve, a temperature fluctuation of up to 49°F, corresponding to 10^6 cycles is acceptable.

Fatigue effects, including that from thermal cycling, were originally analyzed for a design life of 50 years. A new analysis was performed to address the six criteria from ASME B&PV Code, Section III, [C-3][1], Subsection NB-3222.4 affecting fatigue for the DSCs and TC at Rancho Seco. The criteria are: 1) Atmosphere-to-Service Pressure Cycle; 2) Normal Service Pressure Fluctuation; 3) Temperature Difference - Startup and Shutdown; 4) Temperature Difference - Normal Service; 5) Temperature Difference - Dissimilar Materials; and 6) Mechanical Loads. The results of the analysis indicate that the limits of peak stress intensities, as governed by fatigue, have been satisfied by compliance with these six criteria and that no additional analysis is required for the PEO.

[1] Reference # for [C-3] in FSAR Volume I, Section 8.1.1.9 should be changed to existing reference [8.8].

C.4 References

Add the following references to FSAR Volume I, Section 9.7:

C-1 Rancho Seco Independent Spent Fuel Storage Installation Materials License SNM-2510 Amendment 4, November 2017 (Docket 72-11).

C-2 U.S. Nuclear Regulatory Commission, NUREG-1927, Revision 1, “Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel,” June 2016.

C-3 ASME B&PV Code, Section III, Division 1, 1992 Edition, with Addenda through 1993.

C-4 Nuclear Energy Institute, “Format, Content and Implementation Guidance for Dry Storage Operations-Based Aging Management,” NEI 14-03 Revision 2, 2016.

Table C-1
(New Rancho Seco ISFSI FSAR Table 9.8-1)
Scoping Evaluation of Rancho Seco ISFSI SSCs

[Insert Final LRA Table 2-1]

Table C-2
(New Rancho Seco ISFSI FSAR Table 9.8-2)
Scoping Evaluation Results for Spent Fuel Assemblies

[Insert Final LRA Table 2-9]

Table C-3
(New Rancho Seco ISFSI FSAR Table 9.8-3)
Rancho Seco FO-DSC Intended Functions and AMR Results

[Insert Final LRA Table 3-3]

Table C-4
(New Rancho Seco ISFSI FSAR Table 9.8-4)
Rancho Seco FC-DSC Intended Functions and AMR Results

[Insert Final LRA Table 3-4]

Table C-5
(New Rancho Seco ISFSI FSAR Table 9.8-5)
Rancho Seco FF-DSC Intended Functions and AMR Results

[Insert Final LRA Table 3-5]

Table C-6
(New Rancho Seco ISFSI FSAR Table 9.8-6)
Rancho Seco GTCC DSC Intended Functions and AMR Results

[Insert Final LRA Table 3-6]

Table C-7
(New Rancho Seco ISFSI FSAR Table 9.8-7)
Rancho Seco HSM Intended Functions and AMR Results

[Insert Final LRA Table 3-8]

Table C-8
(New Rancho Seco ISFSI FSAR Table 9.8-8)
Rancho Seco TC Intended Functions and AMR Results

[Insert Final LRA Table 3-10]

Table C-9
(New Rancho Seco ISFSI FSAR Table 9.8-9)
DSC External Surfaces Aging Management Program

[Insert Final LRA Table B-1]

Table C-10
(New Rancho Seco ISFSI FSAR Table 9.8-10)
HSM Aging Management Program for External and Internal Surfaces

[Insert Final LRA Table B-2]

Table C-11
(New Rancho Seco ISFSI FSAR Table 9.8-11)
TC Aging Management Program

[Insert Final LRA Table B-3]

Table C-12
(New Rancho Seco ISFSI FSAR Table 9.8-12)
ISFSI Basemat Aging Management Program

[Insert Final LRA Table B-4]

Table C-13
(New Rancho Seco ISFSI FSAR Table 9.8-13)
Rancho Seco ISFSI Tollgates

[Insert Final LRA Table 3-11]

APPENDIX D
PROPOSED LICENSE/TECHNICAL SPECIFICATIONS CHANGES

CONTENTS

D.1 Introduction

As recommended in Section 1.4.7 of NUREG-1927, Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel [D-1], and consistent with the guidance of NEI 14-03, Format, content and Implementation Guidance for Dry Storage Operations-Based Aging Management [D-2], the independent spent fuel storage installation (ISFSI) license renewal application (LRA) should provide proposed changes to the specific license and Technical Specifications (TS) associated with the license renewal for the period of extended operation (PEO). The Rancho Seco ISFSI license (SNM-2510), including the TS in the appendix, have been reviewed and proposed changes are provided below.

D.2 Proposed License Condition Changes

D.2.1 Revised License Conditions

Consistent with NUREG-1927, Section 1.4.4, Sacramento Municipal Utility District (SMUD) proposes the following editorial changes in license conditions associated with this renewal licensing action:

1. Revise License Condition #2 to change reference to the facility from the "Rancho Seco Nuclear Generating Station" to the "Rancho Seco Independent Spent Fuel Storage Installation."
2. Because the Part 50 operating license has been terminated, License Condition #20 related to fuel and cask movement and handling activities being performed in the Rancho Seco Nuclear Generating Station (RSNGS) Fuel Storage Building under the requirements of the Operating License (DPR-54) and associated TS is no longer needed. Therefore, SMUD requests that License Condition #20 be deleted.

D.2.2 New License Conditions

The following new license conditions are proposed associated with renewal:

- SMUD shall submit an updated final safety analysis report (FSAR) to the U.S. Nuclear Regulatory Commission (NRC), in accordance with 10 CFR 72.4, within 90 days of the effective date of the renewal. The updated FSAR shall reflect the information provided in Appendix C of the Rancho Seco ISFSI License Renewal Application and any changes and commitments resulting from the review and approval of the renewal of the license.
- Programs or procedures shall be revised, or new ones created for implementing the activities in the aging management programs (AMPs) described in the updated FSAR within 180 days after the license renewal becoming effective, or prior to September 28, 2021 (i.e., 180 days after the 20th anniversary of the loading of the first dry storage system at the Rancho Seco ISFSI site), whichever is later.

D.3 Proposed Technical Specifications Changes

NUREG-1927, [D-1] indicates that an application for license renewal should include any TS changes or additions that are necessary to manage the effects of aging during the PEO. A review of the information provided in this LRA and the Rancho Seco ISFSI TS confirms that no changes to the ISFSI TS are necessary to manage aging effects. Therefore, no changes to the existing TS are proposed.

D.4 References

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

D-2 Nuclear Energy Institute, NEI 14-03, Revision 2, “Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management,” December 2016.

APPENDIX E
ENVIRONMENTAL REPORT SUPPLEMENT

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E.1 Introduction

E.1.1 Purpose and Need for Proposed Action

The U.S. Nuclear Regulatory Commission (NRC) licenses the operation of Independent Spent Fuel Storage Installations (ISFSIs) for storing power reactor spent fuel and associated radioactive materials. The NRC issues licenses in accordance with the Atomic Energy Act of 1954 (42 United States Code (USC) 2011, et seq.) and NRC implementing regulations (10 Code of Federal Regulations (CFR) Part 72). On June 30, 2000, the NRC issued Sacramento Municipal Utility District (SMUD) a specific license (SNM-2510) valid for 20 years to receive, possess, store, and transfer the Rancho Seco Nuclear Generating Station (RSNGS) spent fuel to sealed storage canisters at an Independent Spent Fuel Storage Installation (ISFSI) located on the Rancho Seco site.

The ISFSI was constructed to facilitate decommissioning of the RSNGS. The ISFSI provides interim storage for the spent nuclear fuel[1] that had been stored in the RSNGS Spent Fuel Pool, and thereby allowed SMUD to proceed with decommissioning of the spent fuel pool and associated systems. By contract, the U.S. Department of Energy (DOE) has the ultimate responsibility for the permanent disposition of the spent fuel stored at RSNGS. Interim storage for the RSNGS spent fuel was necessary because there was no operational DOE facility for permanent disposal or storage for irradiated spent nuclear fuel at the time the RSNGS was being decommissioned.

Extended operation of the Rancho Seco ISFSI is necessary, since SMUD must be able to store spent fuel until the DOE has removed all spent fuel from the Rancho Seco site.

E.1.2 Proposed Action

The proposed action is to renew the specific license, SNM-2510, for the Rancho Seco ISFSI. The current specific license will expire on June 30, 2020. SMUD proposes to extend the Rancho Seco ISFSI license for 40 years beyond the current specific license term, through June 2060, in accordance with 10 CFR 72.42. Extending the specific license for the ISFSI will allow SMUD to maintain safe storage of the spent fuel until its acceptance by DOE for removal from the Rancho Seco site.

[1] The Rancho Seco ISFSI also stores one DSC containing GTCC waste.

E.1.2.1 Licensing History

In June of 1989, the RSNGS ceased operation, and the reactor was completely defueled in December of 1989. SMUD's decommissioning plan called for storing the spent fuel in a site specific ISFSI until the spent fuel was accepted by the DOE. On October 21, 1991, SMUD submitted Supplement to Rancho Seco Environmental Report – Post Operating License Stage, [E-1]. The Supplement provided an assessment of the environmental effects of decommissioning RSNGS, and provided a comparison of those impacts with the NRC's Generic Environmental Impact Statement (GEIS), NUREG-0586, Final Generic Environmental Impact Statement on decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors, [E-2].

