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Humboldt Bay Independent Spent Fuel Storage Installation: Site-Specific License Renewal Application

N/A

Humboldt Bay
Independent Spent Fuel Storage Installation

Site-Specific License Renewal Application

Pacific Gas and Electric Company

Revision 0 July 2018
NRC Docket No. 72-27

ACRONYMS AND ABBREVIATIONS

ACI	American Concrete Institute
AMID	Aging Management Institute of Nuclear Power Operations Database
AMP	Aging Management Program
AMR	Aging Management Review
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CAP	Corrective Action Program
CFR	Code of Federal Regulations
CLB	Current Licensing Basis
CO	Confinement
CoC	Certificate of Compliance
CPUC	California Public Utilities Commission
CR	Criticality Control (Intended Function)
DFC	Damaged Fuel Container
DOE	U.S. Department of Energy
EPRI	Electric Power Research Institute
FSAR	Final Safety Analysis Report
ft.	Feet
GTCC	Greater Than Class C
GWC	GTCC Waste Container
GWd/MTU	Gigawatt-Days per Metric Ton Uranium
HB	Humboldt Bay
HBPP	Humboldt Bay Power Plant
HBU	High Burn-Up
ISFSI	Independent Spent Fuel Storage Installation
ISG	Interim Staff Guidance
ITS	Important To Safety
LRA	License Renewal Application

MAPS	Managing Aging Processes in Storage
MLLW	Mean Lower Low Water
MPC	Multi-Purpose Container
N/A	Not Applicable
NEI	Nuclear Energy Institute
NITS	Not Important To Safety
No.	Number
NRC	Nuclear Regulatory Commission
OE	Operating Experience
PEO	Period of Extended Operation
PG&E	Pacific Gas and Electric Company
PWC	Process Waste Container
RE	Retrievability (Intended Function)
SCC	Stress Corrosion Cracking
SFA	Spent Fuel Assembly
SFP	Spent Fuel Pool
SH	Radiation Shielding (Intended Function)
SR	Structural Support (Intended Function)
SSC	Structure, System, and Component
TH	Heat Transfer (Intended Function)
TLAA	Time-Limited Aging Analysis
TLD	Thermoluminescent Dosimeter

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1 GENERAL INFORMATION

In accordance with the requirements of 10 CFR 72, PG&E has prepared this application for renewal of the site-specific license for the HB ISFSI. This application supports license renewal for an additional 40-year period beyond the end of the current license term of Materials License Number SNM-2514 (Docket No. 72-27). The original 20-year license will expire on November 17, 2025. This application is submitted, in accordance with 10 CFR 72.42(b) and includes the general, technical, and environmental supporting information required by applicable portions of Subpart B of 10 CFR Part 72.

The information contained in this section includes:

1. Information on the organization of the application (Section 1.1),
2. A general description of the HB ISFSI facility (Section 1.2),
3. The administrative information required by 10 CFR 72.22 (Section 1.3),
4. Summary of the financial assurance for decommissioning (Section 1.4),
5. Summary of abbreviations and intended function code definitions (Section 1.5), and
6. A list of the references for Section 1.0, General Information (Section 1.6).

1.1 Application Format and Content

The application format and content are based on 10 CFR Part 72 (Reference 1.6.1) and the guidance contained in NUREG-1927, "Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance"(Reference 1.6.2) and NEI 14-03 (Reference 1.6.3). The format and content include:

1. General Information – Section 1 has been expanded beyond the requirements of 10 CFR 72.22 to provide (1) information on the format and content of the application, (2) a general facility description, (3) financial assurance for decommissioning, and (4) a summary of abbreviations and intended function code definitions used in the application.
2. Scoping Evaluations – Section 2 provides the scoping evaluations for the ISFSI SSCs.
3. Aging Management Review – Section 3 includes the methodology and results of the AMRs performed for site-specific ISFSI SSCs that are in-scope of license renewal.
4. Time-Limited Aging Analyses – Section 4 includes the methodology and results of the TLAA review for ISFSI SSCs that are in-scope of license renewal.
5. Appendices:
   Appendix A: Aging Management Programs
   Appendix B: Granted Exemptions
   Appendix C: Proposed License Changes

Appendix D: FSAR Update Supplement and Changes (including 10 CFR 72.48 changes since the last biennial update)
Appendix E: Pre-Application Inspection Report
Appendix F: Environmental Report Supplement
Appendix G: HB ISFSI Decommissioning Funding Plan

1.2 Facility Description

The Humboldt Bay ISFSI consists of an ISFSI storage vault, cask transporter, and the Holtec International HI-STAR 100 dry cask system, as modified for the HBPP spent fuel. The physical characteristics of the spent fuel assemblies and GTCC waste to be stored are described in Sections 3.2 and 3.7. The HB-specific design is referred to as the HI-STAR HB. The HI-STAR HB is both a storage and transport cask that provides structural protection and radiation shielding for the MPC-HB (containing the spent fuel).

The ISFSI is located on the same property as the existing HBPP which is owned by PG&E and is undergoing decommissioning. The ISFSI storage vault is an interim facility consisting of an in-ground concrete vault structure with storage capacity for six shielded casks, five containing spent nuclear fuel and one containing GTCC waste. The spent fuel will be stored there until the Department of Energy takes possession of the spent fuel and transports it to an off-site licensed facility.

1.3 Information Required by 10 CFR 72.22

1.3.1 Name of Applicant

PG&E is the applicant and hereby applies for renewed Materials License Number SNM-2514 (Docket No. 72-27) for the HB ISFSI.

PG&E is a wholly owned subsidiary of PG&E Corporation.

1.3.2 Address of Applicant

The principal executive offices of PG&E Corporation are located at One Market, Spear Tower, Suite 2400, San Francisco, California 94105. The principal executive offices of PG&E are located at 77 Beale Street, P.O. Box 770000, San Francisco, California, 94177.

1.3.3 Address of the Humboldt Bay ISFSI

The address for PG&E at Humboldt Bay Power Plant is:

Pacific Gas and Electric Company
Humboldt Bay Power Plant
1000 King Salmon Avenue
Eureka, CA 95503

1.3.4 Description of Business or Occupation of Applicant

PG&E is an operating public utility primarily regulated by the California Public Utilities Commission and engaged principally in the business of providing electric and natural gas services throughout most of northern and central California.

PG&E Corporation was incorporated in 1995 and became the holding company for PG&E and its subsidiaries on January 1, 1997. PG&E Corporation is headquartered in San Francisco, California. PG&E Corporation is an energy-based holding company that conducts its business principally through PG&E.

1.3.5 Organization and Management of Applicant

The Humboldt Bay ISFSI is owned by PG&E.

PG&E is a wholly owned subsidiary of PG&E Corporation, which is organized and exists under the laws of the State of California. Its principal office is located in San Francisco, California at the address stated above. PG&E is not foreign owned, controlled or dominated by an alien, a foreign, corporation, or foreign government. PG&E is not acting as an agent or representative of any other person.

The directors and principal officers of PG&E Corporation, as of January 30, 2018, are presented below. All persons listed are U. S. citizens and may be contacted at the following address:

77 Beale St.
P.O. Box 770000
San Francisco, CA 94177

PG&E Corporation Board of Directors

Lewis Chew
Fred J. Fowler
Jeh. C. Johnson
Richard C. Kelly
Roger H. Kimmel
Richard A. Meserve
Forrest E. Miller
Eric D. Mullins
Rosendo G. Parra
Barbara L. Rambo
Anne Shen Smith
Geisha J. Williams

PG&E Corporation Officers	
Name	**Title**
Geisha J. Williams	Chief Executive Officer and President of PG&E Corporation
John R. Simon	Executive Vice President and General Counsel
Julie M. Kane	Senior Vice President, Chief Ethics and Compliance Officer, and Deputy General Counsel
Steven E. Malnight	Senior Vice President, Strategy and Policy
Dinyar B. Mistry	Senior Vice President, Human Resources and Chief Diversity Officer
Jason P. Wells	Senior Vice President and Chief Financial Officer
Nicholas M. Bijur	Vice President and Treasurer
Stephen J. Cairns	Vice President, Internal Audit and Chief Risk Officer
Mark T. Caron	Vice President, Tax
Linda Y.H. Cheng	Vice President, Corporate Governance and Corporate Secretary
David S. Thomason	Vice President and Controller

1.3.6 Financial Qualifications of PG&E

PG&E will remain financially qualified to carry out the operation and decommissioning of the ISFSI during the period of the renewed material license as required by 10 CFR 72.22(e). Information supporting this statement is submitted in annual financial reports, as required by regulations. A link to the most-recent annual financial report for PG&E is: http://investor.pgecorp.com/financials/annual-reports-and-proxy-statements/default.aspx (click on most recent year)

1.4 Financial Assurance for Decommissioning (10 CFR 72.30)

A decommissioning funding plan for the ISFSI was submitted to the NRC in its original application for a materials license on December 15, 2003 (Reference 1.6.4). The basic elements of the plan, i.e., shipping of the fuel to an off-site licensed facility and decontamination and disposal of the dry storage casks, remain unchanged. The actual activities at the time of decommissioning will be dependent upon the regulations and practices in effect at that time. Discussion of decommissioning of the Humboldt Bay ISFSI is contained in Section 4.7 of the HB ISFSI FSAR Update (Reference 1.6.5).

Pursuant to 10 CFR 72.30(b), PG&E submitted its most recent decommissioning funding plan for the HB ISFSI on December 17, 2015 (Reference 1.6.6).
10 CFR 72.30(c) requires each holder of a license under Part 72 to resubmit the decommissioning funding plan at the time of license renewal and at intervals not to exceed three (3) years with adjustments as necessary to account for changes in costs and the extent of contamination. In accordance with 10 CFR 72.30(c), Appendix G provides PG&E's update to the HB ISFSI decommissioning funding plan at the time of license renewal.

1.5 Abbreviations and Intended Function Code Definitions

1.5.1 Abbreviations

The acronyms and abbreviations that pertain to the administrative and technical information in this application, as well as Appendices A through E and G, are listed prior to the Table of Contents.

1.5.2 Intended Function Code Definitions

This section contains the meanings for the subcomponent intended function represented by the abbreviations used in subsequent sections of this application, including Table 2-2 through Table 2-9 and Table 3.2-1 through Table 3.9-1. Subcomponent intended functions are the specific functions that support the intended function of the structure and component of which they are a part.

Intended Function Code	Definition
CR	Provides criticality control of spent fuel
TH	Provides heat transfer
CO	Directly or indirectly maintains the cask pressure boundary (confinement)
SH	Provides radiation shielding
SR	Provides structural support and/or functional support, missile shielding, and/or maintains geometry to support retrievability of important to safety equipment (structural integrity)
RE	Provides function to support retrievability

1.6 Section 1.0 References

1.6.1 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste

1.6.2 NUREG-1927, Revision 1, Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel, Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, June 2016. ADAMS Accession No. ML16179A148.

1.6.3 NEI 14-03, Revision 2, Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management, December 2016. ADAMS Accession No. ML16356A210.

1.6.4 PG&E Letter HIL-03-001, License Application for Humboldt Bay Independent Spent Fuel Storage Installation, December 15, 2003. ADAMS Accession No. ML033640441.

1.6.5 PG&E Letter HIL-17-005, Final Safety Analysis Report Update, Revision 6, November 8, 2017. ADAMS Accession Nos. ML17320A148 and ML17320A151 (except 2.6 figures).

1.6.6 PG&E Letter HIL-15-007, Humboldt Bay Independent Spent Fuel Storage Installation, Decommissioning Funding Plan, December 17, 2015. ADAMS Accession No. ML15351A510.

2.0 SCOPING EVALUATIONS

2.1 Introduction

The HB ISFSI license renewal process and methodology follows the guidance contained in NUREG-1927, “Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance” (Reference 2.4.1). The 10 CFR Part 72 license renewal process, as described in NUREG-1927, follows the principle that the basis for renewal of the license depends on “the continuation of the existing licensing basis throughout the period of extended operation and on the maintenance of the intended functions of the SSCs important to safety” (Reference 2.4.1). Based on these principles, license renewal is not intended to impose requirements beyond those reflected in the CLB. Therefore, the CLB for the HB ISFSI will be carried forward through the period of extended operation.

The scoping process involves identification of the SSCs of the ISFSI and their subcomponents that are within the scope of license renewal, and thus require evaluation for the effects of aging. A description of the scoping process is provided in Section 2.2, Scoping Methodology, and the results are provided in Section 2.3, Scoping Results.

2.2 Scoping Methodology

The first step in the license renewal process involves the identification of the in-scope ISFSI SSCs. The scoping criteria used for this scoping evaluation are defined in NUREG-1927 and are based upon the ITS Quality Assurance classification system. ISFSI SSCs are considered in-scope if their safety function(s) meet either of the following scoping criteria:

<u>Criterion 1</u>

The SSC is classified as ITS as it is relied on to do one of the following functions:

a. Maintain the conditions required by the regulations, specific license, or 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 ITS functions are met for: (1) confinement, (2) radiation shielding, (3) sub-criticality control, (4) heat-removal capability, (5) structural integrity, and (6) retrievability.

<u>Criterion 2</u>
The SSC is classified as NITS but, according to the design bases, their failure could prevent fulfillment of a function that is important to safety.

The ISFSI SSCs that meet the Scoping Criteria are presented in Section 2.3, Scoping Results.

A basic premise of the license renewal scoping process is that the CLB identifies SSCs and their safety functions. Thus, the CLB is reviewed to determine those SSCs with safety functions that meet either Scoping Criterion 1 or 2, as defined above. The following documents comprise the CLB for the HB ISFSI:

- Humboldt Bay ISFSI Final Safety Analysis Report (FSAR) Update (Reference 2.4.2) and associated 10 CFR 72.48 evaluations
- Materials License No. SNM-2514 (Reference 2.4.3)
- Technical Specifications (Reference 2.4.3, Appendix A)
- Docketed Licensing Correspondence (see Docket No. 72-27)

The Humboldt Bay ISFSI FSAR Update provides a description of the ISFSI, ISFSI SSCs and their functions, including safety classifications as established by the safety analyses. The Technical Specifications govern the safety of the receipt, possession, and storage of irradiated nuclear fuel at the ISFSI, and the transfer of such irradiated fuel to and from the ISFSI. Additionally, the Safety Evaluation Report (Reference 2.4.4), which summarizes the results of the NRC Staff's safety review of the original licensing, and the Safety Evaluation Reports associated with subsequent amendments were used in the license renewal scoping process.

2.3 Scoping Results

The HB ISFSI is designed to store up to 400 SFAs in five casks, with a sixth cask to store GTCC waste. The HB ISFSI uses the HI-STAR 100 HB system which is housed in an in-ground concrete storage vault structure. HI-STAR 100 HB system is composed of an all-welded MPC-HB designed to store up to 80 HB fuel assemblies inside a bolted-lid steel overpack. The HI-STAR 100 HB system is similar to the HI-STAR 100 system described in the HI-STAR 100 FSAR Update (Reference 2.4.5). Certain differences were incorporated into the HI-STAR 100 HB system design to take advantage of the smaller HBPP fuel, advances in the neutron absorber material, and lessons learned in the fabrication of the HI-STAR 100 system. The differences between the HI-STAR 100 HB and the HI-STAR 100 systems are described in the Humboldt Bay ISFSI FSAR Update, Section 4.2.3. Further description of each HI-STAR 100 HB SSC is provided in Humboldt Bay ISFSI FSAR Update, Section 4.2.

The SSCs comprising the Humboldt Bay ISFSI are identified in Table 2-1, Scoping Results. Those SSCs meeting Scoping Criterion 1 or 2 are identified in the table as being within the scope of license renewal, except as noted.

As indicated in Table 2-1, only the SFAs, damaged fuel container, MPC-HB, HI-STAR 100 HB overpack, process waste container, HI-STAR HB GTCC waste container, HI-STAR 100 HB GTCC overpack, and ISFSI storage vault were determined to be within the scope of license renewal and to require further review in the aging management review process.

The intended functions performed by the individual subcomponents of these in-scope SSCs are identified in Tables 2-2 through 2-9. SSC sub-components were identified by review of licensing and fabrication drawings.

Table 2-1 Scoping Results

Structures/Components	Criterion 1	Criterion 2	In-Scope
Spent Fuel Assemblies	Yes	N/A	Yes
Damaged Fuel Container	Yes	N/A	Yes
MPC-HB[1]	Yes	N/A	Yes
HI-STAR 100 HB Overpack	Yes	N/A	Yes
Process Waste Container	Yes	N/A	Yes
HI-STAR HB GTCC Waste Container	Yes	N/A	Yes
HI-STAR 100 HB GTCC Overpack	Yes	N/A	Yes
ISFSI Storage Vault[3]	Yes	N/A	Yes
Cask Transportation System[2]	Yes	N/A	No[4]
Helium Fill Gas	Yes	N/A	No[6]
Lid Retention Device	Yes	N/A	No[5]
Loose Fuel Debris	No	No	No
Process Waste[7]	No	No	No
GTCC Waste[7]	No	No	No
Security Systems	No	No	No
Fencing	No	No	No
Lighting	No	No	No
Electrical Power	No	No	No
Communications Systems	No	No	No
Automated Welding System	No	No	No
MPC Forced Helium Dehydration System	No	No	No
Overpack Vacuum Drying System	No	No	No
Rail Dolly	No	No	No
ISFSI Storage Vault Drainage Pipe[8]	No	No	No

Notes:

1. Includes, but is not limited to the fuel basket, basket spacers, and fuel spacers.
2. Includes, but is not limited to the cask transporter, transporter lift links, and transporter connector pins.
3. Includes, but is not limited to the vault liner, seismic restraints, and vault closure lid.
4. The cask transportation system was used for initial ISFSI loading and may be used for future cask retrievability. While these SSCs are needed for retrievability, they are not maintained at the HB ISFSI site, but are shared with and housed at the Diablo Canyon ISFSI. As discussed in HB ISFSI FSAR Update, Section 3.3.3.2.1, the "cask transporter design life is 20 years. The cask transporter may be replaced or re-certified for continued use at the end of its design life." In addition, as discussed in the HB ISFSI Technical Specifications, Section 4.3.3, "lifting of a SFSC outside of structures governed by 10 CFR 50 shall be performed with load handling equipment that is designed, fabricated, inspected, maintained, operated and tested in accordance with the applicable guidelines of NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants"."
   Consistent with NUREG-1927, Section 2.4.3, because the current FSAR and Technical Specification requirements to not only inspect, maintain, and test the transporter prior to use in accordance with NUREG-0612, but to *replace or re-certify based on a qualified*

life or service time period, this SSC should be considered "short-lived" (not "long-lived" like those SSCs that are in the scope of license renewal) and not be included in the scope of license renewal.

5. Although the lid retention device is listed as ITS in the Humboldt Bay ISFSI FSAR Update, this component only supported initial loading of the casks. Because this component does not support a long-term storage function, it is not in the scope of license renewal.
6. The helium fill gas is the actual gas used to backfill the MPC-HBs and overpacks during initial loading. It was listed as ITS to ensure the quality and purity prior to loading and is credited for the long-term environment used to determine aging.
7. The process and GTCC waste do not meet the definitions of Criteria 1 or 2 because they are not related to handling or storage of spent fuel nor could impact the function of the PWC, GWC, or GTCC overpack. The process and GTCC waste configurations are not relied upon in the safety analyses. Rather, the process and GTCC waste weights, heat loads, dose rate, and source strengths were reviewed during design and licensing efforts without knowledge of the actual storage configurations.
8. As discussed in HB ISFSI FSAR Update, Table 4.5-1, Note (d), the storage vault drainage pipe is classified as NITS because the drainage system is only one of several design features relied upon in a defense-in-depth approach to ensure adequate performance of the cask and storage vault system in the event of standing water in the vault cells. During the original HB ISFSI licensing review, PG&E provided NRC a response to request for additional information regarding the safety classification of the drainage system (Reference 2.4.6). PG&E concluded that, based on the defense-in-depth approach described in the letter, since reliance is not placed solely on the drainage system to prevent significant water corrosion of the casks, the drainage pipe and associated components are NITS. This conclusion is reflected in the NRC's Safety Evaluation Report. Thus, Criterion 1 is not met. Criterion 2 is also not met because failure of the drainage system would not solely result in any loss of intended function to the HB ISFSI SSCs. Although the drainage system is not in the scope of license renewal, Appendix A, Table A-1, Element 4 describes conduct of annual vault cell inspections that would identify any standing water in the vault cell.

N/A – Not Applicable
Reference: Humboldt Bay ISFSI FSAR Update, Table 4.5-1

Table 2-2 Intended Functions of Spent Fuel Assemblies Subcomponents

Subcomponent	Part Number	Reference Drawing[1]	Intended Function
Fuel Pellets	N/A	6019924-13, 14	None[2]
Upper Tie Plate	N/A	6019924-13, 14	CR, SR, RE
Guide Spring	N/A	6019924-13	None[2]
Locking Tab Washer	N/A	6019924-14	None[2]
Expansion Spring	N/A	6019924-13, 14	None[2]
Plenum Spring	N/A	6019924-13, 14	None[2]
Channel	N/A	6019924-13, 14	CR, TH
Fuel Spacers	N/A	6019924-13, 14	CR, SR, TH, RE
Fuel Cladding	N/A	6019924-13, 14	CO, CR, SH, SR, TH, RE
Fuel Rod Wafer	N/A	6019924-13	None[2]
Lower Tie Plate	N/A	6019924-13, 14	CR, SR, RE
Tie Rods	N/A	6019924-13, 14	None[2]
Hex Nuts	N/A	6019924-13, 14	None[2]
Hex Head Cap Screw and Lockwasher	N/A	6019924-13, 14	None[2]
Lockwire	N/A	6019924-13	None[2]

Notes:

1. Drawing 6019924-13 and -14, Revision 3 is not docketed, but is available at the HB ISFSI for NRC review.
2. None – These sub-components have no ITS intended function and their failure would not affect an ITS function, and are, therefore, screened out of the scope of LR.

Intended Functions: Confinement (CO), Sub-criticality (CR), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH), Retrievability (RE)

Table 2-3 Intended Functions of Damaged Fuel Container Subcomponents

Subcomponent	Part Number	Reference Drawing[1]	Intended Function	ITS Category
Top Ring	1	6023993-22	SR	ITS-C
Tube	2	6023993-22	CO, SR	ITS-C
Pan-Base	3	6023993-22	CO, SR	ITS-C
Pan-Side	4	6023993-22	CO, SR	ITS-C
Pan-Top	5	6023993-22	CO, SR	ITS-C
Mesh	6	6023993-22	SR	ITS-C
Lock Bolt	7	6023993-22	CO, SR	ITS-A
Lock Plate	8	6023993-22	CO, SR	ITS-C
Washer	9	6023993-22	None[2]	NITS
Hexnut	10	6023993-22	None[2]	NITS
Mesh Ring	11	6023993-22	None[2]	NITS
Baseplate	12	6023993-22	CO, SR	ITS-C
Mesh Plate	13	6023993-22	None[2]	NITS
Base Feet	14	6023993-22	SR	ITS-C

Notes:

1. Drawing 6023993-22, Revision 1 is not docketed, but is available at the HB ISFSI for NRC review.
2. None – These sub-components have no ITS intended function and their failure would not affect an ITS function, and are, therefore, screened out of the scope of LR.

Intended Functions: Confinement (CO), Structural Integrity (SR)

Table 2-4 Intended Functions of MPC-HB Subcomponents

Subcomponent	Part Number[3]	Reference Drawing[1]	Intended Function	ITS Category
MPC – Base Plate	1	6023993-3 and FSAR Update Figure 3.3-1	CO, SH, SR, TH	ITS-A
MPC – Shell	2, 3	6023993-3 and FSAR Update Figure 3.3-1	CO, SH, SR, TH	ITS-A
Lug Lift Baseplate	4	6023993-3	None – only used with unloaded MPC	ITS-C
Lug Lift	5	6023993-3 and FSAR Update Figure 3.3-1	None – only used with unloaded MPC	ITS-C
Lug Lift Shim	6	6023993-3	None – only used with unloaded MPC	NITS
MPC – Lid	7	6023993-3 and FSAR Update Figure 3.3-1	CO, SH, SR, TH	ITS-A
Closure Ring	8	6023993-3 and FSAR Update Figure 3.3-1	CO	ITS-A
Drain Shield Block	9	6023993-3 and FSAR Update Figure 3.3-1	SH	ITS-C
Vent / Drain Tube	10	6023993-3 and FSAR Update Figure 3.3-1	SR	ITS-C
Vent / Drain Cap	11	6023993-3 and FSAR Update Figure 3.3-1	SR	ITS-C
Port Cover Plate	12	6023993-3 and FSAR Update Figure 3.3-1	CO	ITS-A
Drain Port Coupling	13	6023993-3	None[2]	NITS
Drain Line	14	6023993-3 and FSAR Update Figure 3.3-1	None[2]	NITS
Vent Shield Block	15	6023993-3 and FSAR Update Figure 3.3-1	SH	ITS-C
Vent Shield Spacer	16	6023993-3	SR	ITS-C
Vent Port Seal Washer	17	6023993-3	None[2]	NITS
Vent Port Seal Bolt	18	6023993-3	None[2]	NITS
Vent Port Cap Screw	19	6023993-3	None[2]	NITS

Table 2-4 Intended Functions of MPC-HB Subcomponents

Subcomponent	Part Number[3]	Reference Drawing[1]	Intended Function	ITS Category
Upper Fuel Spacers	20, 21	6023993-3 and FSAR Update Figure 3.3-1	SR	ITS-B
Fuel Basket Supports	22, 23	6023993-3 and FSAR Update Figure 3.3-1	CR, SR	ITS-A
Drain Tube Plate	24	6023993-3	None[2]	NITS
Drain Guide Tube	25	6023993-3	None[2]	NITS
Lid Lift Hole Plug	26	6023993-3	None[2]	NITS
Vent Port Seal Lock Washer	27	6023993-3	None[2]	NITS
Lid Shim	28	6023993-3	None[2]	NITS
Top Handling Hole Plug	29	6023993-3	None[2]	NITS
Fuel Spacer	30	6023993-3 and FSAR Update Figure 3.3-1	SR	ITS-B
Fuel Basket Cell Spacer Plates	4, 9, 12, 13	6023993-2 and FSAR Update Figure 3.3-2	CR, SR	ITS-A
Fuel Basket Spacer Angle Plates	11	6023993-2	CR, SR	ITS-A
Fuel Basket Cell Plates	1, 5, 6, 7, 8, 10, 14, 15, 17, 18	6023993-2 and FSAR Update Figure 3.3-2	CR, SH, SR, TH	ITS-A
Sheathing	2	6023993-2 and FSAR Update Figure 3.3-2	SR	ITS-A
Neutron Absorber	3	6023993-2	CR, SH ,TH	ITS-A

Notes:

1. Drawing 6023993-2 and -3, Revision 1 is not docketed, but are available at the HB ISFSI for NRC review.
2. None – These sub-components have no ITS intended function and their failure would not affect an ITS function, and are, therefore, screened out of the scope of LR.
3. Part number 16 from drawing 6023993-2 was deleted, and thus, is not included in the above table.

Intended Functions: Confinement (CO), Sub-criticality (CR), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 2-5 Intended Functions of HI-STAR HB Overpack Subcomponents

Subcomponent	Part Number	Reference Drawing[1]	Intended Function	ITS Category
Bottom Plate	1	6023993-1 and FSAR Update Figure 3.3-3	CO, SH, SR	ITS-A
Port Plugs	2	6023993-1 and FSAR Update Figure 3.3-3	CO	ITS-A
Port Plug Seals	3	6023993-1 and FSAR Update Figure 3.3-3	CO	ITS-A
Port Covers	4	6023993-1 and FSAR Update Figure 3.3-3	SR	ITS-B
Port Cover Seals	5	6023993-1 and FSAR Update Figure 3.3-3	CO	ITS-B
Port Cover Bolts	6	6023993-1 and FSAR Update Figure 3.3-3	SR	ITS-C
Base Plugs	7, 8, 9	6023993-1 and FSAR Update Figure 3.3-3	None[2]	NITS
Inner Shell	10	6023993-1 and FSAR Update Figure 3.3-3	CO, SH, SR	ITS-A
Top Flange	11	6023993-1 and FSAR Update Figure 3.3-3	CO, SH, SR	ITS-A
Flange Overlay	12	6023993-1	CO	ITS-A
Lifting Trunnion	13	6023993-1 and FSAR Update Figure 3.3-3	RE	ITS-A
Top Flange Screw	14	6023993-1	None[2]	NITS
Flange Top Plug	15	6023993-1	None[2]	NITS
Intermediate Shell	16, 17, 18, 19, 20	6023993-1 and FSAR Update Figure 3.3-3	SH, SR	ITS-B
Toe Ring Plate	21	6023993-1	CO	ITS-B
Neutron Cover Plate	22	6023993-1	SR	ITS-B
Neutron Rib	23	6023993-1	SR	ITS-B
Rupture Plate	24	6023993-1	SR	ITS-C
Rupture Side	25	6023993-1	SR	ITS-B
Rupture Disk	26	6023993-1 and FSAR Update Figure 3.3-3	SR	ITS-C

Table 2-5 Intended Functions of HI-STAR HB Overpack Subcomponents

Subcomponent	Part Number	Reference Drawing[1]	Intended Function	ITS Category
Top Ring Plate	27	6023993-1	SR	ITS-B
Neutron Shield	28	6023993-1 and FSAR Update Figure 3.3-3	CR, SH	ITS-B
Neutron Foam	29	6023993-1 and FSAR Update Figure 3.3-3	None[2]	NITS
Storage Plate	30	6023993-1	None[2]	NITS
Transport Plate	31	6023993-1	None[2]	NITS
Closure Plate	32	6023993-1 and FSAR Update Figure 3.3-3	CO, SH, SR	ITS-A
Closure Plate Overlay	33	6023993-1	CO	ITS-A
Closure Plate Inner Seal	34	6023993-1	CO	ITS-A
Closure Plate Outer Seal	35	6023993-1	CO	ITS-A
Closure Plate Bolts	36, 37	6023993-1 and FSAR Update Figure 3.3-3	CO, SR	ITS-A
Closure Plate Washer	38	6023993-1	None[2]	NITS
Closure Plate Plug	39	6023993-1 and FSAR Update Figure 3.3-3	None[2]	NITS

Notes:

1. Drawing 6023993-1, Revision 1 is not docketed, but is available at the HB ISFSI for NRC review.
2. None – These sub-components have no ITS intended function and their failure would not affect an ITS function, and are, therefore, screened out of the scope of LR.

Intended Functions: Confinement (CO), Sub-criticality (CR), Radiation Shielding (SH), Structural Integrity (SR), Retrievability (RE)

Table 2-6 Intended Functions of Process Waste Container Subcomponents

Subcomponent	Part Number	Reference Drawing[1]	Intended Function
Container Shell	1	6019924-287 6019924-284	CO, SR
Quick Disconnect Body	2	6019924-287	CO
Vacuum Drying Insert	3	6019924-287	CO
Pipe Cap	4	6019924-287	None[2]
Sleeve	5	6019924-287	None[2]
Cap Lifting Lug	6	6019924-287	None – only used during loading
PWC Filter Assembly	7	6019924-287	None[2]
Gasket	8	6019924-287	None[2]
Top Plate	2	6019924-284	SR
Flange	3	6019924-284	None[2]
Dowel Pin	4	6019924-284	None[2]
Nut	5	6019924-284	None[2]

Notes:

1. Drawing 6019924-284 and -287, Revision 1 is not docketed, but is available at the HB ISFSI for NRC review.
2. None – These sub-components have no ITS intended function and their failure would not affect an ITS function, and are, therefore, screened out of the scope of LR.

Intended Functions: Confinement (CO), Structural Integrity (SR)

Table 2-7 Intended Functions of GTCC Waste Container Subcomponents

Subcomponent	Part Number[3]	Reference Drawing[1]	Intended Function	ITS Category
MPC Base Plate	1	6023993-26	CO, SH, SR, TH	ITS-A
MPC Shell	2, 3	6023993-26 and FSAR Update Figure 3.3-4	CO, SH, SR, TH	ITS-A
Waste Pipes	4, 5	6023993-26	None[2]	NITS
Lift Lug Base Plate	6	6023993-26	None – only used with unloaded GWC	ITS-C
Lift Lug	7	6023993-26	None – only used with unloaded GWC	ITS-C
Lift Lug Shim	8	6023993-26	None – only used with unloaded GWC	NITS
Waste Cover Plate	9	6023993-26	None[2]	NITS
Waste Shell Top	10	6023993-26	None[2]	NITS
Waste Lid Lift Lug	11	6023993-26	None[2]	NITS
Inner Shell	12	6023993-26	SH, SR, TH	ITS-B
Drain Tube Guide	13	6023993-26 and FSAR Update Figure 3.3-4	None[2]	NITS
Drain Guide Funnel	14	6023993-26	None[2]	NITS
Connector Tube	15	6023993-26	None[2]	NITS
Plate, Closure, Connector	16	6023993-26	None[2]	NITS
MPC Lid Top	18	6023993-26	CO, SH, SR, TH	ITS-A
MPC Lid Bottom	19	6023993-26	CO, SH, SR, TH	ITS-B
Sleeve Insert	20	6023993-26	SR	ITS-C
Closure Ring	21	6023993-26	CO	ITS-A
Drain Shield Block	22	6023993-26	SH	ITS-C
Vent Drain Tube	23	6023993-26	SR	ITS-C
Vent Drain Cap	24	6023993-26	SR	ITS-C
Port Cover Plate	25	6023993-26	CO	ITS-A
Coupling	26	6023993-26	None[2]	NITS
Drain Line	27	6023993-26	None[2]	NITS
Seal Washer	30	6023993-26	None[2]	NITS
Seal Bolt	31	6023993-26	None[2]	NITS
Port Cover Bolt	32	6023993-26	None[2]	NITS
Lock Washer	33	6023993-26	None[2]	NITS
Drain Tube Guide Support	34	6023993-26	None[2]	NITS
Lid Lift Hole Plug	35	6023993-26	None[2]	NITS
Top Handling Hole Plug	36	6023993-26	None[2]	NITS

Notes:

1. Drawing 6023993-26, Revision 1 is not docketed, but is available at the HB ISFSI for NRC review.
2. None – These sub-components have no ITS intended function and their failure would not affect an ITS function, and are, therefore, screened out of the scope of LR.
3. Part numbers 17, 28, and 29 from drawing 6023993-26 were not used, and thus, are not included in the above table.

Intended Functions: Confinement (CO), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 2-8 Intended Functions of GTCC Overpack Subcomponents

Subcomponent	Part Number[3]	Reference Drawing[1]	Intended Function	ITS Category
Bottom Plate	1	6023993-27	SH, SR	ITS-A
Base Plate Plugs	7, 8, 9	6023993-27	None[2]	NITS
Shell	10	6023993-27	SH, SR	ITS-A
Top Flange	11	6023993-27	SH, SR	ITS-A
Lifting Trunnion	13	6023993-27 and FSAR Update Figure 3.3-4	RE	ITS-A
Top Flange Screws	14	6023993-27	None[2]	NITS
Flange Top Plug	15	6023993-27	None[2]	NITS
Intermediate Shells	16, 17, 18, 19, 20	6023993-27 and FSAR Update Figure 3.3-4	SH, SR	ITS-B
Toe-Ring Plate	21	6023993-27	SR	ITS-B
Storage Plate	30	6023993-27	None[2]	NITS
Transport Plate	31	6023993-27	None[2]	NITS
Closure Lid	32	6023993-27	SH, SR	ITS-A
Lid Bolts	36, 37	6023993-27	SR	ITS-A
Lid Washers	38	6023993-27	None[2]	NITS
Lid Plug	39	6023993-27	None[2]	NITS
Drain Plug	40	6023993-27	None[2]	NITS

Notes:

1. Drawing 6023993-27, Revision 1 is not docketed, but is available at the HB ISFSI for NRC review.
2. None – These sub-components have no ITS intended function and their failure would not affect an ITS function, and are, therefore, screened out of the scope of LR.
3. Part numbers 2-6, 12, 22-29, and 33-35 from drawing 6023993-27 are not used, and thus, are not included in the above table.

Intended Function: Radiation Shielding (SH), Structural Integrity (SR), Retrievability (RE)

Table 2-9 Intended Functions of ISFSI Storage Vault Subcomponents

Subcomponent	Part Number	Reference Drawing[1]	Intended Function	ITS Category
Vault Shell Base Plate	1	6023993-5 and FSAR Update Figure 3.2-1	SR	ITS-B
Vault Shell	2	6023993-5 and FSAR Update Figure 3.2-1	SR	ITS-B
Vault Shell Lid Ring	3	6023993-5 and FSAR Update Figure 3.2-1	SR	ITS-B
Vault Shell Drain Ring	4	6023993-5	SR[3]	NITS
Vault Shell Anchor Block	5	6023993-5 and FSAR Update Figure 3.2-1	SR	ITS-B
Vault Shell Gusset	6	6023993-5	SR	ITS-B
Vault Shell Stop Plate	7	6023993-5 and FSAR Update Figure 3.2-1	SR	ITS-B
Vault Shell Guide Plates	8, 9	6023993-5 and FSAR Update Figure 3.2-1	SR	ITS-B
Vault Shell Alignment Plates (Seismic Restraints)	10, 11	6023993-5 and FSAR Update Figure 3.2-1	SR	ITS-B
Vault Shell Alignment (Seismic) Shims	12	6023993-5 and FSAR Update Figure 3.2-1	None[2]	NITS
Vault Shell Thermocouple	13	6023993-5	None[2]	NITS
Vault Shell Thermal Conduit	14	6023993-5	None[2]	NITS
Vault Shell Lid Guide	15	6023993-5	None[2]	NITS
Vault Shell Gusset Guide	16	6023993-5	None[2]	NITS
Vault Shell Guide Screw	17	6023993-5	None[2]	NITS
Vault Lid Base and Top Plates	18, 27	6023993-5 and FSAR Update Figure 3.2-1	SR	ITS-B
Vault Lid Center Bar	19	6023993-5 and FSAR Update Figure 3.2-1	SR	ITS-B
Vault Lid Outer Shell	20	6023993-5 and FSAR Update Figure 3.2-1	SR	ITS-B

Table 2-9 Intended Functions of ISFSI Storage Vault Subcomponents

Subcomponent	Part Number	Reference Drawing[1]	Intended Function	ITS Category
Vault Lid Rib Plate	21, 23	6023993-5 and FSAR Update Figure 3.2-1	SR	ITS-B
Vault Lid Stud Pipe	22	6023993-5	None[2]	NITS
Vault Lid Bolts	24	6023993-5 and FSAR Update Figure 3.2-1	SR	ITS-B
Vault Lid Washers	25	6023993-5	SR	ITS-B
Vault Lid Shield Block	26	6023993-5 and FSAR Update Figure 3.2-1	SH, SR	ITS-B
Vault Lid Bolt Access Port	28	6023993-5 and FSAR Update Figure 3.2-1	None[2]	NITS
Vault Lid Bolt Access Cap	29	6023993-5 and FSAR Update Figure 3.2-1	None[2]	NITS
Vault Lid Lift Lugs	30	6023993-5 and FSAR Update Figure 3.2-1	None[2]	NITS
Vault Lid View Port Tube	31	6023993-5	None[2]	NITS
Vault Lid View Port Ring	32	6023993-5	None[2]	NITS
Vault Lid View Port Cap	33	6023993-5	None[2]	NITS
Vault Lid View Port Plug	34	6023993-5	SH	ITS-B
Vault Lid Plug Lift	35	6023993-5	None[2]	NITS
Vault Lid Bolt Stud Plug	36	6023993-5 and FSAR Update Figure 3.2-1	None[2]	NITS
ISFSI Vault	N/A	FSAR Update Figure 3.2-1	SH, SR	ITS-B

Notes:

1. Drawing 6023993-5, Page 3, Revision 1 is not docketed, but is available at the HB ISFSI for NRC review.
2. None – These sub-components have no ITS intended function and their failure would not affect an ITS function, and are, therefore, screened out of the scope of LR.
3. Although design drawings list the Vault Shell Drain Ring as NITS, it is being assigned an intended function for license renewal because it is being credited for in Table A-1, Element 4.

Intended Functions: Radiation Shielding (SH), Structural Integrity (SR), Retrievability (RE)

2.4 Section 2.0 References

2.4.1 NUREG-1927, Revision 1, Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel, Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, June 2016, ADAMS Accession No. ML16179A148.

2.4.2 PG&E Letter HIL-17-005, Final Safety Analysis Report Update, Revision 6, November 8, 2017. ADAMS Accession Nos. ML17320A148 and ML17320A151 (except 2.6 figures).

2.4.3 Humboldt Bay Independent Spent Fuel Storage Installation Materials License No. SNM-2514 and Appendix, Technical Specifications.

2.4.4 Humboldt Bay Independent Spent Fuel Storage Installation Safety Evaluation Report, Docket 72-27, Materials License No. SNM-2514, November 2005, ADAMS Accession No. ML053140041.

2.4.5 Final Safety Analysis Report for the Holtec International Storage, Transport, and Repository Cask System (HI-STAR 100 Cask System), Docket 72-1008, Revision 3, Report HI-2012610, ADAMS Accession Nos. ML11285A100 and ML11285A101.

2.4.6 PG&E Letter HIL-04-007, Response to NRC Request for Additional Information for the Humboldt Bay Independent Spent Fuel Storage Installation Application (TAC No. L23683), October 1, 2004.

3.0 AGING MANAGEMENT REVIEWS

3.1 Aging Management Review Methodology

The purpose of the AMR process is to assess the in-scope SSCs determined to be within the scope of license renewal with respect to aging effects that could affect the ability of the SSC to perform its intended function during the renewed license period. The AMR process involves the following four (4) major steps:

1. Identification of in-scope subcomponents requiring aging management reviews (screening);
2. Identification of materials and environments;
3. Identification of aging effects requiring management;
4. Determination of the activities/programs required to manage the effects of aging.

Each of these steps is discussed in Sections 3.1.1 through 3.1.4. Also, the operating experience review for confirmation of the AMR process and the document sources used in the process are discussed in Sections 3.1.5 and 3.1.6.

The results of the AMR for the subcomponents of the ISFSI SSCs that are in the scope of license renewal are provided in the following sections:

- Section 3.2, Aging Management Review Results – Spent Fuel Assemblies
- Section 3.3, Aging Management Review Results – Damaged Fuel Container
- Section 3.4, Aging Management Review Results – MPC-HB
- Section 3.5, Aging Management Review Results – HI-STAR 100 HB Overpack
- Section 3.6, Aging Management Review Results – Process Waste Container
- Section 3.7, Aging Management Review Results – GTCC Waste Container
- Section 3.8, Aging Management Review Results – GTCC Overpack
- Section 3.9, Aging Management Review Results – ISFSI Storage Vault

Each section provides the results of the aging management review of SSCs, which were determined to be within the scope of license renewal as identified in Section 2.3, Scoping Results.

Subcomponents that did not undergo an aging management review are listed in Tables 2-2 through 2-9. A summary of the results of the aging management review for the subcomponents that supported an intended function is provided in corresponding AMR tables (3.2-1 through 3.9-1), at the end of Section 3.0. The AMR tables provide the following information related to each subcomponent determined to require aging management review:

(1) the intended function,
(2) material,
(3) environment,
(4) aging effect,
(5) aging mechanism, and
(6) specific aging management activity.

3.1.1 Identification of In-Scope Subcomponents Requiring Aging Management Review

Subcomponents that perform or support any one of the identified intended functions in a passive manner, without moving parts or a change in configuration or properties, are determined to require an aging management review.

Those subcomponents that either do not support an intended function, or perform an intended function by a change in configuration or properties (active), or have their condition monitored at some established frequency, are excluded from further evaluation in the aging management review with supporting justification.

Tables 2-2, 2-3, 2-4, 2-5, 2-6, 2-7, 2-8, and 2-9 identify the intended functions for the ISFSI subcomponents that require an aging management review. The tables also identify subcomponents that do not support the SSC intended function and are not subject to an aging management review.

3.1.2 Identification of Materials and Environments

The second step of the aging management review process is the identification of the materials of construction and the environments to which these materials are exposed for the ISFSI subcomponents that require an aging management review.

The materials of construction were identified through a review of pertinent design bases, which are discussed in Section 3.1.6. A summary of the materials of construction is provided in Sections 3.2.2, 3.3.2, 3.4.2, 3.5.2, 3.6.2, 3.7.2, 3.8.2, and 3.9.2 and are reflected in the corresponding aging management review summary tables (Tables 3.2-1, 3.3-1, 3.4-1, 3.5-1, 3.6-1, 3.7-1, 3.8-1, and 3.9-1). An overview of the material designations utilized in the HI-STAR 100 HB system are provided in Table 3.1-1.

Table 3.1-1 Use of Terms for Materials

Term	Usage in This Document
Carbon steels	Carbon steels for the HB ISFSI include SA350 LF3, SA350 203E, SA515-Gr. 70, SA516-Gr. 70, and SA193-Gr. B7
Concrete	A mixture of hydraulic cement, aggregates, and water with or without admixtures, fibers, or other cementitious materials (Reference 3.10.7)
Holtite-A	A Holtec neutron shielding material consisting of epoxy polymer, B_4C added as a finely divided powder, and aluminum hydroxide. It is fully encased in a metal enclosure. (Reference 3.10.7)
Metamic®	Boron-carbide aluminum metal-matrix composite for neutron poison application produced by cold isostatic pressing followed by vacuum sintering (Reference 3.10.7)
Nickel Alloys	Nickel alloys for the HB ISFSI include Inconel X750 and SB637 NO7718
Stainless steels	Stainless steels for the HB ISFSI include SA-240, Types 304 and 304L, SA193-Gr. B8, and Holtec-defined Alloy X (see Reference 3.10.1, Section 4.6.1)
Zirconium-based alloys	The materials of construction of fuel cladding and fuel assembly hardware. The cladding type for HBPP is Zircaloy-2.

The environments to which components are exposed play a critical role in the determination of potential aging mechanisms and effects. A review of plant documentation, discussed in Section 3.1.6, was performed to quantify the environmental conditions to which the ISFSI SSCs are continuously or frequently exposed. The environmental conditions identified during this review include any conditions known to exist on a recurring basis. They are based on operating experience, unless design features have been implemented to preclude those conditions from recurring. Descriptions of the internal and external environments, which have been used in the aging management review, are included in Sections 3.2.3, 3.3.3, 3.4.3, 3.5.3, 3.6.3, 3.7.3, 3.8.3, and 3.9.3, are reflected in the corresponding aging management review summary tables, and are summarized below in Table 3.1-2.

Table 3.1-2 Use of Terms for Environments

Term	Usage in This Document
Air-outdoor	This term is used for the exterior surfaces outside of the HB ISFSI vault that are exposed to all weather-related effects, including insolation, wind, rain, snow, ice, and ambient air as discussed in the Humboldt Bay ISFSI FSAR Update Table 3.4-1 and Table 4.6-1.
Embedded	The embedded environment applies for materials that are encased, embedded, or sealed inside another material. Items in this environment include intermediate shells of the HI-STAR 100 HB overpack. The embedded items are exposed to the same temperatures of the components in which they are embedded.
Enclosed Air	The enclosed air environment applies to the interior of the HI-STAR HB GTCC overpack. During cask loading, the HI-STAR HB GTCC container was placed into the overpack, and the overpack was bolted shut. No overpack drying was implemented during this bolting process. Thus, the interior environment, while isolated during the long-term storage period, is considered saline air.
Helium	The helium environment refers to the inside of the MPC-HB, HI-STAR 100 HB overpack, HI-STAR HB GTCC waste container, and HI-STAR HB process waste container, which are backfilled with inert helium gas. The environment has negligible amounts of oxygen or moisture, based on the vacuum drying process, and may contain trace quantities of nitrogen, oxygen, argon, and fission product gases. The inert environment is exposed to the range of temperatures calculated for each of the components, and significant radiation impacts to the MPC-HB and HI-STAR 100 HB overpack from the stored fuel. The GTCC waste container is exposed to significantly less radiation than the stored fuel SSCs.
Soil	This environment applies to the exterior portions of the HB ISFSI vault. The HB ISFSI vault extends down into the soil to 30.25 ft. MLLW. As described in Humboldt Bay ISFSI FSAR Update, Section 2.5.2.2, the highest groundwater level under the ISFSI is at approximately 6 ft. MLLW. As described in Humboldt Bay ISFSI FSAR Update, Section 2.5.2.2, the highest perched water level under the ISFSI was estimated to occur between 25-30 ft. MLLW. Due to the proximity to the bottom of the

Table 3.1-2 Use of Terms for Environments

Term	Usage in This Document
	ISFSI vault (at 30.25 ft. MLLW) to the perched water level, a french drain was installed approximately 6 inches below the vault structure. The french drain precludes any perched rainwater from long-term contact with the vault structure. In 2016, soil sampling was conducted in the vicinity of the HB ISFSI. The soil sample results demonstrated that the soil was non-aggressive: • pH: 5.8 – 6.3 • Sulfates: 12 ppm – 140 ppm • Chlorides: 5.8 ppm – 30 ppm
Sheltered	The sheltered environment is experienced in the enclosed HB ISFSI vault cells that are protected from weather-related effects, including insolation, wind, rain, snow, and ice. The interior of the vault would be exposed to ambient air via the vault drainage system. The ambient air is a saline air due to the proximity to the Pacific Ocean. The average ambient air annual daily temperature is 52°F (Reference 3.10.1, Table 3.2-3). Table 4.2-10 of the Humboldt Bay ISFSI FSAR Update provides the results of the vault internal temperature analysis. As discussed in the Humboldt Bay ISFSI FSAR Update, Section 3.3.1.3.2, the vault interior temperatures were monitored following loading of the HI-STAR 100 HB overpacks to validate the results of the vault temperature analysis (the temperature monitors are no longer used). The maximum internal vault temperature was 113.3°F which is well below the predicted vault temperature analysis results in the Humboldt Bay ISFSI FSAR Update, Table 4.2-10. The interior vault temperature is higher than the outside ambient temperature (based on a passive heat balance of the MPC-HB and its surroundings). As discussed in ASTM Standard C33-01 (Reference 3.10.9), weathering effects for the area in which the HB ISFSI is located are negligible. Thus, freeze-thaw is not a concern. HI-STAR 100 HB overpack subcomponents are also exposed to gamma and neutron radiation.

3.1.3 Identification of Aging Effects Requiring Management

The third step in the aging management review, process involves the identification of the aging effects requiring management. Aging effects requiring management during the renewed license period are those that could cause a loss of passive SSC intended function(s). If degradation of a subcomponent would be insufficient to cause a loss of function, or the relevant conditions do not exist at the Humboldt Bay ISFSI for the aging effect to occur and propagate, then no aging management is required.

Potential aging effects, presented in terms of material and environment combinations, have been evaluated and those aging effects requiring management have been determined. Both potential aging effects that theoretically occur, as well as aging effects that have actually occurred based upon industry ISFSI operating experience, Humboldt ISFSI operating experience, and nuclear power plant license renewal guidance, were considered. The evaluation was applied to subcomponents, regardless of form (i.e., canister body, cover, lid, guide tube, etc.).

As described above, the environments considered in this evaluation are the environments that the subcomponents normally experience. Environmental stressors that are conditions not normally experienced (such as accident conditions), or that may be caused by a design problem, are considered event-driven situations and have not been characterized as sources of long-term aging. Such event-driven situations would be evaluated and corrective actions, if any, implemented at the time of the event.

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 application. Therefore, the aging management review process identifies both the aging effects and the associated aging mechanisms which cause them. Various mechanisms are only applicable at certain conditions, such as high temperature or moisture, for example. Each identified mechanism was characterized by a set of applicable conditions that must be met for the mechanism to occur and/or propagate. Given this evaluation process, each subcomponent that was subjected to aging management review was evaluated to determine if the potential aging effects/mechanisms were credible considering the material, environment, and conditions of storage.

3.1.4 Determination of the Activities Required to Manage the Effects of Aging

The final step in the AMR process involves the determination of the aging management activities or the aging management program to be credited or developed for managing the aging effects/mechanisms. The existing ISFSI surveillance programs were evaluated and supplemented as necessary for the management of aging effects/mechanisms that could cause a loss of component intended function during the PEO.

There are no aging effects/mechanisms requiring management during the period of extended operation for the SFA, damaged fuel container, MPC, process waste container, or GTCC waste container subcomponents as indicated in Sections 3.2, 3.3, 3.4, 3.6, and 3.7 and the corresponding AMR summary tables (Tables 3.2-1, 3.3-1, 3.4-1, 3.6-1, and 3.7-1, respectively). The aging management program for the HI-STAR 100 HB overpack, HI-STAR HB GTCC overpack, and ISFSI storage vault are described in Sections 3.5, 3.8, and 3.9, respectively, and are listed in the corresponding AMR summary tables (Tables 3.5-1, 3.8-1, and 3.9-1, respectively).

The effectiveness of the aging management programs that were selected for the subcomponents is demonstrated as discussed in Appendix A, Aging Management Programs.

3.1.5 Operating Experience Review for Process Confirmation

As described in Section 3.1.3, Identification of Aging Effects Requiring Management, potential aging effects and mechanisms were evaluated based on industry ISFSI and plant operating experience, as well as various references relating specific materials and environments to aging effects and mechanisms. The evaluations were based on the premise that similar materials in similar environments experience similar aging effects.

The operating experience evaluations were primarily conducted to identify any aging effects and mechanisms not previously identified in the aging effects evaluation.

Based on the guidance in NUREG-1927, Section 3.4.1.2, PG&E performed a pre-application inspection of the ISFSI storage vaults, HI-STAR HB overpacks, and HI-STAR HB GTCC overpack. All inspections, analyses, and maintenance activities were performed with acceptable results. A copy of the HB ISFSI Pre-Application Inspection Report is provided in Appendix E.

The following inspections are conducted for current ISFSI operations. The inspection results were reviewed and a discussion of HB ISFSI operating experience, as it pertains to the effectiveness of the HB ISFSI aging management programs credited with the management of aging, is contained in Appendix A.

- Vault drainage system inspection
- Vault lid caulking inspection
- External vault concrete inspections
- Radiation surveys

3.1.6 Documentation Sources Used for the Aging Management Review Process

The Humboldt Bay ISFSI FSAR Update (Reference 3.10.1) was the primary source for determination of the materials and environmental conditions for SSCs identified as in-scope for license renewal:

Other plant documents such as drawings, technical reports, vendor manuals, and procedures were consulted, as appropriate, to further clarify materials and environmental conditions.

Lastly, the following industry topical reports, reference books, and standards were consulted as appropriate for description and evaluation of aging effects/mechanisms as discussed in Section 3.1.3.

- Draft MAPS Report (Reference 3.10.7)
- NUREG-1801, Generic Aging Lessons Learned (Reference 3.10.8)
- EPRI Structural Tools (Reference 3.10.3)
- EPRI Mechanical Tools (Reference 3.10.6)

3.2 Aging Management Review Results – Spent Fuel Assemblies

This section provides the results of the aging management review of spent fuel assemblies, which were determined to be within the scope of license renewal as identified in Section 2.3, Scoping Results.

SFA subcomponents that did not undergo an aging management review are listed in Table 2-2. A summary of the results of the aging management review for the SFA subcomponents that supported an intended function is provided in Table 3.2-1.

A description of the SFA subcomponents which support an SSC intended function is provided in Section 3.2.1, and a summary of the materials and environments for the SFAs is provided in Section 3.2.2 and 3.2.3, respectively. Section 3.2.4 references the aging effects requiring management and any aging management activities used to manage the effects of aging. Section 3.2.5 provides an AMR conclusion.

3.2.1 Description of the Spent Fuel Assemblies

As discussed in HB ISFSI FSAR Update, Section 3.1.1.1, the SFAs stored consist of General Electric Type II (a 7 x 7 array of fuel rods), General Electric Type III, Exxon Type III, and Exxon Type IV (a 6 x 6 array of fuel rods) fuel assemblies. The main support structure for an assembly consists of fuel rods used as tie rods between upper and lower tie plates. All assemblies use three spacer grids attached to a single spacer capture rod to maintain fuel rod spacing. The licensing basis fuel cladding material for all assemblies is zirconium-based alloy. Fuel records indicate that all HBPP fuel cladding material for intact and damaged assemblies is Zircaloy-2. Channels are fabricated from Zircaloy material. The stored loose fuel debris may have either Zircaloy cladding, stainless steel cladding, or may be unclad pellets.

No HBU fuel (i.e., fuel with burnups generally exceeding 45 GWd/MTU) is stored in the MPC-HBs.

3.2.2 Materials Evaluated (Spent Fuel Assemblies)

The materials of construction for the SFA subcomponents that are subject to AMR are zirconium-based alloy (zircaloy) and stainless steel. Materials were identified from plant drawings referenced in Table 2-2. The material group of individual SFA subcomponents is identified in Table 3.2-1.

3.2.3 Environments (Spent Fuel Assemblies)

The environments that affect the SFA subcomponents, both externally and internally, are those that are normally experienced and are described below:

<u>External</u>

The external environment seen by the SFAs is the same internal environment of the MPC-HB. The helium back-fill gas is the identified as the inert gas environment used in the AMR.

Following initial cask loading, the maximum fuel cladding temperature was calculated to be 373°F for fuel in a HI-STAR 100 HB cask under normal conditions of storage (Reference 3.10.1, Table 4.2-10) and 411°F under accident conditions (Reference 3.10.1, Table 8.2-14). Fuel cladding temperature will then decrease over time while in storage.

<u>Internal</u>

The intact fuel cladding is the only SFA subcomponent that has an internal environment. The fuel rods were initially 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.

3.2.4 Aging Effects Requiring Management and Aging Management Activities (Spent Fuel Assemblies)

This section identifies the possible aging effects/mechanisms of storage on SFAs and the bases for concluding that there are no aging effects/mechanisms that require management. Relevant EPRI and NRC documents were used to identify the possible aging effects/mechanisms. Each line item in Table 3.2-1 is consistent with the applicable line items in Draft MAPS Report (Reference 3.10.7), Table 4-25.

The HB ISFSI does not store any HBU fuel, and therefore the cladding is not susceptible to hydrogen embrittlement and radial hydride formation aging mechanisms, as discussed in NRC ISG-11.

Consistent with the Draft MAPS Report (Reference 3.10.7), the following aging effects and mechanisms related to the SFAs were determined non-credible for the HB ISFSI:

- Loss of load bearing capacity due to oxidation – see Reference 3.10.7, Section 3.6.1.6
- Loss of material due to pitting, galvanic, or general corrosion – see Reference 3.10.7, Sections 3.6.1.7, 3.6.1.8, and 3.6.2.3
- Cracking due to stress corrosion cracking, delayed hydride cracking, fatigue, or mechanical overload – see Reference 3.10.7, Sections 3.6.1.9, 3.6.1.2, 3.6.1.11, 3.6.1.5, 3.6.2.4
- Loss of ductility due to hydride-induced embrittlement – see Reference 3.10.7, Section 3.6.1.1
- Changes in dimensions due to thermal creep since the HB ISFSI does not store HBU fuel – see Reference 3.10.7, Section 3.6.1.3
- Changes in dimensions due to low-temperature creep – see Reference 3.10.7, Section 3.6.1.4
- Loss of strength due to radiation embrittlement – see Reference 3.10.7, Section 3.6.1.10
- Changes in dimensions due to creep or hydriding – see Reference 3.10.7, Sections 3.6.2.1 and 3.6.2.2

The AMR results for the SFA subcomponents are listed in Table 3.2-1. Based on the aging management review of the SFA materials and the environments experienced during long-term storage, there are no aging effects requiring management, and thus, no aging management activities designated.

3.2.5 AMR Conclusion (Spent Fuel Assemblies)

There are no aging effects/mechanisms requiring management during the period of extended operation for the SFAs subcomponents. Therefore, the intended function(s) of the SFAs will be maintained for the period of extended operation.

3.3 Aging Management Review Results – Damaged Fuel Container

This section provides the results of the aging management review of DFC subcomponents, which were determined to be within the scope of license renewal as identified in Section 2.3, Scoping Results.

DFC subcomponents that did not undergo an aging management review are listed in Table 2-3. A summary of the results of the aging management review for the DFC subcomponents that supported an intended function is provided in Table 3.3-1.

A description of the DFC subcomponents which support an SSC intended function is provided in Section 3.3.1, and a summary of the materials and environments for the DFC is provided in Section 3.3.2 and 3.3.3, respectively. Section 3.3.4 references the aging effects requiring management and any aging management activities used to manage the effects of aging. Section 3.3.5 provides an AMR conclusion.

3.3.1 Description of the Damaged Fuel Container

The DFC is used to contain fuel assemblies classified as damaged fuel as described in Section 10.2 of the Humboldt Bay ISFSI FSAR Update (Reference 3.10.1). At PG&E's discretion, intact fuel assemblies were also stored in DFCs.

The DFC is a long, square, stainless steel container with screened openings at the top and bottom. The DFC design includes an appropriate lifting attachment at the top to allow it to be handled with a hoist. Each DFC is inserted into a designated storage cell within the MPC, as specified in the Humboldt Bay ISFSI FSAR Update, Section 10.2.

The function of the DFC is to retain the damaged fuel in its storage cell and provide the means for removal of the damaged fuel if needed. The DFC permits gaseous and liquid media to escape into the interior of the MPC, but minimizes dispersal of gross particulates during all design basis conditions of storage, including accident conditions. The total quantity of fuel-related material permitted in a single DFC is limited to the equivalent weight and special nuclear material quantity of one intact fuel assembly. Humboldt Bay ISFSI FSAR Update Figure 4.2-3 shows the general arrangement and pertinent design details for the DFC.

3.3.2 Materials Evaluated (Damaged Fuel Container)

The DFC subcomponents in the scope of the license renewal are constructed of stainless steel. Materials for the DFC subcomponents are provided in Table 3.3-1.

3.3.3 Environments (Damaged Fuel Container)

The DFC is contained within a storage cell within the MPC which is sealed, dried, and backfilled with helium prior to entering storage. Therefore, both the internal and external DFC subcomponents are maintained in a very low moisture, inert gas environment. The temperature range varies from the highest value at the maximum canister heat load to the minimum calculated air temperature as the heat load reduces over time. DFC subcomponents are also exposed to significant gamma and neutron radiation.

3.3.4 Aging Effects Requiring Management and Aging Management Activities (Damaged Fuel Container)

Each line item in Table 3.3-1 is consistent with the applicable line item for “damaged fuel container” in Draft MAPS Report (Reference 3.10.7), Table 4-7.

Consistent with the Draft MAPS Report (Reference 3.10.7), the following aging effects and mechanisms related to the DFC were determined non-credible for the HB ISFSI:

- Change in dimensions due to creep for stainless steels exposed to helium – see Reference 3.10.7, Section 3.2.2.6
- Cracking due to radiation embrittlement for stainless steels exposed to helium – Reference 3.10.7, Section 3.2.2.9

The AMR results for the DFC subcomponents are listed in Table 3.3-1. Based on the aging management review of the DFC materials and the environments experienced during long-term storage, the applicable aging effect and mechanisms are:

- Cracking of stainless steel SSCs due to fatigue

Based on the aging management review of the DFC during long-term storage, it has been determined that an evaluation is required for cracking of stainless steel SSCs due to fatigue effects during the PEO (see Section 4.5).

3.3.5 AMR Conclusion (Damaged Fuel Container)

As discussed in Section 4, the applicable aging effects/mechanisms have been demonstrated to be acceptable for the PEO. Therefore, the intended function(s) of the DFC will be maintained for the PEO.

3.4 Aging Management Review Results – MPC-HB

This section provides the results of the aging management review of MPC-HB subcomponents, which were determined to be within the scope of license renewal as identified in Section 2.3, Scoping Results.

MPC-HB subcomponents that did not undergo an aging management review are listed in Table 2-4. A summary of the results of the aging management review for the MPC-HB subcomponents that supported an intended function is provided in Table 3.4-1. A description of the MPC-HB subcomponents which support an SSC intended function is provided in Section 3.4.1, and a summary of the materials and environments for the MPC-HB is provided in Section 3.4.2 and 3.4.3, respectively. Section 3.4.4 references the aging effects requiring management and any aging management activities used to manage the effects of aging. Section 3.4.5 provides an AMR conclusion.

3.4.1 Description of the MPC-HB

The MPC-HB enclosure vessel is a welded cylindrical structure with flat ends that provides confinement of the spent nuclear fuel during storage operations (see Humboldt Bay FSAR Update Figure 3.3-1). The confinement boundary, comprised of a baseplate, shell, lid, port cover plates, and a closure ring, is constructed entirely of stainless steel. The MPC-HB lid is a circular plate edge-welded to the MPC-HB shell. Access to the MPC-HB cavity for the purposes of moisture/air removal and subsequent backfilling with a specified amount of inert gas (helium) is achieved via two penetrations (i.e., vent and drain ports) in the MPC-HB lid. Circular cover plates are seal welded over the vent and drain ports, completing the primary closure system. A circular closure ring is welded to the MPC-HB shell and lid, providing a redundant closure system at the top end of the MPC-HB. Lifting lugs attached to the inside surface of the enclosure vessel serve to permit lifting and placement of the empty MPC-HB into the overpack. The lifting lugs also serve to axially locate the lid prior to welding. These internal lifting lugs are not used to handle a loaded MPC-HB. Since the MPC-HB lid is installed prior to any handling of the loaded MPC-HB, there is no access to the lifting lugs once the MPC-HB is loaded. The MPC-HB lid is sufficiently rigid to permit the entire MPC-HB loaded with spent nuclear fuel to be lifted via threaded holes in the top of the lid.

MPC-HB Fuel Basket

Within each MPC enclosure vessel is a honeycombed fuel basket responsible for maintaining the spent nuclear fuel in a subcritical condition. The HI-STAR 100 HB fuel baskets are formed from an array of Alloy X stainless steel plates welded to each other such that the final assembly resembles a multi-flanged, closed-section beam (see Humboldt Bay ISFSI FSAR Update, Figure 3.3-2). The location of neutron absorber panels against the walls of the fuel storage cells is fixed via enveloping stainless steel sheathings stitch welded to the basket panels.

The fuel basket is positioned within the enclosure vessel by "basket support plates" located in the space between the inside of the shell and the basket. Fuel spacers attached to the MPC lid, are utilized to maintain the axial position of the fuel assembly within the MPC-HB basket.

3.4.2 Materials Evaluated (MPC-HB)

With the exception of the neutron absorbers which are constructed of Metamic®, all other MPC-HB subcomponents in the scope of the license renewal are constructed of Alloy X stainless steel. Materials for the MPC-HB subcomponents are provided in Table 3.4-1.

3.4.3 Environments (MPC-HB)

Because the MPC-HB and the HI-STAR 100 HB overpack cavities are both sealed, dried, and backfilled with helium prior to entering storage, both the internal and external MPC-HB subcomponents are maintained in a very low moisture, inert gas environment. The temperature range varies from the highest value at the maximum canister heat load to the minimum calculated air temperature as the heat load reduces over time. MPC-HB subcomponents are also exposed to significant gamma and neutron radiation.

3.4.4 Aging Effects Requiring Management and Aging Management Activities (MPC-HB)

Each line item in Table 3.4-1 is consistent with the applicable line items in Draft MAPS Report (Reference 3.10.7), Table 4-7 supplemented by Draft MAPS Report (Reference 3.10.7), Table 3-2. Because Draft MAPS Report, Table 4-7 was prepared for the standard HI-STAR and HI-STORM MPCs and not the MPC-HB, material/environment combinations did not always align. Those combinations that did not align were not included in the LRA. To determine the aging effects/mechanisms for those materials/environment combinations that were not in Draft MAPS Report, Table 4-7, Table 3-2, an overall summary table for all system types, was used.

Consistent with the Draft MAPS Report (Reference 3.10.7), the following aging effects and mechanisms related to the MPC-HB were determined non-credible for the HB ISFSI:

- Change in dimensions due to creep for stainless steels exposed to helium – see Reference 3.10.7, Section 3.2.2.6
- Loss of material due to general corrosion for Metamic exposed to helium – see Reference 3.10.7, Section 3.4.2.1
- Change in dimensions due to creep for Metamic exposed to helium – see Reference 3.10.7, Section 3.4.2.5
- Loss of strength due to thermal aging for Metamic exposed to helium – see Reference 3.10.7, Section 3.4.2.6

- Cracking due to radiation embrittlement for stainless steels exposed to helium – Reference 3.10.7, Section 3.2.2.9
- Loss of fracture toughness and loss of ductility due to radiation embrittlement for Metamic exposed to helium – Reference 3.10.7, Section 3.4.2.7

Based on the aging management review of the MPC-HB materials and the environments experienced during long-term storage, the applicable aging effects and mechanisms are:

- Loss of criticality control of the neutron absorber due to boron depletion
- Cracking of stainless steel SSCs due to fatigue

Based on the aging management review of the MPC-HB during long-term storage, it has been determined that a TLAA is required for boron depletion of the neutron absorber (see Section 4.4.1) and evaluation is required for cracking due to fatigue during the PEO (see Section 4.5).

3.4.5 AMR Conclusion (MPC-HB)

As discussed in Section 4, the applicable aging effects/mechanisms have been demonstrated to be acceptable for the PEO. Therefore, the intended function(s) of the MPC-HB will be maintained for the period of extended operation.

3.5 Aging Management Review Results – HI-STAR 100 HB Overpack

This section provides the results of the aging management review of HI-STAR 100 HB overpack subcomponents, which were determined to be within the scope of license renewal as identified in Section 2.3, Scoping Results.

HI-STAR 100 HB overpack subcomponents that did not undergo an aging management review are listed in Table 2-5. A summary of the results of the aging management review for the HI-STAR 100 HB overpack subcomponents that supported an intended function is provided in Table 3.5-1. A description of the HI-STAR 100 HB overpack subcomponents which support an SSC intended function is provided in Section 3.5.1, and a summary of the materials and environments for the HI-STAR 100 HB overpack is provided in Section 3.5.2 and 3.5.3, respectively. Section 3.5.4 references the aging effects requiring management and any aging management activities used to manage the effects of aging. Section 3.5.5 provides an AMR conclusion.

3.5.1 Description of the HI-STAR 100 HB Overpack

The HI-STAR 100 HB overpack is a canister-based system designed to store boiling water reactor spent fuel in a dry configuration at the Humboldt Bay ISFSI. The HI-STAR 100 HB overpack is a shortened version of the HI-STAR 100 cask, which is certified under 10 CFR 72, Subpart L, for use by 10 CFR 50 license holders under the general license provisions of 10 CFR 72.

The HI-STAR 100 HB overpack is a heavy-walled steel cylindrical vessel that provides the helium retention boundary during storage operations. The helium retention boundary is comprised of the overpack inner shell welded to a cylindrical forging at its bottom and a heavy flange with a bolted closure plate at its top. The closure plate is equipped with two concentric grooves for self-energizing seals. Access to the overpack's internal cavity for the purposes of moisture/air removal and subsequent backfilling with a specified amount of inert gas (helium) is achieved via a vent port in the closure plate and a drain port in the bottom forging. Both ports are sealed by threaded port plugs with seals.

Intermediate shells installed against the outer surface of the inner shell (i.e., helium retention boundary) provide additional structural strength to resist puncture or penetration, as well as provide gamma shielding from the spent fuel contained within. Radial plates welded to the outermost intermediate shell create vertical cavities for retaining and protecting neutron shielding material. To relieve internal pressure that could develop in the neutron shielding cavities, rupture disks are installed atop the outer enclosure shell.

Lifting and rotating the loaded/unloaded overpack between the vertical and horizontal orientations is achieved via a pair of trunnions attached to the heavy top flange.

3.5.2 Materials Evaluated (HI-STAR 100 HB Overpack)

The majority of the HI-STAR 100 HB overpack is constructed of carbon steel. As discussed in the Humboldt Bay ISFSI FSAR Update, Section 4.6.3, the internal and external carbon steel surfaces of the overpack are coated to minimize any chemical reactions with the SFP water during loading operations and to preclude surface oxidation of the steel during long term storage. Threaded holes, lifting trunnions, and stainless steel sealing surfaces are not coated. The coating materials are Thermaline 450 for the inner overpack surfaces and Carboline 890 for the outer surfaces as are licensed for the HI-STAR 100 overpack. As discussed in the Humboldt Bay ISFSI FSAR Update, Section 4.4.3.8, the HI-STAR 100 HB overpack is coated with a paint that would allow for substantial resistance to corrosion even when exposed to water.

Other materials included in the construction are Holtite for the purposes of neutron shielding and non-ferrous alloys for lifting appurtenances and seals. Materials for the HI-STAR 100 HB overpack subcomponents are provided in Table 3.5-1.

3.5.3 Environments (HI-STAR 100 HB Overpack)

During fuel loading operations, the exterior surface of the overpack is exposed to water, while the annulus between the MPC-HB and the inner cavity wall of the overpack is exposed to demineralized water. Prior to entering storage, the annulus water is purged and the overpack cavity is sealed, dried, and backfilled with helium creating a very low moisture, inert gas environment for the inner surface of the overpack helium-retention boundary. The inert gas environment used in Table 3.5-1 is the helium back fill gas. Intermediate overpack components such as the intermediate shells or the inner surfaces of the radial channels and enclosure shell panels are considered to be in embedded/encased environments where potential chemical reactions between adjacent materials are the primary concerns.

The outer surfaces of the overpack, including the enclosure shell, bottom forging, top flange, and closure plate, are enclosed in a vault that is protected from weather-related effects, including insolation, wind, rain, snow, and ice. The exterior of the overpack would be exposed to ambient air via the vault drainage system. The ambient air is a saline air due to the proximity to the Pacific Ocean. The average ambient air annual daily temperature is 52°F (Reference 3.10.1, Table 3.2-3). Table 4.2-10 of the Humboldt Bay ISFSI FSAR Update provides the results of the vault internal temperature analysis. As discussed in the Humboldt Bay ISFSI FSAR Update, Section 3.3.1.3.2, the vault interior temperatures were monitored following loading of the HI-STAR 100 HB overpacks to validate the results of the vault temperature analysis. The maximum internal vault temperature was 113.3°F which is well below the predicted vault temperature analysis results in the Humboldt Bay ISFSI FSAR Update Table 4.2-10. The interior vault temperature is higher than the outside ambient temperature (based on a passive heat balance of the MPC-HB and its surroundings). In Table 3.5-1, the external overpack environment is designated as "Sheltered."

HI-STAR 100 HB overpack subcomponents are also exposed to gamma and neutron radiation.

3.5.4 Aging Effects Requiring Management and Aging Management Activities (HI-STAR 100 HB Overpack)

Unless annotated by a table note, each line item in Table 3.5-1 is consistent with the applicable line items in Draft MAPS Report (Reference 3.10.7), Table 4-9 supplemented by Draft MAPS Report, Table 3-2. Because Draft MAPS Report, Table 4-9 was prepared for the standard HI-STAR 100 overpack and not the HB overpack configuration, material/environment combinations did not always align. Those combinations that did not align were not included in the LRA. To determine the aging effects/mechanisms for those materials/environment combinations that were not in Draft MAPS Report, Table 4-9, Table 3-2, an overall summary table for all system types, was used.

Consistent with the Draft MAPS Report (Reference 3.10.7), the following aging effects and mechanisms related to the HI-STAR 100 HB overpack were determined non-credible for the HB ISFSI:

- Loss of material due to microbiologically influenced corrosion for carbon steel or stainless steel exposed to a sheltered environment – see Reference 3.10.7, Section 3.2.1.4 and 3.2.2.4
- Cracking due to radiation embrittlement for carbon and stainless steels exposed to helium, sheltered, or embedded environments – Reference 3.10.7, Sections 3.2.1.9 and 3.2.2.9

This section describes the aging effects/mechanisms that could, if left unmanaged, cause degradation of the HI-STAR 100 HB overpack subcomponents and result in loss of intended function(s) during the period of extended operation. The AMR results for individual HI-STAR 100 HB overpack subcomponents are listed in Table 3.5-1. Based on the material and environment combinations, and consideration of the conditions during the period of extended operation, the following aging effects and associated mechanism(s) were determined applicable:

- Cracking due to fatigue
- Cracking due to radiation embrittlement
- Loss of material due to crevice corrosion
- Loss of material due to galvanic corrosion
- Loss of material due to general corrosion
- Loss of material due to pitting corrosion
- Loss of fracture toughness and loss of ductility due to thermal aging
- Loss of preload due to stress relaxation
- Loss of shielding due to boron depletion

Based on the aging management review of the HI-STAR HB overpack during long-term storage, it has been determined that an AMP (see Appendix A) is required, as well as TLAAs for the effects of loss of shielding due to Boron depletion (see Section 4.4.1) and cracking due to fatigue of the HI-STAR HB overpack closure bolts and threads (see Section 4.4.2). Evaluations for the effects of cracking due to fatigue are provided in Section 4.5.