On October 4, 1991, SMUD submitted an application, Rancho Seco Independent Spent Fuel Storage License Installation Application and Safety Analysis Report, [E-3] for a NRC license to construct and operate a dry cask ISFSI under 10 CFR Part 72, of the Commissions regulations. As part of the specific license process, SMUD submitted a revised Environmental Report, Revision 1 to the Rancho Seco Independent Spent Fuel Storage Installation Environmental Report, [E-4] on June 16, 1993. In August 1994, the NRC issued an, Environmental Assessment related to the Construction and Operation of the Rancho Seco Independent Spent Fuel Storage Installation, [E-5] for the Rancho Seco ISFSI. The Environmental Assessment concluded that the ISFSI would not significantly affect the quality of the human environment and an environmental impact statement was not warranted. The NRC issued SMUD a specific 10 CFR Part 72 materials license (SNM-2510) on June 30, 2000.

SMUD completed the construction of the Rancho Seco ISFSI in 1996 and all spent fuel from the RSNGS was placed in dry storage by August 2002.

On July 19, 2004, SMUD submitted a License Amendment Request (LAR), Rancho Seco Independent Spent Fuel Storage Installation Request for Exemption From 10 CFR 72.44(d)(3) and Proposed License Amendment No. 1, [E-6] to eliminate the requirement for an annual report specifying the quantity of principal radionuclides released to the environment in liquid and gaseous effluents during the previous 12 months of ISFSI operations. The NRC found that the proposed action was an administrative change that would not significantly affect the quality of the human environment and an environmental impact statement was not warranted, Exemption From 10 CFR 72.44(d)(3) for Dry Spent Fuel Storage Activities with Conforming Amendment (TAC Nos. L23752 and L23753), [E-7] and, Sacramento Municipal Utility District; Rancho Seco Independent Spent Fuel Storage Installation; Issuance of Environmental Assessment and Finding of No Significant Impact Regarding a Proposed Exemption and Conforming Amendment, [E-8].

On July 29, 2004, SMUD submitted a LAR for storage of Greater Than Class C waste at the Rancho Seco ISFSI, Rancho Seco Independent Spent Fuel Storage Installation Proposed License Amendment No. 2 for the Storage of Greater than Class C Waste, [E-1]. On March 24, 2005, the NRC issued an Issuance of Environmental Assessment and Finding of No Significant Impact of the Rancho Seco Independent Spent Fuel Storage Installation (ISFSI) Request for Proposed License Amendment (TAC. No. L23757), [E-9] for Amendment 2 to license SNM-2510, concluding that the ISFSI would not significantly affect the quality of the human environment and an environmental impact statement was not warranted.

On November 5, 2008, SMUD submitted a LAR, Rancho Seco Independent Spent Fuel Storage Installation Proposed License Amendment No. 3, [E-10] to allow storage of six fuel assemblies with known or suspected cladding defects greater than hairline cracks or pinhole leaks to be stored in five different FC-DSCs (Dry Shielded Canisters containing Fuel and Control Components). The NRC found that the proposed action requested in Amendment 3 qualified for the categorical exclusion listed in 10 CFR 51.22(c)(11) and no further environmental review was required [E-11].

On January 17, 2017, SMUD submitted Rancho Seco Independent Spent Fuel Storage Installation Proposed License Amendment No. 4. The amendment was seeking NRC approval to transfer the licensing for one Sr-90 radioactive source currently possessed by SMUD under its 10 CFR 50 License (DPR-054, Docket 50-312), to its 10 CFR 72 license. This is necessary since the 10 CFR 50 license is in the process of being terminated and SMUD is committed to maintaining a radioactive source for the purpose of calibrating instrumentation in order to monitor the ISFSI and for use in emergency response. The NRC found that the proposed action to transfer the source to the Part 72 license was acceptable. No further environmental review was required [E-22].

E.1.2.2 Operations

The Rancho Seco ISFSI consists of a dry fuel storage system that includes a reinforced concrete pad, sealed dry shielded canisters (DSCs), and reinforced concrete horizontal storage modules (HSMs). The system provides radiation shielding and passive decay heat removal. The system provides adequate heat removal capacity to maintain safe fuel clad temperatures without active cooling systems. The Rancho Seco ISFSI Final Safety Analysis Report (FSAR), Rancho Seco Independent Spent Fuel Storage Installation Final Safety Analysis Report, [E-12] contains a detailed description of the dry fuel storage system.

The Rancho Seco ISFSI is located within a secure area on the former RSNGS site.

The onsite SMUD staff currently performs daily activities associated with the operation of the ISFSI facility, which primarily involve security, routine maintenance, and monitoring. No major changes in staffing levels are anticipated during the period of extended operation (PEO). The passive nature of the facility requires little periodic maintenance and surveillance. Radioactive waste is not generated during routine operation at the ISFSI.

No major construction or refurbishment projects are currently planned for the ISFSI during the PEO. Due to the delay in DOE removing the waste from the site, the spent nuclear fuel from the RSNGS reactor will be stored onsite for an extended period. The ISFSI will be subject to aging management activities to ensure the continued performance of the DSCs, Transfer Cask, HSMs, and Basemat during the ISFSI PEO. The aging management programs are summarized in Appendix B of the LRA.

E.1.3 Environmental Report Supplement Scope and Methodology

SMUD has prepared this supplemental Environmental Report as part of its application to the NRC to renew the specific ISFSI license in accordance with the following NRC 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
  - 10 CFR 72.34, Environmental report; and
  - 10 CFR 72.42, Duration of license, renewal.
- 10 CFR Part 51, Environmental Protection Requirements for Domestic Licensing and Related Regulatory Functions
  - 10 CFR 51.45, Environmental report; and
  - 10 CFR 51.60, Environmental report-materials licenses.

NRC regulation 10 CFR 72.42 provides for ISFSI license renewal, and regulation 10 CFR 72.34 requires an application to include an Environmental Report that meets the requirements of 10 CFR 51, Subpart A. In Subpart A, 10 CFR 51.60 requires that the Environmental Report be a separate document entitled “Supplement to Applicant’s Environmental Report” and specifies the Environmental Report contents. The regulation focuses on presenting any significant environmental change from the previously submitted Environmental Report. NUREG-1927 [E-14], Section 1.4.3 specifies submittal of a supplemental environmental report with the LRA.

In determining what information to include in the ISFSI supplement Environmental Report, SMUD has relied on guidance provided in Environmental Review Guidance for Licensing Actions Associated with NMSS Programs, NUREG-1748, [E-13] and NRC guidance provided in Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel, NUREG-1927, [E-14]. This indicates that license renewal is not an exercise in re-licensing and is not intended to impose requirements beyond those that were met by the facility when it was initially licensed. SMUD assembled a team to review the Environmental Report submitted with the original Rancho Seco ISFSI license application and NRC's subsequent environmental analysis to identify areas that require updating to meet the expectations of NUREG-1748. The review included evaluation of any significant changes during the initial licensing period and considered whether significant changes are anticipated during the PEO.

SMUD has prepared Table E-1 to verify conformance with the regulatory requirements. Table E-1 provides the locations of supplemental Environmental Report content that respond to regulatory requirements.

E.1.4 Applicable Regulatory Requirements, Permits, and Required Consultations

Continued operation of the Rancho Seco ISFSI does not require any additional permits, licenses, or approvals other than the renewal of the NRC materials license. Table E-2 lists the authorizations and consultations that are related to the Rancho Seco ISFSI license renewal application. This section discusses the consultations in more detail.

E.1.4.1 Threatened and Endangered Species Consultation

Section 7 of the Endangered Species Act (16 USC 1531 et seq.) requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of species that are listed, or proposed for listing, as endangered or threatened. Depending on the type of action and potential effects involved, the Act requires consultation with the U.S. Fish and Wildlife Service (USFWS) regarding effects on terrestrial and freshwater species, and with the National Marine Fisheries Service (NMFS) regarding effects on anadromous and marine species. USFWS and NMFS have issued joint procedural regulations at 50 CFR Part 402, Subpart B, that address consultation, and USFWS maintains the joint list of threatened or endangered species at 50 CFR Part 17.

A federal agency is not required to consult with the USFWS and/or NMFS if it determines an action will not affect listed endangered or threatened species, or their designated critical habitat. The agency is required to consult if it determines that the action may affect listed species or critical habitat, even if the effects are expected to be beneficial. If the agency determines that the action is not likely to adversely affect listed endangered or threatened species or their critical habitat, it can request the concurrence of the USFWS and/or NMFS with that determination. Therefore, whether and how the NRC may choose to request consultation with USFWS and NMFS will depend upon the determination as to potential effect. As discussed in Section E.4.4, SMUD expects that there will be a "no-effect" determination. The NRC may choose to solicit comments from the California Department of Fish and Wildlife, and California Native Plant Society regarding species listed in California prior to renewing the ISFSI license.

E.1.4.2 Historic Preservation Consultation

Section 106 of the National Historic Preservation Act (16 USC 470 et seq.) requires that federal agencies having the authority to license any undertaking, prior to issuing the license, take into account the effect of the undertaking on historic properties and afford the Advisory Council on Historic Preservation (ACHP) the opportunity to comment on the undertaking. The ACHP regulations provide for establishing an agreement with any State Historic Preservation Office (SHPO) to substitute state review for council review (36 CFR 800.2). Therefore, the NRC may request comments from the California SHPO to ensure that the proposed action will not impact historic properties.

E.2 Alternatives

E.2.1 No-Action Alternative

Under the no-action alternative, the NRC would not renew the specific license for the Rancho Seco ISFSI. The license would expire on June 30, 2020, at which time SMUD would no longer be able to legally store spent fuel at the ISFSI. SMUD would need to remove the stored fuel from the ISFSI, transport the fuel to another licensed storage facility, and decommission the ISFSI associated with SNM-2510. There is no federal repository or other federal disposition path available for the spent fuel presently stored under SNM-2510. Therefore, the no-action alternative is not a reasonable alternative.