3.5.4.1 Closure Plate Outer Seals

As discussed in the HI-STAR 100 FSAR Update, Section 9.2.2 (Reference 3.10.2), metallic (nickel alloy) seals are used on the overpack helium retention boundary to ensure the retention of the helium in the overpack. These seals are not temperature sensitive within the design temperature range, are resistant to corrosion up to 1300ºF (Reference 3.10.10) and radiation environments, and are helium leak tested after fuel loading. There are no credible normal, off-normal, or accident events which can cause the failure of the overpack helium retention boundary seals.

For the unlikely scenario where the overpack helium retention boundary seals fail, an evaluation was completed of no helium remaining in the overpack. The results of the analysis show that the temperatures and pressures of the fuel cladding, MPC-HB, overpack, and vault concrete remain below the normal, off-normal, and accident temperature and pressure limits as defined in HB ISFSI FSAR Update, Tables 4.2-10 and 8.2-14. Further, if no helium remained in the overpack, the long-term environment would more closely resemble an “enclosed air environment” (see Table 3.1-2). While potential loss of material from pitting and crevice corrosion are identified as credible for metallic surfaces that are exposed to enclosed air, no specific inspections are required during the period of extended operation based on the similarity of the enclosed air environment and an embedded environment. Reference 3.10.7 (Section 3.2.2.2) states “because of limited water and oxygen, stainless steel is also not susceptible to pitting and crevice corrosion in embedded environments. As such, pitting and crevice corrosion of stainless steel exposed to… embedded environments are not considered to be credible, and therefore, aging management is not required during the 60-year timeframe.” Although the enclosed air environment initially contains more moisture and oxygen, similar to an embedded environment as discussed in Reference 3.10.7, the enclosed air environment that may be created if there is no helium remaining inside the overpacks does not allow for the opportunity to introduce additional water or oxygen to the environment after initial cask bolting. Thus, the same logic presented in Reference 3.10.7 applies to the enclosed air environment and no aging management is necessary for the period of extended operation. Therefore, no leakage tests are required as part of the long-term storage period.

3.5.4.2 Port Cover Bolting

While potential aging effects/mechanisms were identified for the HI-STAR 100 HB overpack closure plate bolting for loss of preload, no specific bolting inspections are required during the period of extended operation based on:

- lack of thermal fluctuations in the ISFSI storage vault,
- lack of Holtec operating experience for loose bolts, and
- results of the Humboldt Bay ISFSI pre-application inspection.

3.5.4.3 Neutron Shielding

Although the potential for loss of fracture toughness and loss of ductility due to thermal aging was identified for the neutron shielding (Holtite) in the overpack, this will not be directly monitored during the PEO. As discussed in Reference 3.10.7 (Section 3.3.1.2), thermal aging is a credible aging mechanism because “shrinkage and embrittlement can locally displace shielding material and potentially diminish shielding effectiveness.” Thus, the resulting effects from shrinkage and embrittlement are potentially cracking and loss of shielding. Cracking will be addressed by radiation monitoring as described in Appendix A, Table A-2. Loss of shielding is addressed in Section 4.

3.5.5 AMR Conclusion (HI-STAR 100 HB Overpack)

The HB ISFSI Aging Management Programs described in Appendix A and TLAA evaluations in Section 4 provide reasonable assurance that the HI-STAR 100 HB overpack aging effects/mechanisms will be managed effectively such that it will continue to perform its intended function during the period of extended operation.

3.6 Aging Management Review Results – HI-STAR HB Process Waste Container

This section provides the results of the aging management review of the HI-STAR HB PWC, which was determined to be within the scope of license renewal as identified in Section 2.3, Scoping Results.

HI-STAR HB PWC subcomponents that did not undergo an aging management review are listed in Table 2-6. A summary of the results of the aging management review for the HI-STAR HB PWC subcomponents that supported an intended function is provided in Table 3.6-1. A description of the HI-STAR HB PWC subcomponents which support an SSC intended function is provided in Section 3.6.1, and a summary of the materials and environments for the HI-STAR HB PWC is provided in Section 3.6.2 and 3.6.3, respectively. Section 3.6.4 references the aging effects requiring management and any aging management activities used to manage the effects of aging. Section 3.6.5 provides an AMR conclusion.

3.6.1 Description of HI-STAR HB PWC

The process waste is contained in a PWC, shown on Humboldt Bay ISFSI FSAR Update Figure 3.3-5. The HI-STAR HB PWC is a stainless steel, cylindrical container, approximately 12 inches in diameter and 24 inches high and is mechanically sealed, vacuum dried, backfilled with helium and leak tested. The process waste was dried to ensure thermal destruction of all organics or hydrogen generating materials before being converted to a dry powder. The HI-STAR HB PWC was placed inside the HI-STAR HB GWC into a lidded outer container that is welded onto the bottom of the GWC. The outer container is designed to provide stabilization for the PWC and prevents co-mingling between the process waste and activated components. After loading was complete, the HI-STAR HB GWC was drained, backfilled with helium and sealed. The HI-STAR HB GWC was placed in a HI-STAR HB GTCC overpack and bolted shut.

3.6.2 Materials Evaluated (HI-STAR HB PWC)

Material details for the HI-STAR HB PWC subcomponents are provided in Table 3.6-1.

3.6.3 Environments (HI-STAR HB PWC)

The HI-STAR HB PWC is contained within the HI-STAR HB GWC. The internal environment of the HI-STAR HB PWC was sealed, dried, and backfilled with helium prior to entering storage. The internal environment of the HI-STAR HB GWC (external environment of the PWC) is a very low moisture, inert gas environment. The temperature range is the minimum calculated air temperature as there is no heat load with GTCC.

3.6.4 Aging Effects Requiring Management and Aging Management Activities (HI-STAR HB PWC)

The Draft MAPS Report (Reference 3.10.7) did not include a specific evaluation of a PWC-type component. Thus, aging effects and mechanisms associated with the PWC were determined by review of the Draft MAPS Report, Table 3-2, which is a summary table for all system types. Each line item in Table 3.6-1 is consistent with the applicable material/environment combination in Draft MAPS Report, Table 3-2.

Consistent with the Draft MAPS Report (Reference 3.10.7), the following aging effects and mechanisms related to the HI-STAR HB PWC were determined non-credible for the HB ISFSI:

- Change in dimensions due to creep for stainless steels exposed to helium – see Reference 3.10.7, Section 3.2.2.6
- Cracking due to radiation embrittlement for stainless steels exposed to helium – Reference 3.10.7, Section 3.2.2.9

The AMR results for the PWC subcomponents are listed in Table 3.6-1. Based on the aging management review of the HI-STAR HB PWC materials and the environments experienced during long-term storage, the applicable aging effect and mechanisms are:

- Cracking of stainless steel SSCs due to fatigue

Based on the aging management review of the HI-STAR HB PWC in long-term storage, it has been determined that an evaluation is required for cracking of stainless steel SSCs due to fatigue effects during the PEO (see Section 4.5).

3.6.5 AMR Conclusion (HI-STAR HB PWC)

As discussed in Section 4, the applicable aging effects/mechanisms have been demonstrated to be acceptable for the PEO. Therefore, the intended function(s) of the PWC will be maintained for the PEO.

3.7 Aging Management Review Results – HI-STAR HB GTCC Waste Container

This section provides the results of the aging management review of the HI-STAR HB GWC, which was determined to be within the scope of license renewal as identified in Section 2.3, Scoping Results.

HI-STAR HB GWC subcomponents that did not undergo an aging management review are listed in Table 2-7. A summary of the results of the aging management review for the HI-STAR HB GWC subcomponents that supported an intended function is provided in Table 3.7-1. A description of the HI-STAR HB GWC subcomponents which support an SSC intended function is provided in Section 3.7.1, and a summary of the materials and environments for the HI-STAR HB GWC is provided in Section 3.7.2 and 3.7.3, respectively. Section 3.7.4 references the aging effects requiring management and any aging management activities used to manage the effects of aging. Section 3.7.5 provides an AMR conclusion.

3.7.1 Description of HI-STAR HB GWC

Neutron activated components and process waste materials are stored in the GWC. The process waste material was generated during cleanup of the spent fuel pool. The material consists of distributed and particulate SNM waste mixed with resins, metallic oxides, and small Stellite particles. The neutron activated components include portions of the segmented reactor internals: upper core guide, upper core shroud, and chimney hanger assembly.

The HI-STAR HB GWC is shown in the Humboldt Bay ISFSI FSAR Update Figure 3.3-4. The GWC is a container with a welded lid, similar to the MPC-HB within a HI-STAR 100 HB overpack. As discussed in Section 3.6.1, the GWC also includes an outer container with a lid that houses the PWC and is welded to the bottom of the GWC. The outer container is designed to provide stabilization for the PWC and prevents co-mingling between the process waste and activated components.

3.7.2 Materials Evaluated (HI-STAR HB GWC)

All HI-STAR HB GWC subcomponents in the scope of the license renewal are constructed of stainless steel. Materials for the HI-STAR HB GWC subcomponents are provided in Table 3.7-1.

3.7.3 Environments (HI-STAR HB GWC)

The HI-STAR HB GWC is contained within the HI-STAR HB GTCC overpack. Because the HI-STAR HB GWC cavity was sealed, dried, and backfilled with helium prior to entering storage, the internal HI-STAR HB GWC subcomponents are maintained in a very low moisture, inert gas environment. The temperature is minimum ambient air temperature as there is no heat load with GTCC.

The external HI-STAR HB GWC subcomponents are exposed to the internal HI-STAR HB GTCC overpack environment, which is ambient air (see environment "Enclosed Air" in Table 3.1.2).

3.7.4 Aging Effects Requiring Management and Aging Management Activities (HI-STAR HB GWC)

Unless annotated by a table note, each line item in Table 3.7-1 is consistent with the applicable line items in Draft MAPS Report (Reference 3.10.7), Table 4-7 supplemented by Draft MAPS Report, Table 3-2. Because Draft MAPS Report, Table 4-7 was prepared for the standard HI-STAR and HI-STORM MPCs and not the MPC-HB or HB GWC, material/environment combinations did not always align. Those combinations that did not align were not included in the LRA. To determine the aging effects/mechanisms for those materials/environment combinations that were not in Draft MAPS Report, Table 4-7, Table 3-2, an overall summary table for all system types, was used. Because the environment of "Enclosed Air" was not in the Draft MAPS Report, when determining potential aging effects, the "Sheltered" environment was used.

Consistent with the Draft MAPS Report (Reference 3.10.7), the following aging effects and mechanisms related to the HI-STAR HB GWC were determined non-credible for the HB ISFSI:

- Change in dimensions due to creep for stainless steels exposed to helium – see Reference 3.10.7, Section 3.2.2.6
- Cracking due to radiation embrittlement for stainless steels exposed to helium or enclosed air – Reference 3.10.7, Section 3.2.2.9

The AMR results for the HI-STAR HB GWC subcomponents are listed in Table 3.7-1. Based on the material and environment combinations, and consideration of the conditions during the period of extended operation, the following aging effects and associated mechanism(s) were determined applicable:

- Cracking due to fatigue
- Loss of material due to crevice corrosion
- Loss of material due to pitting corrosion

Based on the aging management review of the HI-STAR HB GWC during long-term storage, it has been determined that an evaluation is required for the effects of cracking due to fatigue (see Section 4.5).

3.7.4.1 External Surfaces Exposed to Enclosed Air

While potential loss of material from pitting and crevice corrosion were identified for the HI-STAR HB GWC external surfaces that are exposed to enclosed air within the HI-STAR HB GTCC overpack, no specific inspections are required during the period of extended operation based on the similarity of the enclosed air environment and an embedded environment. Reference 3.10.7 (Section 3.2.2.2) states "because of limited water and oxygen, stainless steel is also not susceptible to pitting and crevice corrosion in embedded environments. As such, pitting and crevice corrosion of stainless steel exposed to… embedded environments are not considered to be credible, and therefore, aging management is not required during the 60-year timeframe." Although the enclosed air environment initially contains more moisture and oxygen, similar to an embedded environment as discussed in Reference 3.10.7, the enclosed air environment at the HB ISFSI (created by bolted casks, not backfilled with helium) does not allow for the opportunity to introduce additional water or oxygen to the environment after initial cask bolting. Thus, the same logic presented in Reference 3.10.7 applies to the enclosed air environment and no aging management is necessary for the period of extended operations.

3.7.5 AMR Conclusion (HI-STAR HB GWC)

As discussed in Section 4, the applicable aging effects/mechanisms have been demonstrated to be acceptable for the PEO. Therefore, the intended function(s) of the HI-STAR HB GWC will be maintained for the PEO.

3.8 Aging Management Review Results – HI-STAR HB GTCC Overpack

This section provides the results of the aging management review of the HI-STAR HB GTCC overpack, which was determined to be within the scope of license renewal as identified in Section 2.3, Scoping Results.

HI-STAR HB GTCC overpack subcomponents that did not undergo an aging management review are listed in Table 2-8. A summary of the results of the aging management review for the HI-STAR HB GTCC overpack subcomponents that supported an intended function is provided in Table 3.8-1. A description of the HI-STAR HB GTCC overpack subcomponents which support an SSC intended function is provided in Section 3.8.1, and a summary of the materials and environments for the HI-STAR HB GTCC overpack is provided in Section 3.8.2 and 3.8.3, respectively. Section 3.8.4 references the aging effects requiring management and any aging management activities used to manage the effects of aging. Section 3.8.5 provides an AMR conclusion.

3.8.1 Description of the HI-STAR HB GTCC Overpack

The Humboldt Bay ISFSI FSAR Update, Table 3.1-3 lists neutron activated components and process waste materials at HBPP that is classified as GTCC and stored at the ISFSI. The process waste material was generated during cleanup of the spent fuel pool. The material consists of distributed and particulate SNM waste mixed with resins, metallic oxides, and small Stellite particles.

The HI-STAR HB GTCC overpack is shown in the Humboldt Bay ISFSI FSAR Update Figure 3.3-4. The HI-STAR 100 HB overpack houses the GWC, similar to the HI-STAR 100 HB overpack housing the MPC-HB.

3.8.2 Materials Evaluated (HI-STAR HB GTCC Overpack)

The majority of the HI-STAR HB GTCC overpack is constructed of carbon steel, with exposed surfaces coated to protect against corrosion. Threaded holes and lifting trunnions surfaces are not coated. The coating materials are Thermaline 450 for the inner overpack surfaces and Carboline 890 for the outer surfaces as are licensed for the HI-STAR 100 overpack. The HI-STAR HB GTCC overpack is coated with a paint that would allow for substantial resistance to corrosion even when exposed to water. Other materials included in the construction are non-ferrous alloys for lifting appurtenances. Materials for the HI-STAR HB GTCC overpack subcomponents are provided in Table 3.8-1.

3.8.3 Environments (HI-STAR HB GTCC Overpack)

The outer surfaces of the HI-STAR HB GTCC overpack are enclosed in a vault that is protected from weather-related effects, including insolation, wind, rain, snow, ice. The interior of the vault is exposed to ambient air via the vault drainage system. The ambient air is a saline air due to the proximity to the Pacific Ocean. The average ambient air annual daily temperature is 52°F (Reference 3.10.1, Table 3.2-3). Table 4.2-10 of the Humboldt Bay ISFSI FSAR Update provides the results of the vault internal temperature analysis. The interior vault temperature is higher than the outside ambient temperature (based on a passive heat balance of the MPC-HB and its surroundings). In Table 3.8-1, the interior vault environment is designated as “Sheltered.”

The inner surfaces of the bolted HI-STAR HB GTCC overpack are filled with ambient air (see environment “Enclosed Air” in Table 3.1-2).

3.8.4 Aging Effects Requiring Management and Aging Management Activities (HI-STAR HB GTCC Overpack)

Unless annotated by a table note, each line item in Table 3.8-1 is consistent with the applicable line items in Draft MAPS Report (Reference 3.10.7), Table 4-9 supplemented by Draft MAPS Report, Table 3-2. Because Draft MAPS Report, Table 4-9 was prepared for the standard HI-STAR 100 overpack and not the HB overpack configuration, material/environment combinations did not always align. Those combinations that did not align were not included in the LRA. To determine the aging effects/mechanisms for those materials/environment combinations that were not in Draft MAPS Report, Table 4-9, Table 3-2, an overall summary table for all system types, was used. Because the environment of “Enclosed Air” was not in the Draft MAPS Report, when determining potential aging effects, the “Sheltered” environment was used.

Consistent with the Draft MAPS Report (Reference 3.10.7), the following aging effects and mechanisms related to the HI-STAR HB GTCC Overpack were determined non-credible for the HB ISFSI:

- Cracking due to radiation embrittlement for carbon steels and nickel alloys exposed to sheltered, or enclosed air – Reference 3.10.7, Sections 3.2.1.9 and 3.2.4.6

The AMR results for individual HI-STAR HB GTCC overpack subcomponents are listed in Table 3.8-1. Based on the material and environment combinations, and consideration of the conditions during the period of extended operation, the following aging effects and associated mechanism(s) were determined to be applicable:

- Cracking due to fatigue
- Loss of material due to crevice corrosion
- Loss of material due to galvanic corrosion
- Loss of material due to general corrosion
- Loss of material due to pitting corrosion

Based on the aging management review of the HI-STAR HB GTCC overpack during long-term storage, it has been determined that an AMP (see Appendix A) is required as well as an evaluation for the effects of cracking due to fatigue (see Section 4.5).

3.8.4.1 Internal Surfaces Exposed to Enclosed Air

While potential loss of material from pitting and crevice corrosion were identified for the HI-STAR HB GTCC internal surfaces that are exposed to enclosed air, no specific inspections are required during the period of extended operation based on the similarity of the enclosed air environment and an embedded environment. Reference 3.10.7 (Section 3.2.2.2) states “because of limited water and oxygen, stainless steel is also not susceptible to pitting and crevice corrosion in embedded environments. As such, pitting and crevice corrosion of stainless steel exposed to… embedded environments are not considered to be credible, and therefore, aging management is not required during the 60-year timeframe.” Although the enclosed air environment initially contains more moisture and oxygen, similar to an embedded environment as discussed in Reference 3.10.7, the enclosed air environment at the HB ISFSI (created by bolted casks, not backfilled with helium) does not allow for the opportunity to introduce additional water or oxygen to the environment after initial cask bolting. Thus, the same logic presented in

Reference 3.10.7 applies to the enclosed air environment and no aging management is necessary for the period of extended operation.

3.8.5 AMR Conclusion (HI-STAR HB GTCC Overpack)

The HB ISFSI External Surfaces Monitoring Aging Management Program activities described in Appendix A and evaluation in Section 4 provide reasonable assurance that the HI-STAR HB GTCC overpack aging effects/mechanisms will be managed effectively such that it will continue to perform its intended function during the period of extended operation.

3.9 Aging Management Review Results – ISFSI Storage Vault

This section provides the results of the aging management review of the ISFSI storage vault, which was determined to be within the scope of license renewal as identified in Section 2.3, Scoping Results.

ISFSI storage vault subcomponents that did not undergo an aging management review are listed in Table 2-9. A summary of the results of the aging management review for the ISFSI storage vault subcomponents that supported an intended function is provided in Table 3.9-1. A description of the ISFSI storage vault subcomponents which support an SSC intended function is provided in Section 3.9.1, and a summary of the materials and environments for the ISFSI storage vault is provided in Section 3.9.2 and 3.9.3, respectively. Section 3.9.4 references the aging effects requiring management and any aging management activities used to manage the effects of aging. Section 3.9.5 provides an AMR conclusion.

3.9.1 Description of the ISFSI Storage Vault

The Humboldt Bay ISFSI storage vault is an underground, heavily reinforced concrete structure with a carbon steel liner designed to support the static and dynamic loads imparted by the loaded overpacks under all design basis conditions of storage. The ISFSI vault meets the applicable guidance in ACI 349-01 as clarified by Regulatory Guide 1.142 and NUREG-1536. The ISFSI vault is designed with a capacity for six HI-STAR HB casks (five having space for 400 spent fuel assemblies and one for GTCC waste). The carbon steel liner and other exposed carbon steel materials are coated with a material suitable for the saline air service conditions to prevent corrosion. The materials of construction for example (additives in the vault concrete), were chosen to be compatible with the environment at the Humboldt Bay ISFSI site.

3.9.2 Materials Evaluated (ISFSI Storage Vault)

The ISFSI storage vault is constructed of concrete with embedded ASTM reinforcing bar and vault cell liners, lids, and seismic restraints made of carbon steel. Materials for the ISFSI storage vault subcomponents are provided in Table 4.6-1 of the Humboldt Bay ISFSI FSAR Update and in Table 3.9-1.

As discussed in the Humboldt Bay ISFSI FSAR Update, Section 4.4.3.8, the vault liner is coated with a paint that would allow for substantial resistance to corrosion even when exposed to water.

3.9.3 Environments (ISFSI Storage Vault)

During construction of the ISFSI storage vault, the reinforcing bars were embedded in the concrete before the concrete sets, thereby protecting the rebar from direct exposure to the ambient environment. The concrete itself is exposed to all weather-related effects, including insolation, wind, rain, snow, ice, and ambient air as discussed in the Humboldt Bay ISFSI FSAR Update Table 3.4-1 and Table 4.6-1. The reinforced concrete of the ISFSI storage vault is in contact with a soil-like subgrade. The interior of the vault is exposed to ambient air via the vault drainage system. The ambient air is a saline air due to the proximity to the Pacific Ocean. The average ambient air annual daily temperature is 52°F (Reference 3.10.1, Table 3.2-3). Table 4.2-10 of the Humboldt Bay ISFSI FSAR Update provides the results of the vault internal temperature analysis. As discussed in the Humboldt Bay ISFSI FSAR Update, Section 3.3.1.3.2, the vault interior temperatures were monitored following loading of the HI-STAR 100 HB overpacks to validate the results of the vault temperature analysis. The maximum internal vault temperature was 113.3°F which is well below the predicted vault temperature analysis results in the Humboldt Bay ISFSI FSAR Update Table 4.2-10. The interior vault temperature is higher than the outside ambient temperature (based on a passive heat balance of the MPC-HB and its surroundings). In Table 3.9-1, the interior vault environment is designated as "Sheltered."

3.9.4 Aging Effects Requiring Management and Aging Management Activities (ISFSI Storage Vault)

Each line item in Table 3.9-1 is consistent with the applicable line items in Draft MAPS Report (Reference 3.10.7), Table 4-24 supplemented by Draft MAPS Report, Table 3-2.

Consistent with the Draft MAPS Report (Reference 3.10.7), the following aging effects and mechanisms related to the ISFSI Storage Vault were determined non-credible for the HB ISFSI:

- Cracking, loss of material, or loss of strength due to delayed ettringite formation for concrete exposed to air- outdoor or soil – see Reference 3.10.7, Section 3.5.1.13
- Cracking due to shrinkage for concrete exposed to air-outdoor or soil – see Reference 3.10.7, Section 3.5.1.7
- Cracking due to fatigue for concrete exposed to air-outdoor or soil – see Reference 3.10.7, Section 3.5.1.10
- Cracking and loss of strength due to radiation damage for concrete exposed to air-outdoor or soil – see Reference 3.10.7, Section 3.5.1.9
- Cracking due to radiation embrittlement for carbon steels exposed to sheltered, air-outdoor, and embedded (in concrete) environments – Reference 3.10.7, Sections 3.2.1.9

Based on the material and environment combinations, and consideration of the conditions during the period of extended operation, the following aging effects and associated mechanism(s) were determined to require management:

- Change in material properties due to leaching of $Ca(OH)_2$
- Cracking due to aggressive chemical attack
- Cracking due to corrosion of reinforcing steel
- Cracking due to differential settlement
- Cracking due to fatigue for carbon steels

- Cracking due to freeze-thaw
- Cracking due to reaction with aggregates
- Increase in porosity and permeability due to leaching of calcium hydroxide
- Increase in porosity and permeability due to microbiological degradation
- Loss of concrete/steel bond due to corrosion of reinforcing steel
- Loss of material due to aggressive chemical attack
- Loss of material due to crevice corrosion
- Loss of material due to general corrosion
- Loss of material due to pitting corrosion
- Loss of material due to freeze-thaw
- Loss of material due to microbiological degradation
- Loss of material due to salt scaling
- Loss of material due to corrosion of reinforcing steel
- Loss of strength due to aggressive chemical attack
- Loss of strength due to corrosion of reinforcing steel
- Loss of strength due to leaching of calcium hydroxide
- Loss of strength due to microbiological degradation
- Loss of strength due to reaction with aggregates
- Reduction of concrete pH due to aggressive chemical attack
- Reduction of concrete pH due to leaching of calcium hydroxide
- Reduction of concrete pH due to microbiological degradation

Based on the aging management review of the ISFSI storage vault during long-term storage, it has been determined that AMPs (see Appendix A) are required as well as an evaluation for the effects of cracking due to fatigue (see Section 4.5).

Vault Temperature

As discussed in Section 3.9.3, the inside ISFSI storage vault temperature was monitored following loading of the five HI-STAR 100 HB casks to determine the ambient inside vault temperature. The maximum vault temperature was 113.3°F, which is well below the temperature (300°F) that EPRI Structural Tools (Reference 3.10.3) defines as an environment that would result in concrete aging effects. This being said, Table 3.9-1 conservatively provides the aging effects and mechanisms discussed in the Draft MAPS Report.

Soil Corrosivity

Soil samples were taken as part of the pre-application inspection. The analyses of these soil samples determined that the soil is non-corrosive. It was determined that no additional soil samples should be required since there is no mechanism to change the corrosivity of the soil. However, as discussed in Appendix A, PG&E is conservatively proposing soil samples at five-year frequency throughout the period of extended operation.

Settlement

Settlement of the vault was reviewed during the initial licensing of the Humboldt Bay ISFSI (References 3.10.4; 3.10.5, Sections 2.1.6.4 and 5.1.3.2). Calculations of potential storage vault settlement demonstrated that if the maximum calculated settlement occurred, it would not impact the operation of the ISFSI or retrievability. This conclusion is reflected in Section 5.1.3.2 of the NRC's Safety Evaluation Report. Although no settlement monitoring is required based on the previous evaluations, settlement of the ISFSI pad will be monitored during the period of extended operation (see Appendix A).

3.9.5 AMR Conclusion (ISFSI Storage Vault)

The HB ISFSI External Surfaces Monitoring Aging Management Program and HB ISFSI Reinforced Concrete Structures Aging Management Program activities described in Appendix A and evaluation in Section 4 provide reasonable assurance that the ISFSI storage vault aging effects/mechanisms will be managed effectively such that it will continue to perform its intended function during the period of extended operation.

3.10 Section 3.0 References

3.10.1 PG&E Letter HIL-17-005, Final Safety Analysis Report Update, Revision 6, November 8, 2017, ADAMS Accession Nos. ML17320A148 and ML17320A151 (except 2.6 figures).

3.10.2 Final Safety Analysis Report for the Holtec International Storage, Transport, and Repository Cask System (HI-STAR 100 Cask System), Docket 72-1008, Revision 3, Report HI-2012610, ADAMS Accession Nos. ML11285A100 and ML11285A101.

3.10.3 EPRI Report 1002950, Aging Effects for Structures and Structural Components (Structural Tools), Revision 1, August 2003.

3.10.4 PG&E Letter HIL-04-007, Response to NRC Request for Additional Information for the Humboldt Bay Independent Spent Fuel Storage Installation Application (TAC No. L23683), October 1, 2004.

3.10.5 Humboldt Bay Independent Spent Fuel Storage Installation Safety Evaluation Report, Docket 72-27, Materials License No. SNM-2514, November 2005, ADAMS Accession No. ML053140041.

3.10.6 EPRI Report 1010639, Non-Class 1 Mechanical Implementation Guideline and Mechanical Tools, Revision 4, January 2006.

3.10.7 Managing Aging Processes in Storage (MAPS) Report, Draft Report for Comment, NUREG-2214, October 2017, Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, ADAMS Accession No. ML17289A237.

3.10.8 NUREG-1801, Generic Aging Lessons Learned (GALL) Report, Revision 2, Nuclear Regulatory Commission, December 2010, ADAMS Accession No. ML103490041.

3.10.9 ASTM Standard C33-01, Standard Specification for Concrete Aggregates.

3.10.10 2010 ASME Boiler and Pressure Vessel Code, Section II, Part B.

Table 3.2-1 Aging Management Review of Spent Fuel Assemblies

Subcomponent	Intended Function	Material	Environment[1]	Aging Effect	Aging Mechanism	Aging Management
Upper Tie Plate	CR, SR, RE	Stainless Steel	Helium	None	N/A	None
Channel	CR, TH	Zirconium-Based Alloy	Helium	None	N/A	None
Fuel Spacers	CR, SR, TH, RE	Stainless Steel	Helium	None	N/A	None
Fuel Cladding	CO, CR, SH, SR, TH, RE	Zirconium-Based Alloy	Helium	None	N/A	None
Lower Tie Plate	CR, SR, RE	Stainless Steel	Helium	None	N/A	None

Notes:

1. As described in Section 3.4.3, the MPC-HB is sealed and filled with helium, so both the inner and outer surfaces of the SFAs are contained within a helium environment.
2. Intended Functions: Confinement (CO), Sub-criticality (CR), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH), Retrievability (RE)

Table 3.3-1 Aging Management Review of Damaged Fuel Container

Subcomponent	Intended Function[2]	Material	Environment[1]	Aging Effect	Aging Mechanism	Aging Management
Top Ring	SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Tube	CO, SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Pan-Base	CO, SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Pan-Side	CO, SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Pan-Top	CO, SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Mesh	SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Lock Bolt	CO, SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Lock Plate	CO, SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Baseplate	CO, SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Base Feet	SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5

Notes:
1. As described in Section 3.4.3, the MPC-HB is sealed and filled with helium, so both the inner and outer surfaces of the DFC are contained within a helium environment.
2. Intended Functions: Confinement (CO), Structural Integrity (SR)

Table 3.4-1 Aging Management Review of MPC-HB

Subcomponent	Intended Function[2]	Material	Environment[1]	Aging Effect	Aging Mechanism	Aging Management
MPC – Base Plate	CO, SH, SR, TH	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
MPC – Shell	CO, SH, SR, TH	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
MPC – Lid	CO, SH, SR, TH	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Closure Ring	CO	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Drain Shield Block	SH	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Vent / Drain Tube	SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Vent / Drain Cap	SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Port Cover Plate	CO	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Vent Shield Block	SH	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Vent Shield Spacer	SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Upper Fuel Spacers	SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Fuel Basket Supports	CR, SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Fuel Spacer	SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Fuel Basket Cell Spacer Plates	CR, SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Fuel Basket Spacer Angle Plates	CR, SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5

Table 3.4-1 Aging Management Review of MPC-HB

Subcomponent	Intended Function[2]	Material	Environment[1]	Aging Effect	Aging Mechanism	Aging Management
Fuel Basket Cell Plates	CR, SH, SR, TH	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Sheathing	SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Neutron Absorber	CR, SH, TH	Metamic®	Helium	Loss of Criticality Control	Boron Depletion	TLAA will be valid to the end of the period of extended operation in accordance with TLAA disposition (ii) – see Section 4.4.1

Notes:

1. As described in Section 3.4.3, the HI-STAR 100 HB overpack and MPC-HB is sealed and filled with helium, so both the inner and the outer surfaces of the MPC-HB are contained within a helium environment.
2. Intended Functions: Confinement (CO), Sub-criticality (CR), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)

Table 3.5-1 Aging Management Review of HI-STAR HB Overpack

Subcomponent	Intended Function[1]	Material	Environment[2,3]	Aging Effect	Aging Mechanism	Aging Management
Bottom Plate	CO, SH, SR	Carbon Steel with Coating	(I) Helium	Cracking	Fatigue	None – see Section 4.5
			(E) Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					Galvanic Corrosion	
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Port Plugs	CO	Stainless Steel	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Port Plug Seals	CO	Nickel Alloy, Silver Plated	Sheltered	Cracking	Fatigue	None – see Section 4.5
Port Covers	SR	Carbon Steel with Coating	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					Galvanic Corrosion	
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Port Cover Seals	CO	Nickel Alloy, Silver Plated	Sheltered	Cracking	Fatigue	None – see Section 4.5
Port Cover Bolts	SR	Carbon Steel	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Loss of Preload	Stress Relaxation	None – see Section 3.5.4.2[4]
				Cracking	Fatigue	None – see Section 4.5
Inner Shell	CO, SH, SR	Carbon Steel with Coating	Helium	Cracking	Fatigue	None – see Section 4.5

Table 3.5-1 Aging Management Review of HI-STAR HB Overpack

Subcomponent	Intended Function[1]	Material	Environment[2,3]	Aging Effect	Aging Mechanism	Aging Management
Top Flange	CO, SH, SR	Carbon Steel with Coating	(I) Helium	Cracking	Fatigue	None – see Section 4.5
			(E) Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					Galvanic Corrosion	
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Flange Overlay	CO	Stainless Steel	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Lifting Trunnion	RE	Nickel Alloy	Sheltered	Cracking	Fatigue	None – see Section 4.5
Intermediate Shells	SH, SR	Carbon Steel	Embedded (Holtite-A)	None	N/A	None
Toe Ring Plate	CO	Carbon Steel with Coating	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Neutron Cover Plate	SR	Carbon Steel with Coating	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Neutron Rib	SR	Carbon Steel	Embedded	Cracking	Fatigue	None – see Section 4.5

Table 3.5-1 Aging Management Review of HI-STAR HB Overpack

Subcomponent	Intended Function[1]	Material	Environment[2,3]	Aging Effect	Aging Mechanism	Aging Management
Rupture Plate	SR	Carbon Steel with Coating	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					Galvanic Corrosion	
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Rupture Side	SR	Carbon Steel with Coating	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Rupture Disk	SR	Stainless Steel	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Top Ring Plate	SR	Carbon Steel with Coating	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5

Table 3.5-1 Aging Management Review of HI-STAR HB Overpack

Subcomponent	Intended Function[1]	Material	Environment[2,3]	Aging Effect	Aging Mechanism	Aging Management
Neutron Shield	CR, SH	Holtite-A	Embedded (Carbon Steel)	Cracking	Radiation Embrittlement	HB ISFSI Reinforced Concrete Structures AMP[4]
				Loss of Fracture Toughness and Loss of Ductility	Thermal Aging	None – see Section 3.5.4.3[4]
				Loss of Shielding	Boron Depletion	TLAA will be valid to the end of the period of extended operation in accordance with TLAA disposition (ii) – see Section 4.4.1
Closure Plate	CO, SH, SR	Carbon Steel with Coating	(I) Helium	Cracking	Fatigue	None – see Section 4.5
			(E) Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					Galvanic Corrosion	
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Closure Plate Overlay	CO	Stainless Steel	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Closure Plate Inner Seal	CO	Nickel Alloy, Silver Plated	Helium	Cracking	Fatigue	None – see Section 4.5
Closure Plate Outer Seal	CO	Nickel Alloy, Silver Plated	Sheltered	Loss of Material	Crevice Corrosion	None – see Section 3.5.4.1[4]
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5

Table 3.5-1 Aging Management Review of HI-STAR HB Overpack						
Subcomponent	**Intended Function[1]**	**Material**	**Environment[2,3]**	**Aging Effect**	**Aging Mechanism**	**Aging Management**
Closure Plate Bolts	CO, SR	Nickel Alloy	Sheltered	Cracking	Fatigue	TLAA will be valid to the end of the period of extended operation in accordance with TLAA disposition (ii) – see Section 4.4.2

Notes:

1. Intended Functions: Confinement (CO), Sub-criticality (CR), Radiation Shielding (SH), Structural Integrity (SR), Retrievability (RE)
2. (I)=internal environment, (E)=external environment
3. As described in Section 3.4.3, the HI-STAR HB overpack is sealed and filled with helium, so the inner surfaces of the overpack are contained within a helium environment.
4. This line item is not consistent with the Draft MAPS Report (Reference 3.10.7).

Table 3.6-1 Aging Management Review of Process Waste Container

Subcomponent	Intended Function[1]	Material	Environment[2,3]	Aging Effect	Aging Mechanism	Aging Management
Container Shell	CO, SR	Stainless Steel	(I) Helium	Cracking	Fatigue	None – see Section 4.5
			(E) Helium	Cracking	Fatigue	None – see Section 4.5
Quick Disconnect Body	CO	Stainless Steel	(I) Helium	Cracking	Fatigue	None – see Section 4.5
			(E) Helium	Cracking	Fatigue	None – see Section 4.5
Vacuum Drying Insert	CO	Stainless Steel	(I) Helium	Cracking	Fatigue	None – see Section 4.5
			(E) Helium	Cracking	Fatigue	None – see Section 4.5
Top Plate	SR	Stainless Steel	(I) Helium	Cracking	Fatigue	None – see Section 4.5
			(E) Helium	Cracking	Fatigue	None – see Section 4.5

Notes:
1. Intended Functions: Confinement (CO), Structural Integrity (SR)
2. (I)=internal environment, (E)=external environment
3. As described in Section3.6.3, the HI-STAR HB PWC is within the HI-STAR HB GWC, which is sealed and filled with helium, so the interior environment is helium.

Table 3.7-1 Aging Management Review of GTCC Waste Container

Subcomponent	Intended Function[1]	Material	Environment[2,3]	Aging Effect	Aging Mechanism	Aging Management
MPC Base Plate	CO, SH, SR, TH	Stainless Steel	(I) Helium	Cracking	Fatigue	None – see Section 4.5
			(E) Enclosed Air	Loss of Material	Crevice Corrosion	None – see Section 3.7.4.1[4]
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
MPC Shell	CO, SH, SR, TH	Stainless Steel	(I) Helium	Cracking	Fatigue	None – see Section 4.5
			(E) Enclosed Air	Loss of Material	Crevice Corrosion	None – see Section 3.7.4.1[4]
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Inner Shell	SH, SR, TH	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
MPC Lid Top	CO, SH, SR, TH	Stainless Steel	Enclosed Air	Loss of Material	Crevice Corrosion	None – see Section 3.7.4.1[4]
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
MPC Lid Bottom	CO, SH, SR, TH	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Sleeve Insert	SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Drain Shield Block	SH	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Vent Drain Tube	SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Vent Drain Cap	SR	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5
Closure Ring	CO	Stainless Steel	(I) Helium	Cracking	Fatigue	None – see Section 4.5
			(E) Enclosed Air	Loss of Material	Crevice Corrosion	None – see Section 3.7.4.1[4]
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Port Cover Plate	CO	Stainless Steel	Helium	Cracking	Fatigue	None – see Section 4.5

Notes:

1. Intended Functions: Confinement (CO), Radiation Shielding (SH), Structural Integrity (SR), Thermal/Heat Removal (TH)
2. (I)=internal environment, (E)=external environment

3. As described in Section 3.7.3, the HI-STAR HB GWC is sealed and filled with helium, so the interior environment is helium.
4. This line item is not consistent with the Draft MAPS Report (Reference 3.10.7).

Table 3.8-1 Aging Management Review of HI-STAR HB GTCC Overpack

Subcomponent	Intended Function[1]	Material	Environment[2]	Aging Effect	Aging Mechanism	Aging Management
Bottom Plate	SH, SR	Carbon Steel with Coating	(I) Enclosed Air	Loss of Material	Crevice Corrosion	None – see Section 3.8.4.1[3]
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
			(E) Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					Galvanic Corrosion	
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Shell	SH, SR	Carbon Steel with Coating	(I) Enclosed Air	Loss of Material	Crevice Corrosion	None – see Section 3.8.4.1[3]
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
			(E) Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Top Flange	SH, SR	Carbon Steel with Coating	(I) Enclosed Air	Loss of Material	Crevice Corrosion	None – see Section 3.8.4.1[3]
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
			(E) Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					Galvanic Corrosion	
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Lifting Trunnion	RE	Nickel Alloy	(I) Enclosed Air	Loss of Material	Crevice Corrosion	None – see Section 3.8.4.1[3]
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
			(E) Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5

Table 3.8-1 Aging Management Review of HI-STAR HB GTCC Overpack

Subcomponent	Intended Function[1]	Material	Environment[2]	Aging Effect	Aging Mechanism	Aging Management
Intermediate Shells	SH, SR	Carbon Steel	(I) Enclosed Air	Loss of Material	Crevice Corrosion	None – see Section 3.8.4.1[3]
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
			(E) Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Toe Ring Plate	SR	Carbon Steel with Coating	(I) Enclosed Air	Loss of Material	Crevice Corrosion	None – see Section 3.8.4.1[3]
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
			(E) Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Closure Lid	SH, SR	Carbon Steel with Coating	(I) Enclosed Air	Loss of Material	Crevice Corrosion	None – see Section 3.8.4.1[3]
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
			(E) Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					Galvanic Corrosion	
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Lid Bolts	SR	Nickel Alloy	Sheltered	Cracking	Fatigue	None – see Section 4.5

Notes:

1. Intended Functions: Radiation Shielding (SH), Structural Integrity (SR), Retrievability (RE)
2. (I)=internal environment, (E)=external environment
3. This line item is not consistent with the Draft MAPS Report (Reference 3.10.7).

Table 3.9-1 Aging Management Review of ISFSI Storage Vault

Subcomponent	Intended Function[1]	Material	Environment[2]	Aging Effect	Aging Mechanism	Aging Management
Vault Shell Base Plate	SR	Carbon Steel with Coating	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Vault Shell	SR	Carbon Steel with Coating	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Vault Shell Lid Ring	SR	Carbon Steel with Coating	(I) Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
			(E) Air-outdoor	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Vault Shell Drain Ring	SR	Carbon Steel with Coating	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Vault Shell Anchor Block	SR	Carbon Steel with Coating	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Vault Shell Gusset	SR	Carbon Steel with Coating	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5

Table 3.9-1 Aging Management Review of ISFSI Storage Vault

Subcomponent	Intended Function[1]	Material	Environment[2]	Aging Effect	Aging Mechanism	Aging Management
Vault Shell Stop Plate	SR	Carbon Steel with Coating	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Vault Shell Guide Plates	SR	Carbon Steel with Coating	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Vault Shell Alignment Plates (Seismic Restraints)	SR	Carbon Steel with Coating	Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Vault Lid Base and Top Plates	SR	Carbon Steel with Coating	(I) Sheltered	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
			(E) Air-outdoor	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Vault Lid Center Bar	SR	Carbon Steel	Embedded (Concrete)	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Vault Lid Outer Shell	SR	Carbon Steel with Coating	Air-outdoor	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5

Table 3.9-1 Aging Management Review of ISFSI Storage Vault

Subcomponent	Intended Function[1]	Material	Environment[2]	Aging Effect	Aging Mechanism	Aging Management
Vault Lid Rib Plate	SR	Carbon Steel	Embedded (Concrete)	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Vault Lid Bolts	SR	Carbon Steel	Air-outdoor	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Vault Lid Washers	SR	Carbon Steel	Air-outdoor	Loss of Material	Crevice Corrosion	HB ISFSI External Surfaces Monitoring AMP
					General Corrosion	
					Pitting Corrosion	
				Cracking	Fatigue	None – see Section 4.5
Vault Lid Shield Block	SH, SR	Concrete	Embedded (Metal)	None	None	None[3]
Vault Lid View Port Plug	SH	Concrete	Air-outdoor	Change in Material Properties	Leaching of $Ca(OH)_2$	HB ISFSI External Surfaces Monitoring AMP
				Cracking	Aggressive Chemical Attack	HB ISFSI External Surfaces Monitoring AMP
					Differential Settlement	
					Freeze-Thaw	
					Reaction with Aggregates	
				Increase in Porosity and Permeability	Leaching of Calcium Hydroxide	HB ISFSI External Surfaces Monitoring AMP
				Loss of Material	Aggressive Chemical Attack	HB ISFSI External Surfaces Monitoring AMP
					Freeze-Thaw	

Table 3.9-1 Aging Management Review of ISFSI Storage Vault

Subcomponent	Intended Function[1]	Material	Environment[2]	Aging Effect	Aging Mechanism	Aging Management
					Salt Scaling	
				Loss of Strength	Aggressive Chemical Attack	HB ISFSI External Surfaces Monitoring AMP
					Leaching of Calcium Hydroxide	
					Reaction with Aggregates	
				Reduction of concrete pH	Aggressive Chemical Attack	HB ISFSI External Surfaces Monitoring AMP
					Leaching of Calcium Hydroxide	
ISFSI Vault	SH, SR	Concrete (Reinforced)	(E) Air-outdoor	Change in Material Properties	Leaching of $Ca(OH)_2$	HB ISFSI Reinforced Concrete Structures AMP
				Cracking	Aggressive Chemical Attack	HB ISFSI Reinforced Concrete Structures AMP
					Differential Settlement	
					Freeze-Thaw	
					Reaction with Aggregates	
				Increase in Porosity and Permeability	Leaching of Calcium Hydroxide	HB ISFSI Reinforced Concrete Structures AMP
				Loss of Material	Aggressive Chemical Attack	HB ISFSI Reinforced Concrete Structures AMP
					Freeze-Thaw	
					Salt Scaling	

Table 3.9-1 Aging Management Review of ISFSI Storage Vault

Subcomponent	Intended Function[1]	Material	Environment[2]	Aging Effect	Aging Mechanism	Aging Management
				Loss of Strength	Aggressive Chemical Attack	HB ISFSI Reinforced Concrete Structures AMP
					Leaching of Calcium Hydroxide	
					Reaction with Aggregates	
				Reduction of concrete pH	Aggressive Chemical Attack	HB ISFSI Reinforced Concrete Structures AMP
					Leaching of Calcium Hydroxide	
			(E) Soil	Change in Material Properties	Leaching of $Ca(OH)_2$	HB ISFSI Reinforced Concrete Structures AMP
				Cracking	Aggressive Chemical Attack	HB ISFSI Reinforced Concrete Structures AMP
					Differential Settlement	
					Freeze-Thaw	
					Reaction with Aggregates	
				Increase in Porosity and Permeability	Leaching of Calcium Hydroxide	HB ISFSI Reinforced Concrete Structures AMP
					Microbiological Degradation	
				Loss of Material	Aggressive Chemical Attack	HB ISFSI Reinforced Concrete Structures AMP
					Freeze-Thaw	
					Microbiological Degradation	

Table 3.9-1 Aging Management Review of ISFSI Storage Vault

Subcomponent	Intended Function[1]	Material	Environment[2]	Aging Effect	Aging Mechanism	Aging Management
					Salt Scaling	
				Loss of Strength	Aggressive Chemical Attack	HB ISFSI Reinforced Concrete Structures AMP
					Leaching of Calcium Hydroxide	
					Microbiological Degradation	
					Reaction with Aggregates	
				Reduction of concrete pH	Aggressive Chemical Attack	HB ISFSI Reinforced Concrete Structures AMP
					Leaching of Calcium Hydroxide	
					Microbiological Degradation	
		Reinforcing Steel	Soil	Cracking	Corrosion of Reinforcing Steel	HB ISFSI Reinforced Concrete Structures AMP
				Loss of Concrete/ Steel Bond		
				Loss of Material		
				Loss of Strength		

Notes:
1. Intended Functions: Radiation Shielding (SH), Structural Integrity (SR), Retrievability (RE)
2. (I)=internal environment, (E)=external environment
3. This line item is not consistent with the Draft MAPS Report (Reference 3.10.7) as this material and environment combination is not discussed. Because the concrete is completely surrounded by carbon steel plates, there are no credible aging mechanisms.

4 TIME-LIMITED AGING ANALYSES

4.1 Introduction

Per 10 CFR 72.42(a)(1), an ISFSI license renewal application must include TLAAs that demonstrate SSCs important to nuclear safety will continue to perform their intended functions for the period of extended operation (Reference 4.6.1). This Section outlines the screening process used to identify design basis calculations that may be time-limited upon extending the ISFSI license by 40 additional years (Section 4.2), the TLAA identified (Section 4.3), and the disposition of each TLAA (Section 4.4). This Section also discusses an evaluation that does not meet the definition of a TLAA, but was used as a basis for the proposed aging management (Section 4.5).

4.2 Identification and Disposition of TLAAs

As described in NUREG-1927 (Reference 4.6.2), an analysis, calculation, or evaluation is a TLAA under 10 CFR 72.3 only if it meets all six of the following criteria:

> Time-limited aging analyses, for the purposes of this part, are those licensee calculations and analyses that:
> (1) Involve systems, structures, and components important to safety within the scope of license renewal;
> (2) Consider the effects of aging;
> (3) Involve time-limited assumptions defined by the current operating term, for example, 40 years;
> (4) Were determined to be relevant by the licensee in making a safety determination;
> (5) Involve conclusions or provide the basis for conclusions related to the capability of the system, structure, and component to perform its intended functions; and
> (6) Are contained or incorporated by reference in the design basis.

TLAA should provide conclusions or a basis for conclusions regarding the capability of the SSC to perform its intended function through the license period of extended operation. The TLAAs must show either one of the following dispositions:

(i) The analyses remain valid for the period of extended operation;
(ii) The analyses have been projected to the end of the period of extended operation; or
(iii) The effects of aging on the intended function(s) of the SSCs will be adequately managed for the period of extended operation.

4.3 Identification Process and TLAA Results

Keyword searches of the HB ISFSI CLB were performed to determine whether the design or analysis feature of each potential TLAA in fact exists at the HB ISFSI and in its licensing basis, and to identify additional potential site-specific TLAAs. The CLB search included:

- HB ISFSI FSAR Update (Reference 4.6.3)

- Technical Specifications
- NRC Safety Evaluation Report for the original license
- Subsequent NRC Safety Evaluations
- PG&E and NRC docketed licensing correspondence

The following types of source design documents were also reviewed for potential TLAAs.

- Vendor, NRC, and licensee topical reports
- Design calculations
- Code stress reports or code design reports
- Drawings
- Specifications

Two evaluations were identified as meeting all six criteria per 10 CFR 72.3:

- Neutron Absorber and Shielding Depletion
- Fatigue of the Overpack Closure Bolts and Threads

Although not meeting all six criteria, the following evaluation was reviewed to disposition aging on SSCs within the scope of renewal, and justify their exclusion from an Aging Management Program:

- Fatigue of the MPC-HB and Overpack

4.4 Evaluation and Disposition of Identified TLAAs

4.4.1 Neutron Absorber and Shielding Depletion

HB ISFSI FSAR Update, Section 4.2.3.3.7, describes the boron depletion of the fixed neutron absorber (Metamic) within the MPC-HB and the neutron shielding (Holtite) within the HI-STAR HB Overpack. The original analysis, incorporated by reference from the HI-STORM 100 FSAR Update and HI-STAR 100 FSAR Update (Reference 4.6.5), demonstrated that the boron depletion of the neutron absorbing and shielding materials is negligible over a 50-year duration.

To support the 60-year storage duration for license renewal, neutron flux and fluence values for depletion of Boron-10 from the original analysis were conservatively scaled up by a factor of 6/5 (60 years/50 years) (Reference 4.6.4). The analysis concludes that the total depletion of Boron-10 over a 60-year period remains negligible (less than $5x10^{-10}$ of total Boron-10 atoms depleted). The TLAA for neutron absorber and shielding depletion has been projected to 60 years and is therefore valid to the end of the period of extended operation in accordance with TLAA disposition (ii).

4.4.2 Fatigue of the Overpack Closure Bolts and Threads

The HB ISFSI FSAR Update (Reference 4.6.3) does not provide any fatigue-related discussions for the overpack closure bolts or closure bolt threads. However, the HB ISFSI FSAR Update incorporates the HI-STAR 100 FSAR Update by reference. As discussed in the generic analysis of the HI-STAR 100 System, fatigue analyses of the overpack closure bolts and closure bolt threads were performed in accordance with ASME Code, Section III (Reference 4.6.5, Section 2.6.1.3.3).

For a design life of 40 years, the HI-STAR 100 System FSAR Update fatigue analyses determined that the allowable number of torqueing/untorquing cycles for the overpack closure bolts is 166. For a design life of 40 years, it was determined that the allowable number of torqueing/untorquing cycles for the overpack closure bolt threads is 3,950. The TLAA evaluation will use the limiting number of cycles of 166.

Torqueing and untorquing the overpack closure bolts/threads occurs during initial overpack loading and during potential future unloading/re-loading of overpacks. All six HB ISFSI casks are loaded and are in long-term storage. No torqueing or untorquing has taken place since the initial overpack loading. As shown in Table 3.5-1, no potential aging effects have been identified that would lead to overpack closure bolts requiring torqueing or untorquing during the long-term storage period, and thus, no aging management activities are required.

Conservatively assuming that the overpack closure bolts/threads experienced 10 torqueing/untorquing cycles during initial loading, and adding an additional 10 torqueing/untorquing cycles that may occur during the first 20-year storage period, the total torqueing/untorquing cycles is 20 for the initial 20-year storage period. Projecting this conservative number of torqueing/untorquing cycles to 60 years by assuming an additional 10 torqueing/untorquing cycles per every 20 years of storage (20 cycles + 10 cycles (years 21-40) + 10 cycles (years 41-60)) equates to a total of 40 cycles, which is significantly less than the HI-STAR 100 System FSAR Update fatigue analysis allowable number of 166.

The torqueing/untorquing cycles associated with the overpack closure bolts/threads have been projected to 40 cycles during 60 years of operation. 40 cycles remains significantly below the calculated cycle limit of 166. Therefore, the overpack closure bolts will be valid to the end of the period of extended operation in accordance with TLAA disposition (ii).

4.5 Fatigue of the MPC-HB and Overpack

As discussed in the HB ISFSI FSAR Update (Reference 4.6.3, Section 4.6.1), the passive, non-cyclic nature of dry storage conditions does not subject the MPC-HB to conditions that might lead to structural fatigue failure. Ambient temperature and insolation cycling during normal dry storage conditions and the resulting fluctuations in the MPC thermal gradients and internal pressure is the only mechanism for fatigue. These low-stress, high-cycle conditions cannot lead to a fatigue failure of the MPC enclosure vessel or fuel basket structural materials, that are made from austenitic stainless steel. All other off-normal or postulated accident conditions are infrequent or one-time occurrences, which cannot produce fatigue failures.

An ASME Section III NB-3200 screening was performed for the HI-STAR 100 MPC enclosure vessel during the original design process (Reference 4.6.5, Section 2.6.1.3.3). Although the screening was originally performed for the standard HI-STAR 100 MPC and overpack, it also applies to the MPC-HB and overpack.

As discussed in Reference 4.6.5, Section 2.6.1.3.3, the temperature and pressure cycles within the MPC and the inner shell of the overpack are entirely governed by the mechanical and thermal-hydraulic conditions presented by the fuel. The external surfaces of the overpack, however, are in direct contact with the sheltered environment. The considerations of cyclic fatigue due to temperature and pressure cycling of the HI-STAR 100 System, therefore, must focus on different locations depending on the source of the cyclic stress. The overpack and the MPCs in the HI-STAR 100 System do not require a detailed fatigue analysis because all applicable loadings are well within the range that permits exemption from fatigue analysis per the provisions of Section III of the ASME Code. Paragraph NB-3222.4 (d) of Section III of the ASME Code provides five criteria that are strictly material and design condition dependent to determine whether a component can be exempted from a detailed fatigue analysis. The sixth criterion is applicable only when dissimilar materials are involved, which is not the case in the HI-STAR 100 System.

Because the overpack and the MPC were evaluated under the exemption criteria of the ASME Code, these components, and their subcomponents (such as the fuel basket, damaged fuel container, GTCC process waster container, and GTCC waste container), do not have a fatigue analysis, and are therefore, not TLAAs.

4.6 Section 4.0 References

4.6.1 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste

4.6.2 NUREG-1927, Revision 1, Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel, Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, June 2016. ADAMS Accession No. ML16179A148.

4.6.3 PG&E Letter HIL-17-005, Final Safety Analysis Report Update, Revision 6, November 8, 2017, ADAMS Accession Nos. ML17320A148 and ML17320A151 (except 2.6 figures).

4.6.4 Holtec Calculation HI-2033047, ISFSI Dose Assessment for Humboldt Bay, Revision 10, February 8, 2017.

4.6.5 Holtec International Report No. HI-951251, Safety Analysis Report on the HI-STAR 100 Cask System, Revision 16, January 27, 2016.

APPENDIX A

AGING MANAGEMENT PROGRAMS

A.1 Introduction

This appendix is a summary of the activities that manage the effects of aging for the HB ISFSI SSCs that have been identified as being subject to AMR. The AMPs credited for the management of those aging effects and mechanisms identified for the HB ISFSI are the External Surfaces Monitoring AMP and the Reinforced Concrete Structures AMP.

Section A.2 provides a description of the External Surfaces Monitoring AMP which includes an introduction and an evaluation in terms of the attributes or elements of an effective AMP (Table A-1). Section A.3 provides a description of the Reinforced Concrete Structures AMP which includes an introduction and an evaluation in terms of the attributes or elements of an effective AMP (Table A-2).

A.2 HB ISFSI External Surfaces Monitoring Program

The HB ISFSI provides for long-term interim storage for spent fuel assemblies and GTCC waste until such time that the spent fuel assemblies and GTCC waste may be shipped off-site for final disposition. The casks utilized at the Humboldt Bay ISFSI are the Holtec HI-STAR 100 HB and are designed for outdoor storage.

The purpose of the HB ISFSI External Surfaces Monitoring AMP is to ensure that the external surfaces of SSCs are not degraded for the HI-STAR 100 HB Overpacks, HI-STAR HB GTCC Overpack, and ISFSI Storage Vault SSCs.

A description of the HB ISFSI External Surfaces Monitoring AMP is provided below in Table A-1 using each attribute of an effective AMP as described in NUREG-1927 (Reference A5.1) and Draft MAPS Report (Reference A5.2) for the renewal of a site-specific Part 72 license. The HB ISFSI External Surfaces Monitoring AMP is based on the External Surfaces Monitoring of Metallic Components example AMP described in Draft MAPS Report, Section 6.7 (Reference A5.2)

Table A-1: HB ISFSI External Surfaces Monitoring AMP	
Element	**Description**
1. Scope of Program	The HB ISFSI External Surfaces Monitoring AMP manages the external surfaces of sub-components exposed to an embedded, sheltered environment, or air-outdoor requiring aging management as shown in LRA Tables 3.2-1 through 3.9-1 with the following intended functions: • Confinement • Radiation shielding • Structural integrity • Retrievability The program requires periodic inspection activities that monitor the condition of SSCs within the scope of License Renewal as the method used to manage aging effects and mechanisms listed in LRA Tables 3.2-1 through 3.9-1. The scope of the HB ISFSI External Surfaces Monitoring AMP includes: 1) Visual inspection of the exterior of the carbon steel, coated HI-STAR 100 HB Overpacks (including associated relief devices)

Table A-1: HB ISFSI External Surfaces Monitoring AMP	
Element	**Description**
	and HI-STAR HB GTCC Waste Overpack 2) Visual inspection of the ISFSI Storage Vault carbon steel, coated cell liners (including associated appurtenances such as the seismic restraints), vault lid bolting, and vault lid caulking
2. Preventive Actions	The HB ISFSI External Surfaces Monitoring AMP is a condition monitoring program to detect evidence of degradation. It does not provide guidance for the prevention of aging.
3. Parameters Monitored or Inspected	The parameters monitored by the HB ISFSI External Surfaces Monitoring AMP ensure degraded conditions are identified and corrected by clearly defining degraded condition criteria and associated corrective action requirements to prevent the loss of intended function. Industry and site specific OE are also reviewed to ensure that parameters inspected focus on conditions identified during these OE reviews. See LRA Tables 3.2-1 through 3.9-1 for a detailed list of aging effects and mechanisms for structures and components inspected or monitored as required by the HB ISFSI External Surfaces Monitoring AMP. Overpack Inspections The condition of the accessible portions of the exterior of each HI-STAR 100 HB Overpack and the HI-STAR HB GTCC Waste Overpack is inspected visually to ensure the intended functions of the cask exterior are not compromised. Visual inspections will look for signs of deterioration of the accessible cask exterior surfaces, including coatings, such that the confinement and structural integrity intended functions are maintained. Specifically, parameters monitored and inspected include: • visual evidence of discontinuities, imperfections, and rust staining indicative of corrosion and wear • visual evidence of missing bolts and physical displacement • visual evidence of coating degradation (e.g., blisters, cracking, flaking, delamination) indicative of corrosion of the base material • visual evidence of premature rupture, including bubbling or deformation, of the relief device disk The aging effect that is monitored by these inspections is loss of material. Vault Inspections A visual inspection of the accessible areas of the ISFSI Storage Vault liners, coatings, vault lid bolting, and vault lid caulking is performed to determine that no deterioration has occurred, water is not collecting in the vault cells, and that the intended function is not compromised. Parameters monitored or inspected include: • visual evidence of discontinuities, imperfections, and rust staining indicative of corrosion and wear • visual evidence of missing bolts and physical displacement • visual evidence of coating degradation (e.g., blisters, cracking,

Table A-1: HB ISFSI External Surfaces Monitoring AMP	
Element	**Description**
	flaking, delamination) indicative of corrosion of the base material The aging effect that is monitored by these inspections is loss of material.
4. Detection of Aging Effects	A summary of the inspections conducted by this AMP are shown in Table A-3. The method or technique, frequency, sample size, data collection, and timing of inspections are provided for each monitoring activity discussed below. Consistent with the HB ISFSI Technical Specifications, the specified frequency for each inspection is met if it is performed within 1.25 times the interval specified in the frequency, as measured from the previous performance or as measured from the time a specified condition of the frequency is met. <u>Overpack Inspections</u> A visual inspection of the exterior surface of the HI-STAR100 HB Overpacks and HI-STAR HB GTCC Waste Overpack provides a means to detect degradation of these components due to a potential loss of material and confirm that the intended functions are not compromised. The visual overpack inspections are two-fold: • On an annual frequency, visual inspections will be conducted via the cell access port for all six cells. The annual inspection scope includes all HI-STAR 100 HB Overpack and HI-STAR HB GTCC Waste Overpack areas accessible by a standard video probe via the cell access port. The video probe visual resolution will meet VT-3 requirements, however all requirements to qualify this as a VT-3 exam cannot be verified due to configuration limitations. Thus, the annual video probe exam will provide general area observation capable of determining surface conditions. • On a five-year frequency, a vault lid will be removed on one cell for a more thorough inspection. The same vault lid may be removed for each five-year inspection so that results may be trended. The five-year inspection scope will include a VT-3 visual inspection of 100 percent of areas accessible by a standard video probe (without lifting the overpack). The video probe used during the inspections will have sufficient resolution and lighting to identify degradation. These inspections will be implemented prior to November 2024 (one year prior to license expiration). As shown in HB ISFSI FSAR Update, Figure 3.2-1, drain rings (i.e., shims) are located between the overpack bottom plates and vault liner underneath the overpacks. Any evidence of water collection in the bottom of the ISFSI storage vault would be visible during the periodic vault inspections. Because the overpack bottom plates and vault liner are not in direct contact (except where the overpack bottom plate sits on the drain ring), accessible portions of the vault liner and overpacks are indicative of the overpack bottom. Therefore, inspections of these surfaces are not

Table A-1: HB ISFSI External Surfaces Monitoring AMP	
Element	**Description**
	necessary. <u>Vault Inspections</u> A visual surface condition examination is an acceptable method used to identify aging effects and is consistent with methods provided in industry codes and standards. Consistent with the overpack inspections, the visual vault inspections are two-fold: • On an annual frequency, visual inspections will be conducted via the cell access port for all six cells. The annual inspection scope includes all carbon steel, coated vault lids and carbon steel, coated vault cell liners accessible by a standard video probe via the access port. The visual survey should identify evidence of water intrusion, the source of any staining or corrosion-related activity, and the degree of damage. This visual inspection identifies the current condition of the vault and can identify the extent and cause of any aging effect noted. These inspections will be implemented prior to November 2024 (one year prior to license expiration). • On a five-year frequency, a vault lid will be removed on one cell for a more thorough inspection. The five-year inspection scope will include a VT-3 visual inspection of 100 percent of the carbon steel, coated vault lids and carbon steel, coated vault cell liner accessible by a standard video probe. The same vault lid may be removed for each five-year inspection so that results may be trended. A VT-3 inspection of the vault cell steel liner provides a means to determine whether water is collecting in the vault cells, detect degradation of these components due to a potential loss of material, and confirm that the intended functions are not compromised. These inspections will be implemented prior to November 2024 (one year prior to license expiration). 100 percent of the vault lid bolting is inspected on a five-year basis. The visual inspection provides a means to detect degradation of these components due to a potential loss of material and confirm that the intended functions are not compromised. These inspections will be implemented prior to November 2024 (one year prior to license expiration). 100 percent of the caulking sealant around the vault lids is inspected annually to ensure effectiveness. The vault lids caulking inspection is done to identify any gaps, tears, and/or thin spots mostly in the areas between the vault lid itself and the concrete where water is most likely to intrude into the vault cell. These inspections will be implemented prior to November 2024 (one year prior to license expiration). Data from all inspection and monitoring activities, including evidence of degradation and its extent and location, shall be documented on a checklist or inspection form. The results of the inspection shall be documented, including descriptions of observed aging effects and

Table A-1: HB ISFSI External Surfaces Monitoring AMP	
Element	**Description**
	supporting sketches, photographs, or video. Additionally, the HB ISFSI External Surfaces Monitoring AMP requires inspection personnel to be trained and technically qualified to perform these examinations. The personnel evaluating the structural examination results (ISFSI Storage Vault, HI-STAR 100 HB Overpack and HI-STAR HB GTCC Waste Overpack) are degreed engineers with one or more years of structural inspection experience. The personnel evaluating the HI-STAR 100 HB Overpack and HI-STAR HB GTCC Waste Overpack examination results shall be VT-3 certified. The personnel responsible for assessing the type and extent of coating degradation will either (a) possess a NACE Coating Inspector Program Level 2 or 3 inspector qualification; (b) have completed the EPRI Comprehensive Coatings Course; or (c) be qualified as a coatings specialist in accordance with an ASTM standard endorsed in Regulatory Guide 1.54, "Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants."
5. Monitoring and Trending	The baseline will be established prior to the beginning of the period of extended operation. The HB ISFSI External Surfaces Monitoring AMP requires monitoring and trending the condition of structures and components using current and historical operating experience along with industry operating experience to detect, evaluate, and trend degraded conditions. The frequencies of these inspections were developed based on industry operating experience, pre-application inspection results, and NRC adopted standards. In addition, literature research for carbon steel in a marine environment concludes that up to 0.026 inches of wall loss may be experienced over a 5-year period (Reference A5.5), which is less than the calculated wall loss that will not impact the overpack components' intended functions (see Element 6). When degraded conditions are detected and all associated corrective actions are complete, the structures and components are again monitored against established performance goals. The program ensures the original design basis for the structures and components is maintained by effectively managing the applicable aging effects. All observations regarding the material condition of the ISFSI are recorded in inspection procedures. Pictures and video are maintained to allow comparison in subsequent inspections so that the progression of degradation can be evaluated and predicted. To facilitate trending, the same vault cell may be inspected during each five-year cycle. Procedures discuss the required processes for providing timely reporting of OE to the industry via use of the ISFSI AMID. The HB ISFSI External Surfaces Monitoring AMP includes a process used to evaluate past and current conditions of structures and components and to determine whether they represent an adverse trend or random deficiency indicative of normal aging. If degradation exceeds or appears that it will exceed that expected of a properly maintained structure or component, the condition is entered

Table A-1: HB ISFSI External Surfaces Monitoring AMP	
Element	**Description**
	into the Corrective Action Program requiring further engineering evaluation. All degraded conditions that result in a corrective action are trended in accordance with the Corrective Action Program.
6. Acceptance Criteria	The HB ISFSI External Surfaces Monitoring AMP includes acceptance criteria to evaluate the extent of a degraded condition and the need for corrective action before the loss of intended function. The acceptance criteria include sufficient detail to ensure timely detection of any degraded condition, followed by an evaluation in the Corrective Action Program to ensure that the structure or component intended function(s) is maintained under the existing licensing basis design conditions. Industry and plant-specific OE are also reviewed to ensure that the HB ISFSI External Surfaces Monitoring AMP's acceptance criteria focus on conditions identified during these OE reviews. If the below acceptance criteria are not met, the degradation is characterized using nondestructive examination (NDE) methods consistent with PG&E procedures. Instances of degradation are entered into the Corrective Action Program for evaluation and determination of corrective actions (see Element 7). <u>Overpack Inspections</u> The acceptance criteria for all visual inspections of HI-STAR 100 HB Overpacks and the HI-STAR HB GTCC Waste Overpack are the absence of any degradation aging effects listed in LRA Tables 3.5-1 and 3.8-1 which, if left uncorrected could adversely affect the component intended function prior to the next inspection. These include: • no detectable loss of material from the base metal, including uniform wall thinning, localized corrosion pits, and crevice corrosion • no red-orange-colored corrosion products on the base metal, coatings, or concrete • no coating defects (e.g., peeling, delamination, blisters, cracking, flaking, and rusting) • no indications of loose bolts or hardware, displaced parts • no indications of premature rupture, including bubbling or deformation, of the relief device disk Consistent with LR-ISG-2015-01, "Changes to Buried and Underground Piping and Tank Recommendations" (Reference A5.6; Element 6) developed for power plant license renewal, for coated steel components, there is either no evidence of coating degradation, or the type and extent of coating degradation is evaluated as insignificant by an individual: (a) possessing a NACE Coating Inspector Program Level 2 or 3 inspector qualification; (b) who has completed the EPRI Comprehensive Coatings Course; or (c) a coatings specialist qualified in accordance with an ASTM

Table A-1: HB ISFSI External Surfaces Monitoring AMP	
Element	**Description**
	standard endorsed in Regulatory Guide 1.54, "Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants." <u>Vault Inspections</u> The acceptance criteria for all visual inspections of the carbon steel, coated vault liner are the absence of any degradation aging effects listed in LRA Table 3.9-1, which, if left uncorrected could adversely affect the component intended function prior to the next inspection. These include: • no detectable loss of material from the base metal, including uniform wall thinning, localized corrosion pits, and crevice corrosion • no red-orange-colored corrosion products on the base metal, coatings, or concrete • no coating defects (e.g., peeling, delamination, blisters, cracking, flaking, and rusting) • no indications of loose bolts or hardware, displaced parts Consistent with LR-ISG-2015-01, "Changes to Buried and Underground Piping and Tank Recommendations" (Reference A5.6; Element 6) developed for power plant license renewal, for coated steel components, there is either no evidence of coating degradation, or the type and extent of coating degradation is evaluated as insignificant by an individual: (a) possessing a NACE Coating Inspector Program Level 2 or 3 inspector qualification; (b) who has completed the EPRI Comprehensive Coatings Course; or (c) a coatings specialist qualified in accordance with an ASTM standard endorsed in Regulatory Guide 1.54, "Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants." The acceptance criteria of the vault lid bolting is no detectable loss of material from the base metal, including uniform wall thinning, localized corrosion pits, and crevice corrosion, or the type and extent of degradation is evaluated as insignificant by a degreed engineer with one or more years of structural inspection experience. The acceptance criteria for visual inspection of the vault lid caulking is no gaps, tears, and/or thin spots between the vault lid and the concrete. This ensures there is no opportunity for water intrusion.
7. Corrective Actions	The HB ISFSI Corrective Action Program requirements are established in accordance with the requirements of the Quality Assurance Program. The Corrective Action Program procedures require the initiation of a corrective action document for actual or potential problems including failures, malfunctions, discrepancies, deviations, defective material and equipment, nonconformances, and administrative control discrepancies, to ensure that conditions adverse to quality, operability, functionality, and

Table A-1: HB ISFSI External Surfaces Monitoring AMP	
Element	**Description**
	reportability issues are promptly identified, evaluated if necessary, and corrected as appropriate. Guidance on establishing priority and timely resolution of issues is contained within the Corrective Action Program procedure. All corrective actions for deviating conditions that are adverse to quality are performed in accordance with the requirements of the Quality Assurance Program which complies with the requirements of 10 CFR 72, Subpart G. Any resultant maintenance, repair/replacement activities, or special handling requirements are performed in accordance with approved procedures. Corrective actions provide reasonable assurance that deficiencies adverse to quality are either promptly corrected or are evaluated to determine whether there is reasonable assurance that the intended function is maintained until the next inspection frequency. Where evaluations are performed without repair or replacement, engineering analysis reasonably assures that the intended function is maintained consistent with the current licensing basis. If the deviating condition is assessed to be significantly adverse to quality, the cause and extent of the condition is determined and an action plan is developed to preclude recurrence. Corrective actions identify recurring discrepancies and initiate additional corrective actions including root cause analysis to preclude recurrence. Conditions identified by the AMP inspections that do not meet AMP acceptance criteria will be entered into the Corrective Action Program. Actions required to resolve the inspection findings will be tracked to completion and trended within the Corrective Action Program. Although the acceptance criteria is no detectable loss of material from the base metal, an evaluation of the design basis calculations demonstrates that up to 0.125 inches of wall loss over a gross area will not impact the vault liner intended functions. Literature research for carbon steel in a marine environment concludes that, over a 5-year period, up to 0.026 inches of wall loss may be experienced (Reference A5.5).
8. Confirmation Process	The confirmation process is part of the PG&E Corrective Action Program and ensures that the corrective actions taken are adequate and appropriate, have been completed, and are effective. The approved Corrective Action Program complies with the requirements of 10 CFR 72, Subpart G. The focus of the confirmation process is on the follow-up actions that must be taken to verify effective implementation of corrective actions. The measure of effectiveness is in terms of correcting the adverse condition and precluding repetition of significant conditions adverse to quality. Procedures include provisions for timely evaluation of adverse conditions and implementation of any corrective actions required, including root cause evaluations, and prevention of recurrence where appropriate. These procedures provide for tracking, coordinating,

Table A-1: HB ISFSI External Surfaces Monitoring AMP	
Element	**Description**
	monitoring, reviewing, verifying, validating, and approving corrective actions, to ensure effective corrective actions are taken. The Corrective Action Program is also monitored for potentially adverse trends. The existence of an adverse trend due to recurring or repetitive adverse conditions will result in the initiation of corrective action document. The AMP will also uncover unsatisfactory conditions resulting from ineffective corrective action.
9. Administrative Controls	The Quality Assurance Program, associated formal review and approval processes, and administrative controls applicable to the AMP and Aging Management Activities, are implemented in accordance with the requirements of the 10 CFR Part 72, Subpart G. The administrative controls that govern Aging Management Activities at Humboldt Bay ISFSI are established in accordance with the PG&E Administrative Control Program and associated procedures. The administrative controls include provisions that define: • Instrument calibration and maintenance • Inspector requirements • Record retention requirements • Document control The administrative controls define: • methods for reporting results to the NRC per 10 CFR 72.75 • frequency for updating the AMP based on industry-wide operational experience
10. Operating Experience	The HB ISFSI External Surfaces Monitoring AMP has been effective in maintaining ISFSI structures and components. A review of ISFSI operating history provides evidence that any potential aging effects have been identified, evaluated, and managed effectively, ensuring that structures and components remain capable of performing their intended functions. It can be concluded that there is reasonable assurance that these structures and components will continue to perform their intended functions during the period of extended operation. <u>Routine Inspections</u> The Humboldt Bay ISFSI has been in operation since 2008. Inspections of the vault drainage system identified water on the floor in one of the vault cells in 2012, which failed procedure acceptance criteria. An evaluation was undertaken to determine the cause and to implement corrective actions. The evaluation determined that the seals between the vault liners and the vault lids were not fully intact and that allowed rain water to enter. Caulking was added to the vault lid to mitigate against water intrusion. The caulking is currently verified intact by periodic security inspections. Since implementation of this corrective action, no standing water has been

Table A-1: HB ISFSI External Surfaces Monitoring AMP	
Element	**Description**
	identified in the vault cells. As shown in Appendix D, HB ISFSI FSAR Update Section 4.4.3.8 is being revised for the period of extended operation to rely on the annual video probe inspection of the vault accessible areas via the access port to identify corrosion. As discussed in the Humboldt Bay ISFSI FSAR Update Section 3.3.1.3.2, the vault interior temperatures were monitored following loading of the HI-STAR 100 HB overpacks to validate the results of the vault temperature analysis. The monitoring was performed from August 2008 through June 2012. The maximum internal vault temperature seen during monitoring was 113.3°F, which is well below the predicted vault temperature analysis results in the Humboldt Bay ISFSI FSAR Update Table 4.2-10. This data was used in defining the internal ISFSI storage vault environment for use in the AMR process as described in LRA Section 3. <u>Pre-Application Inspections</u> Additional visual inspections of the normally inaccessible external surfaces of the overpacks and vault liner were conducted during a pre-application inspection. See Appendix E for information on the scope and inspections results. <u>Corrective Action Program</u> A review of items in the Corrective Action Program was performed. Minor maintenance items were identified for components which are not within the scope of License Renewal, such as security-related components. As discussed above, inspections of the vault drainage system identified water on the floor in one of the vault cells in 2012, which failed procedure acceptance criteria. The Corrective Action Program was used to evaluate and correct the issue. Since implementation of the corrective action, no standing water has been identified in the vault cells. Other than findings from the Pre-Application Inspection and identification of water in one of the vault cells in 2012, no other issues or findings were noted in the Corrective Action Program database relative to aging of the in-scope ISFSI SSCs. <u>NRC Inspection Reports</u> NRC inspection reports issued during the period of January 1, 2008 through January 15, 2018 were reviewed for the ISFSI site. No issues or findings were noted relative to the ISFSI structures and components. <u>Industry OE</u> EPRI Report 1002882, "Dry Cask Storage Characterization Project - Final Report" (Reference A5.3), indicated the possibility of corrosion of the

Table A-1: HB ISFSI External Surfaces Monitoring AMP	
Element	**Description**
	stainless steel fasteners for the rear breech plate which is located on the bottom of the CASTOR V/21 casks. Although the HB ISFSI does not utilize the CASTOR V/21 cask design, this OE was evaluated for applicability. As described above in Element 4, drain rings (i.e., shims) are located between the HI-STAR HB overpack bottom plates and vault liner underneath the overpacks. Any evidence of significant water collection in the bottom of the ISFSI storage vault would be visible during the periodic vault inspection. Because the overpack bottom plates and vault liner are not in direct contact (except where the overpack bottom plate sits on the drain ring), accessible portions of the vault liner and overpacks are indicative of the overpack bottom. <u>Precedent License Renewal Applications OE</u> A review of precedent ISFSI license renewal applications was performed to evaluate any relevant operating experience. ISFSIs included in this review were Prairie Island, Calvert Cliffs, H. B. Robinson, Surry, North Anna, and Trojan. The results of these reviews informed the pre-application inspection scope, and based on pre-application inspection results, PG&E concluded that the HS ISFSI External Surfaces Monitoring AMP is effective in monitoring and detecting degradation and taking effective corrective actions as needed to preclude loss of intended function. <u>Assessment of AMP Effectiveness</u> The HB ISFSI External Surfaces Monitoring AMP provides reasonable assurance that the ISFSI structures, systems, and components will be managed effectively so that the subcomponents will continue to perform their intended functions during the period of extended operation. PG&E will perform an AMP Effectiveness Review on a five-year frequency. Each AMP Effectiveness Review will include evaluation of AMP documentation (e.g., site procedures, inspection results, internal and external operating experience) compared to each of the ten AMP elements to determine whether the AMP is effectively managing the affects of aging. In addition, an ISFSI Program Health Report will be issued on an annual basis. The Program Health Report will display program health performance metrics, describe issues that impact or may impact program performance, and the actions to address the issues. This report will also evaluate operating experience from the Humboldt Bay ISFSI-specific and industry sources (including the ISFSI AMID) to ensure that this experience is systematically reviewed on an ongoing basis in accordance with the Quality Assurance Program, which meets the requirements of 10 CFR 72, Subpart G. Focused self assessments may also be performed to evaluate specific issues. The Humboldt Bay ISFSI Program Health Report will specifically determine whether the effects of aging are adequately managed. A determination will be made as to whether the frequency of future inspections should be adjusted, whether new inspections should be

Table A-1: HB ISFSI External Surfaces Monitoring AMP	
Element	**Description**
	established, and whether the inspection scope should be adjusted or expanded. If there is an indication that the effects of aging may not be adequately managed, the Corrective Action Program will be used to determine AMP enhancements are necessary. Because the AMP Effectiveness Reviews and Program Health Reports are based, in part, upon site-specific operating experience, but are not providing new age-related information, they are not required to be entered into the ISFSI AMID. However, they will be maintained on-site in an auditable fashion. <u>Conclusion</u> The OE, reviews, and monitoring described above confirm that any potential aging effects will be identified, evaluated, and managed effectively, ensuring that these structures and components remain capable of performing their intended functions.