E.2.2 Other Alternatives

In the original ISFSI license application Environmental Report (Reference [E-4], SMUD evaluated the following alternatives to constructing the Rancho Seco ISFSI in addition to the no-action alternative:

- Ship spent fuel from Rancho Seco to a reprocessing facility.
- Store spent fuel in other dry storage technologies.
- Ship spent fuel to other utility's spent fuel pools.
- Continue to store spent fuel wet in the spent fuel pool.
- Ship spent fuel to a permanent federal repository.

There are still no commercial reprocessing facilities operating in the United States. Transferring the spent fuel to another dry storage system would not alleviate the need to renew the Rancho Seco specific ISFSI License. There are no utilities storing fuel from other utilities in their spent fuel pools. Continued storage of discharged spent fuel in the Rancho Seco spent fuel pool is not a viable alternative, because the spent fuel pool and associated facilities have been decommissioned.

An updated evaluation of the alternative of shipping spent fuel to a permanent Federal repository along with a new alternative of shipping fuel to an offsite interim storage facility are discussed in the following sections.

E.2.2.1 Ship Fuel to a Permanent Federal Repository

SMUD and the NRC intend for storage at the Rancho Seco ISFSI to be interim pending availability of a federal repository. There is uncertainty regarding when a federal repository will be licensed and the schedule under which it will be available to accept spent fuel shipments. This uncertainty supports the need for Rancho Seco ISFSI specific license renewal. The repository schedule drives the ISFSI duration; the longer it takes for the repository to begin accepting spent fuel shipments, the longer the ISFSI must store spent fuel.

Availability of a geological repository to accept nuclear fuel is not yet known and it is reasonable to assume a repository will not be ready prior to expiration of the Rancho Seco ISFSI license in 2020. The shipment of Rancho Seco spent fuel to a permanent federal repository is not a viable alternative to the ISFSI license renewal.

E.2.2.2 Ship Fuel to an Offsite Interim Storage Facility

Commercial entities have expressed interest in establishing a consolidated interim storage facility (CISF) for away-from-reactor storage of spent nuclear fuel. Two locations in the southwestern U.S., the Eddy-Lea Alliance facility in New Mexico and the Waste Control Specialists (WCS) facility in Andrews County, Texas have been proposed.

WCS submitted its CISF application to the NRC in April of 2016, License Application to Construct and Operate a Consolidated Interim Storage Facility for Spent Nuclear Fuel in Andrews County, Texas, [E-15]; and Revision 1 of the application in March of 2017, License Application to Construct and Operate a Consolidated Interim Storage Facility for Spent Nuclear Fuel in Andrews County, Texas, [E-16]. Holtec International submitted its CISF application for the Eddy-Lea Alliance facility to the NRC in March 2017, Holtec International HI-STORE CIS (Consolidated Interim Storage Facility) License Application, [E-17].

Because the availability of a CISF is unlikely in time to eliminate the need for the Rancho Seco ISFSI license renewal (i.e., by 2020), the shipment of the spent fuel to a CISF is not a reasonable alternative at this time.

E.3 Affected Environment

E.3.1 Site Location

The Rancho Seco ISFSI is located within the Owner Controlled Area of the Rancho Seco site, which is owned and operated by SMUD. The Rancho Seco site comprises approximately 2,480 acres in Sacramento County, California.

The Rancho Seco site occupies all or parts of Sections 27, 28, 29, 32, 33, and 34 of Township 6 North, Range 8 East. The site is approximately 26 miles north-northeast of Stockton and 25 miles southeast of Sacramento, as shown in Figure E-1.

More generally, the Rancho Seco site is located between the Sierra Nevadas to the east and the Coast Range along the Pacific Ocean to the west in an area of flat to lightly rolling terrain at an elevation of approximately 200 feet above mean sea level. To the east of the site, the land becomes hilly, rising to an elevation of 600 feet at a distance of about seven miles, and increasing in elevation thereafter approaching the Sierra Nevada foothills.

The approximate coordinates of the site are 38°-20'-40" North Latitude and 121°-07'-10" West longitude, or 4245500 Mn and 664400 Me Universal Transverse Mercator coordinates. The Rancho Seco Owner-Controlled Area is shown in Figure E-2. As shown in Figure E-3, the Rancho Seco ISFSI is located west of the site’s Industrial Area, approximately 600 feet west of the Interim Onsite Storage Building. The Rancho Seco ISFSI pad is approximately 225 feet by 170 feet in size, and contained within an approximately 14 acre licensed area.

E.3.2 Land Use

Surrounding the ISFSI site to the north, east and south are rolling hills vegetated with naturalized annual grasses. Seasonal wetlands, swales, and intermittent drainages are present throughout much of this surrounding area. Further to the north are agricultural uses. The area includes the decommissioned RSNGS, Rancho Seco Photovoltaic Solar Project, Cosumnes Power Plant (CPP), Rancho Seco Lake and associated recreational facilities, and Amanda Blake Memorial Wildlife Refuge.

The Rancho Seco Photovoltaic Solar Project is a 10-MW power facility located within the boundary of the former RSNGS. The CPP is a 500 MW combined-cycle gas fired power plant located approximately 0.5 miles south of the ISFSI.

In the early 1970s, a small pond located on the Rancho Seco property was expanded into a 160-acre lake (Ranch Seco Lake). The current lake and surrounding park facilities (developed area) are located east of the ISFSI site.

In 1995, SMUD entered into a lease agreement with the Performing Animal Welfare Society to establish the Amanda Blake Memorial Wildlife Refuge. The refuge is a 75-acre sanctuary that houses rescued animals. The refuge is located southeast of the ISFSI site.

On October 1, 2002, a Memorandum of Agreement was recorded between SMUD and the Nature Conservancy for construction and maintenance of a foot trail that would extend through a portion of SMUD's property. In June 2006, SMUD, working cooperatively with the Nature Conservancy, dedicated the Howard Ranch Nature Trail, a seven-mile-long trail through its property and the adjoining Howard Ranch.

E.3.3 Transportation

As shown in Figure E-2, State Route 104 (Twin Cities Road) runs just north of the site in a general east-west direction and connects with State Route 99 to the west and State Route 88 to the east. There are no public highways that traverse the Rancho Seco ISFSI site. Route 104 is travelled primarily by local traffic. The Twin Cities Access Road is the main access road to the ISFSI and to the nearby Rancho Seco Recreational Park.

There is a Union Pacific railroad line north of the site that, at one point, comes within one-half mile of the Rancho Seco ISFSI. The track runs roughly parallel to State Route 104, and is used to haul a variety of commodities.

Rail access to the Rancho Seco site is available via a rail spur from the existing Union Pacific Railroad line described above.

E.3.4 Geology, Soils, and Seismology

The Rancho Seco site is about 25 miles southeast of Sacramento in the low hills at the edge of the Sierra Nevada Mountains. The site is founded on the Pliocene Laguna Formation and is underlain by approximately 1,500 to 2,000 feet of tertiary or older sediments deposited on a basement complex of granitic to metamorphic rocks. Detailed field mapping, auger holes, soil samples, and geophysical refraction profiles indicate the unfaulted nature of the sediments.

There is no indication of faulting beneath the site. The nearest fault system, the Foothill Fault System, is about 10 miles to the east of the site. It has been inactive since the Jurassic Period, some 135 million years ago. The nearest active faulting along which historic large earthquake shocks have originated are the Hayward and San Andreas Faults, some 70 and 89 miles to the west, respectively, and the faults over 80 miles to the east beyond the Sierra Nevada Range. Earthquake shaking will occur as the result of shocks along distant faults, but because of their distant origin and the nature of the foundation material beneath the site, ground accelerations greater than 0.05g should not occur during the life of the Rancho Seco ISFSI. Conservative values of 0.25g horizontal and 0.17 g vertical were used for the design basis earthquake for the Rancho Seco ISFSI.

As part of the Rancho Seco ISFSI site selection process, SMUD had borings analyzed from the proposed Rancho Seco ISFSI sites. Based on the results of the boring analyses, SMUD performed appropriate remedial measures (e.g., compaction and/or replacement of soil) to ensure adequate structural support for the Rancho Seco ISFSI.

A detailed discussion of the geology, soils and seismology of the Rancho Seco ISFSI site may be found in Sections 2.5 and 2.6 of the Rancho Seco ISFSI FSAR, [E-12].

E.3.5 Water Resources

The site is bounded on the north by Hadselville Creek, which intercepts all drainage from the site and empties into Laguna Creek to the west. The flow is continued westerly by Laguna Creek South, a tributary of the Consumnes River, and into the Mokelumne River. The Mokelumne is a tributary of the southerly flowing Sacramento River and enters the Sacramento River approximately 20 miles south of the city of Sacramento.

Storm water runoff at the Rancho Seco site is controlled primarily by surface ditches. Generally, overland flows will be intercepted by the ditches and diverted around the ISFSI to natural stream channels. When this is not possible, runoff will be diverted down cut slopes in culvert pipes and discharged to the plant drainage ditch system.

Pumping tests conducted in exploratory holes indicated the presence of ground water underlying the Rancho Seco site approximately 150 feet below the original ground surface. The water is of good quality and is readily extracted by wells.

Groundwater in this area occurs under free or semi-confined conditions as a part of the Sacramento Valley Groundwater Basin. The water is stored chiefly in the Mehrten Formation. The sand and gravel zones of that formation yield water readily to wells.