A.3 ISFSI Reinforced Concrete Structures Program

The Humboldt Bay ISFSI provides for long-term dry fuel interim storage for spent fuel assemblies and GTCC waste until such time that the spent fuel assemblies and GTCC waste may be shipped off-site for final disposition. The casks utilized at the Humboldt Bay ISFSI are the Holtec HI-STAR 100 HB and are designed for outdoor storage.

The purpose of the HB ISFSI Reinforced Concrete Structures AMP is to ensure that concrete ISFSI Storage Vault SSCs are not degraded during the period of extended operation.

A description of the HB ISFSI Reinforced Concrete Structures AMP is provided below in Table A-2 using each attribute of an effective AMP as described in NUREG-1927 (Reference A5.1) and Draft MAPS Report (Reference A5.2) for the renewal of a site-specific Part 72 license. The HB ISFSI Reinforced Concrete Structures AMP is based on the Reinforced Concrete Structure example AMP described in Draft MAPS Report, Section 6.6 (Reference A5.2).

Table A-2: HB ISFSI Reinforced Concrete Structures AMP

Element	Description
1. Scope of Program	The HB ISFSI Reinforced Concrete Structures AMP manages the concrete sub-components exposed to an embedded, soil, or air-outdoor environment requiring aging management as shown in LRA Tables 3.5-1 and 3.9-1 with the following intended functions: • Radiation shielding • Structural integrity The program requires periodic inspection activities that monitor the condition of SSCs within the scope of License Renewal as the method used to manage aging effects and mechanisms listed in LRA Tables 3.5-1 and 3.9-1. The scope of the HB ISFSI Reinforced Concrete Structures AMP includes: 1) Visual inspection of the ISFSI Storage Vault concrete 2) Radiation monitoring to ensure compliance with 10 CFR 72.104 (i.e., dose equivalent requirements beyond the controlled area during normal and off-normal conditions of storage) and to monitor performance of the concrete and HI-STAR Overpack as a neutron/gamma shield at near-system locations as an indicator of shielding material degradation 3) Soil sample analyses in lieu of a groundwater monitoring program to identify conditions conducive to below-grade (underground) aging mechanisms
2. Preventive Actions	Because the HB ISFSI concrete structures were designed and fabricated in accordance with ACI 349-01 (HB ISFSI FSAR Update, Table 3.4-3), the HB ISFSI Reinforced Concrete Structures AMP does not include preventive actions. It is a condition monitoring program to detect evidence of degradation. It does not provide guidance for the prevention of aging.

Table A-2: HB ISFSI Reinforced Concrete Structures AMP	
Element	**Description**
3. Parameters Monitored or Inspected	The parameters monitored by the HB ISFSI Reinforced Concrete Structures AMP are consistent with those identified in industry codes and standards including EPRI Report 1002950, "Aging Effects for Structures and Structural Components (Structural Tools)," EPRI Technical Report 1007933 "Aging Assessment Field Guide," and ACI report 349.3R-18, "Report on Evaluation and Repair of Existing Nuclear Safety-Related Concrete Structures." The parameters included in the program ensure degraded conditions are identified and corrected by clearly defining degraded condition criteria and associated corrective action requirements to prevent the loss of intended function. Industry and site specific OE are also reviewed to ensure that parameters inspected focus on conditions identified during these OE reviews. See LRA Tables 3.5-1 and 3.9-1 for a detailed list of aging effects and mechanisms for structures and components inspected or monitored as required by the HB ISFSI Reinforced Concrete Structures AMP. <u>Vault Inspections</u> A visual inspection of the accessible areas of the ISFSI Storage Vault concrete is performed to determine that no deterioration has occurred and that the intended function is not compromised. Parameters monitored or inspected include: • affected surface area • geometry/depth of defect • cracking, crazing, delaminations, dummy areas • curling, settlements or deflections • honeycombing, bug holes • popouts and voids • exposure of embedded steel • staining evidence of corrosion • dusting, efflorescence of any color The parameters evaluated consider any surface geometries that may support water ponding and potentially increase the rate of degradation. The aging effects that are monitored by these inspections are loss of material, cracking, change in material properties, increase in porosity and permeability, loss of strength, reduction of concrete pH, and loss of concrete/ steel bond. <u>Radiation Monitoring</u> Radiation surveys of the overpack closure plates and vault lids, as well as monitoring via thermoluminescent dosimeters (TLD) at the ISFSI site boundary (as required by FSAR Update Section 7.3.4) are used to verify that the radiation levels and dose rates remain within the specified limits and that the shielding materials in the HI-STAR 100 HB, HI-STAR HB GTCC Waste Overpack, and ISFSI Storage Vault are intact and are effectively performing their shielding intended function. Degradation in the effectiveness of the shielding material would be detected by a

Table A-2: HB ISFSI Reinforced Concrete Structures AMP	
Element	**Description**
	corresponding increase in radiation levels (gamma dose rate and neutron fluence rate). The aging effect that is monitored by this monitoring is cracking. Soil Samples Soil samples are taken to verify that pH, and concentrations of chlorides and sulfates are indicative of non-corrosive soil. Inspections of exposed portions of the below grade concrete are conducted when excavated for any reason. The aging effects that are monitored by these inspections are change in material properties, cracking, loss of material, increase in porosity and permeability, loss of strength, reduction of concrete pH, and loss of concrete/ steel bond.
4. Detection of Aging Effects	A summary of the inspections conducted by this AMP are shown in Table A-3. The method or technique, frequency, sample size, data collection, and timing of inspections are provided for each monitoring activity discussed below. Consistent with the HB ISFSI Technical Specifications, the specified frequency for each inspection is met if it is performed within 1.25 times the interval specified in the frequency, as measured from the previous performance or as measured from the time a specified condition of the frequency is met. Vault Inspections Visual inspections of 100 percent of the accessible above-grade areas of the ISFSI Storage Vault concrete will be conducted with feeler gauges, crack comparators, or other suitable visual quantification methods in accordance with ACI 349.3R-18 every five years to provide a means to detect degradation of these areas due to potential change in material properties, cracking, and loss of material. The ACI 349.3R-18 inspections will include evaluation of settlement. Because the storage vault is an integrated structure with reinforcing steel, settlement measurements on the above-grade areas will be indicative of settlement for the below-grade portions of the structure. These inspections confirm that the intended function is not compromised. These inspections will be implemented prior to November 2024 (one year prior to license expiration). See “soil samples” below for discussion of inaccessible below-grade concrete inspections. Radiation Monitoring On a quarterly basis, a gamma radiation survey is conducted and ISFSI TLD data is collected. The gamma radiation survey includes dose rates at the lid of each vault cell and the general area dose rates at several locations within the HB ISFSI Security Area Fence. The radiation surveys results and ISFSI TLDs are reviewed to verify that the radiation levels remain within the license-specified limits and that the shielding materials in the HI-STAR 100 HB Overpacks, HI-STAR HB GTCC Waste Overpack, and ISFSI Storage Vault are intact and are effectively performing their intended function. Degradation in the shielding material effectiveness

Table A-2: HB ISFSI Reinforced Concrete Structures AMP	
Element	**Description**
	would be detected by a corresponding increase in radiation levels. TLD locations are those credited in the Environmental Monitoring Program, as specified in the FSAR Update, Section 7.7. In addition, a shielding effectiveness survey shall be performed every five years. Calibrated neutron and gamma dose meters with valid energy ranges shall be used to measure the actual neutron and gamma dose rates at the surface of the vault cell lid and the HI-STAR 100 HB Overpack and HI-STAR HB GTCC Waste Overpack closure plates that are accessible during the five-year vault cell inspection. The shielding effectiveness survey locations were chosen to correspond to the calculated dose rates as discussed in the FSAR Update (see Element 6). These surveys will be implemented prior to November 2024 (one year prior to license expiration). <u>Soil Samples</u> Soil samples at a five-year frequency, consistent with ACI 349.3R-18 inspection frequencies, will confirm that soil corrosive conditions will not compromise the intended function of the buried concrete vaults. These soil samples will be implemented prior to November 2024 (one year prior to license expiration). Soil testing will include determination of pH, and concentrations of chlorides and sulfates of soil in the vicinity of the HB ISFSI by a chemical analysis method with a valid measurement range relative to the acceptance criteria and adequate resolution and sensitivity. Examinations of representative samples of the exposed portions of the below grade concrete are conducted when excavated for any reason if conditions exist in accessible areas that could indicate the presence of or result in degradation to inaccessible below-grade concrete structural elements,. For inaccessible below-grade concrete structural elements with aggressive water/soil (pH <5.5, chlorides >500 ppm, or sulfates > 1500 ppm), and/or where the concrete structural elements have experienced degradation, a plant-specific aging management program accounting for the extent of the degradation experienced will be implemented to manage the concrete aging during the PEO. Data from all inspection and monitoring activities, including evidence of degradation and its extent and location, shall be documented on a checklist or inspection form. The results of the inspection shall be documented, including descriptions of observed aging effects and supporting sketches, photographs, or video. Additionally, the HB ISFSI Reinforced Concrete Structures AMP requires inspection personnel to be trained and technically qualified to perform these examinations. Vault inspectors are qualified consistent with ACI 349.3R-18. Personnel reviewing vault concrete inspection results are

Table A-2: HB ISFSI Reinforced Concrete Structures AMP	
Element	**Description**
	licensed civil engineers. Radiation monitoring personnel are qualified in accordance with PG&E radiation protection procedures.
5. Monitoring and Trending	The baseline will be established prior to the beginning of the period of extended operation. The HB ISFSI Reinforced Concrete Structure AMP, requires monitoring and trending the condition of structures and components using current and historical operating experience along with industry operating experience to detect, evaluate, and trend degraded conditions. The frequencies of these inspections were developed based on industry operating experience and NRC adopted standards. When degraded conditions are detected and all associated corrective actions are complete, the structures and components are again monitored against established performance goals. The program ensures the original design basis for the structures and components is maintained by effectively managing the applicable aging effects. All observations regarding the material condition of the ISFSI are recorded in inspection procedures. Pictures and video are maintained to allow comparison in subsequent inspections so that the progression of degradation can be evaluated and predicted. Procedures discuss the required processes for providing timely reporting of operating experience to the industry via use of the ISFSI AMID. The HB ISFSI Reinforced Concrete Structures AMP includes a process used to evaluate past and current conditions of structures and components and to determine whether they represent an adverse trend or random deficiency indicative of normal aging. If degradation exceeds or appears that it will exceed that expected of a properly maintained structure or component, the condition is entered into the Corrective Action Program requiring further engineering evaluation. All degraded conditions that result in a corrective action are trended in accordance with the Corrective Action Program. Trending of concrete inspection results are consistent with defect evaluation guides and standards (e.g., ACI 201.1R, ACI 207.3R, ACI 364.1R, or ACI 224.1R for crack evaluation). Measurements obtained during the shielding effectiveness survey will be compared to the design basis limits for surface dose rates established in the Humboldt Bay ISFSI FSAR Update Chapter 5 and previous measured radiation levels provide a means to detect shielding material degradation of the HI-STAR 100 HB Overpacks, HI-STAR HB GTCC Waste Overpack, and ISFSI Storage Vault and confirm that the intended function is not compromised.
6. Acceptance Criteria	The HB ISFSI Reinforced Concrete Structures AMP includes acceptance criteria to evaluate the extent of a degraded condition and the need for corrective action before the loss of intended function. The acceptance criteria include sufficient detail to ensure timely detection of any degraded

Table A-2: HB ISFSI Reinforced Concrete Structures AMP	
Element	**Description**
	condition, followed by an evaluation in the Corrective Action Program to ensure that the structure or component intended function(s) is maintained under the existing licensing basis design conditions. Industry and plant-specific OE are also reviewed to ensure that the HB ISFSI Reinforced Concrete Structures AMP's acceptance criteria focus on conditions identified during these OE reviews. Vault Inspections The acceptance criteria for all visual inspections of the ISFSI Storage Vault concrete are consistent with those contained in ACI 349.3R-18. American Concrete Institute Standard 349.3R-18 includes quantitative three-tier acceptance criteria for visual inspections of concrete surfaces, namely (1) acceptance without further evaluation, (2) acceptance after review, (3) acceptance requiring further evaluation. Acceptable signifies that a component is free of significant deficiencies or degradation that could lead to the loss of structural support. Acceptable after review signifies that a component contains deficiencies or degradation but will remain able to perform its design basis function until the next inspection or repair. Acceptance requiring further evaluation signifies that a component contains deficiencies or degradation that could prevent (or could prevent prior to the next inspection) the ability to perform their design basis function. Degradations or conditions meeting or exceeding the ACI 349.3R-18 Tier 2 criteria will be entered into the site's Corrective Action Program for evaluation and resolution. Should the site determine there is a need to deviate from the ACI 349.3R-18 acceptance criteria; a technical justification will be fully documented. Although the acceptance criteria from ACI 349.3R-18 will be used for settlement measurements, it should be noted that during the original HB ISFSI licensing review, PG&E provided NRC a response to request for additional information regarding potential settlement of the storage vault (Reference A5.4). Calculations of potential storage vault settlement demonstrated that if the maximum calculated settlement occurred, it would not impact the operation of the ISFSI or retrievability. This conclusion is reflected in Section 5.1.3.2 of the NRC's Safety Evaluation Report. Radiation Monitoring The acceptance criterion for radiation dose rate monitoring of the HI-STAR 100 HB Overpacks, HI-STAR HB GTCC Waste Overpack, and ISFSI Storage Vault is as follows: • Less than 0.15 mrem/hour (150 µrem/hour) dose rate for the external quarterly vault monitoring. This acceptance criterion was established based on the calculated dose rate as discussed in HB ISFSI FSAR Update, Section 7.3.2.1 for meeting the requirements of 10 CFR 20. • Less than 9.9 mrem/hour (9,900 µrem/hour) dose rate for the internal vault monitoring (i.e., at the overpack lid). This acceptance

Table A-2: HB ISFSI Reinforced Concrete Structures AMP	
Element	**Description**
	criterion was established based on the calculated dose rate as discussed in HB ISFSI FSAR Update, Table 7.3-1, Point 4 at the overpack lid for meeting the requirements of 10 CFR 20. Soil Samples Consistent with NUREG-1801, Revision 2, Sections IX.D and IX.F, soil sample acceptance criteria for determination of a non-aggressive environment are as follows: Chloride less than or equal to 500 ppm Sulfate less than or equal to 1500 ppm pH greater than or equal to 5.5
7. Corrective Actions	The HB ISFSI Corrective Action Program requirements are established in accordance with the requirements of the Quality Assurance Program. The Corrective Action Program procedures require the initiation of a corrective action document for actual or potential problems including failures, malfunctions, discrepancies, deviations, defective material and equipment, nonconformances, and administrative control discrepancies, to ensure that conditions adverse to quality, operability, functionality, and reportability issues are promptly identified, evaluated if necessary, and corrected as appropriate. Guidance on establishing priority and timely resolution of issues is contained within the Corrective Action Program procedure. All corrective actions for deviating conditions that are adverse to quality are performed in accordance with the requirements of the Quality Assurance Program which complies with the requirements of 10 CFR 72, Subpart G. Any resultant maintenance, repair/replacement activities, or special handling requirements are performed in accordance with approved procedures. Corrective actions provide reasonable assurance that deficiencies adverse to quality are either promptly corrected or are evaluated to determine whether there is reasonable assurance that the intended function is maintained until the next inspection frequency. Where evaluations are performed without repair or replacement, engineering analysis reasonably assures that the intended function is maintained consistent with the current licensing basis. If the deviating condition is assessed to be significantly adverse to quality, the cause and extent of the condition is determined and an action plan is developed to preclude recurrence. Corrective actions identify recurring discrepancies and initiate additional corrective actions including root cause analysis to preclude recurrence. Conditions identified by the AMP inspections that do not meet AMP acceptance criteria will be entered into the Corrective Action Program. Actions required to resolve the inspection findings will be tracked to completion and trended within the Corrective Action Program.

Table A-2: HB ISFSI Reinforced Concrete Structures AMP	
Element	**Description**
	For concrete inspections not meeting acceptance criteria, the following concrete rehabilitation guides or standards may be used: • cracking: ACI 224.1R, ACI 562, ACI 364.1R, and ACI RAP Bulletins • spalling/scaling: ACI 562, ACI 364.1R, ACI 506R, and ACI RAP Bulletins
8. Confirmation Process	The confirmation process is part of the PG&E Corrective Action Program and ensures that the corrective actions taken are adequate and appropriate, have been completed, and are effective. The approved Corrective Action Program complies with the requirements of 10 CFR 72, Subpart G. The focus of the confirmation process is on the follow-up actions that must be taken to verify effective implementation of corrective actions. The measure of effectiveness is in terms of correcting the adverse condition and precluding repetition of significant conditions adverse to quality. Procedures include provisions for timely evaluation of adverse conditions and implementation of any corrective actions required, including root cause evaluations, and prevention of recurrence where appropriate. These procedures provide for tracking, coordinating, monitoring, reviewing, verifying, validating, and approving corrective actions, to ensure effective corrective actions are taken. The Corrective Action Program is also monitored for potentially adverse trends. The existence of an adverse trend due to recurring or repetitive adverse conditions will result in the initiation of corrective action document. The AMP will also uncover unsatisfactory conditions resulting from ineffective corrective action.
9. Administrative Controls	The Quality Assurance Program, associated formal review and approval processes, and administrative controls applicable to the AMP and Aging Management Activities, are implemented in accordance with the requirements of the 10 CFR Part 72, Subpart G. The administrative controls that govern Aging Management Activities at Humboldt Bay ISFSI are established in accordance with the PG&E Administrative Control Program and associated procedures. The administrative controls include provisions that define: • Instrument calibration and maintenance • Inspector requirements • Record retention requirements • Document control The administrative controls define: • methods for reporting results to the NRC per 10 CFR 72.75 • frequency for updating the AMP based on industry-wide operational experience

Table A-2: HB ISFSI Reinforced Concrete Structures AMP	
Element	**Description**
10. Operating Experience	The HB ISFSI Reinforced Concrete Structures AMP has been effective in maintaining ISFSI structures and components. A review of ISFSI operating history provides evidence that any potential aging effects have been identified, evaluated, and managed effectively, ensuring that structures and components remain capable of performing their intended functions. It can be concluded that there is reasonable assurance that these structures and components will continue to perform their intended functions during the period of extended operation. <u>Routine Inspections</u> The Humboldt Bay ISFSI has been in operation since 2008. In response to NRC Information Notice 2011-20, "Concrete Degradation by Alkali Silica Reaction," Humboldt Bay initiated inspections of the exterior vault concrete. Commercial-grade inspections completed 2012-2017 have identified minor cases of cracking, none of which met the criteria for Alkali Silica Reaction-induced. The minor cracking identified was within the ACI 349.3R-02 Tier 2 criteria and are being monitored and trended annually. Annual vault concrete settlement inspections were also initiated in 2012. The settlement survey results determined that all as-found measurements were within the limits of that expected by the concrete surface roughness (i.e., no measureable settlement). <u>Pre-Application Inspections</u> A radiation survey and visual inspection of the accessible concrete vault surfaces was conducted during a pre-application inspection. See Appendix E for information on the scope and inspections results. <u>Radiation Surveys</u> On a quarterly basis, data from the HB ISFSI TLDs is collected and reviewed to verify that the radiation levels remain within the license-specified limits and that the shielding materials are intact and are effectively performing their intended function. Trending of these dose results shows no evidence that the shielding is degrading. <u>Corrective Action Program</u> A review of items in the Corrective Action Program was performed. Minor maintenance items were identified for components which are not within the scope of License Renewal, such as security-related components. As discussed above, commercial-grade inspections of the vault concrete conducted 2012-2017 identified cracking within the ACI 349.3R-02 Tier 2 criteria. The Corrective Action Program is being used to trend these findings. No other issues or findings were noted in the Corrective Action Program database relative to aging of the in-scope ISFSI SSCs.

Table A-2: HB ISFSI Reinforced Concrete Structures AMP	
Element	**Description**
	NRC Inspection Reports NRC inspection reports issued during the period of January 1, 2008 through January 15, 2018 were reviewed for the ISFSI site. No issues or findings were noted relative to the ISFSI structures and components. Industry OE Industry OE is routinely evaluated for the HB ISFSI. As discussed above in "Routine Inspections," PG&E evaluated and implemented a new recurring inspection program in response to potentially applicable industry OE. Inspection findings are being monitored and trended. Precedent License Renewal Applications OE A review of precedent ISFSI license renewal applications was performed to evaluate any relevant operating experience. ISFSIs included in this review were Prairie Island, Calvert Cliffs, H. B. Robinson, Surry, North Anna, and Trojan. The results of these reviews informed the pre-application inspection scope, and based on pre-application inspection results, PG&E concluded that the HS ISFSI Reinforced Concrete Structures AMP is effective in monitoring and detecting degradation and taking effective corrective actions as needed to preclude loss of intended function. Assessment of AMP Effectiveness The HB ISFSI Reinforced Concrete Structures AMP provides reasonable assurance that the ISFSI structures, systems, and components will be managed effectively so that the subcomponents will continue to perform their intended functions during the period of extended operation. PG&E will perform an AMP Effectiveness Review on a five-year frequency. Each AMP Effectiveness Review will include evaluation of AMP documentation (e.g., site procedures, inspection results, internal and external operating experience) compared to each of the ten AMP elements to determine whether the AMP is effectively managing the affects of aging. In addition, a Program Health Report will be issued on an annual basis. The Program Health Report will display program health performance metrics, describe issues that impact or may impact program performance, and the actions to address the issues. This report will also evaluate operating experience from the Humboldt Bay ISFSI-specific and industry sources (including the ISFSI AMID) to ensure that this experience is systematically reviewed on an ongoing basis in accordance with the Quality Assurance Program, which meets the requirements of 10 CFR 72, Subpart G. Focused self assessments may also be performed to evaluate specific issues. The Humboldt Bay ISFSI Program Health Report will specifically determine whether the effects of aging are adequately managed. A determination will be made as to whether the frequency of future inspections should be adjusted, whether new inspections should be

Table A-2: HB ISFSI Reinforced Concrete Structures AMP	
Element	**Description**
	established, and whether the inspection scope should be adjusted or expanded. If there is an indication that the effects of aging may not be adequately managed, the Corrective Action Program will be used to determine AMP enhancements are necessary. Because the AMP Effectiveness Reviews and Program Health Reports are based, in part, upon site-specific operating experience, but are not providing new age-related information, they are not required to be entered into the ISFSI AMID. However, they will be maintained on-site in an auditable fashion. Conclusion The OE, reviews, and monitoring described above confirm that any potential aging effects will be identified, evaluated, and managed effectively, ensuring that these structures and components remain capable of performing their intended functions.

A.4 Summary

The review of operating experience (obtained from HB ISFSI, previous ISFSI LRAs, and the ISFSI AMID) identified a number of incidents related to dry fuel storage. Although many of these were event-driven and most were not age-related, for those that did involve credible aging effects and mechanisms, evaluations were conducted to assess potential susceptibility. These evaluations indicated that the aging effects and mechanisms that were identified at the Humboldt Bay ISFSI are bounded by the Aging Management Reviews that were performed for those structures and components identified as within the scope of License Renewal.

Operating experience to date has not indicated any degradation that would affect the structures or component intended function(s). Inspections, monitoring, and surveillances continue to be conducted that would identify deficiencies. The Corrective Action Program is in place to track and correct deficiencies in a timely manner. Corrective actions have been effectively implemented when inspection and monitoring results have indicated degradation. Continued implementation of the HB ISFSI AMPs provides reasonable assurance that the aging effects will be managed such that the intended functions will be maintained during the period of extended operation.

Table A-3: AMP Inspections			
SSC	**Method or Technique**	**Frequency**	**Sample Size**
Overpacks and Vault Liners	Visual inspection using standard video probe (meeting VT-3 visual resolution requirements)	Annual ± 25%	100% of areas accessible by a standard video probe via the access port
	Visual inspection using standard video probe (VT-3)	5 Years ± 25%	• Lift lid on one cell; may be same cell each time for trending • 100% of areas accessible

Table A-3: AMP Inspections			
SSC	**Method or Technique**	**Frequency**	**Sample Size**
			by a standard video probe without lifting the overpack (larger inspection scope of accessible areas due to vault lid lift)
Vault Lid Bolting	Visual inspection	5 Years ± 25%	100% vault lid bolting
Vault Lid Caulk	Visual inspection	Annual ± 25%	100% vault lid caulking
ISFSI Storage Vault concrete	Visual inspection in accordance with ACI 349.3R-18, including settlement monitoring	5 Years ± 25%	100% of accessible areas
		Opportunistic	100% of areas that become accessible for any reason
Radiation monitoring	Gamma TLD dose results and dose rate at each vault lid	Quarterly ± 25%	All vault lids; all TLD locations credited in the Environmental Monitoring Program
	Neutron and gamma measurements at each vault cell lid and each overpack lid accessible during the five-year vault cell inspection	5 Years ± 25%	All vault lids; each overpack lid accessible during the five-year vault cell inspection
Soil samples	Chemical analysis	5 Years ± 25%	Representative samples in vicinity of ISFSI
		Opportunistic	Representative samples of exposed portions of below-grade concrete if excavated

A.5 References

A5.1 NUREG-1927, Revision 1, Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel, Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, June 2016. ADAMS Accession No. ML16179A148.

A5.2 Managing Aging Processes in Storage (MAPS) Report, Draft Report for Comment, NUREG-2214, October 2017, Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, ADAMS Accession No. ML17289A237.

A5.3 EPRI Report 1002882, Dry Cask Storage Characterization Project, Final Report, September 2002.

A5.4 PG&E Letter HIL-04-007, Response to NRC Request for Additional Information for the Humboldt Bay Independent Spent Fuel Storage Installation Application (TAC No. L23683), October 1, 2004.

A5.5 Practical Building Conservation: Metals ISBN 13: 9780754645559.

A5.6 License Renewal Interim Staff Guidance LR-ISG-2015-01, Changes to Buried and Underground Piping and Tank Recommendations, January 2016, Nuclear Regulatory Commission. ADAMS Accession No. ML15308A018.

APPENDIX B

GRANTED EXEMPTIONS

B.1 Introduction

An application for a renewed license includes a list of site-specific exemptions granted pursuant to 10 CFR 72.7. The applicant shall provide information pertaining to these granted exemptions and their implication to aging management (Reference B5.1).

B.2 Methodology

A search of docketed NRC incoming and outgoing correspondence, the operating license (Reference B5.2), and the HB ISFSI FSAR Update (Reference B5.3) identified and listed all exemptions in effect. Each exemption in effect was then evaluated to determine whether it affected the HB ISFSI AMP as described in Appendix A.

The search found one 10 CFR 72.7 exemption for the HB ISFSI. This exemption is described in the HB ISFSI FSAR Update, Sections 1.1, 5.3, 9.4.2, NRC correspondence, and is License Condition 16 of the Humboldt Bay ISFSI License SNM-2514. See Section B.3 for the evaluation of its impact to aging management.

B.3 Evaluation

PG&E was granted an exemption from 10 CFR 72.72(d), which requires that spent fuel and high level radioactive waste records in storage be kept in duplicate. The exemption allows PG&E to maintain records of spent fuel and high level radioactive waste in storage either in duplicate, as required by 10 CFR 72.72(d), or alternatively; a single set of records may be maintained at a records storage facility that satisfies the standards of ANSI N45.2.9-1974. All other requirements of 10 CFR 72.72(d) must be met.

This exemption has no implication on aging management because, as discussed in Element 9 of each AMP, the records retention requirements are addressed through administrative controls required by the Humboldt Bay Quality Assurance Program. The implementing HB ISFSI records procedure meets ANSI N45.2.9-1974, and it is credited for implementing the Humboldt Bay Quality Assurance Program.

B.4 Conclusion

There are no implications to the proposed aging management.

B.5 References (Appendix B, Granted Exemptions)

B5.1 NUREG-1927, Revision 1, Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel, Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, June 2016, ADAMS Accession Nos. ML16179A148.

B5.2 Humboldt Bay Independent Spent Fuel Storage Installation Materials License No. SNM-2514 and Appendix, Technical Specifications.

B5.3 PG&E Letter HIL-17-005, Final Safety Analysis Report Update, Revision 6, November 8, 2017. ADAMS Accession Nos. ML17320A148 and ML17320A151 (except 2.6 figures).

APPENDIX C

PROPOSED LICENSE CHANGES

C.1 Proposed License Changes

NUREG-1927, Section 1.4.4 (Reference C2.1), states the LRA shall include changes or additions to technical specifications or to the specific license. A review of the information provided in this LRA and the Humboldt Bay ISFSI Technical Specifications confirms that no changes to the Humboldt Bay ISFSI Technical Specifications are necessary. Proposed changes to the Humboldt Bay ISFSI license (SNM 2514) are listed below.

Proposed changes to the Humboldt Bay ISFSI license (SNM 2514) are shown as electronic markups (deletions crossed out and insertions italicized).

- New license condition 18 would discuss incorporation of the LRA, Appendix D FSAR Update changes into the FSAR Update. The proposed condition would read:

  Within 90 days after issuance of the license, PG&E shall submit an updated SAR to the Commission and continue to update the SAR pursuant to the requirements in 10 CFR 72.70(b) and (c).

  The updated SAR shall include Appendix D, "Final Safety Analysis Report Update Supplement and Changes" as documented in the License Renewal Application (hereinafter referred to as Appendix D). The licensee may make changes to the SAR, including changes to Appendix D, consistent with 10 CFR 72.48(c).

- New license condition 19 would discuss incorporation of the LRA, Appendix D FSAR Update AMP summaries into implementing procedures. The proposed condition would read:

  PG&E shall create, update, or revise procedures for implementing the activities in the Aging Management Programs (AMPs) summarized in Appendix D at least one year prior to the period of extended operation.

  PG&E shall maintain procedures that implement the AMPs throughout the term of this license.

  Each procedure for implementing the AMPs shall contain a reference to the specific AMP provision the procedure is intended to implement. The reference shall be maintained if procedures are modified.

- Existing license condition 18 would be moved to new license condition 20 to discuss the license effective date. The proposed condition would read:

  This *renewed* license is effective as of the date of issuance shown below.

C.2 References

C2.1 NUREG-1927, Revision 1, Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel, Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, June 2016. ADAMS Accession No. ML16179A148.

APPENDIX D

FINAL SAFETY ANALYSIS REPORT UPDATE SUPPLEMENT AND CHANGES

D.1 Introduction

This appendix identifies pertinent changes to the HB ISFSI FSAR Update. Section D.2 of this appendix contains proposed changes to the existing HB ISFSI FSAR Update. Section D.3 of this appendix contains new proposed sections to be added to HB ISFSI FSAR Update Section 9. The new sections provide the scoping results, a table of the AMR results, a summarized description of the HB ISFSI AMPs for managing the effects of aging of ISFSI structures and components, and a summary description of the time-limited aging analyses and conclusions for the period of extended operation. Section D.4 of this appendix contains 10 CFR 72.48 (“Changes, Tests, and Experiments”) changes since last biannual update as required by 10 CFR 72.48(d)(2).

D.2 Changes to Existing HB ISFSI FSAR Update

Proposed changes to the HB ISFSI FSAR Update are shown as electronic markups (deletions crossed out and insertions italicized).

- FSAR Update Section 3.3.2.3: Clarify the design life of the HB ISFSI was evaluated for 60 years of operation. The proposed sentence would read:

  The ***original*** ISFSI design life is 40 years***, but was evaluated for 60 years of operation in accordance with 10 CFR 72.42(a)(1)***.

- FSAR Update Section 3.3.3.2.1: Clarify when the cask transporter was initially used. The proposed sentence would read:

  The cask transporter design life of 20 years ***(from initial use in 2007)*** has been established based on a reasonable length of time for a vehicle of its type with normal maintenance. The cask transporter may be replaced or re-certified for continued use ***as needed and*** at the end of its design life.

- FSAR Update Table 3.4-2: Change the design life of the HI-STAR HB System from 40 years to 60 years. The proposed table line would read:

Design Criterion	Design *Evaluation* Value	Reference Documents
HI-STAR HB System Design Life	~~40~~***60*** years	Holtec HI-STAR 100 FSAR, Section 2.0.1 and Humboldt Bay ISFSI FSAR Section 3.3.2.3

- FSAR Update Table 3.4-3: Clarify the design life of the HB ISFSI storage vault was evaluated for 60 years of operation. The proposed table line would read:

Design Criterion	Design *Evaluation* Value	Reference Documents
Design Life	~~40~~***60*** years	Humboldt Bay ISFSI FSAR Section 3.3.2.3

- FSAR Update Section 4.2.3.3.7: Based on the evaluation of neutron absorber effectiveness described in Section 4.4.1, change the neutron absorber effectiveness from 50 years to 60 years. The proposed sentences would read:

> The HI-STAR HB System is designed such that the fixed neutron absorber (METAMIC®~~**or Boral®**~~) will remain effective for a ~~**50**~~***60***-yr storage period, and there are no credible means to lose the neutron absorber's effectiveness. As discussed in Section ***4.4.1***~~**6.3.2**~~ of the ***HB ISFSI License Renewal Application***~~**HI-STORM 100 System FSAR, as amended by LAR 1014-2**~~, the reduction in Boron-10 concentration due to neutron absorption from storage of design basis fuel in a HI-STAR HB overpack over a ~~**50**~~***60***-year period is expected to be negligible. Further, the analysis in Appendix 3.M.1 of the HI-STAR 100 System FSAR demonstrates that the sheathing, which affixes the neutron absorber panel, remains in place during all credible accident conditions, and thus the neutron absorber panel remains fixed for the life of the Humboldt Bay ISFSI. Therefore, verification of continued efficacy of the neutron absorber is not required. This is consistent with the requirements of 10 CFR 72.124(b).

- FSAR Update Section 4.4.3.8: Based on the proposed annual aging management activities to perform visual inspections of the vault cell interior, add a clarifying statement regarding this commitment for the period of extended operation and remove the statement regarding 20 years of operation. The proposed sentences would read:

> The inspection for water in the vault drain system ~~**will be**~~***was*** performed initially on a monthly basis. The subsequent inspection interval ~~**will be**~~***was*** selected based on the results obtained during the initial 12-month period (selected to bound all seasons). The inspection method ~~**will be**~~***was*** visual inspection of the drain collection point, combined for this initial period with remote camera inspection through the vault viewports. The vault cells are closed and no significant water is expected to be found in the vault cells~~**even after 20 years of operation**~~. ***For the period of extended operation, an annual remote inspection will be conducted via the vault access port to look for evidence of water intrusion.***

- FSAR Update Section 4.6: Clarify the design life of the HB ISFSI Cask System SSCs was evaluated for 60 years of operation. The proposed sentence would read:

> Design Life – The design life of the Cask System SSCs is 40 years***, but was evaluated for 60 years of operation in accordance with 10 CFR 72.42(a)(1)***~~**which is twice the licensed life of the ISFSI of 20 years**~~.

- FSAR Update Section 4.6.1.2: Clarify the design life of the MPC was evaluated for 60 years of operation. The proposed sentence would read:

> Thus, sufficient levels of boron are present in the fuel basket neutron absorbing material to maintain criticality safety functions over the ~~**40**~~***60***-year ***evaluated***~~**design**~~ life of the MPC.

- FSAR Update Section 4.6.4: Clarify the design life of the MPC was evaluated for

60 years of operation. Based on the evaluation of neutron absorber effectiveness described in Section 4.4.1, change the neutron absorber effectiveness from 50 years to 60 years. The proposed sentences would read:

> The effectiveness of the fixed borated neutron absorbing material used in the MPC-HB fuel basket design requires that sufficient concentrations of boron be present to assure criticality safety during worst case design basis conditions over the **~~40~~*60***-year ***evaluated*****~~design~~** life of the MPC…. An evaluation discussed in Section ***4.4.1*****~~6.3.2~~** of the ***HB ISFSI License Renewal Application*****~~HI-STORM 100 System FSAR, as amended by LAR 1014-2~~** demonstrates that the boron depletion in the METAMIC®**~~ and BORAL~~** is negligible over a **~~50~~*60***-year duration. Thus, sufficient levels of boron are present in the fuel basket neutron absorbing material to maintain criticality safety functions over the **~~40~~*60***-year ***evaluated*****~~design~~** life of the MPC.

- FSAR Update Section 4.7.2: Change the HB ISFSI storage period from 40 years to 60 years.

> After decontamination, the only radiological hazard the HI-STAR 100 system may pose is slight activation of the HI-STAR 100 materials caused by irradiation over a **~~40~~*60***-year storage period.

- FSAR Update Table 4.2-4: Clarify the design life of the HI-STAR HB overpack was evaluated for 60 years of operation. The proposed table line would read:

Parameter	***Evaluated* Value**
Design Life	**~~40~~*60*** years

D.3 New HB ISFSI FSAR Update Supplement

The following information will be integrated into HB ISFSI FSAR Update Section 9 to document scoping results, AMR results, and summaries of TLAAs and the HB ISFSI AMPs credited in the HB ISFSI LRA. The information will be located in new ISFSI FSAR Update Section 9.4.3.

9.4.3 License Renewal Aging Management

The HB ISFSI License Renewal Application was submitted to the NRC in 2018. The license renewal (LR) process and methodology followed the guidance contained in NUREG-1927, Revision 1, "Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance." The 10 CFR Part 72 license renewal process, as described in NUREG-1927, follows the principle that the basis for renewal of the license depends on "the continuation of the existing licensing basis throughout the period of extended operation and on the maintenance of the intended functions of the SSCs important to safety." The following subsections document the salient portions of the HB ISFSI License Renewal Application upon which the NRC based their conclusion that the HB ISFSI is safe to continue storing spent fuel for an additional 40 years. Section 9.4.3.1 provides the scoping results. Section 9.4.3.2 provides a table of the aging management review (AMR) results for those in-scope SSCs that require aging management. Section 9.4.3.3 provides a summary of the HB ISFSI aging management programs (AMPs) that will be required to manage aging for the period of extended operation. Section 9.4.3.4 provides a summary description of time-limited aging analyses (TLAAs) and the evaluation conclusions for the period of extended operation.

9.4.3.1 License Renewal Scoping Results

The LR scoping process involves identification of the HB ISFSI SSCs and their subcomponents that are within the scope of license renewal, and thus require evaluation for the effects of long-term aging. The following SSCs were determined to be in the scope of LR:

- Spent fuel assemblies
- Damaged fuel container
- MPC-HB
- HI-STAR 100 HB overpack
- Process waste container
- HI-STAR HB GTCC waste container
- HI-STAR 100 HB GTCC overpack
- ISFSI storage vault

The following SSCs were determined not to be in the scope of LR:

- Cask transportation system*
- Helium fill gas
- Lid retention device
- Loose fuel debris
- Process waste
- GTCC waste
- Security systems
- Fencing
- Electrical power
- Communications systems
- Automated welding system
- MPC forced helium dehydration system
- Overpack vacuum drying system
- Rail dolly
- ISFSI storage vault drainage pipe

* Includes, but is not limited to, the cask transporter, transporter lift links, and transporter connector pins.

9.4.3.2 Aging Management Review Results

An AMR of the ISFSI SSCs was conducted as part of the ISFSI LR process. The AMR assessed aging effects/mechanisms that could adversely affect the ability of the SSCs to perform their intended functions during the period of extended operation. Aging effects, and the mechanisms that cause them, are evaluated for the combinations of materials and environments identified for the subcomponent of the in-scope SSCs based on a review of relevant technical literature, available industry operating experience, and HB ISFSI operating experience. Aging effects that could adversely affect the ability of the in-scope SSC to perform their safety function(s) require additional aging management activity to address potential degradation that may occur during the extended storage period. The TLAAs and AMPs that are credited with managing aging effects during the extended period of operation are discussed in Sections 9.4.3.3 and 9.4.3.4, respectively.

The results of the AMR determined that there were aging effects that require aging management activities for the MPC-HB, HI-STAR 100 HB overpacks, HI-STAR 100 HB GTCC overpack, and ISFSI storage vault. However, there were no aging effects identified for the spent fuel assemblies, damaged fuel container, process waste container, and HI-STAR HB GTCC waste container. Table 9.4-1 provides the AMR results for those SSCs requiring aging management for the period of extended operation.

9.4.3.3 Aging Management Programs

Aging effects that could result in the loss of in-scope SSCs' intended function(s) are managed during the extended storage period. Many aging effects are adequately managed for the extended period of operation using TLAAs, as discussed in Section 9.4.3.4. An AMP is used to manage those aging effects that are not addressed by TLAAs. The AMPs that manage each of the identified aging effects for all in-scope SSCs include the HB ISFSI External Surfaces Monitoring AMP and the HB ISFSI Reinforced Concrete Structures AMP. The purpose of these AMPs is to ensure that the intended functions of SSCs listed in Table 9.4-1 are maintained for the license renewal period.

A summary of the HB ISFSI External Surfaces Monitoring AMP and the HB ISFSI Reinforced Concrete Structures AMP are provided in the sections below:

9.4.3.3.1 HB ISFSI External Surfaces Monitoring AMP

Scope of Program:

- Inspection of external surfaces of the HI-STAR 100 HB Overpacks and HI-STAR HB GTCC Waste Overpack.
- Inspection of the ISFSI Storage Vault cell liners, vault lid bolting, and vault lid caulking.

Preventive Actions:
The program is a condition-monitoring program that does not include preventive actions.

Parameters Monitored or Inspected:

- Visual evidence of discontinuities, imperfections, and rust staining indicative of corrosion and wear.

- Visual evidence of missing bolts and physical displacement.
- Visual evidence of coating degradation (e.g., blisters, cracking, flaking, delamination) indicative of corrosion of the base material.
- Visual evidence of premature rupture, including bubbling or deformation, of the relief device disk.

Detection of Aging Effects:

SSC	Method or Technique	Frequency	Sample Size
Overpacks and Vault Liners	Visual inspection using standard video probe (meeting VT-3 visual resolution requirements)	Annual ± 25%	100% of areas accessible by a standard video probe via the access port
	Visual inspection using standard video probe (VT-3)	5 Years ± 25%	• Lift lid on one cell; may be same cell each time for trending • 100% of areas accessible by a standard video probe without lifting the overpack (larger inspection scope of accessible areas due to vault lid lift)
Vault Lid Bolting	Visual inspection	5 Years ± 25%	100% vault lid bolting
Vault Lid Caulk	Visual inspection	Annual ± 25%	100% vault lid caulking

Data collection: Record of the inspection, including evidence of degradation and its extent and location and supporting photos or videos.

Monitoring and Trending:

- The baseline will be established prior to the beginning of the period of extended operation.
- Degraded conditions are monitored and trended by reviewing the condition of SSCs using current and historical operating experience along with industry operating experience.
- To facilitate trending, the same vault cell may be inspected during each five-year cycle.

Acceptance Criteria:
Overpacks and Vault Liners:

- No detectable loss of material from the base metal, including uniform wall thinning, localized corrosion pits, and crevice corrosion.
- No red-orange-colored corrosion products on the base metal, coatings, or concrete.
- No coating defects (e.g., peeling, delamination, blisters, cracking, flaking, and rusting).
- No indications of loose bolts or hardware, displaced parts.

- No indications of premature rupture, including bubbling or deformation, of the relief device disk.

Vault Lid Bolting:
No detectable loss of material from the base metal, including uniform wall thinning, localized corrosion pits, and crevice corrosion, or the type and extent of degradation is evaluated as insignificant by a degreed engineer with one or more years of structural inspection experience.

Vault Lid Caulk:
No gaps, tears, and/or thin spots between the vault lid and the concrete.

Corrective Actions:
Conditions identified by the AMP inspections that do not meet AMP acceptance criteria will be entered into the Corrective Action Program. Corrective actions provide reasonable assurance that deficiencies adverse to quality are either promptly corrected or are evaluated to determine whether there is reasonable assurance that the intended function is maintained until the next inspection frequency. Where evaluations are performed without repair or replacement, engineering analysis reasonably assures that the intended function is maintained consistent with the current licensing basis. If the deviating condition is assessed to be significantly adverse to quality, the cause of the condition is determined and an action plan is developed to preclude recurrence.

Confirmation Process:
Confirmatory actions, as needed, are implemented as part of the Corrective Action Program.

Administrative Controls:
Administrative controls under the PG&E Quality Assurance Program procedures and Corrective Action Program provide a formal review and approval process.

Operating Experience:
PG&E will perform an AMP Effectiveness Review on a five-year frequency. Each AMP Effectiveness Review will include evaluation of AMP documentation (e.g., site procedures, inspection results, internal and external operating experience) compared to each of the ten AMP elements to determine whether the AMP is effectively managing the affects of aging. In addition, an ISFSI Program Health Report will be issued on an annual basis. The Program Health Report will display program health performance metrics, describe issues that impact or may impact program performance, and the actions to address the issues.

9.4.3.3.2 HB ISFSI Reinforced Concrete Structures AMP

Scope of Program:
- Inspection of the ISFSI Storage Vault concrete.
- Radiation monitoring.
- Soil sample analyses.

Preventive Actions:
The program is a condition-monitoring program that does not include preventive actions.

Parameters Monitored or Inspected:

ISFSI Storage Vault concrete:

- Affected surface area
- Geometry/depth of defect
- Cracking, crazing, delaminations, dummy areas
- Curling, settlements or deflections
- Honeycombing, bug holes
- Popouts and voids
- Exposure of embedded steel
- Staining evidence of corrosion
- Dusting, efflorescence of any color

Radiation monitoring:

- Dose rates

Soil sample analyses:

- pH
- Chloride concentrations
- Sulfate concentrations

Detection of Aging Effects:

Inspection	Method or Technique	Frequency	Sample Size
ISFSI Storage Vault concrete	Visual inspection in accordance with ACI 349.3R-18, including settlement monitoring	5 Years ± 25%	100% of accessible areas
		Opportunistic	100% of areas that become accessible for any reason
Radiation monitoring	Gamma TLD dose results and dose rate at each vault lid	Quarterly ± 25%	All vault lids; all TLD locations credited in the Environmental Monitoring Program
	Neutron and gamma measurements at each vault cell lid and each overpack lid accessible during the five-year vault cell inspection	5 Years ± 25%	All vault lids; each overpack lid accessible during the five-year vault cell inspection
Soil samples	Chemical analysis	5 Years ± 25%	Representative samples in vicinity of ISFSI
		Opportunistic	Representative samples of exposed portions of below-grade concrete if excavated

Data collection: Record of the inspection, including evidence of degradation and its extent and location and supporting photos or videos.

Monitoring and Trending:

- The baseline will be established prior to the beginning of the period of extended operation.
- Degraded conditions are monitored and trended by reviewing the condition of SSCs using current and historical operating experience along with industry operating experience.

Acceptance Criteria:
ISFSI Storage Vault concrete:

- Consistent with the three-tier acceptance criteria contained in ACI 349.3R-18.
- Degradations or conditions meeting or exceeding the ACI 349.3R-18 Tier 2 criteria will be entered into the Corrective Action Program for evaluation and resolution.
- Should the site determine there is a need to deviate from the ACI 349.3R-18 acceptance criteria; a technical justification will be fully documented.

Radiation monitoring:

- Less than 0.15 mrem/hour (150 µrem/hour) dose rate for external quarterly vault monitoring (based on the calculated dose rate as discussed in Section 7.3.2.1).
- Less than 9.9 mrem/hour (9,900 µrem/hour) dose rate for the internal vault monitoring (i.e., at the overpack lid) (based on the calculated dose rate as discussed in Table 7.3-1, Point 4 at the overpack lid).

Soil sample analyses:
A soil sample is non-aggressive if:

Chloride	less than or equal to 500 ppm
Sulfate	less than or equal to 1500 ppm
pH	greater than or equal to 5.5

Corrective Actions:
Conditions identified by the AMP inspections that do not meet AMP acceptance criteria will be entered into the Corrective Action Program. Corrective actions provide reasonable assurance that deficiencies adverse to quality are either promptly corrected or are evaluated to determine whether there is reasonable assurance that the intended function is maintained until the next inspection frequency. Where evaluations are performed without repair or replacement, engineering analysis reasonably assures that the intended function is maintained consistent with the current licensing basis. If the deviating condition is assessed to be significantly adverse to quality, the cause of the condition is determined and an action plan is developed to preclude recurrence.

Confirmation Process:
Confirmatory actions, as needed, are implemented as part of the Corrective Action Program.

Administrative Controls:
Administrative controls under the PG&E Quality Assurance Program procedures and Corrective Action Program provide a formal review and approval process.

Operating Experience:
PG&E will perform an AMP Effectiveness Review on a five-year frequency. Each AMP Effectiveness Review will include evaluation of AMP documentation (e.g., site procedures, inspection results, internal and external operating experience) compared to each of the ten AMP elements to determine whether the AMP is effectively managing the affects of aging. In addition, an ISFSI Program Health Report will be issued on an annual basis. The Program Health Report will display program health performance metrics, describe issues that impact or may impact program performance, and the actions to address the issues.

9.4.3.4 Time-Limited Aging Analyses

10 CFR 72.42(a)(1) requires that an applicant for a renewed ISFSI license identify TLAAs and evaluate them for the period of extended operation. A comprehensive review to identify the TLAAs for the in-scope SSCs of the HB ISFSI was performed to determine the analyses that could be credited with managing aging effects over the period of extended operation. The TLAAs identified involved the in-scope SSCs, considered the effects of aging, involved explicit time-limited assumptions, provided conclusions regarding the capability of the SSC to perform its intended function through the operating term, and were contained or incorporated in the licensing basis. The following TLAAs have been identified and evaluated for the HB ISFSI and are summarized below.

9.4.3.4.1 Neutron Absorber and Shielding Depletion

To support the 60-year storage duration for license renewal, neutron flux and fluence values for depletion of Boron-10 from the original 50-year neutron absorbing and shielding materials analysis were conservatively scaled up by a factor of 6/5 (60 years/50 years). The analysis concludes that the total depletion of Boron-10 over a 60-year period remains negligible (less than $5x10^{-10}$ of total Boron-10 atoms depleted). The TLAA for neutron absorber (METAMIC®) and shielding (Holtite) depletion has been projected to 60 years and is therefore valid to the end of the period of extended operation in accordance with TLAA disposition (ii).

9.4.3.4.2 Fatigue of the Overpack Closure Bolts and Threads

The HB ISFSI FSAR incorporates the HI-STAR 100 FSAR by reference. As discussed in the generic analysis of the HI-STAR 100 System, fatigue analyses of the overpack closure bolts and closure bolt threads were performed in accordance with ASME Code, Section III.

For a design life of 40 years, the HI-STAR 100 System FSAR fatigue analyses determined that the allowable number of torqueing/untorquing cycles for the overpack closure bolts is 166. For a design life of 40 years, it was determined that the allowable number of torqueing/untorquing cycles for the overpack closure bolt threads is 3,950. The TLAA evaluation will use the limiting number of cycles of 166.

Based on torqueing/untorquing cycles to-date, the torqueing/untorquing cycles associated with the overpack closure bolts/threads have been projected to 40 cycles during 60 years of operation. 40 cycles remains significantly below the calculated cycle limit of 166. Therefore, the overpack closure bolts will be valid to the end of the period of extended operation in accordance with TLAA disposition (ii).

TABLE 9.4-1

LICENSE RENEWAL AGING MANAGEMENT REVIEW RESULTS FOR COMPONENTS REQUIRING AGING MANAGEMENT

Subcomponent	Aging Effect	Aging Mechanism	Aging Management
MPC-HB (PG&E Drawing 6023993-24)			
Neutron Absorber	Loss of Criticality Control	Boron Depletion	TLAA will be valid to the end of the period of extended operation in accordance with TLAA disposition (ii) – see Section 9.4.3.4.1
HI-STAR HB Overpack (PG&E Drawing 6023993-14)			
Bottom Plate	Loss of Material	Crevice, Galvanic, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Port Plugs	Loss of Material	Crevice, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Port Covers	Loss of Material	Crevice, Galvanic, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Port Cover Bolts	Loss of Material	Crevice, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Top Flange	Loss of Material	Crevice, Galvanic, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Flange Overlay	Loss of Material	Crevice, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Toe Ring Plate	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Neutron Cover Plate	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Neutron Rib	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Rupture Plate	Loss of Material	Crevice, Galvanic, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Rupture Side	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Rupture Disk	Loss of Material	Crevice, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Top Ring Plate	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP

Subcomponent	Aging Effect	Aging Mechanism	Aging Management
Neutron Shield	Cracking	Radiation Embrittlement	HB ISFSI Reinforced Concrete Structures AMP
	Loss of Shielding	Boron Depletion	TLAA will be valid to the end of the period of extended operation in accordance with TLAA disposition (ii) – see Section 9.4.3.4.1
Closure Plate	Loss of Material	Crevice, Galvanic, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Closure Plate Overlay	Loss of Material	Crevice, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Closure Plate Bolts	Cracking	Fatigue	TLAA will be valid to the end of the period of extended operation in accordance with TLAA disposition (ii) – see Section 9.4.3.4.2
HI-STAR HB GTCC Overpack (PG&E Drawing 6023993-27)			
Bottom Plate	Loss of Material	Crevice, Galvanic, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Shell	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Top Flange	Loss of Material	Crevice, Galvanic, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Lifting Trunnion	Loss of Material	Crevice, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Intermediate Shells	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Toe Ring Plate	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Closure Lid	Loss of Material	Crevice, Galvanic, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
ISFSI Storage Vault (PG&E Drawing 6023993-54)			
Vault Shell Base Plate	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP

Subcomponent	Aging Effect	Aging Mechanism	Aging Management
Vault Shell	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Vault Shell Lid Ring	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Vault Shell Drain Ring	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Vault Shell Anchor Block	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Vault Shell Gusset	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Vault Shell Stop Plates	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Vault Shell Guide Plates	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Vault Shell Alignment Plates (Seismic Restraints)	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Vault Lid Base and Top Plates	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Vault Lid Center Bar	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Vault Lid Outer Shell	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Vault Lid Rib Plate	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Vault Lid Bolts	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP
Vault Lid Washers	Loss of Material	Crevice, General, Pitting Corrosion	HB ISFSI External Surfaces Monitoring AMP

Subcomponent	Aging Effect	Aging Mechanism	Aging Management
Vault Lid View Port Plug	Change in Material Properties	Leaching of $Ca(OH)_2$	HB ISFSI External Surfaces Monitoring AMP
	Cracking	Aggressive Chemical Attack	HB ISFSI External Surfaces Monitoring AMP
		Differential Settlement	
		Freeze-Thaw	
		Reaction with Aggregates	
	Increase in Porosity and Permeability	Leaching of Calcium Hydroxide	HB ISFSI External Surfaces Monitoring AMP
	Loss of Material	Aggressive Chemical Attack	HB ISFSI External Surfaces Monitoring AMP
		Freeze-Thaw	
		Salt Scaling	
	Loss of Strength	Aggressive Chemical Attack	HB ISFSI External Surfaces Monitoring AMP
		Leaching of Calcium Hydroxide	
		Reaction with Aggregates	
	Reduction of concrete pH	Aggressive Chemical Attack	HB ISFSI External Surfaces Monitoring AMP
		Leaching of Calcium Hydroxide	
ISFSI Vault	Change in Material Properties	Leaching of $Ca(OH)_2$	HB ISFSI Reinforced Concrete AMP
	Cracking	Aggressive Chemical Attack	HB ISFSI Reinforced Concrete AMP
		Differential Settlement	
		Freeze-Thaw	
		Reaction with Aggregates	
	Increase in Porosity and Permeability	Leaching of Calcium Hydroxide	HB ISFSI Reinforced Concrete AMP
	Loss of Material	Aggressive Chemical Attack	HB ISFSI Reinforced Concrete AMP
		Freeze-Thaw	
		Salt Scaling	

Subcomponent	Aging Effect	Aging Mechanism	Aging Management
	Loss of Strength	Aggressive Chemical Attack	HB ISFSI Reinforced Concrete AMP
		Leaching of Calcium Hydroxide	
		Reaction with Aggregates	
	Reduction of concrete pH	Aggressive Chemical Attack	HB ISFSI Reinforced Concrete AMP
		Leaching of Calcium Hydroxide	
	Change in Material Properties	Leaching of $Ca(OH)_2$	HB ISFSI Reinforced Concrete AMP
	Cracking	Aggressive Chemical Attack	HB ISFSI Reinforced Concrete AMP
		Differential Settlement	
		Freeze-Thaw	
		Reaction with Aggregates	
	Increase in Porosity and Permeability	Leaching of Calcium Hydroxide	HB ISFSI Reinforced Concrete AMP
		Microbiological Degradation	
	Loss of Material	Aggressive Chemical Attack	HB ISFSI Reinforced Concrete AMP
		Freeze-Thaw	
		Microbiological Degradation	
		Salt Scaling	
	Loss of Strength	Aggressive Chemical Attack	HB ISFSI Reinforced Concrete AMP
		Leaching of Calcium Hydroxide	
		Microbiological Degradation	
		Reaction with Aggregates	
	Reduction of concrete pH	Aggressive Chemical Attack	HB ISFSI Reinforced Concrete AMP
		Leaching of Calcium Hydroxide	
		Microbiological Degradation	
	Cracking	Corrosion of Reinforcing Steel	HB ISFSI Reinforced Concrete AMP
	Loss of Concrete/ Steel Bond		

Subcomponent	Aging Effect	Aging Mechanism	Aging Management
	Loss of Material		
	Loss of Strength		

D.4 10 CFR 72.48 Changes Since the Last Biannual HB ISFSI FSAR Submittal

As of January 30, 2018, there have been no 10 CFR 72.48 changes made to the HB ISFSI FSAR Update since the last biannual submittal.

APPENDIX E

PRE-APPLICATION INSPECTION REPORT

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Executive Summary

To support Humboldt Bay (HB) Independent Spent Fuel Storage Installation (ISFSI) License Renewal (LR) in accordance with Nuclear Regulatory Commission (NRC) guidance, PG&E performed a pre-application inspection of the HB ISFSI. The pre-application inspection included a borescope inspection via the vault access ports for all vault cells (completed in March 2017), a detailed inspection of 1 of 6 vault cells at the HB ISFSI (completed in August 2017), soil sampling (completed in November 2016), and concrete vault and settlement inspection (completed March 2018).

The inspection results demonstrated that the HB ISFSI is in overall good condition. The following items were entered into Corrective Action Program (CAP) for evaluation and determination of corrective actions. Conditions did not indicate a challenge to the proposed inspection frequency.

1. Cell 1 Vault Closure Lid Bolting – HB SAPN 1433249
2. Cell 6 Vault Closure Lid Bolting – HB SAPN 1433270
3. Cell 2 Vault Closure Lid – HB SAPN 1433133
4. Cell 2 Overpack – HB SAPN 1433272
5. Cell 2 Liner Rust Specks – HB SAPN 1433273
6. Cell 2 Vault Closure Lid Bolt Washers – HB SAPN 1433450
7. Vault Concrete Inspection: >Tier 1 Findings – CAP 114406201
8. Vault Concrete Inspection: >Tier 2 Findings – CAP 114406209

While the conditions entered into CAP do not prevent the systems, structures, or components (SSCs) from performing their intended function, the information will be evaluated and used for future trending. Based on review of the inspection results, the aging effects discussed in the LR Application (LRA) are appropriately identified. In response to the pre-application inspection findings, the HB ISFSI External Surfaces Monitoring Aging Management Program (AMP) in LRA, Appendix A was modified to include inspection of all vault closure lid bolts on a five-year frequency. The AMPs proposed in LRA Appendix A will adequately manage the aging associated with the HB ISFSI and will be modified, as necessary, based on future inspection results.

The following document describes the inspection background, methodology, and results, and is laid out with hyperlinks and photos for ease of navigation between text and photos in the attachments.

E.1 Purpose

In accordance with NUREG-1927, Revision 1, Section 3.4.1.2, the applicant for an ISFSI license renewal may choose to verify the condition of the system and demonstrate that SSCs within the scope of the LRA have not undergone unanticipated aging and degradation prior to entering the period of extended operation (PEO). If the system inspection reveals unanticipated aging or degradation, then the applicant would need to address the condition of the SSCs in the LRA.

The pre-application inspection is an important element in an operations-focused aging management approach and provides valuable operating experience. The results from the pre-application inspection will be used to develop detailed AMPs, including inspection and maintenance frequencies, and provide a baseline for the monitoring and trending element of AMPs in the PEO.

In response to NUREG-1927 guidance, PG&E performed a pre-application inspection of the HB ISFSI to support LR efforts. The pre-application inspection included a borescope inspection via the vault access ports for all vault cells (completed in March 2017), a detailed inspection of 1 of 6 vault cells at the HB ISFSI (completed in August 2017), soil sampling (completed in November 2016), and concrete vault and settlement inspection (completed March 2018).

E.2 Site Description

The Holtec HI-STAR 100 HB System is licensed for use at the HB ISFSI. This system is a modified version of the generically-licensed HI-STAR 100 System. The HB ISFSI is comprised of an underground vault with six concrete cells with steel liners. Vault cells 1-5 contain spent fuel stored in HI-STAR 100 HB Overpacks. Vault cell 6 contains greater-than-class C (GTCC) waste stored in a HI-STAR HB GTCC Overpack. Vault cell 1 is on the plant west side of the ISFSI and vault cell 6 is on the plant east side of the ISFSI. As shown in Figure 1, each cell is comprised of a storage vault that houses the storage casks. Each multi-purpose canister is housed in a storage cask (also referred to as overpack) that is lowered into the storage vault.

The vaults are closed off from weather by bolted, caulked vault lids. Each cell contains a drainage system in the event of water intrusion. The inner surface of the vault cell is covered by a zinc clad coated, carbon steel liner, except for a small grouted area surrounding the vault drain which provides a slope/funnel to the drain cover. As shown in Figure 2, while the vault lid is installed, overpack access is limited to a 3-inch access port. The 3-inch access port opening is further restricted by a seismic shim just underneath the access port.

Figure 1: Cut-A-Way View of HB ISFSI Storage Vault

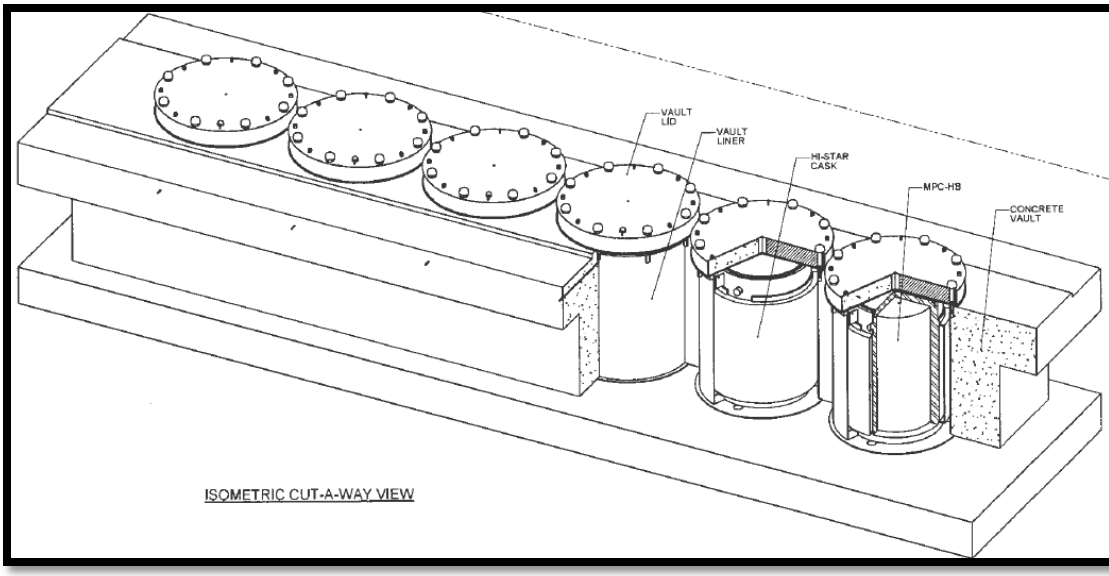


Figure 2: HB ISFSI Storage Vault in Storage Configuration (Looking Plant East)

E.3 Scope Determination

License Renewal Scoping Results
The HB ISFSI license renewal process and methodology follows the guidance contained in NUREG-1927, "Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance." A description of the scoping process is provided in LRA Section 2.2, Scoping Methodology, and the results are provided in LRA Section 2.3, Scoping Results.

The SSCs comprising the HB ISFSI are identified in Table 2-1, Scoping Results. The spent fuel assemblies, damaged fuel container, HI-STAR HB multi-purpose canister (MPC), HI-STAR 100 HB Overpack, ISFSI Storage Vault, HI-STAR HB GTCC Overpack, GTCC Waste Container, and Process Waste Container were determined to be within the scope of license renewal and to require further review in the aging management review (AMR) process.

LRA Chapter 3 describes the AMR process that was conducted as part of the ISFSI License Renewal process. The AMR addresses aging effects and aging mechanisms that could affect the ability of the structures or components to perform their intended function during the period of extended operation. The results of the AMR demonstrated that there were aging effects that require aging management activities for the HI-STAR 100 HB overpacks, HI-STAR 100 HB GTCC overpack, and ISFSI storage vault. However, based on NRC guidance, there were no aging effects identified for the spent fuel assemblies, MPC-HB, damaged fuel canister, process waste container, and HI-STAR HB GTCC waste container.

Pre-Application Inspection Scope Determination
The pre-application inspection scope included those types of SSCs that have aging effects that require aging management. As discussed below, the specific SSCs chosen for inspection were based on site-specific conditions, operating experience, system design, material combinations, and operating parameters that may contribute to aging and degradation. Considering the results of the AMR and the degradation mechanism(s) of concern for the in-scope SSCs, the system components selected for a lead inspection are the ISFSI Storage Vault, HI-STAR 100 HB Overpack, and HI-STAR HB GTCC Overpack.

The vault cell that should be chosen for the detailed inspection would be that which is most-likely to show degradation (i.e., the vault cell that has been stored the longest, with the most aggressive environment, initial heat load, etc.). The following information is known on the vault cells:

- Cells #1-5 are each of the same design and layout, contain HI-STAR 100 HB systems of the same materials, and each contain approximately the same heat load of 1.9 kW. Thus, there are no differences in the material and environments in which potential aging effects may occur.
- Cells #1-5 were each loaded within eight months of each other. Thus, age is of minimal consideration.
- Operating experience reviews indicate that vault cell #2 is the only cell that experienced water intrusion since initial loading. Although the water intrusion has been corrected, this vault cell is the most-likely to have experienced long-term aging effects.

To determine the condition of each vault cell and provide additional insight as to which vault cell may be the most susceptible to degradation, a borescopic exam was conducted via the access port. The borescope inspection was a visual exam of the components accessible by a standard articulating borescope of the coated vault interior liners, and exterior portions of the coated HI-STAR 100 HB Overpacks and HI-STAR HB GTCC Overpack.

The borescope exam results indicated that the coated casks and vault liners are in good condition and that the condition was not noticeably different between the vault cells (Attachment 8 contains a copy of the Boroscope Inspection Report). While several overpacks had slight mechanical markings (such as scuff marks) from the initial ISFSI loading, cell #2 contained more than the others. Because of the similar condition of all cells, but the additional mechanical markings noted in cell #2 and previous operating experience with previous water intrusion, cell #2 was chosen as the "leading" vault cell to be inspected. Figure 3 provides an aerial view of the HB ISFSI with vault cell #2 identified.

Figure 3: HB ISFSI Aerial View with Vault Cell #2 Identified

E.4 Inspection Scope

PG&E conducted inspections, as summarized in Table 1, which are collectively credited for the License Renewal Pre-Application Inspection. Section E.5 discusses the methodology used for each of the below inspections.

Table 1: Summary of Pre-Application Inspection Items

SSC	Inspection/Test	Inspection Scope or Details
Vault Cell # 1, 3, 4, 5, 6: Vault Liner and Overpack Exterior	Borescope	Visual inspection of areas accessible by a standard articulating borescope via the access port. Provides general area observation capable of determining surface conditions and indications of standing water.
Vault Cell # 2: Vault Liner and Overpack Exterior	Borescope	Visual inspection of areas accessible by a standard articulating borescope via the access port. Provides general area observation capable of determining surface conditions and indications of standing water.
	Detailed Inspection	Lift lid on vault cell; VT-3 inspection of 100 percent areas accessible while in the storage configuration; includes inspection of the overpack relief devices and bottom of vault lid
Vault Lid Bolting (All Vault Cells)	Visual verification	Engineering visual inspection
Vault Lid Caulk (All Vault Cells)	Visual verification	Engineering visual inspection
Vault Exterior Concrete	Visual verification	ACI 349 engineering inspection of above-grade accessible concrete, including settlement monitoring
Shielding	Radiation monitoring	Dose rate at each vault lid
		Dose rate measurements at cell # 2 overpack lid when the vault closure lid is removed
Soil	Soil sampling	Chemical analysis of pH, and concentrations of chlorides and sulfates of soil in the vicinity of the HB ISFSI

E.5 Inspection Methodology

This section discusses the methodologies, acceptance criteria, and inspection details that are associated with each item listed in Table 1. Inspection findings resulting from these methodologies are presented in Section E.6.

E.5.1 Borescope Exam – All Vault Cells via Access Ports

As discussed in Section E.3, the borescope inspection was a visual exam of the components accessible by a standard articulating borescope of the coated vault interior liners, and exterior portions of the coated HI-STAR 100 HB Overpacks and HI-STAR HB GTCC Overpack. Due to the configuration restrictions, the extent of the examination is estimated to be 5 percent of the exterior surface of the overpack and 5 percent of the interior surface of the vault liner for each vault cell.

Consistent with the draft Managing Aging Processes in Storage (MAPS) Report, dated October 2017, the following acceptance criteria for external surfaces monitoring were used during the inspection:

- no detectable loss of material from the base metal, including uniform wall thinning, localized corrosion pits, and crevice corrosion
- no red-orange-colored corrosion products on the base metal, coatings, or concrete
- no coating defects (e.g., peeling, delamination, blisters, cracking, flaking, and rusting)
- no indications of loose bolts or hardware, displaced parts

In addition, the vault cells were examined for indications of standing water, and the cask vendor, Holtec, recommended the following additional acceptance criterion for the relief devices on the HI-STAR 100 HB Overpacks: no indications of premature rupture, including bubbling or deformation, of the relief device disk.

The inspection was performed by In-Service Inspection (ISI) engineering personnel and results were reviewed by VT-3 certified personnel. Inspection results were additionally reviewed by a qualified coating specialist (DCPP Nuclear Coating Inspector Level III) that holds a NACE Coating Inspector Program Level III certification with nuclear endorsement.