Galt and Lodi are the closest communities with public groundwater supplies to the south and west. They are supplied by the City of Galt Water System, the Lodi Municipal Water Works, and the North San Joaquin Water Conservation District (Lodi area). The wells supplying Galt and Lodi penetrate a number of aquifers. The Lodi wells draw water from recent alluvium, the Victor Formation, the Laguna Formation, and probably the Mehrten Formation. The Galt wells tap the Laguna Formation and probably the Mehrten Formation.

E.3.6 Ecological Resources

E.3.6.1 Natural Communities

Renewing the ISFSI license does not involve refurbishment or new construction. Therefore, the area of potential ecological impact for continued operations of the ISFSI is limited to the area immediately surrounding the ISFSI potentially disturbed by security personnel and operations staff associated with periodic monitoring, inspections, and maintenance.

The ISFSI site is located at the eastern edge of the Central Valley grassland in the vegetation type known as the California prairie or the California annual grasslands. These grasslands are distinguished as land that is relatively well drained, not containing areas of standing water, and dominated by grasses and forbs (broad-leaved plants) characteristic of annual grassland. The grassland ecosystem in the area appears to be the same as other sections of grazed annual grassland along the east side of the Central Valley, except for the areas of vernal pools found within 1-1/2 to 2 miles to the south and east.

The vernal-pool areas (designated as Critical Habitat) correspond to the extent of hardpan Redding soil. The vernal-pool areas consist of rolling topography underlaid by hardpan. Winter rains fill the depressions to begin the annual cycle of vernal pool development. The plant species of vernal pools are quite unique to this kind of habitat, and the vernal pools tend to retain their unique character except when insufficient rainfall allows typical annual grassland species to successfully invade the vernal pool areas. Often vernal pool basins will remain bare or have only a few non-vernal species during the dry season.

E.3.6.2 Special-Status Species

Table E-3 provides a list of special status species within a five-mile radius of the Rancho Seco ISFSI. The list was obtained from the California Natural Diversity Database (CNDDB).

E.3.7 Meteorology, Climatology, and Air Quality

The climate of the Rancho Seco ISFSI site is generally that of the Great Central Valley of California. Summers are hot and cloudless and the winters are mild. The rainy season occurs between October and May with more than two-thirds of the annual rainfall occurring in December through March. Heavy fog occurs in mid-winter, primarily in December and January, and may last for several days.

The most important controlling geographical influence on the climate results from the mountains that surround the valley to the west, north, and east. During the winter, storms that pass through the area are moderated by the mountains that collect much of the precipitation. The rains that occur in the valley are usually accompanied by south to southeast winds. The cold north and northwest winds pass over the mountains to the north where the air is warmed dynamically by descent into the valley resulting in comparatively warm, dry winds. A similar condition occurs infrequently in the summer when a steep northerly pressure gradient develops, producing a pronounced heat wave.

The Central Valley warms greatly during the day resulting in a marked thermal contrast between the valley and the air over the Pacific. The Coast Range separates the marine air from the valley air except for a gap through the range formed by the Sacramento and San Joaquin Rivers. The heavy marine air flows through this gap and splits into a northerly flow into the San Joaquin Valley and a southerly flow into the Sacramento Valley.

E.3.8 Noise

Storage of irradiated fuel and associated materials at the ISFSI involves use of a passive system that does not generate noise. Audible noise directly attributable to operation of the ISFSI is generally limited to occasional vehicle traffic to and from the ISFSI during routine operations and maintenance activities.

E.3.9 Historical and Cultural Resources

As a federal undertaking, Rancho Seco ISFSI license renewal requires compliance with the National Historic Preservation Act through the Section 106 process of identification, evaluation, and mitigation of effects to historical cultural resources. Subsequent to the submitting of the original Environmental Report, [E-4], additional studies and surveys have been performed. The following summary of the cultural resources for the area is taken from the Initial Study and Mitigated Negative Declaration for the Rancho Seco Photovoltaic Solar Project (Section 5 of Appendix A of Reference E-1).

The entire proposed (solar) project site lies within the ethnographic area once occupied by the Plains Miwok Tribe. The Plains Miwok occupied the lower Mokelumne and Cosumnes Rivers and the Sacramento River from Rio Vista to Freeport. Because very few Plains Miwok were alive when ethnographers began working with Native Americans in the early 1900s, the most comprehensive study of the Miwok was done using Spanish mission records, diaries, and journals. The Miwok were probably not the earliest inhabitants of this area. They are believed to have entered California from the north, sometime around A.D. 500. Before that time, the area may have been occupied by Hokan-speaking people.

According to available written information, explorers, fur trappers, and others (e.g., ranchers) settled in the north valley. The immediate impact of these early contacts was the decimation of the native population through the introduction of diseases. By the late 1700s, Spanish explorers seeking potential inland mission sites had entered the Central Valley. During the historical period (approximately 1850 to the present), the project site and its surroundings were part of the Alabama Township, which extended west from the Arroyo Seco Land Grant to the Central Pacific Railroad's Amador Branch Line that ran from Galt to Ione. In the 1800s, ranching and agriculture flourished. After the discovery of gold in 1848, the influx of people into California changed the subsequent history of the region. The decades following the Gold Rush are marked by Native American displacement, gold mining, agriculture, and commerce. Rail lines were established to transport people and goods more efficiently. Sacramento was the western end of the transcontinental railroad, which was completed in 1869. The railroad helped carry California's agricultural products throughout the country, and further established the Sacramento region as a productive agricultural hub. By the mid to late 1800s, the Central Pacific Railroad owned large portions of land in the Alabama Township. The nearest settlement to the proposed project site was Clay Station, which was along the Galt-Ione Amador Branch Line of the railroad system. Clay Station hosted a post office, store, and blacksmith shop by the later 1870s. The Chinese placer mined in the region of the proposed project site during the late 1800s.

The North Central Information Center (NCIC) of the California Historical Resources Information System located at California State University, Sacramento, was contacted in 2010, and provided the results of a record search dated March 29, 2010. Within a one-mile radius of the project site, 15 surveys were archived and 20 prehistoric or historic sites had been recorded. Seven of the recorded sites are prehistoric and are dispersed throughout the one-mile search radius. The historic sites are related to either placer mining or agriculture. The mining locations are primarily south of the [solar] project site.

In February 2015, the NCIC was again contacted requesting records search for any surveys or site recordation since the 2010 record search. One survey southeast of the project site had been done in 2011, with no new prehistoric or historic records. A placer mining depression complex south of the project site near Clay East Road recorded in 2008 was identified and updated as a result of the 2011 survey.

The Native American Heritage Commission was contacted in 2010 and replied that there were no known Sacred Sites in the area.

On March 20, 2015 a pedestrian survey of the project site was undertaken. No cultural resources were located during the 2015 survey.

Previous surveys of the area included a cultural resource survey of the proposed project site, plus a 250-foot buffer, conducted in 2010. This survey identified a small cluster of gold mining depressions located at the southern edge of the buffer area. These depressions were recorded and submitted to the North Central Information Center in Sacramento. No other cultural resources were located during the 2010 survey. Additionally, portions of the project site were surveyed in 1982 (approximately 20 acres within the northern half of the project site) and in 1994 (approximately 5 acres in the northernmost portion of the project site). Neither of these survey discovered prehistoric or historic cultural resources.

Visual and Scenic Resources

The ISFSI is located within the boundaries of the former RSNGS, a site that is generally characterized by industrial buildings, fences, parking lots, and ornamental landscaping. The site is not considered to be a scenic vista. Viewsheds for motorists traveling east or west on Twin Cities Road (Highway 104) provide views of row crops (vineyards) on the northern side of Twin Cities Road; and open grazing land, small clusters of trees, and structures associated with the former Rancho Seco Nuclear Generating Station (the cooling towers) to the south. Viewsheds for motorists traveling along Clay East Road primarily consist of open grazing lands and industrial facilities associated with the Cosumnes Power Plant and the former Rancho Seco Nuclear Generating Station. While the openness of the terrain and rows of grapevines offer scenic value, and the twin cooling towers from the former Rancho Seco Nuclear Generating Facility offer some distinctive scenic quality for visitors traveling in the vicinity of the project site, general views lack an abundance of cohesive, scenic resources that would contribute to creating a viewpoint that provides expansive views of a highly valued landscape.

E.3.10 Demography and Socioeconomics

The original Rancho Seco ISFSI Environmental Report, [E-4] provided population estimates based on 1989 data along with development plans for the nearby counties and cities. Sections E.3.11.1 through E.3.11.3 below describe the current demographic and economic characteristics for the geographic areas of influence. The demographic data was obtained from the U.S. Census Bureau. State, county and city specific population estimates were obtained using the Census Bureau's Quickfacts software. The data within a specified radius of the ISFSI was obtained using the Circular Area Profiling (CAP) system from the Missouri Census Data Center with their Block-based Inclusion Algorithm. For tracts (or census block groups) that are not entirely within the specified radius, the algorithm uses block-level populations within the specified radius to determine an "apportioning factor," which is applied to the tract or block group data to determine the aggregate data. The coordinates of the ISFSI used with the CAP software were 38.20.40 Latitude and 121.07.10 Longitude.

E.3.10.1 Demography

The nearest major population centers to the ISFSI are shown in Table E-4. The 2010 Census Population and the 2016 Estimate Population were obtained using the Census Bureau's Quickfacts software. The 2060 Projected Population estimates the population at the end of the ISFSI's period of extended operation, assuming the rate of increase from 2010 to 2016 remains constant.