E.5.2 Detailed Vault Cell #2 Inspection – Vault Closure Lid Removed, Overpack Inspection In-Situ

The detailed inspection of vault cell #2 was conducted in accordance with DCPP Procedure NDE VT 3-2 Revision 2, “Visual Examination of Component Interiors,” for a VT-3 exam of the components accessible after removal of the vault closure lid (leaving the overpack in-place). The detailed inspection examined the coated vault interior liner (including the vault floor drain cover) and exterior of the coated HI-STAR 100 HB Overpack (including the overpack relief devices). Direct visual examinations were conducted for the upper portions of the overpack, overpack lid, upper portions of the liner, upper seismic shims, and the entire vault closure lid. Remote visual examinations were conducted for the remainder of the accessible areas by using a magnetic crawler for the vertical portions of the overpack and vault liner or a camera on an extension pole for the lowest portions of the vault and overpack.

Due to the configuration restrictions, the extent of the examination is estimated to be 98.5 percent of total accessible surface area (see calculation of percentage inspected of total accessible surface area in Attachment 1). Non-accessible areas include the overpack bottom, vault liner under the overpack, and vault liner behind the seismic shims/supports. As shown in FSAR Figure 3.2-1, drain rings (i.e., shims) are located between the overpack bottoms and vault liner underneath the overpacks. Any water intrusion into the vault would either enter the vault drain or pond on the vault liner floor. However, there would be no long-term water contact with any components since annual vault inspections would identify and correct any remaining water ponding. In addition, because the overpacks and vault liner are not in direct contact (except where the overpack bottom plate sits on the drain ring), the same environment exists at the overpack bottom and vault liner underneath the overpacks, as the remainder of the vault liner and overpack surface (i.e., vault air). Thus, accessible portions of the vault liner and overpacks are indicative of the overpack bottom, and inspections of these surfaces are not necessary.

Consistent with the draft MAPS Report, dated October 2017, the following acceptance criteria for external surfaces monitoring were used during the inspection (same as that used for the borescope inspections):

- no detectable loss of material from the base metal, including uniform wall thinning, localized corrosion pits, and crevice corrosion
- no red-orange-colored corrosion products on the base metal, coatings, or concrete
- no coating defects (e.g., peeling, delamination, blisters, cracking, flaking, and rusting)
- no indications of loose bolts or hardware, displaced parts

In addition, the vault cell was examined for indications of standing water, and the cask vendor, Holtec, recommended the following additional acceptance criterion for the relief devices on the HI-STAR 100 HB Overpack: no indications of premature rupture, including bubbling or deformation, of the relief device disk.

While the vault drainage system located in the floor of the vault liner is not within the scope of License Renewal and is not important to safety because of a defense-in-depth design, the inspection included an acceptance criterion to ensure the drain cover was not blocked. This acceptance criterion was added to the detailed inspection based on the unclear results from the borescope inspection (i.e., due to the access restrictions, it was inconclusive whether the drain holes were blocked or not).

The inspection was performed by VT-3 certified personnel. Inspection results were additionally reviewed by a qualified coating specialist (DCPP Nuclear Coating Inspector Level III) that holds a NACE Coating Inspector Program Level III certification with nuclear endorsement.

Inspection Preparations and Equipment

Mockup testing was completed prior to the actual inspection to mimic the dimensions between the vault liner and overpack. Based on this mockup testing, it was determined that two inspection magnetic crawlers (Nanomag™ Magnetic Crawler System – see Figure 4) would be used – one to examine the overpack and one to examine the vault liner. Because the vault cells are approximately 10’ deep with only 5.5” of clearance for maneuverability, the remote inspection and magnetic capability of the Nanomag crawler was determined to be an appropriate tool to facilitate the inspection.

The mockup was used to determine crawler resolution and the resultant field of view. The crawler houses separate front and rear cameras, with the front camera utilized for VT-3 examination and the rear camera for navigation. Based upon this mockup testing, the circumference of the vault liner and overpack circumference was divided into 80 scan lines to ensure adequate overlap between scan passes with the resultant field of view (scan lines are discussed in more detail below). To ensure the crawlers follow these scan lines, two fixtures were designed, fabricated, and affixed to the top flange plugs in the overpack lid. One fixture was created for the overpack exam and another fixture created for the vault liner exam. Each fixture supports two plumb bobs that provide visual guidance for the crawlers and aligns with two of the 80 scan passes. The fixtures are then indexed to examine the next two passes until all 80 passes have been examined. Figure 5 shows one of the fabricated fixtures that were used to ensure scan lines were properly adhered to. See additional photos of the fixtures and crawler in Attachment 2 (photos 1-4)

The examination of the overpack was performed with a crawler placed on the vault liner looking across at the overpack. The examination of the vault liner surface was performed with a crawler placed on the overpack looking across at the vault liner.

Figure 4: Nanomag™ Magnetic Crawler System

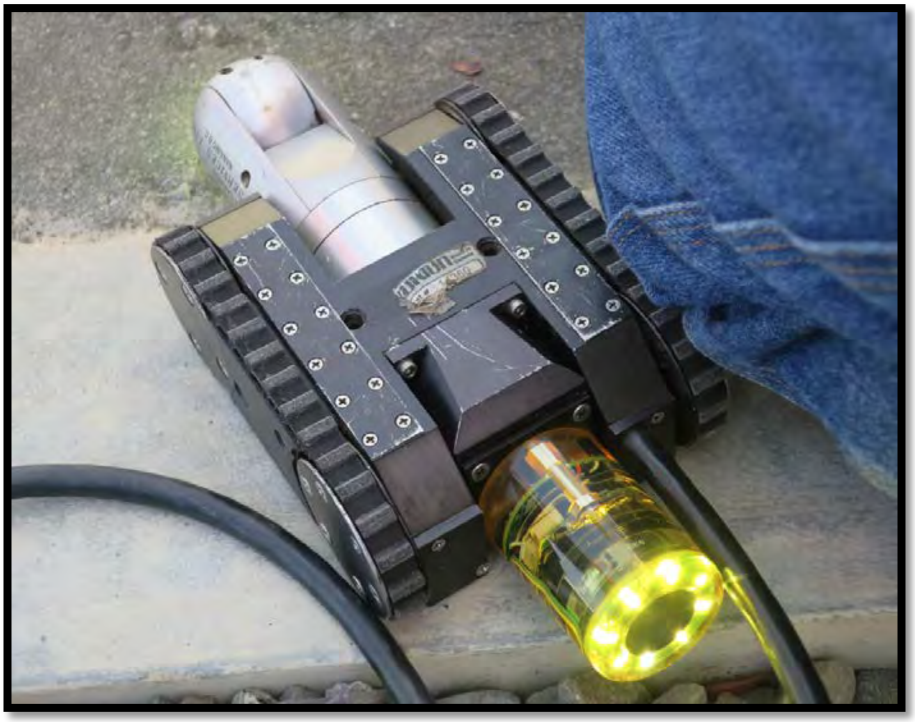
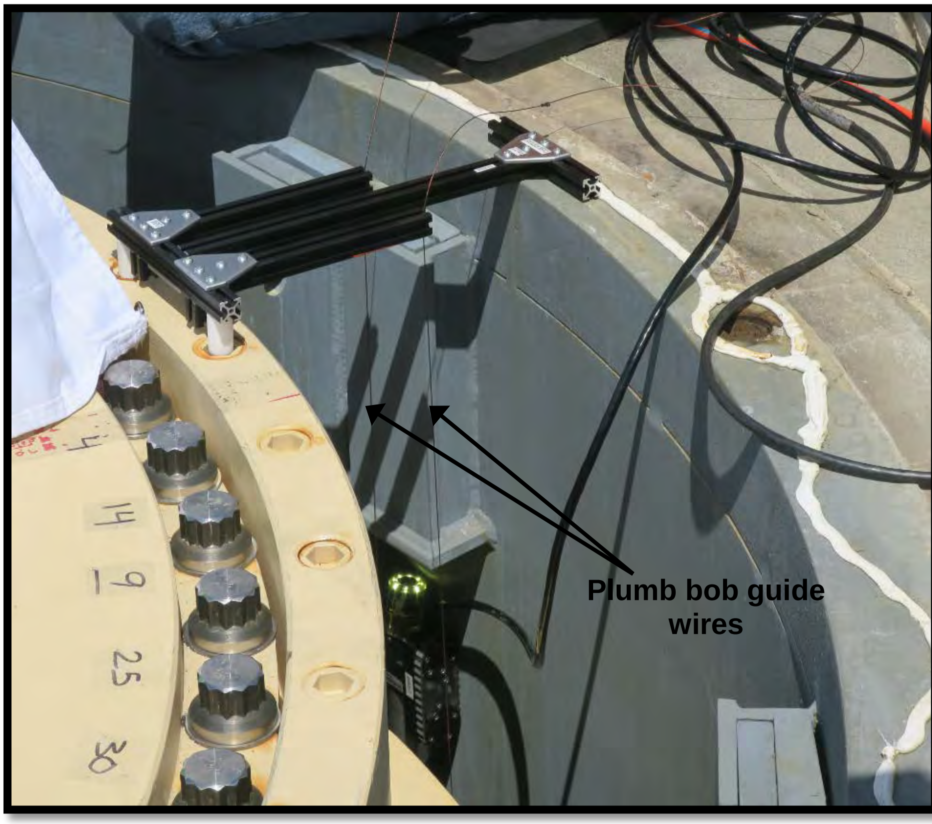


Figure 5: Inspection Fixture



Note: Numbers on the overpack lid are from initial overpack lid torqueing and are not related to this inspection.

Inspection Execution

Figure 6 is a plan view of the vault cell showing key components exposed after removal of the vault closure lid. The overpack has two trunnions located at plant north and south. A lid is bolted to the overpack with an additional ring of set screws that are referred to as the top flange plugs. Eight upper and lower seismic shims are attached to the liner wall. A vault lid ring contains the threaded bolt holes for the vault closure lid. Dashed red lines indicate the radial position and corresponding number for the scan lines numbered 1 through 80. The plumb bobs, suspended by 1/32" diameter wire cord were positioned at these radial lines using the movable fixtures located off of the top flange plugs.

Figure 6: Plan View of Vault Cell with Closure Lid Removed

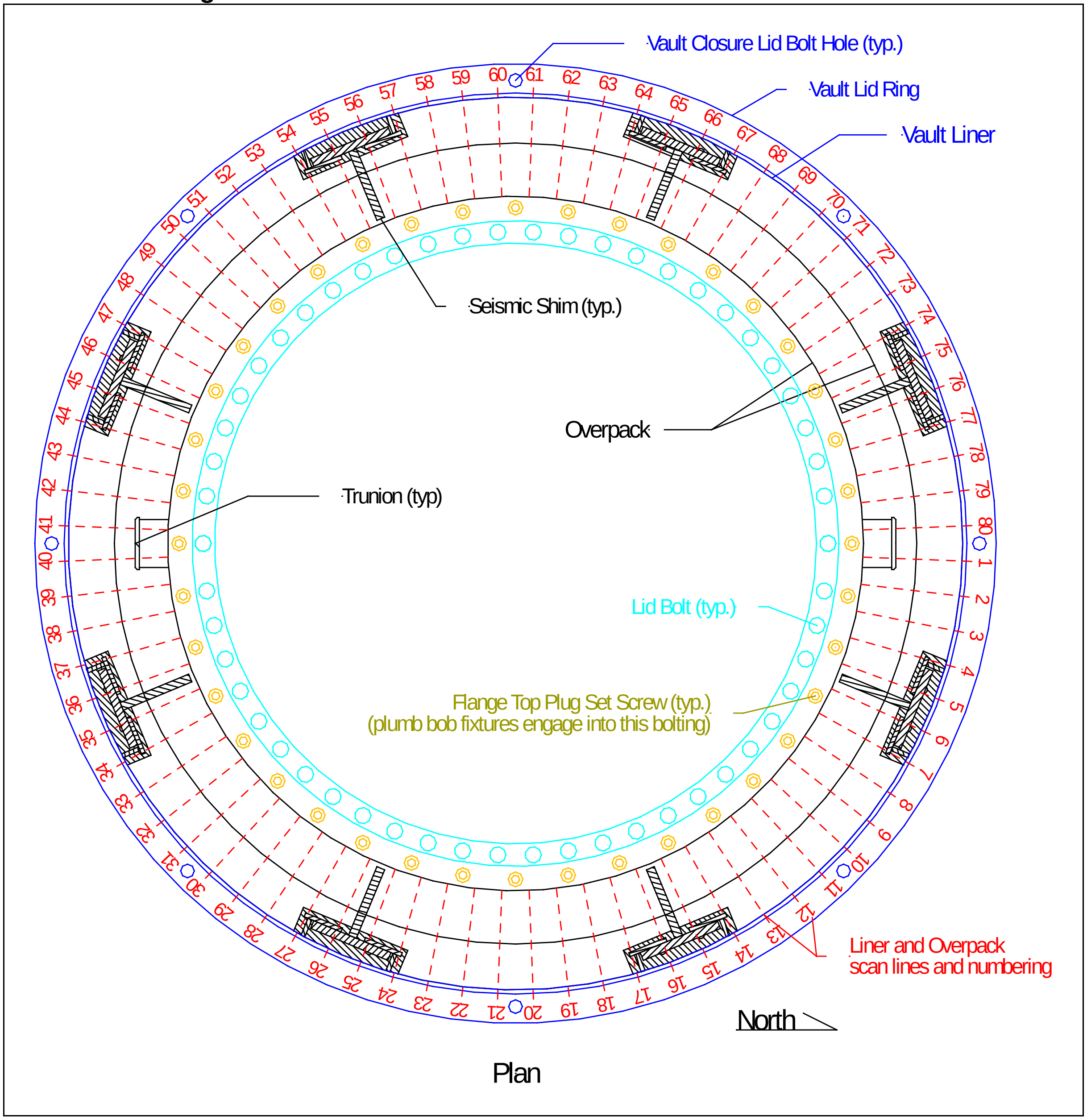
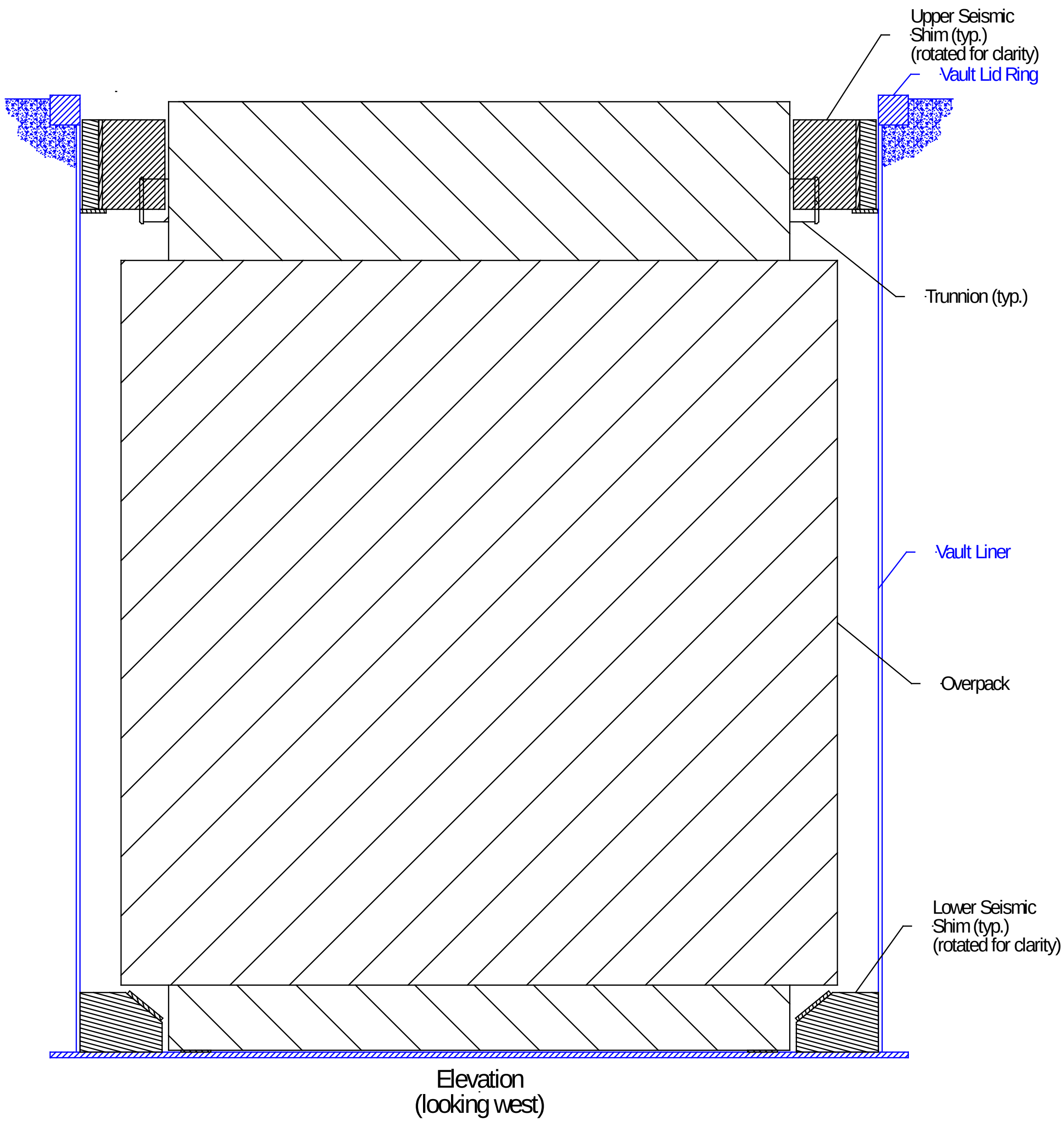


Figure 7 is an elevation view with the overpack housed in the vault. It shows the seismic shims that have an upper and lower component. The upper shims are removable (not removed for this exam) to facilitate installation of the overpack into the vault. However, the seismic shims were not removed for this inspection since installation of seismic shims is the analyzed condition in the storage configuration. In the Figure, the seismic shims are rotated to show vertical position and do not align with the trunnions.

Figure 7: Elevation View of Overpack in the Vault Cell(1)



Note (1): Figure does not show the drain rings that are located between the overpack bottoms and vault liner underneath the overpacks, as discussed in Section E.5.2.

Figure 8 is a rollout of the vault liner. Weld seams are shown in approximate locations, with a circumferential weld in the approximate center and each rolled plate having a longitudinal weld. The vault lid ring is tack welded to the upper liner plate. Dashed red lines indicate the 80 scan lines and are numbered as indicated.

Figure 8: Vault Liner Rollout

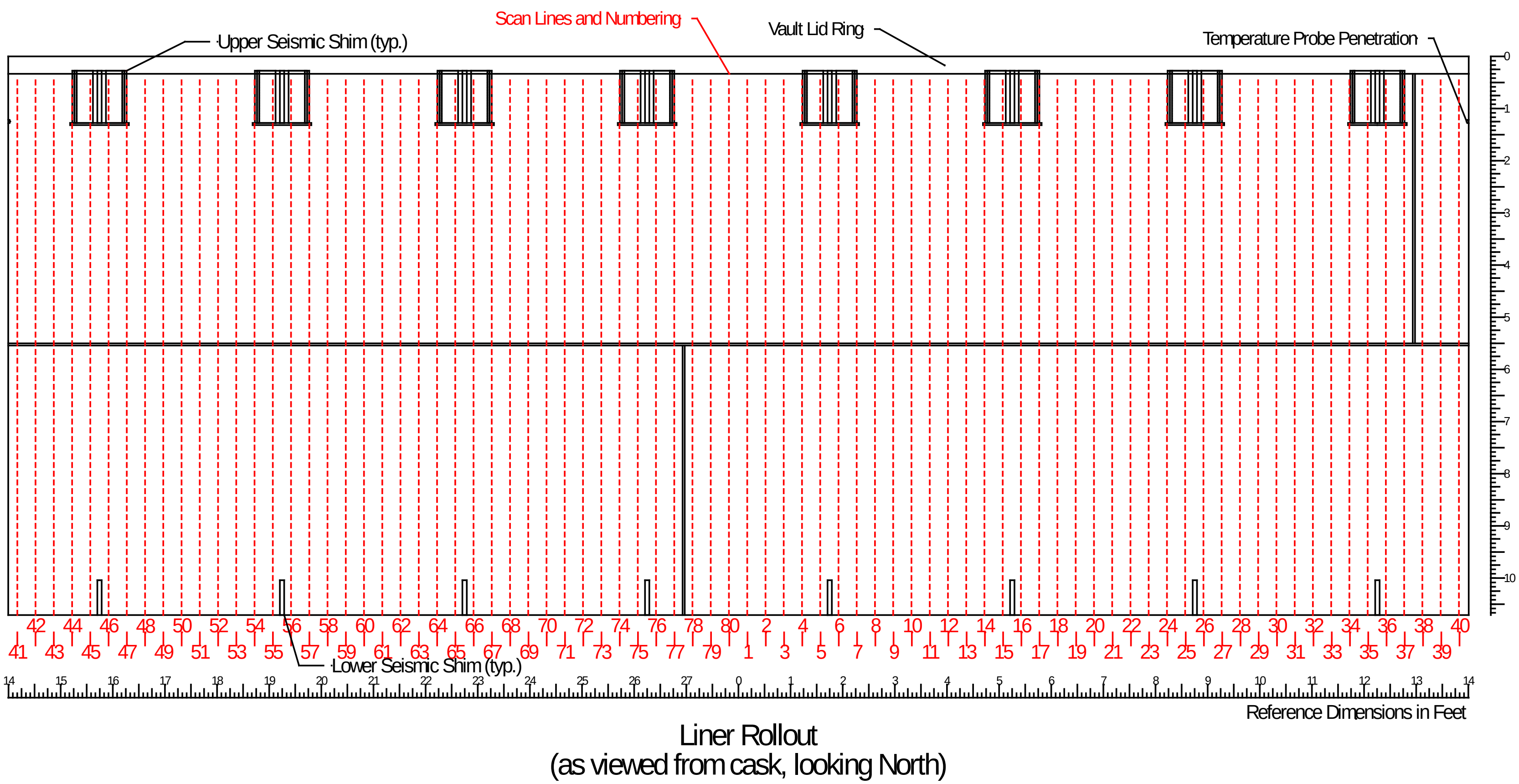


Figure 9 is the overpack rollout. The upper and lower portions of the overpack are smaller diameter. The upper portion was examined directly and the lower portion was examined with a pole-mounted camera. Red dashed lines and corresponding numbers for the scan lines are shown.

Figure 9: Overpack Rollout

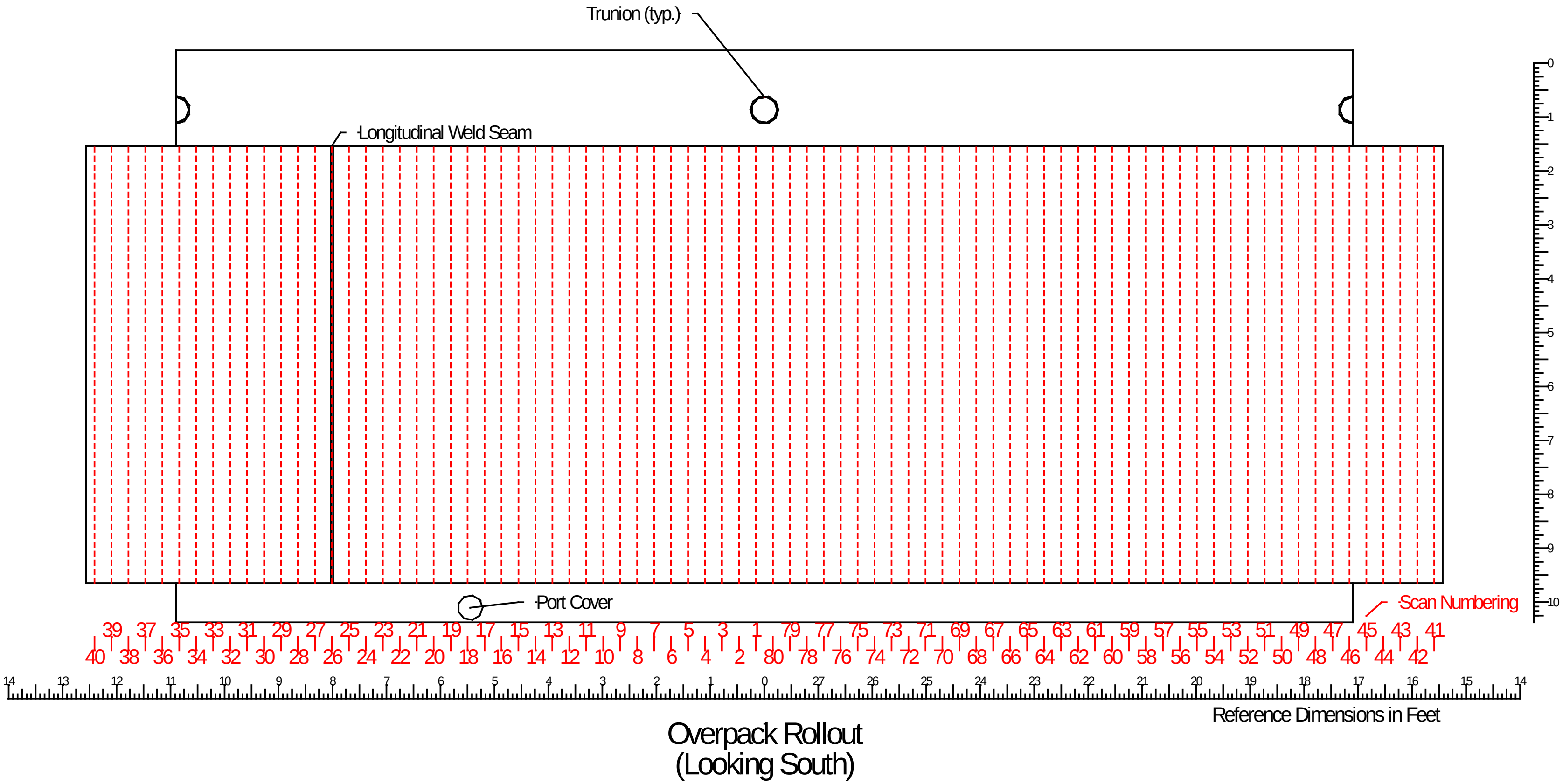
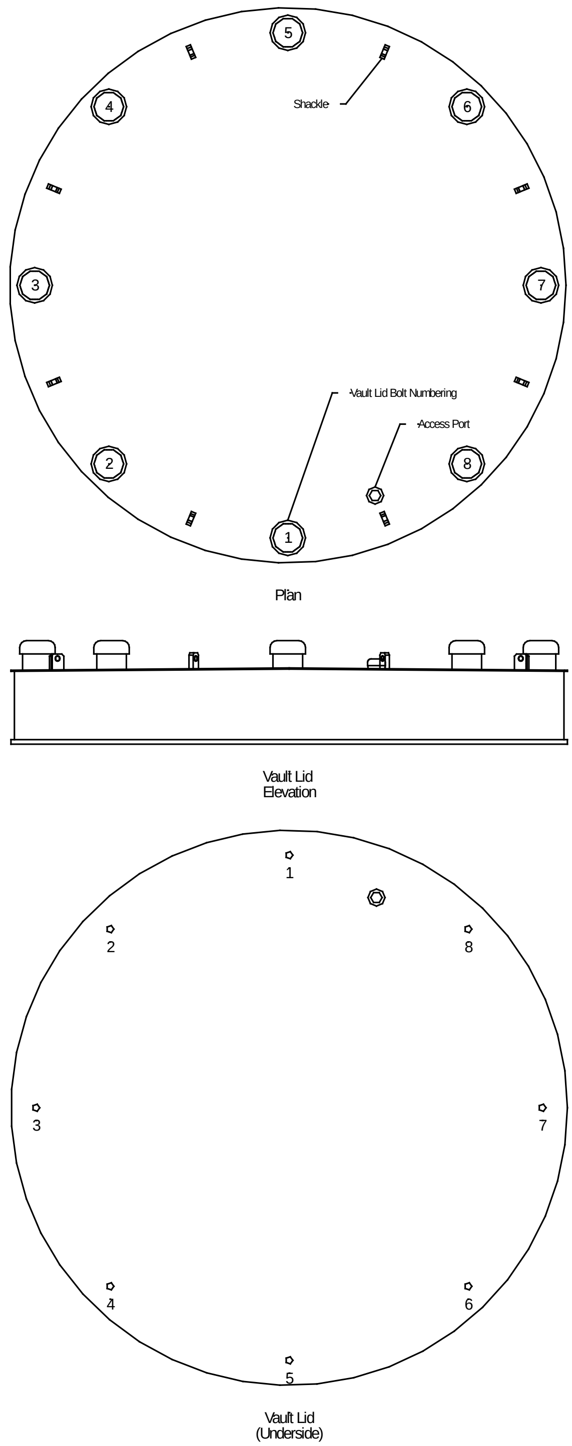


Figure 10 shows details for the vault closure lid removed for examination. The access port used for the borescope exam is shown as well. Bolt hole #1 faced the ISFSI Security building – due south.

Figure 10: Vault Closure Lid Views



E.5.3 Vault Closure Lid Bolting Inspection – All Vault Closure Lids

The vault closure lid bolting inspection included removal, cleaning, visual engineering examination for defects, re-lubrication, and re-installation. Because the long-term storage configuration of the HB ISFSI includes installation of the vault closure lids, the initial scope of the pre-application inspection included inspection of the vault closure lid bolting only associated with vault cell #2. As discussed in Section E.6, in response to the results of the cell #2 bolting inspections, PG&E expanded the scope to include all six vault cells' closure lid bolts.

To ensure that bolt condition trending can be completed in the future, the bolts and bolting pattern were numbered and replaced in the same configuration. The bolting pattern was determined by calling the closest bolt to the ISFSI Security building (i.e., Plant South) as bolt 1 and going in order clockwise (see Figure 10). The vault closure lids were also marked with a permanent marker in this order.

The acceptance criterion of the vault lid bolting is no indication of loss of material that would preclude adequate thread engagement or adequate function of the shank or head.

E.5.4 Vault Closure Lid Caulking Inspection – All Vault Closure Lids

Caulking is used on all six vault closure lids to mitigate water intrusion into the vault cells (see Attachment 3 photos). To ensure that the caulking will adequately perform its function to aid in maintaining the vault cell environment free of rainwater, the caulking for all six vault cells was inspected by VT-3 certified personnel. Because the caulking on vault cell #2 was removed to facilitate the detailed inspection discussed in Section E.5.2, both the as-found and as-left conditions were inspected.

The acceptance criteria for visual inspection of the vault lid caulking are no gaps, tears, and/or weak spots between the vault lid and the concrete.

E.5.5 Vault Exterior Concrete Inspection – All Above-Grade Accessible Concrete

The inspection of the above-grade accessible portions of the ISFSI vault concrete (including settlement) was conducted in accordance with DCPP Procedure PEP DF-19, "Inspection of ISFSI Concrete Structures," Revision 0, which implements the criteria of American Concrete Institute (ACI) 349.3R-18, "Report on Evaluation and Repair of Existing Nuclear Safety-Related Concrete Structures." The acceptance criteria for all visual inspections of the ISFSI Storage Vault concrete are consistent with those contained in ACI 349.3R-18. ACI 349.3R-18 includes quantitative three-tier acceptance criteria for visual inspections of concrete surfaces, namely (1) acceptance without further evaluation, (2) acceptance after review, (3) acceptance requiring further evaluation.

Differential Settlement Survey

The 2018 survey of the ISFSI vault concrete pad was performed by utilizing a calibrated digital level. Twelve repeatable temporary benchmarks were established by scribing crosshairs into the concrete as shown in Figure 11. Each of the crosshairs is located approximately 3" from the surrounding perimeter steel angle. The location of each of the twelve benchmarks is shown in Figure 12. The temporary benchmark at the northeast corner was assumed to be an elevation of 0.00 feet as directed by PEP DF-19.

Concrete Visual Inspection
The vault was divided into three areas:

1. The north side, which is approximately 4.5’ wide by 76.7’ long. The concrete surfaces are bordered by steel angles on all four sides.
2. The south side, which is approximately 4.5’ wide by 76.7’ long. The concrete surfaces are bordered by steel angles on all four sides.
3. The center section is raised from the north and south sides by approximately 4”. The section is 11’ wide by 76.7’ long. There are six, equally spaced, cask storage locations.

An X-Y coordinate system was used to locate indications, with the northeast corner being (0,0). The X-direction is in the east-west (long direction) and the Y-direction is in the north-south (short direction) as shown in Figure 12.

Deficiencies that did not exceed first tier degradation criteria were considered acceptable, and required no further documentation. Deficiencies that exceeded first tier were documented in accordance with the inspection procedure. Cracks were documented by measuring the location, width, and length of the cracked surface. Other deficiencies were documented by location and general dimensions of the defect. Calibrated crack comparator cards and tape measures were used to measure the remaining defect attributes.

Figure 11: Typical Scribed Markings for Differential Settlement Survey

Figure 12: Temporary Concrete Benchmarks

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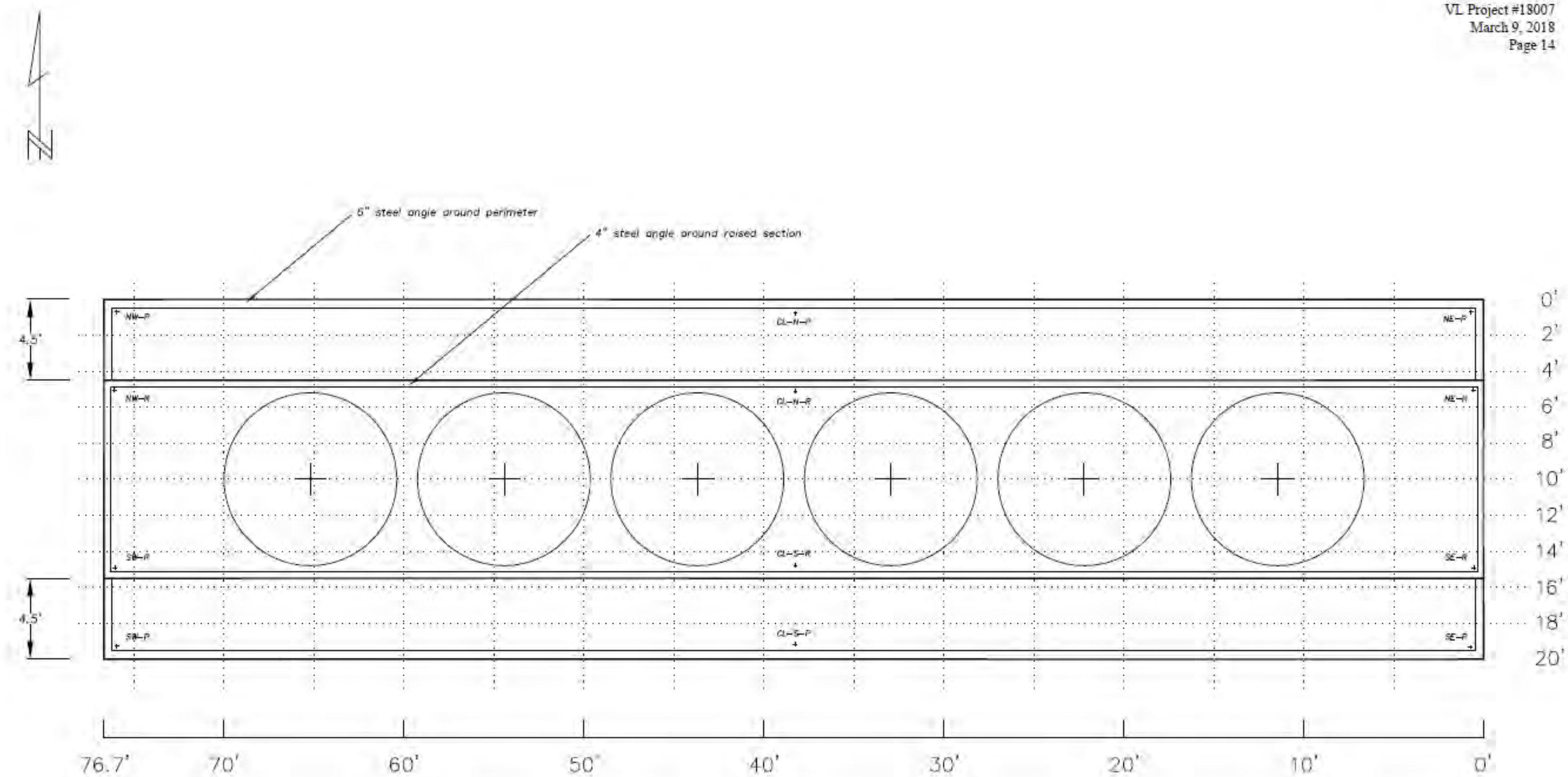


PERIMETER SURVEY

Point	Elev.
NE-P	0.00'
SE-P	0.01'
CL-N-P	0.01'
CL-S-P	0.01'
NW-P	0.01'
SW-P	-0.03'

CENTER RAISED SECTION SURVEY

Point	Elev.
NE-R	0.35'
SE-R	0.38'
CL-N-R	0.41'
CL-S-R	0.40'
NW-R	0.36'
SW-R	0.36'

NOTES:

1. Point NE-P is assumed to be 0.00' Elev.
2. Survey points were scribed into the concrete approximately 3" from bordering steel/concrete interface.

HUMBOLDT BAY ISFSI VAULT CONCRETE PAD DIFFERENTIAL SETTLEMENT SURVEY	DRN: GSM CHK: TAV APR: TAV	DATE : 03-06-18 SCALE: As Shown SHEET 1 of 2 SHTS	
Voss Laboratories, Inc.	FIGURE 1		REV. 0

E.5.6 Radiation Monitoring – At All Vault Lids and at Vault Cell #2 Overpack Lid

Radiation measurements were taken on all six of the vault closure lids. While the cell #2 vault closure lid was removed for the detailed inspection discussed in Section E.5.2, radiation measurements were taken on the HI-STAR 100 HB Overpack coverplate so that the vault closure lid readings could be correlated with the overpack coverplate reading. This will allow the vault closure lid readings to be used in future measurements without removal of the vault closure lids. The measurements were obtained using calibrated neutron and gamma dose meters, as applicable, with valid energy ranges.