Table E-5 provides the population estimate within a 2-, 4-, 10-, and 50-mile radius of the ISFSI. The information was obtained using the Missouri Census Data Center's Beta Version caps16acs (April 2016) using 2011-2015 data with the block-based apportioning algorithm to apportion block group data.

E.3.10.2 Environmental Justice

The original Environmental Report, [E-4] did not address environmental justice, so this section has been added to provide information on minority and low-income populations. Appendix C of NUREG-1748, [E-13] provides guidance on the methodology to identify the locations of minority and low-income populations of interest. The guidance suggests that a 4-mile radius could reasonably be expected to contain the area of potential effect and that the state and county are considered the appropriate geographic areas for comparative analysis. U.S. Census Bureau demographic data provide the necessary information on race, ethnicity, and poverty.

The guidance in [E-13] defines minority categories as: American Indian or Alaskan Native; Asian; Native Hawaiian or other Pacific Islander; African American (not of Hispanic or Latino origin); some other race; and Hispanic or Latino ethnicity (of any race). There is also a “Multiracial” category. This includes individuals that identify themselves as more than one race.

Low-income is defined as being below the poverty level as defined by the U.S. Census Bureau.

The guidance indicates that the area of assessment has a significant minority or low-income population if either of the following two conditions is met:

- The minority or low-income population of the block groups in the area for assessment exceeds 50 percent of the total population.
- The minority or low-income population percentage of the block groups in the area for assessment is significantly greater (typically at least 20 percentage points) than the minority or low-income population percentage in the geographic areas chosen for comparative analysis.

Table E-6 provides minority and low-income percentages for each of the geographic comparison areas (4-mile radius, state, and counties). The results of the analysis indicate that the 4-mile radius does not have significant percentages of minority or low-income populations, as identified above.

E.3.10.3 Socioeconomics

During the PEO, the workforce at the Rancho Seco ISFSI will continue to consist of security personnel and an operations staff to conduct periodic monitoring and inspections. The size of the work force is not expected to significantly change for ISFSI operations during the PEO.

As a municipal utility, SMUD does not pay property taxes related to the Rancho Seco ISFSI property.

E.4 Environmental Impacts

The following sections discuss environmental consequences associated with continued operations of the Rancho Seco ISFSI. SMUD considered the specific resource areas that have potential impacts associated with the ISFSI operations over the PEO.

On September 19, 2014, the NRC published a revised rule in the Federal Register for 10 CFR 51.23, “Environmental Impacts of Continued Storage of Spent Nuclear Fuel Beyond the Licensed Life for Operations of a Reactor” (the “Continued Storage Rule”), Environmental Impacts of Continued Storage of Spent Nuclear Fuel Beyond the Licensed Life for Operations of a Reactor, [E-18]. The NRC rule codifies the generic impact determinations in NUREG-2157, Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel, Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel, NUREG-2157, September 2014 (Accession Number ML 14196A105), [E-19]. Formerly known as the Waste Confidence Decision and Rule, the revised rule adopts the generic impact determinations made in NUREG-2157, and codifies the NRC’s generic determinations regarding the environmental impacts of continued storage of spent fuel beyond a reactor’s operating license (i.e., those impacts that could occur as a result of the storage of spent fuel at a reactor, or away-from-reactor site, between the time a reactor’s licensed operation ends and a permanent repository becomes available). The updated Continued Storage Rule and NUREG-2157 provide the National Environmental Policy Act analyses of human health and environmental impacts of continued storage of spent fuel beyond the licensed life of a reactor that are needed to support renewal of the Rancho Seco ISFSI license.

The analysis in NUREG-2157 concluded that the potential impacts of at-reactor storage during the short-term time frame (no more than 60 years after the expiration of the reactor’s license to operate) would be small in Section 4.20 of [E-19]. Furthermore, the analysis in NUREG-2157 stated that disposal of the spent fuel in a DOE repository by the end of the short-term time frame is the most likely outcome (Reference E-19, Section 1.2). As described in the following sections, impacts from the proposed renewal of the Rancho Seco ISFSI license are primarily occupational and public health impacts associated with radiological exposure. Cumulative impacts would occur if multiple sources for radiological exposure affect the same population.

E.4.1 Impacts from Refurbishment and Construction

The Proposed Action does not include refurbishment or new construction. Impacts for construction of the Rancho Seco ISFSI were addressed in the original Environmental Assessment, [E-5]. As described in Section E.1.2.2, no refurbishment is planned. Only routine monitoring and maintenance is expected over the proposed 40-year PEO. Therefore, there are no environmental impacts from refurbishment or construction beyond those analyzed in the original Environmental Assessment, [E-5].

E.4.2 Occupational and Public Radiological Health Impacts

No liquid or gaseous effluents are released to the environment from operation of the ISFSI. Therefore, only external radiation from the sealed dry storage canisters could affect workers or members of the public. The design and operational features of the NUHOMS® system, along with the station's radiological protection program, mitigate radiological impacts as described in Section 7 of [E-12]. Potential occupational and public ISFSI doses are addressed separately below.

E.4.2.1 Occupational Dose

As discussed in Section E.1.2.1, all the fuel from RSNGS has been transferred to dry storage in the ISFSI. Therefore, it is not expected that any additional DSCs will need to be loaded. The occupational dose is, thus, limited to the dose the staff receives while performing inspections and monitoring of the ISFSI.

Section 7.4.2 of [E-12] discusses the dose to the staff while performing surveillances at the ISFSI. The annual dose for HSM air inlet vent inspections is estimated to be 1.2 Rem. This value is derived by assuming that one inspector performs an inspection once every day, walking around the HSMs at a distance of 20 feet. The amount of time required for the inspection is assumed to be 10 minutes, and it is further assumed that the inspector is exposed to a dose rate of 20 mrem/hr.

E.4.2.2 Public Dose

Table 7-4, footnote number 2 of [E-12] presents a calculation of the annual dose from ISFSI external radiation to the nearest permanent resident as 0.16 mrem per year, which is below the 25 mrem/yr limit imposed by 10 CFR 72.104(a). The collective dose is calculated as if all the individuals within 2 miles of the site boundary live at the location of the nearest permanent resident. Using the 2-mile radius population of 256 persons (determined in Section E.3.11), the resulting collective dose is 0.041 person-rem. The assumption of locating all the residents at the location of the nearest permanent resident is conservative.

E.4.3 Other Operational Impacts

The routine operation of the ISFSI involves dry storage of spent nuclear fuel in sealed containers. With the exception of inspections and maintenance, storage operation is passive. There are no liquid or gaseous effluents. Accordingly, no impacts are expected other than those from radiation as described in Section E.4.3. NUREG-1748 [E-13] identifies the types of environmental impacts to be analyzed for a materials license Environmental Report. Each identified discipline or resource area is briefly addressed below. Conclusions drawn from the original NRC ISFSI environmental assessment (Reference E-5) are adopted, where available and still appropriate.

Land Use: The land occupied by the ISFSI was committed when the ISFSI was constructed. It is located within the developed Rancho Seco Nuclear Plant site area. No additional land use impacts are expected from continued operation of the ISFSI beyond those described in the original environmental assessment, [E-5] Section 6.2.3.1.

Transportation: No significant changes in staffing are anticipated to manage the ISFSI during the PEO, and no new radwaste shipments or related activities are expected. Therefore, no impacts to transportation are expected.

Geology and Soils: Impacts to geology and soils occurred when the ISFSI was constructed. There are no construction activities associated with renewing the ISFSI license. Therefore, no impacts to the geology or soil are expected.

Water Resources: The ISFSI does not require water for its operation, and does not discharge effluents to surface or groundwater. Based on the size of the ISFSI work force, minimal sanitary waste is generated. It is disposed in a septic system. No impact to water resources is expected from continued operation beyond those described in the original environmental assessment, [E-5] Section 6.2.3.2.

Ecological Resources: Any ecological impacts occurred when the ISFSI was constructed. The original environmental assessment asserted that ISFSI operation would have minimal impact on local wildlife, [E-5] Section 6.2.3.1. Fences provided for other purposes prevent wildlife access to the ISFSI. No ecological impact is expected from continued operation beyond those described in the original environmental assessment, [E-5] Section 6.2.3.1.

Air Quality: The ISFSI does not release airborne emissions. Any air quality impacts occurred when the ISFSI was constructed, [E-5] Section 6.1.3. Therefore, no impacts on air quality are expected during the PEO.

Noise: Storage of irradiated fuel and associated materials at the ISFSI involves use of a passive system that does not generate noise. Audible noise directly attributable to operation of the ISFSI is generally limited to occasional vehicle traffic to and from the ISFSI during routine operations and maintenance activities. No noise impact is expected from continued operation beyond those described in the original environmental assessment, [E-5] Section 6.2.3.3.

Historical and Cultural Resources: Continued operation does not involve any land disturbance. Therefore, no historical or cultural resource impact is expected from continued operation of the ISFSI.

Visual and Scenic: Structures at the ISFSI have limited or no visibility from locations outside of the controlled area, because of the view obstruction created by terrain or by other existing structures on the plant site. The visible evidence of ISFSI operation that could be observed by public viewers is limited to occasional vehicle (passenger cars and light-duty trucks) traffic to and from the ISFSI during routine operations and maintenance activities. Therefore, no adverse visual impact is expected from continued operation of the Rancho Seco ISFSI.

Socioeconomics: Any changes to the local economy as a result of the construction and operation of the ISFSI occurred when the ISFSI was constructed. NRC concluded the Socioeconomic impacts associated with the construction were expected to be minimal, [E-5] Section 6.1.4. Therefore, no socioeconomic impacts are expected from continued operation beyond those described in the original environmental assessment.

Environmental Justice: Based on review of minority and low-income populations near the Rancho Seco ISFSI, no minority or low-income populations are located in a way to be disproportionately affected by Rancho Seco ISFSI license renewal. In addition, the analyses of impacts for all resource areas indicate that the impact of RSNGS ISFSI license renewal would be small. Therefore, based on the analysis in this Supplemental Environmental Report, SMUD considers that there would be no disproportionately high and adverse impacts to any minority or low-income population from the continued operation of the Rancho Seco ISFSI.

Public and Occupational Health: Radiological public and occupational health is addressed in Section E.4.3. As discussed above, ISFSI storage operation is passive with no liquid or gaseous effluents, and therefore, no impact to non-radiological public health. Non-radiological occupational health effects at the Rancho Seco ISFSI are managed through SMUD’s safety and health program. No adverse health impact is expected from continued operation of the ISFSI.

Waste Management: The original environmental assessment stated that operation of the ISFSI would not result in the generation of gaseous, liquid, or solid radioactive wastes Section 5.3 of, [E-5]. No non-radioactive wastes are associated with the operation of the ISFSI. No additional sanitary or other wastes are generated as a result of the operation of the ISFSI. Therefore, no waste management impacts expected from continued ISFSI operation.

E.4.4 Accident Impacts

NRC regulation 10 CFR 72.106(b) prescribes dose limits at the nearest boundary of the controlled area from a design basis accident. The SAR for the Rancho Seco ISFSI Volume I, Section 8.2 of [E-12] examines five design basis accidents:

1. Accident cask drop
2. DSC leakage
3. Accident pressurization
4. Earthquake
5. Fire

The only event with radiological consequences is the postulated DSC leakage event. While the DSC shell is designed as a pressure retaining containment boundary to prevent leakage of contaminated materials, i.e., DSC leakage is considered a non-credible event, the postulated DSC leakage event provides the bounding case for radiological consequences, and demonstrates that the radiation dose from an accident or natural phenomena event does not exceed the limits in 10 CFR 72.106(b).

As specified in Interim Staff Guidance No. 5 (ISG-5) Revision 1, U.S. Nuclear Regulatory Commission, Spent Fuel Project Office, Interim Staff Guidance – 5, Revision 1, “Confinement Evaluation,” [E-20], an accident release is postulated assuming all of the fuel rods in a single DSC are breached and leak to the environment at a specified rate. The whole body dose at the Rancho Seco ISFSI controlled area boundary is computed to be 0.195 rem, as reported in Section 8.2.2.3 of [E-12], which is within the 10 CFR 72.106 limit of 5 rem. All other organ doses are also well below the remaining 10 CFR 72.106 limits.

E.5 Mitigation Measures

As presented in Section E.4, the only impact of the proposed action is radiological dose to workers and the public. SMUD adopted measures to mitigate for those potential impacts in conjunction with construction and operation of the ISFSI under the original license, as discussed below. SMUD will continue to implement these measures throughout the PEO.

Workers in the ISFSI Radiologically Controlled Area wear personnel radiation monitoring devices and dose is recorded and tracked for analysis. Dosimetry is used to monitor direct radiation around the ISFSI. If measured doses were to significantly exceed historical levels, SMUD would perform analyses to determine the cause and would establish mitigation measures. The SMUD Radiological Protection As Low As Reasonably Achievable (ALARA) program is an effective method for ensuring that doses to workers and the public are as low as can be achieved by reasonable, cost-effective methods. In addition to monitoring the radiation environment around the ISFSI, inspection and maintenance activities of the ISFSI equipment are performed to ensure that no degradation of equipment could lead to increased radiation levels.

E.6 Environmental Measurement and Monitoring

The RSNGS structures, systems, and components have been decommissioned and the ISFSI is a passive operation that does not release radioactive effluents into the environment. The only environmental monitoring performed is related to direct radiation. SMUD has placed dosimetry around the ISFSI to monitor direct radiation.

There are no prescribed physical, chemical, or ecological monitoring requirements, beyond those described above, to support operations of the ISFSI. The proposed action does not involve any changes to the ISFSI Technical Specifications, refurbishment of the ISFSI, or changes in ISFSI operation that would impact the effectiveness or validity of the radiation measurement program. Therefore, the current monitoring program would continue through the PEO, and no additional environmental measurements or monitoring would be required.

E.7 Summary of Environmental Consequences

This Supplemental Environmental Report describes the proposed action, which is renewal of the license of the Rancho Seco ISFSI for 40 years, and the associated impacts. Table E-7 identifies the non-radiological and radiological environmental impacts of Rancho Seco ISFSI license renewal. Based on this evaluation, Rancho Seco ISFSI license renewal would involve no significant environmental impact.

E.7.1 Unavoidable Adverse Impacts

As presented in Section E.4, the only adverse impacts of the proposed action are radiological dose to workers and radiological dose to the public. Although SMUD employs inspections, maintenance, monitoring, and ALARA principles (Section E.5) to mitigate these impacts, some impact is unavoidable. However, as indicated in Section E.4, the impact of the extended operation of the ISFSI to both occupational workers and members of the public is within regulatory limits (e.g., radiation protection standards of 10 CFR 72.104(a)).

E.7.2 Irreversible and Irretrievable Commitment of Resources

The continued operation of the Rancho Seco ISFSI for the PEO would result in no additional irreversible or irretrievable resource commitments beyond those committed during the initial licensing (as discussed in References E-4 and E-5) which cannot be recovered or recycled, or those that are consumed or reduced to unrecoverable forms.

E.7.3 Short-Term Uses, Maintenance, and Enhancement of Long-Term Productivity

The current balance between short-term use and long-term productivity of the environment would be unchanged by the renewal of the specific license for the Rancho Seco ISFSI. The ISFSI is a temporary storage facility. Once the spent nuclear fuel is moved to a permanent repository, the DSCs, Transfer Cask, HSMs, concrete pads, and fencing may be removed. The land may then be used for another purpose. Extended operation of the ISFSI would postpone restoration of the site and its potential availability for uses other than fuel storage for up to an additional 40 years.

E.8 References

E-1 Letter from Sacramento Municipal Utility District to NRC, "Supplement to Rancho Seco Environmental Report- Post Operating License Stage," Letter Number DAGM/NUC 91-0136, Docket No. 50-312, October 21, 1991 (a copy maybe found as an attachment in Accession Number ML063200069).

E-2 NUREG-0586, "Final Generic Environmental Impact Statement on decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors," 1988.

E-3 Letter from Sacramento Municipal Utility District to NRC, "Rancho Seco Independent Spent Fuel Storage License Installation Application and Safety Analysis Report," Docket No. 72-11, October 4, 1991.

E-4 Letter from Sacramento Municipal Utility District to NRC, "Revision 1 to the Rancho Seco Independent Spent Fuel Storage Installation Environmental Report," Letter Number DAGM/NUC 93-088, Docket No. 72-11, June 16, 1993.

E-5 U.S. Nuclear Regulatory Commission, "Environmental Assessment related to the Construction and Operation of the Rancho Seco Independent Spent Fuel Storage Installation," Docket 72-11, Office of Nuclear Material Safety and Safeguards, Washington, D.C., August 1994 (Accession Number ML123480187).

E-6 Letter from Sacramento Municipal Utility District to NRC "Rancho Seco Independent Spent Fuel Storage Installation Request for Exemption From 10 CFR 72.44(d)(3) and Proposed License Amendment No. 1," July 19, 2004 (Accession Number ML042150015).

E-7 NRC, "Exemption From 10 CFR 72.44(d)(3) for Dry Spent Fuel Storage Activities with Conforming Amendment (TAC Nos. L23752 and L23753)," March 21, 2005 (Accession Number ML050810333).

E-8 Federal Register, 70 FR 1911, "Sacramento Municipal Utility District; Rancho Seco Independent Spent Fuel Storage Installation; Issuance of Environmental Assessment and Finding of No Significant Impact Regarding a Proposed Exemption and Conforming Amendment," January 11, 2005.

E-9 U.S. Nuclear Regulatory Commission, "Issuance of Environmental Assessment and Finding of No Significant Impact of the Rancho Seco Independent Spent Fuel Storage Installation (ISFSI) Request for Prosed License Amendment (TAC. No. L23757)," March 24, 2005 (Accession Number ML050830420).

E-10 Letter from Sacramento Municipal Utility District to NRC "Rancho Seco Independent Spent Fuel Storage Installation Proposed License Amendment No. 3," November 5, 2008 (Accession Number ML083190249).

E-11 NRC, "Applicability of the General Categorical Exclusion in 10 CFR 51.22(c)(11) to Proposed Amendment 3 to SNM-2510 for the Rancho Seco Independent Spent Fuel Storage Installation," April 30, 2009 (Accession Number ML091210088).

E-12 Rancho Seco Independent Spent Fuel Storage Installation Final Safety Analysis Report, Revision 6, August 2016.

E-13 Environmental Review Guidance for Licensing Actions Associated with NMSS Programs, NUREG-1748, Office of Nuclear Material Safety and Safeguards, Washington, D.C., August 2003 (Accession Number ML032450279).

E-14 Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel, NUREG-1927, Revision 1, Office of Nuclear Material Safety and Safeguards, Washington, D.C., June 2016 (Accession Number ML16179A148).

E-15 Letter from Waste Control Specialists LLC to NRC, "License Application to Construct and Operate a Consolidated Interim Storage Facility for Spent Nuclear Fuel in Andrews County, Texas, Docket 72-1050," April 28, 2016 (Accession Number ML16132A533).

E-16 Letter from Waste Control Specialists LLC to NRC, "Revision 1, License Application to Construct and Operate a Consolidated Interim Storage Facility for Spent Nuclear Fuel in Andrews County, Texas, Docket 72-1050," March 16, 2017 (Accession Number ML17082A007).

E-17 Letter from Holtec International to NRC, "Holtec International HI-STORE CIS (Consolidated Interim Storage Facility) License Application," March 30, 2017 (Accession Number ML17115A418).

E-18 10 CFR 51.23, "Environmental Impacts of Continued Storage of Spent Nuclear Fuel Beyond the Licensed Life for Operations of a Reactor," September 19, 2014 (79 FR 56238-56264).

E-19 Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel, NUREG-2157, September 2014 (Accession Number ML 14196A105).

E-20 U.S. Nuclear Regulatory Commission, Spent Fuel Project Office, Interim Staff Guidance – 5, Revision 1, "Confinement Evaluation."

E-21 Letter from Sacramento Municipal Utility District to NRC, "Rancho Seco Independent Spent Fuel Storage Installation Proposed License Amendment No. 2 for the Storage of Greater than Class C Waste," July 29, 2004 (Accession Number ML042460723).

E-22 Letter from Sacramento Municipal Utility District to NRC "Rancho Seco Independent Spent Fuel Storage Installation Proposed License Amendment No. 4," November 24, 2017 (Accession Number ML17290A008).

Table E-1
Cross-Reference Table for Environmental Requirements of 10 CFR 51

Regulatory Requirement	Section/Title of Supplemental ER
10 CFR 51.60(a)	Entire Supplemental ER
10 CFR 51.45(a)	Entire Supplemental ER
10 CFR 51.45(b), description of proposed action	E.1.2, Proposed Action
10 CFR 51.45(b), statement of purposes	E.1.1, Purpose and Need for Proposed Action
10 CFR 51.45(b), affected environment	E.3, Affected Environment
10 CFR 51.45(b)(1), impact of proposed action on the environment	E.4, Environmental Impacts
10 CFR 51.45(b)(2), adverse environmental effects that cannot be avoided	E.7.1, Unavoidable Adverse Impacts
10 CFR 51.45(b)(3), alternatives to the proposed action	E.2, Alternatives
10 CFR 51.45(b)(4), short-term use versus long-term productivity of environment	E.7.3 Short-Term Uses, Maintenance, and Enhancement of Long-Term Productivity
10 CFR 51.45(b)(5), irreversible and irretrievable commitments of resources	E.7.2, Irreversible and Irretrievable Commitment of Resources
10 CFR 51.45(c), environmental effects, impact of alternatives, and alternatives for reducing or avoiding effects	E.2, Alternatives; E.3, Affected Environment; E.4, Environmental Impacts; and E.5, Mitigation Measures
10 CFR 51.45(d), status of compliance	E.1.4, Applicable Regulatory Requirements, Permits, and Required Consultations

Table E-2
Regulatory Requirements, Permits, and Consultations

Agency	Authority	Requirement	Remarks
U.S. Nuclear Regulatory Commission	Atomic Energy Act (42 USC 2011 et. Seq.)	ISFSI License Renewal	Supplemental Environmental Report submitted in support of the ISFSI license renewal application.
U.S. Fish and Wildlife Service	Endangered Species Act (ESA) Section 7 (16 USC 1536)	Consultation	Requires the federal agency issuing a license to consult with USFWS if the action may affect species listed under the ESA.
California Office of Historic Preservation	National Historic Preservation Act Section 106 (16 USC 470f)	Consultation	Requires the federal agency issuing a license to consult with State Historic Preservation Officer if the action may affect historic properties.

Table E-3
Special Status Species

Common Name	Scientific Name	Federal Status	State Status
Plants			
Dwarf Downingia	Downingia Pusilla	None	None
Legenere	Legenere Limosa	None	None
Pincushion Navarretia	Navarretia Myersii ssp. Myersii	None	None
Sacramento Orcutt Grass	Orcuttia Viscida	Endangered	Endangered
Invertebrates			
California Linderiella	Linderiella Occidentalis	None	None
Midvalley Fairy Shrimp	Branchinecta Mesovallensis	None	None
Vernal Pool Fairy Shrimp	Branchinecta Lynchi	Threatened	None
Vernal Pool Tadpole Shrimp	Lepidurus Packardi	Endangered	None
Amphibians			
California Tiger Salamander	Ambystoma Californiense	Threatened	Threatened
Western Spadefoot	Spea Hammondii	None	None
Reptiles			
Giant Gartersnake	Thamnophis Gigas	Threatened	Threatened
Western Pond Turtle	Emys Marmorata	None	None
Birds			
Bald Eagle	Haliaeetus Leucocephalus	Delisted	Endangered
Burrowing Owl	Athene Cunicularia	None	None
Swainson’s Hawk	Buteo Swainsoni	None	Threatened
Tricolored Blackbird	Agelaius Tricolor	None	Candidate Endangered

Table E-4
Nearest Major Population Center Demographics

City	Distance from ISFSI	Direction From ISFSI	2010 Census Population	2016 Estimate Population	% Change 2010 to 2016	2060 Projected Population
Lodi	17 miles	South-Southwest	291,707	307,072	5.3%	447,562
Sacramento	25 miles	Northwest	466,488	495,234	6.2%	768,123
Stockton	26 miles	South-Southwest	291,707	307,072	5.3%	447,562

Table E-5
Estimated 2015 Populations

Radius (miles)	2015 Data
2	256
4	943
10	24,087
50	3,777,755

Table E-6
Minority and Low-Income Demographics

	Within 4 mile radius(1)	State of California(2)	Amador County(2)	San Joaquin County(2)	Sacramento County(2)
Total population	943	39,250,017	37,383	733,709	1,514,460
American Indian and Alaska Native	0%	1.7%	2.4%	2.0%	1.6%
Asian	3.3%	14.8%	1.5%	16.3%	16.2%
Native Hawaiian and Other Pacific Islander	0%	0.5%	0.3%	0.8%	1.3%
African American	0.4%	6.5%	2.1%	8.2%	10.9%
Hispanic or Latino	17.9%	38.9%	13.6%	41.2%	23.0%
Two or More Races	3.9%	3.8%	3.3%	5.2%	6.1%
Persons below Poverty	5.3%	14.3%	13.1%	17.5%	16.9%

(1) Obtained using the Missouri Census Data Center’s Beta Version caps16acs (April 2016) using 2011-2015 Data with the block-based apportioning algorithm to apportion block group data.

(2) Obtained using U.S. Census Bureau QuickFacts, population estimates, July 1, 2016.

Table E-7
Environmental Impacts of Rancho Seco ISFSI License Renewal

Resource	**Environmental Impacts**
Land Use	NONE
Transportation	NONE
Geology and Soils	NONE
Water Resources	NONE
Ecological Resources	NONE
Air Quality	NONE
Noise	NONE
Historic and Cultural Resources	NONE
Visual/Scenic Resources	NONE
Socioeconomics	NONE
Environmental Justice	SMALL – Impacts on all other resources are small
Nonradiological Occupational Health Effects	SMALL. Any non-radiological health effects would be the result of normal workplace hazards (i.e., moving heavy objects, etc.)
Occupational Dose from Normal Operations	SMALL. Workers conducting inspection and maintenance operations would receive an annual collective dose of 1.2 person-rem.
Dose to the Public from Normal Operations	SMALL. The maximum dose to the nearest potential resident is 0.16 mrem per year. The total collective off-site dose for persons within a 2-mile radius is calculated to be 0.041 person-rem/year.
Dose to the Public from Accidents	SMALL. Even a non-credible DSC leakage event results in a site boundary accident dose rates below 5 rem to the whole body or any organ as specified in 10 CFR 72.106(b).
Waste Management	NONE

Figure E-1
Location of Rancho Seco Site

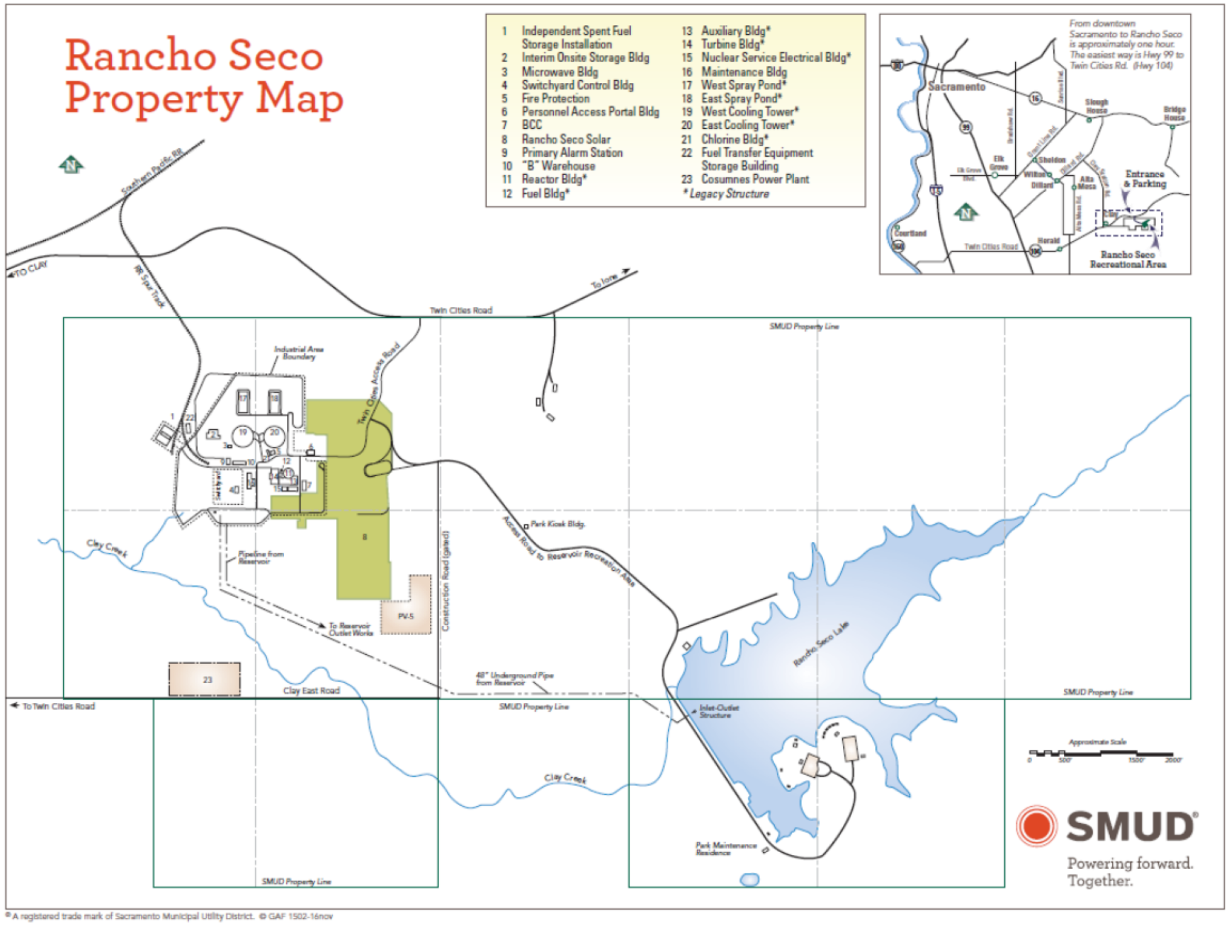

Figure E-2
Rancho Seco Owner-Controlled Area

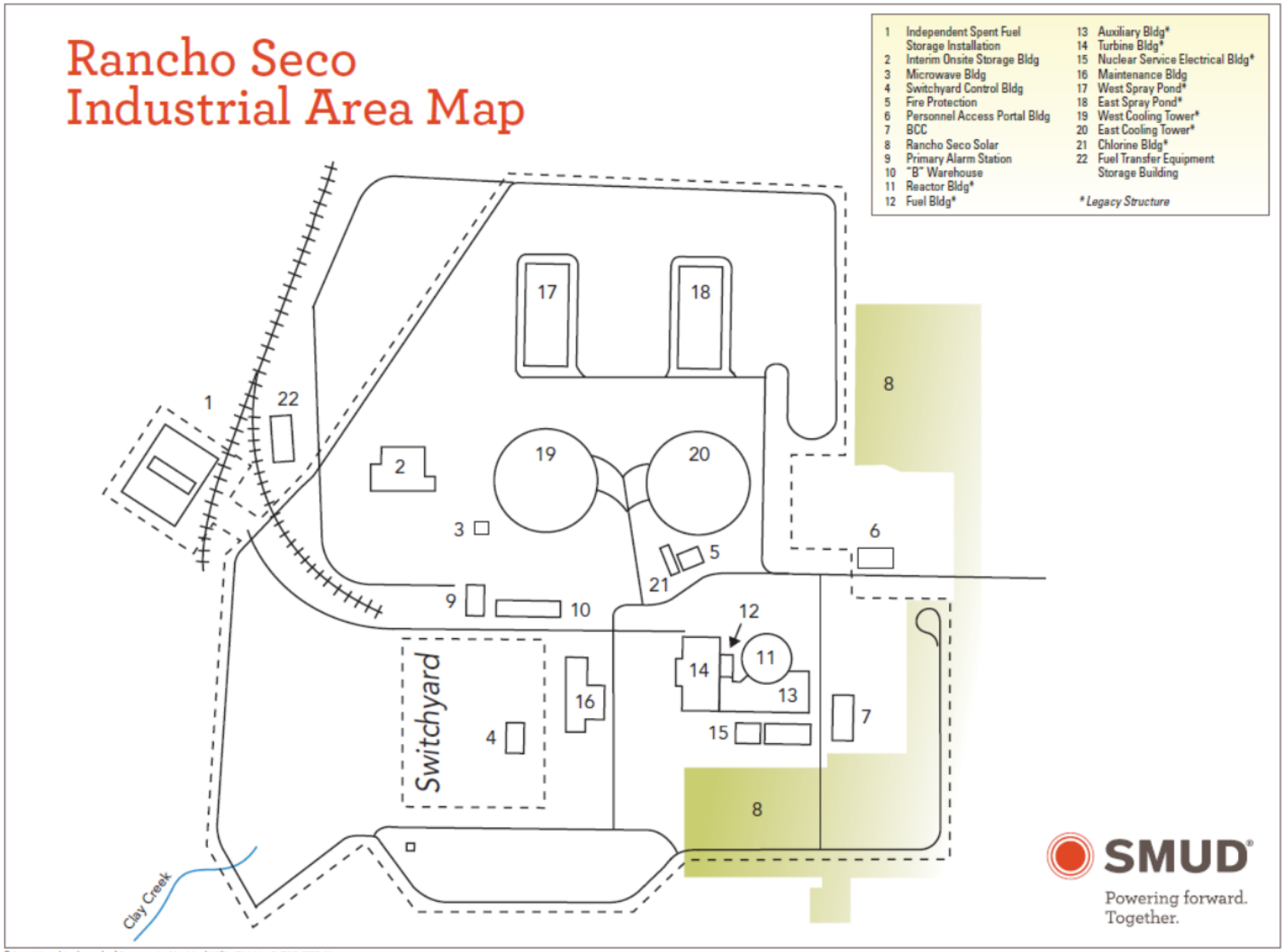

Figure E-3
Rancho Seco ISFSI Site

APPENDIX F
ISFSI DECOMMISSIONING FUNDING PLAN UPDATE

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F.1 Discussion / Status Update

Pursuant to 10 CFR 72.30(c), at the time of license renewal and at least every three years, the Decommissioning Funding Plan must be updated with adjustments, as necessary, to account for changes in costs and the extent of contamination. The most recent report on the Decommissioning Funding Status was provided by Sacramento Municipal Utility District (SMUD) on March 22, 2017, Rancho Seco Report on Decommissioning Funding Status, [F-1]. Rancho Seco has been in the process of decommissioning since February 1997, after being shutdown permanently in June 1989. An "External Sinking Decommissioning Trust Fund" was set up and continues to be maintained by Wells Fargo Bank, on behalf of SMUD. Contributions were made to this Trust Fund through 2008, at which time it was considered to be fully funded. No future contributions to the Trust Fund are planned; however, SMUD will continue to monitor and update the costs and provide contributions if the estimate to complete decommissioning exceeds the available funds.

The 2016 Decommissioning Cost Estimate included in [F-1] indicates that the remaining projected cost to complete decommissioning of Rancho Seco (both Part 50 and Part 72 licenses) is $5.82 million. As noted in the 2016 Decommissioning Cost Estimate, independent spent fuel storage installation (ISFSI) decommissioning costs are minor compared to the costs of decommissioning the reactor facility. Having completed Phase II decommissioning in 2017, SMUD requested termination of its Part 50 license on September 21, 2017, Termination of the Rancho Seco 10 CFR Part 50 License, Number DPR-54, [F-2].

Updated Information Required by 10 CFR 72.30(c)

The Decommissioning Funding Plan update required by 10 CFR 72.30(c) must consider the effect of the following events on decommissioning costs:

- Spills of radioactive material producing additional residual radioactivity in onsite subsurface material
- Facility modifications
- Changes in authorized possession limits
- Actual remediation costs that exceed the previous cost estimate

Changes associated with the first three bulleted events are not anticipated at Rancho Seco. Neither liquid spills of substances containing radioactive material, nor those that may come in contact with radioactive material are considered credible at this stage of decommissioning, since the remaining radioactive material is in solid form and not dispersible. Because decommissioning tasks are only associated with dismantling any remaining facilities, there are no additional significant facility modifications expected. In addition, no change in authorized possession limits for spent fuel is anticipated until the final Part 72 license termination, which occurs after the spent fuel is transferred to the U.S. Department of Energy and shipped offsite for disposal.

Since the 2016 Decommissioning Cost Estimate last provided [F-1], there have been no changes in the expected remaining remediation costs. No additional decommissioning costs will be incurred as a result of the implementation of aging management programs at the ISFSI. In addition, the increase in the possession limits authorized by Amendment 4 for one radioactive byproduct Sr-90 source (transferred from the Part 50 license to the Part 72 license) will have no impact on the total decommissioning costs. The only change in the decommissioning estimate is an inflationary adjustment for 2017. With available funds of $8.41 million in the Decommissioning Trust Fund as of December 31, 2017, the remaining costs projected to complete decommissioning of $5.82 million can be paid from the available Trust Fund balance.

F.2 References

F-1 Sacramento Municipal Utility District (SMUD), “Rancho Seco Report on Decommissioning Funding Status,” DPG 17-051, March 22, 2017 (Dockets 50-312 and 72-11).

F-2 Sacramento Municipal Utility District (SMUD), “Termination of the Rancho Seco 10 CFR Part 50 License, Number DPR-54,” DPG 17-164, September 21, 2017 (Docket 50-312).