The acceptance criteria for radiation dose rate monitoring of the HI-STAR 100 HB Overpacks, HI-STAR HB GTCC Waste Overpack, and ISFSI Storage Vault are as follows:

- Less than 0.15 mrem/hour (150 µrem/hour) dose rate for the external vault monitoring. This acceptance criterion was established based on the calculated dose rate as discussed in FSAR, Section 7.3.2.1 for meeting the requirements of 10 CFR 20.
- Less than 9.9 mrem/hour (9,900 µrem/hour) dose rate for the internal vault monitoring (i.e., at the overpack coverplate). This acceptance criterion was established based on the calculated dose rate as discussed in FSAR, Table 7.3-1, Point 4 at the overpack lid for meeting the requirements of 10 CFR 20.

E.5.7 HB ISFSI Soil Sampling

Soil samples were obtained in the vicinity of the ISFSI (see Attachment 5 for the soil sample locations) to represent the soil conditions at the ISFSI vault structure. A total of four soil samples were taken by hand auger at a depth of 3'. All surface gravel and geotextile were discarded and representative portions from each of the entire soil columns were transferred to a qualified laboratory for analysis. All analytical methods were performed according to Environmental Protection Agency, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Fourth Edition.

Consistent with NUREG-1801, Revision 2, Sections IX.D and IX.F, PG&E used the soil sample acceptance criteria for determination of a non-aggressive environment as follows:

Chloride	less than or equal to 500 ppm
Sulfate	less than or equal to 1500 ppm
pH	greater than or equal to 5.5

During construction of the HB ISFSI, soil was removed at the ISFSI site to build the vault. After completion of construction, the removed soil and additional soil from the HBPP site was used to re-fill the excavated portion. Because the soil samples include four locations spread out around the ISFSI, the sample locations are representative of the soil conditions to which the vault concrete may be exposed.

E.6 Pre-Application Inspection Results

This section presents the results from the inspections described in Table 1. In summary, the pre-application inspection showed that the HB ISFSI is in good condition and that aging effects are consistent with the LRA. Inspection results yielded indications that were entered into the CAP for evaluation; however, none of the findings indicated a loss of SSC intended function.

Borescope Inspection of All Vault Cells

The borescope exam results indicated that the coated casks and vault liners are in very good condition and that the condition was not noticeably different between the vault cells. Attachment 8 contains a copy of the Boroscope Inspection Report, including a list of those items that did not meet acceptance criteria and were entered into CAP for evaluation.

Detailed Inspection of Vault Cell #2

The results of the detailed inspection for cell #2 are divided into the following areas: Vault Closure Lid, Overpack, and Vault Liner. Exam photos are provided in Attachment 2 and are referred to in the descriptions below.

Vault Closure Lid: Attachment 2, photos 5-13

An initial as-found visual examination was performed on all accessible surfaces of the six vault cell exteriors to identify any signs of degradation on the surfaces exposed to the ambient environment. The examination of the vault exterior surfaces found chalking of the coatings on all six cells. The dry film thickness (DFT) taken from the cell #2 vault closure lid exterior had a range of 14.3 mils to 17.0 mils, well within the manufacturer's recommended DFT. Other than the chalking, no coating defects were found on the exterior surfaces of the cells. See an example of the vault closure lid exterior condition in Attachment 2, photo 5. Because the surface conditions met the acceptance criteria, no findings were entered into the CAP for evaluation.

For cell #2, a VT-3 direct visual examination was conducted on the removed vault closure lid. Areas of three-dimensional rusting were noted around vault lid bolt holes #3 and #5 on the underside of the lid and inside the holes (see Attachment 2, photos 7 and 8). The rusting was dark in color and more significant than minor surface rust. Removal of the corrosion products and cleaning of the surface exposed pitting corrosion with the worst pit depth being approximately a 1/16" in depth over an area 1" in diameter (see Attachment 2, photos 9-12). There was no immediate re-coating of the vault lid based on direction from the coating specialist. This condition does not meet VT-3 acceptance criteria and was entered into the CAP for evaluation (HB SAPN 1433133). A plan of action and extent of condition will be completed to address these findings and will be developed based on the engineering CAP evaluation. The indications provided no challenge to the component's intended safety functions prior to the next inspection.

The rusting identified inside the bolt holes also included bolt washers (see Attachment 2, photos 9-10). This condition was entered into the CAP for evaluation (HB SAPN 1433450). The indications provided no challenge to the component's intended safety functions prior to the next inspection.

In general, the zinc coated carbon steel plate that makes up the underside of the vault lid was in good condition with only minor water staining and chipping of the zinc coating noted (see Attachment 2, photos 6 and 13).

Overpack: Attachment 2, photos 14-45

The direct and remote visual exams showed that the overpack is in good overall condition. However, there are several conditions that were noted and entered into CAP for evaluation (HB

SAPN 1433272) and trending during future exams. The indications provided no challenge to the component's intended safety functions prior to the next inspection. Each is discussed below:

- Coating at the overpack lid bolts
  - The direct visual examination found that the coating had cracked or chipped off under a majority of the overpack closure lid bolts (49 out of 54 bolts). This was most likely caused during tightening of the lid bolts during initial loading. Some surfaces under those bolts with cracked coating had developed surface rust (see Attachment 2, photos 15-20). Attachment 2, photo 45 provides an overview of the coating condition near the overpack lid bolts.

- Coating chips or scrapes
  - Edges of the overpack had small areas of coating chipped off (see Attachment 2, photos 20 and 42). Those small areas had no evidence of corrosion. The chipped areas at the top of the overpack were coated with Rustbond epoxy sealer before the vault closure lid was reinstalled (see Attachment 2, photos 21-22).
  - A few areas on the lower portion of the overpack appear to have scraped on the lower seismic shim, thus damaging the overpack coating (see Attachment 2, photos 41 and 44). No rust or discoloration where the coating was damaged was observed.
  - Minor chips on the sides of the overpack were noted, some with rust discoloration (see Attachment 2, photos 24, 35-37).

- General scuff marks and rust staining (including drip marks)
  - Rust discoloration was noted around the top flange plugs (set screws) as well as some smaller set screws (see Attachment 2, photos 40 and 43). A rust colored stain from a drain hole on the side of the upper portion of the overpack was noted (see Attachment 2, photo 23), which may have emanated from the surface rust around the overpack lid bolts discussed above.
  - Minor coating irregularities, some with rust discoloration, were identified on the overpack (see Attachment 2, photos 27-29, 31-32, 35).
  - The overpack had areas of black stains or rub marks that appear to have originated externally (see Attachment 2, photos 25-26, 28-30).

It should be noted that the two overpack relief device rupture discs were specifically inspected. The results met the acceptance criteria, and thus, no conditions were entered into CAP for evaluation.

Vault Liner: Attachment 2, photos 46- 61

The coating on the wall and floor portions of the vault liner was in good condition with less than ten small "freckle" sized rust spots identified (see Attachment 2, photos 53-61). The vault liner typically had streaking (white staining and rust staining) indicative of moisture running down the liner wall and spots at the lower portion (see Attachment 2, photos 49-51). Because the rust spots did not meet acceptance criteria, the conditions were entered into the CAP for evaluation (HB SAPN 1433273). However, the indications provided no challenge to the component's intended safety functions prior to the next inspection.

Consistent with the findings discussed above for the vault closure lid bolt hole rust, inspection of the vault lid ring showed minor rust staining near the vault closure lid bolt holes. Specific indications of the overall coating conditions at the lid ring are shown in Attachment 2, photos 46-48.

It should be noted that the vault drain cover was inspected. While this was not specifically in the scope of the exam to meet license renewal requirements, it was included based on unclear results from the borescope inspection. It was confirmed that the drain cover holes are clear of any obstructions so that water intrusion into the vault cell would drain into the drainage system as designed.

Attachment 2, photo 45 provides an overview of the coating condition near the vault liner and lid ring.

Vault Closure Lid Bolting

Vault closure lid bolts for cell #2 were removed and inspected. The bolts were found to be in an unexpected condition with wetting/condensation (see Attachment 2, photos 63-64). Four bolts were replaced due to corrosion and pitting, primarily on the bolt shaft (see Attachment 2, photo 65). The remaining bolts were cleaned, verified in good condition per visual inspection, re-lubricated, and re-installed. Because the bolting did not meet the acceptance criteria, the condition was entered into CAP for evaluation (HB SAPN 1433133). As mentioned in Section E.5.3, in response to the results of the cell #2 bolting inspections, PG&E expanded the scope to include all vault closure lid bolts for all six vault cells. In addition, the HB ISFSI External Surfaces Monitoring AMP in LRA, Appendix A was modified to include inspection of all vault closure lid bolts on a five-year frequency. Subsequent engineering evaluation determined that all bolt replacements were conservative and the replaced bolts would have continued to meet their intended safety function.

The majority of the vault closure lid bolting on cells 1, 3, 4, 5, and 6 were found to meet acceptance criteria (see Attachment 4 sketch of bolting replacements). Two bolts (one on cell #6 and one on cell #1) were replaced. The bolt that was replaced on cell #6 displayed pitting (see Attachment 2, photo 66). The condition for the cell #6 bolt was entered into CAP for evaluation (HB SAPN 1433270). The bolt that was replaced on cell #1 had a circumferential groove near the bolt head that may have occurred during the onsite bolt milling that did not match the approved design drawings. The cell #1, bolt 4 was replaced with a new bolt to restore the configuration to design. Although the condition for the cell #1 bolt met acceptance criteria, this condition was entered into CAP for past operability evaluation (HB SAPN 1433249). The condition provided no challenge to the component's intended safety functions prior to the next inspection.

Although not in the scope of this inspection or within the scope of License Renewal, several bolt PVC water exclusion caps (design classification is Not Important To Safety) were broken during removal of the vault closure lid bolting and were replaced with new bolt caps.

Vault Closure Lid Caulking

An initial as-found visual examination of the caulking was performed on all six vault cells to identify any sign of degradation. No evidence of service-related caulking degradation was identified on any of the vault cells. However, on vault cells 1, 2, 4, and 5, areas were identified where there was incomplete adhesion between caulking and metallic components. Cell 4 had an area of incomplete adhesion with a measurable depth of 0.75" which is less than the 2.5" depth to the vault lid ring. These noted areas had additional caulking applied and were found satisfactory in the as-left condition. Attachment 3 provides representative photos from the as-found exam (photos 1-14).

An as-left examination was performed on the caulking that was re-applied on vault cell #2 after the vault closure lid re-installation. The as-left condition met the caulking acceptance criteria. Attachment 3 provides representative photos from the as-left exam (photos 15-18).

There were no entries into the CAP for the vault closure lid caulking.

Vault Exterior Concrete

Differential Settlement Survey

The level survey results are shown in Table 2 and Figure 12. As described in Section E.5.5, the settlement survey was conducted at twelve marked locations that can be repeated during subsequent surveys. Previous commercial-grade settlement surveys were conducted at the four ISFSI pad corners, in the same general area as four of the twelve new survey locations. Comparison of results to previous surveys indicates that results were the same or within 0.01'. Sufficient data exists to conclude that the ISFSI pad is not settling and variances compared to previous inspections are due to differences in measurement locations and calibrated instrumentation. For license renewal, this survey represents an initial survey of these scribed points and establishes a baseline for future surveys. The survey of the north and south sides showed that the low point of the slab is the southwest side. The low point of the center section was on the northeast corner.

Table 2 HB ISFSI Differential Settlement Survey Results

Location	Point	Elevation (ft)
Northeast corner perimeter	NE-P	0.00
Northwest to northeast corner edge midpoint perimeter	CL-N-P	0.01
Northwest corner perimeter	NW-P	0.01
Southwest corner perimeter	SW-P	-0.03
Southwest to southeast corner edge midpoint perimeter	CL-S-P	0.01
Southeast corner perimeter	SE-P	0.01
Northeast corner raised center	NE-R	0.35
Northwest to northeast corner edge midpoint perimeter raised center	CL-N-R	0.41
Northwest corner perimeter raised center	NW-R	0.36
Southwest corner perimeter raised center	SW-R	0.36
Southwest to southeast corner edge midpoint perimeter raised center	CL-S-R	0.40
Southeast corner perimeter raised center	SE-R	0.38

Concrete Visual Inspection

There were a total of 32 indications that exceeded the tier 1 degradation criteria and are summarized below. See Table 3 and Attachment 7, Figure 1 for results.

- Four concrete cracks were found with widths greater than 0.015" but less than 0.040". Three of the four cracks were observed between vault cells. All cracks appeared to be passive, as existing cracks showed no signs of recent fractures or any other degradation mechanisms.

- Nine areas of efflorescence deposits were observed in areas typically adjacent to a surrounding steel angle member.
- Seventeen locations of surface voids were observed. Most of the surface voids were located along the middle portions of the north and south sides. The surface voids located in the middle section of the north and south sides along the travel path of the crawler appear to be scraped, resulting in a shallow scaled/peeled surface. The largest area of scaled/peeled concrete is approximately 5" by 10" by 3/8" (see Attachment 7, photo 1).
- All accessible concrete was sounded for delaminated and/or drummy areas. Two areas with disbonded patches were found. The patches are located on the center section on the north and south edges in the space between casks #4 and #5 (see Attachment 7, photos 2-3). No evidence of corrosion was observed.

Because the above conditions did not meet the acceptance criteria, the condition was entered into CAP for evaluation (CAP 114406201).

Three of the thirty-two reportable indications exceed the second tier criteria:

- Surface void greater than 2” in diameter – A surface void that measured 5" by 10" with a maximum depth of 3/8” was found on the south side approximately 18’ from the east side and 2’ from the south edge (see Attachment 7, photo 1). A closeup examination of the void surface showed that the surfaces appeared to be mechanically abraded. No signs of popouts were observed. Additional testing performed on the concrete void area and surrounding concrete surfaces was to sound for “drummy” concrete. Results showed the void surfaces and surrounding concrete were sound and intact. Because this condition did not meet the acceptance criteria, the condition was entered into CAP for evaluation (CAP 114406209).

- Drummy areas that can exceed the cover concrete thickness in depth – Two locations with “drummy” sounding concrete were found by hammer sounding. Both of the areas are located in the center section approximately 27’ from the east edge with one area bordering the north side and the other bordering the south edge (see Attachment 7, photos 2-3). Each of the disbonded areas are located fully within a patched area. The patches appear to be minor repairs during construction after removal of construction aids associated with concrete placement (see Attachment 7, photo 4 taken during original construction). The disbonded patches showed no signs of corrosion or other deterioration mechanism. Because this condition did not meet the acceptance criteria, the condition was entered into CAP for evaluation (CAP 114406209).

While the abovementioned indications were observed during the concrete inspection, none prevented the SSC from performing its intended function or required immediate corrective action. Comparison of the results to the previous commercial-grade inspection results did not indicate a concrete degradation trend that would present a challenge to fulfillment of the intended safety function prior to the next inspection. These indications will be evaluated in the CAP and the information used for future trending purposes.

Table 3 Summary of Vault Concrete Indications Exceeding the First Tier Criteria

Location	(X, Y) (ft)	Condition
North side – N2.1	(2.1, 2.0)	Surface void 1.75” diameter with a depth of 3/8”

Location	(X, Y) (ft)	Condition
North side – N3.5	(3.5, 1.5)	Surface void 1.5” diameter with a depth of 3/8”
North side – N3.6	(3.6, 2.0)	Surface void 1.0” diameter with a depth of 3/8”
North side – N4.0	(4.0, 1.5)	Surface void 1.5” diameter with a depth of 3/8”
North side – N4.3	(4.3, 2.0)	Surface void 1.75” diameter with a depth of 3/8”
North side – N4.5	(4.5, 1.5)	Surface void 1.75” diameter with a depth of 3/8”
North side – N4.5	(4.5, 2.0)	Surface void 1.5” diameter with a depth of 3/8”
North side – N5.0	(5.0, 2.0)	Surface void 1.5” diameter with a depth of 3/8”
North side – N5.1	(5.1, 2.0)	Surface void 1.75” diameter with a depth of 3/8”
North side – N5.2	(5.2, 2.0)	Surface void 1.5” diameter with a depth of 3/8”
North side – N22	(22, 0.5) to (22, 4.5)	Crack approximately 4’ long with a measured width of 0.016”
North side – N28	(28, 4.5)	Efflorescence deposits observed near the steel angle
North side – N37	(37, 4.5)	Efflorescence deposits observed near the steel angle
North side – N62	(62, 2)	Surface void 1.9” diameter with a depth of 1/8”
South side – S11	(11, 17.5)	Surface void 5/8” diameter with a depth of 3/16”
South side – S15	(15, 17.5)	Surface void 1” diameter with a depth of 1/8”
South side – S16	(16, 17.5)	Surface void 1” diameter with a depth of 1/8”
South side – S18	(18, 17.5)	Surface void 10” by 5” area with a depth of 3/8”
South side – S33	(33, 16)	Efflorescence deposits observed near the steel angle
South side – S41	(41, 16)	Efflorescence deposits observed near the steel angle
South side – S54	(54, 16)	Efflorescence deposits observed near the steel angle
South side – S67	(67, 16)	Efflorescence deposits observed near the steel angle
Center – C20	(20, 15)	Surface void 1.5” diameter with a depth of 3/16”
Center – C27	(27, 5)	Disbonded patch that is approximately 17” by 11”
Center – C27	(27, 10) to (27.5, 10)	Crack approximately 6” long with a measured width of 0.020”
Center – C27	(27, 15)	Disbonded patch that is approximately 6” by 8”
Center – C28	(28, 5)	Efflorescence deposits observed near the steel angle
Center – C37	(37, 5)	Efflorescence deposits observed near the steel angle
Center – C40	(40, 15)	Efflorescence deposits observed near the steel angle
Center – C49	(49, 10) to (49.5, 10)	Crack approximately 6” long with a measured width of 0.020”
Center – C60	(60, 10) to (60.5, 10)	Crack approximately 6” long with a measured width of 0.018”
Center – C73	(73, 15)	Surface void 1.25” diameter with a depth of 1/4”

Radiation Monitoring

As discussed in Section E.5.6, dose rates were measured at the overpack lid for vault cell #2 and at the top of each vault closure lid.

- The highest measured dose rate on the top of the overpack was 2.6 mrem/hr (26 percent of the acceptance criterion). Highest dose rate in the vault was measured at 3.4 mrem/hr on the side of the overpack, approximately 12” down (34 percent of the acceptance criterion). Each of these dose rates meets the acceptance criterion of less than 9.9 mrem/hour.

- The highest measured dose rate on the top of all six vault closure lids was 0.02 mrem/hr (13 percent of the acceptance criterion). This meets the acceptance criterion of 0.15 mrem/hr.

In addition, smear samples were taken on the overpack lid and the results did not identify any contamination.

Because the dose rates met the inspection acceptance criteria, there were no entries into the CAP for HB ISFSI radiation monitoring.

Soil Sampling

As shown in Table 4, all soil sample results meet the NUREG-1801, Revision 2, Sections IX.D and IX.F criteria for non-aggressive soil. Although the soil is non-aggressive, the soil conditions may change over time. Thus, as discussed in the HB ISFSI LRA, Appendix A, PG&E will conduct soil sampling and lab analysis on a five-year frequency to confirm that the soil in contact with the HB ISFSI remains non-aggressive during the period of extended operation.

Table 4 HB ISFSI Soil Sample Results

	Concentration			
Parameter/acceptance criteria	ISFSI BORING 1	ISFSI BORING 2	ISFSI BORING 3	ISFSI BORING 4
Chloride (ppm) / <500	14	14	30	5.8
Sulfate (ppm) / <1500	12	13	140	35
pH / >5.5	6.3	6.0	6.3	5.8
Meets Criteria for Non-Aggressive Soil	Yes	Yes	Yes	Yes

E.7 Pre-Application Inspection Conclusions

As discussed in Section E.6, the HB ISFSI is in overall good condition. The following items were entered into CAP for evaluation and determination of corrective actions.

1. Cell 1 Vault Closure Lid Bolting – HB SAPN 1433249
2. Cell 6 Vault Closure Lid Bolting – HB SAPN 1433270
3. Cell 2 Vault Closure Lid – HB SAPN 1433133
4. Cell 2 Overpack – HB SAPN 1433272
5. Cell 2 Liner Rust Specks – HB SAPN 1433273
6. Cell 2 Vault Closure Lid Bolt Washers – HB SAPN 1433450
7. Vault Concrete Inspection: >Tier 1 Findings – CAP 114406201
8. Vault Concrete Inspection: >Tier 2 Findings – CAP 114406209

While the conditions entered into CAP do not prevent the SSC from performing its intended function, the information will be evaluated and used for future trending. The inspection results were entered into the ISFSI aging management INPO database (AMID). Based on review of the inspection results, the aging effects discuss in the LRA are appropriately identified. In response to the pre-application inspection findings, HB ISFSI External Surfaces Monitoring AMP in LRA, Appendix A was modified to include inspection of all vault closure lid bolts on a five-year frequency. The AMPs proposed in LRA Appendix A will adequately manage the aging associated with the HB ISFSI and will be modified, as necessary, based on future inspection results.

E.8 Inspection Report Preparers and Reviewers

The following personnel were involved in preparing or reviewing this inspection report:

- P. Soenen, HB ISFSI License Renewal Project Manager
- M. Olsofsky, HB ISFSI License Renewal Engineer
- R. Hagler, Supervisor, DCPP Dry Fuel Management
- K. Braico, Engineer, DCPP Dry Fuel Management
- K. Duke, Senior Engineer, DCPP Dry Fuel Management
- C. Beard, DCPP ISI Inspector
- T. Carraher, DCPP ISI Inspector
- D. Gonzalez, DCPP ISI Supervisor
- D. Wilson, DCPP ISI Inspector
- J. Cheng, Applied Technology Services Senior Advising Coatings Specialist

Attachment 1
Vault Cell #2 Exam Coverage Calculation

Applicable dimensions:
Liner radius = 53.5"
Liner Height = 124.5"
Vault Lid Ring radius = 57.5"
Vault Lid Ring height = 4"
Overpack lesser radius at top and bottom = 41.63"
Overpack greater radius at mid-section = 48"
Overpack height from mid-section greater radius to top = 21.31"
Overpack height in mid-section = 97.31"
Overpack height from mid-section greater radius to bottom = 8.75"

Lid Exam:
Lid percentage examined = 100 percent - No limitations

Liner Exam:
Liner wall = π(53.5*2)*124.5 = 41,850.7 in^2
Note: Liner wall behind upper seismic shims is not accessible in the storage configuration, this area is 12"x12" for all eight seismic shims (12*12*8) = 1,152 in^2
Vault Lid Ring = π(53.5*2)*4 = 1,344.6 in^2
Vault Lid Ring top = π(57.5*2) - π(53.5*2) = 25.1 in^2
Lower seismic shim occluded area(1) = (5*8*8) = 320 in^2
Total accessible liner area = 41,850.7 + 1,344.6 + 25.1 - 1,152 = 42,068.4 in^2
Examined accessible area = 42,068.4 - 320 = 41,748.4 in^2
Accessible liner wall percentage examined = 100(41,748.4 / 42,068.4) = 99.2 percent

Liner Floor
Total area = $\pi 53.5^2$ = 8,992 in^2
Lower seismic shim occluded area(1) = (5*8*8) = 320 in^2
Liner floor area examined = 8992 - 320 = 8,672 in^2
Liner floor percentage examined = 100(8,672 / 8,992) = 96.4 percent
Note: Liner floor under overpack is not accessible in the storage configuration, this area is $\pi 41.63^2$ = 5,444.6 in^2

Overpack
Horizontal top surface area = $\pi 41.63^2$ = 5,444.6 in^2
Upper vertical surface between top and mid-section area = 21.31(π41.63*2) = 5,574 in^2
Upper mid-section horizontal surface area = ($\pi 48^2$) - ($\pi 41.63^2$) = 1,793.7 in^2
Middle vertical surface area = 97.31(π48*2) = 29,348 in^2
Lower mid-section horizontal surface area = ($\pi 48^2$) - ($\pi 41.63^2$) = 1,793.7 in^2
Lower vertical surface between liner floor and mid-section = 8.75(π41.63*2) = 2,288.8 in^2
Total accessible Overpack surface area: 5444.6 + 5574 + 1,793.7 + 29,348 + 1,793.7 + 2,288.8 = 46,242.8 in^2

[1] An approximately 5" x 8" portion of the exam was not performed at each of the lower seismic shims. This occluded area is noted in the coverage calculation and was caused by not reorienting the pole-mounted camera to look in the CCW direction.

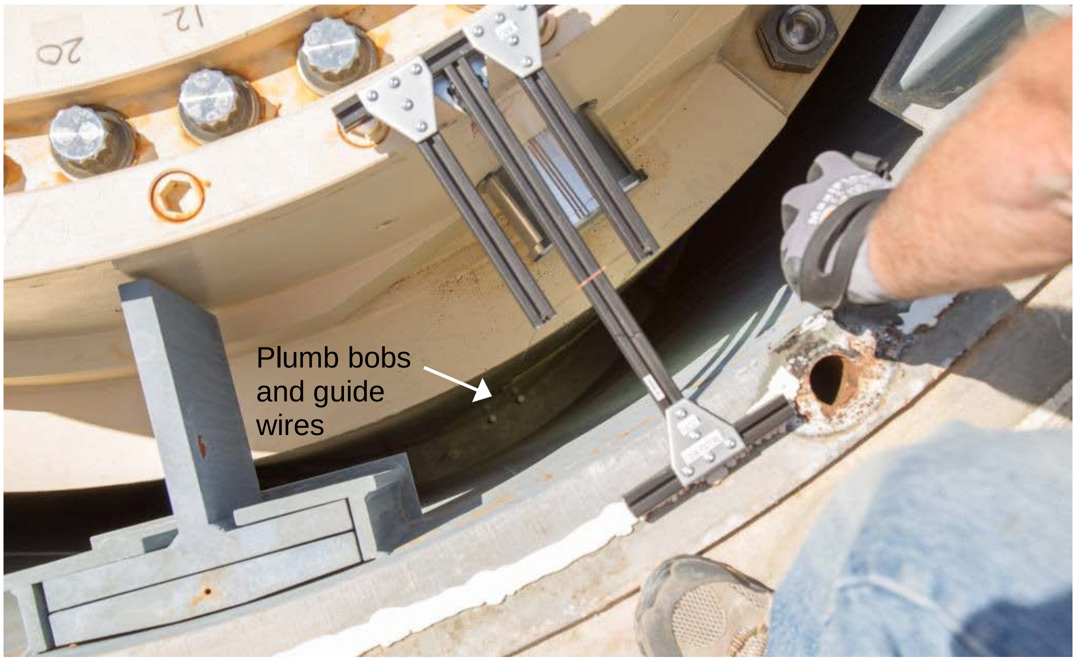
Lower seismic shim occluded area = (5*8*8) = 320 in^2
Missed recording of scan 1 (scan 4" wide)[2] = 4*97.31 = 389.2 in^2
Overpack examined area = 46242.8 - 320 - 389.2 = 45,533.6 in^2
Overpack percentage examined = 100(45,533.6 / 46,242.8) = 98.5 percent
Note: Bottom of overpack is not accessible in the storage configuration, this area is $\pi 41.63^2$ = 5,444.6 in^2

Examination coverage = (100 + 99.2 + 96.4 + 98.5)/4 = 98.5 percent

[2] A portion of scan #1 of the overpack was not recorded, but was observed by a certified VT-3 examiner during the examination.

Attachment 2
Vault Cell #2 and Bolting Exam Results Photos

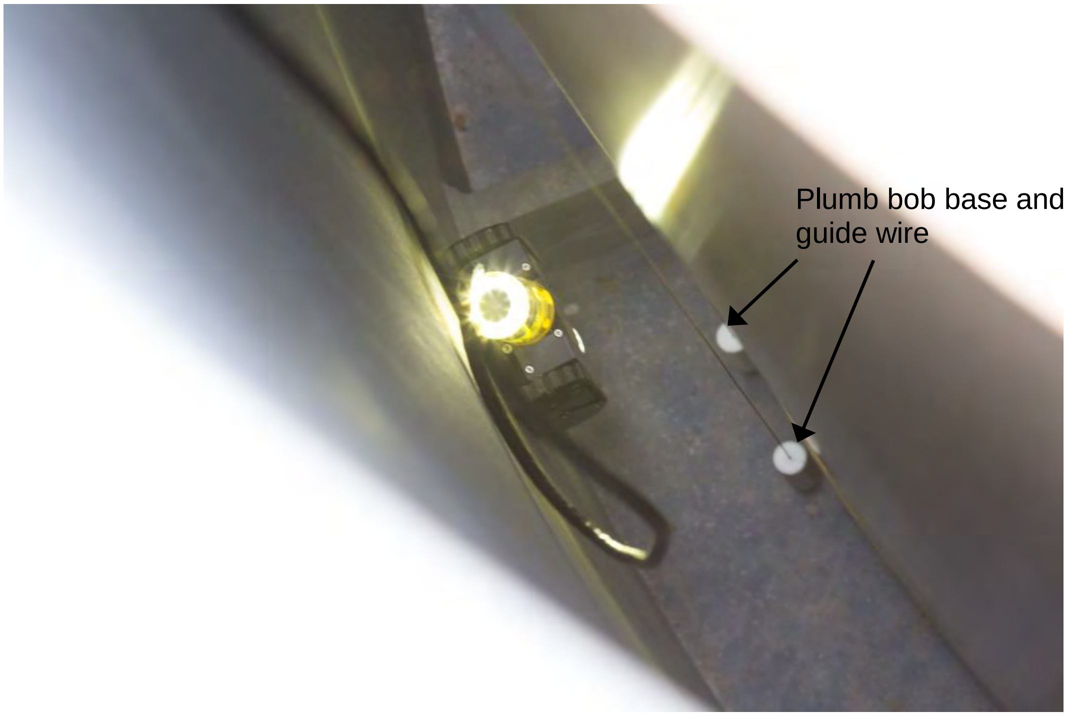
2.1, Remote Examination Crawler and Fixture Photos



1. Overpack exam fixture supporting plumb bobs

2. Liner exam fixture supporting plumb bobs (shown around temperature probe in this location)

3. Crawler on liner examining overpack



4. Crawler on liner at bottom of scan examining overpack – plumb bobs and 1/32" wire cord visible

2.2, Vault Closure Lid Photos

5. Removed lid on cribbing

6. Underside of lid general view

7. Underside hole #3 showing corrosion prior to cleaning

8. Underside hole #5 showing corrosion prior to cleaning

9. Hole #5 after cleaning

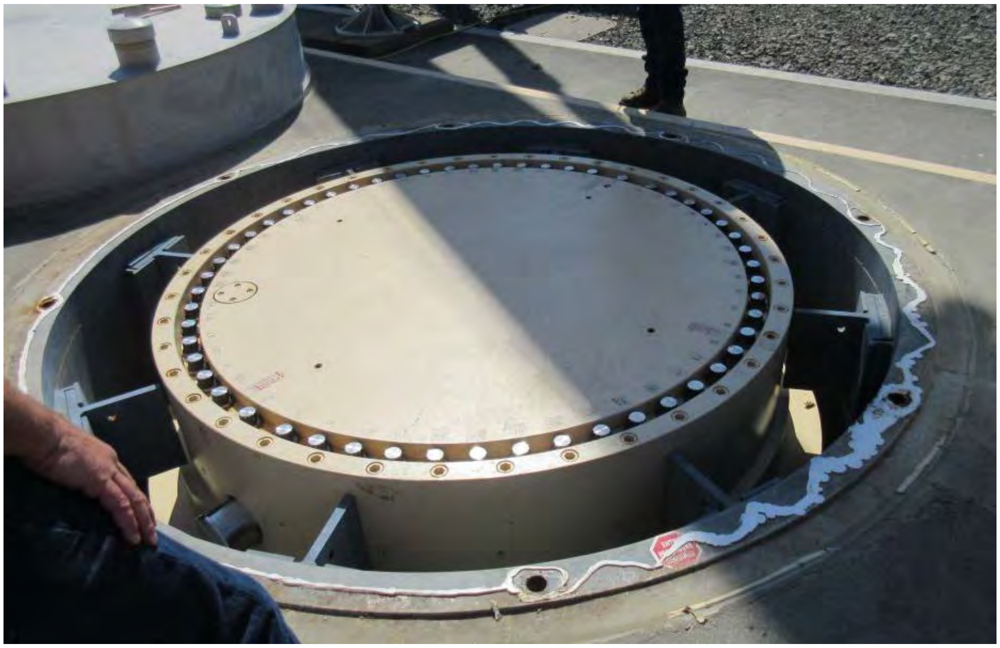
10. Hole #5 after cleaning

11. Hole #3 after cleaning

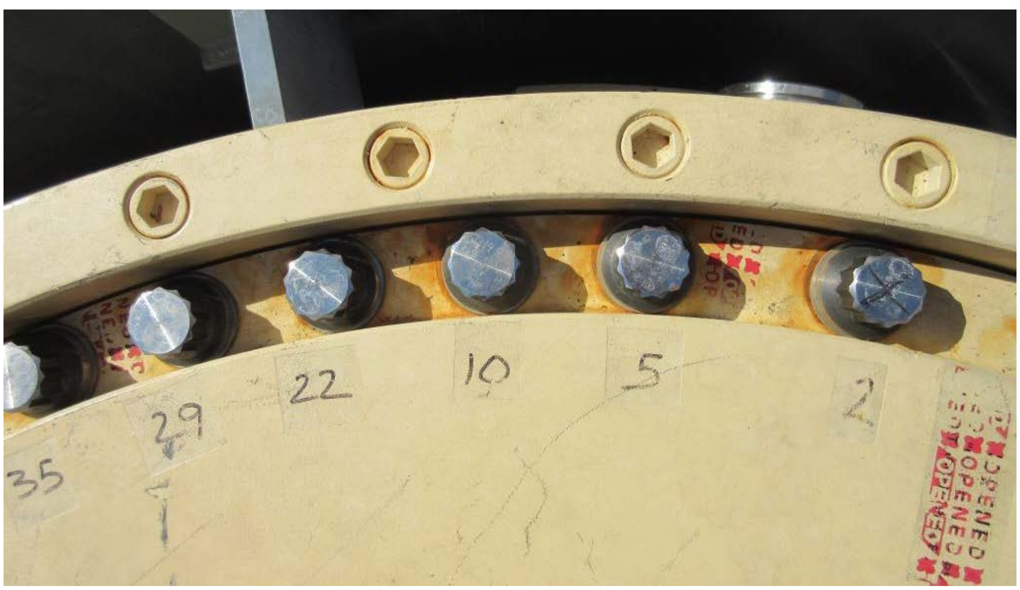
12. Measuring pit depth <1/16"

13. Coating chip on underside of lid

2.3, Overpack Photos



14. Upper portion of overpack exposed for direct visual examination



15. Rust staining around overpack lid closure bolting

Note: Numbers on the overpack lid are from initial overpack lid torqueing and are not related to this inspection.

16. Rust staining around overpack lid closure bolting and around top flange plug set screws

17. Rust staining around overpack lid closure bolting

Note: Numbers on the overpack lid are from initial overpack lid torqueing and are not related to this inspection.

18. Typical rust staining around top flange closure plug set screws

19. Chipped coating under overpack closure lid bolt (at 10 o'clock)

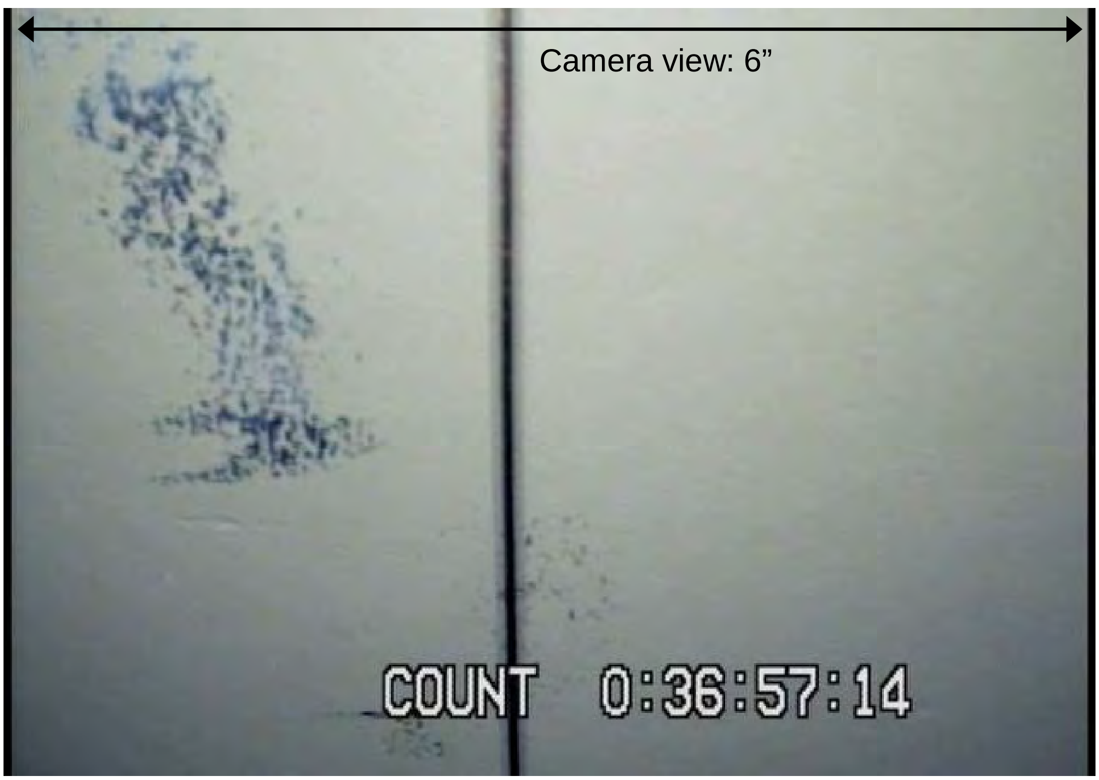
20. Cracked coating under overpack closure lid bolt

21. Coating chip with rust staining

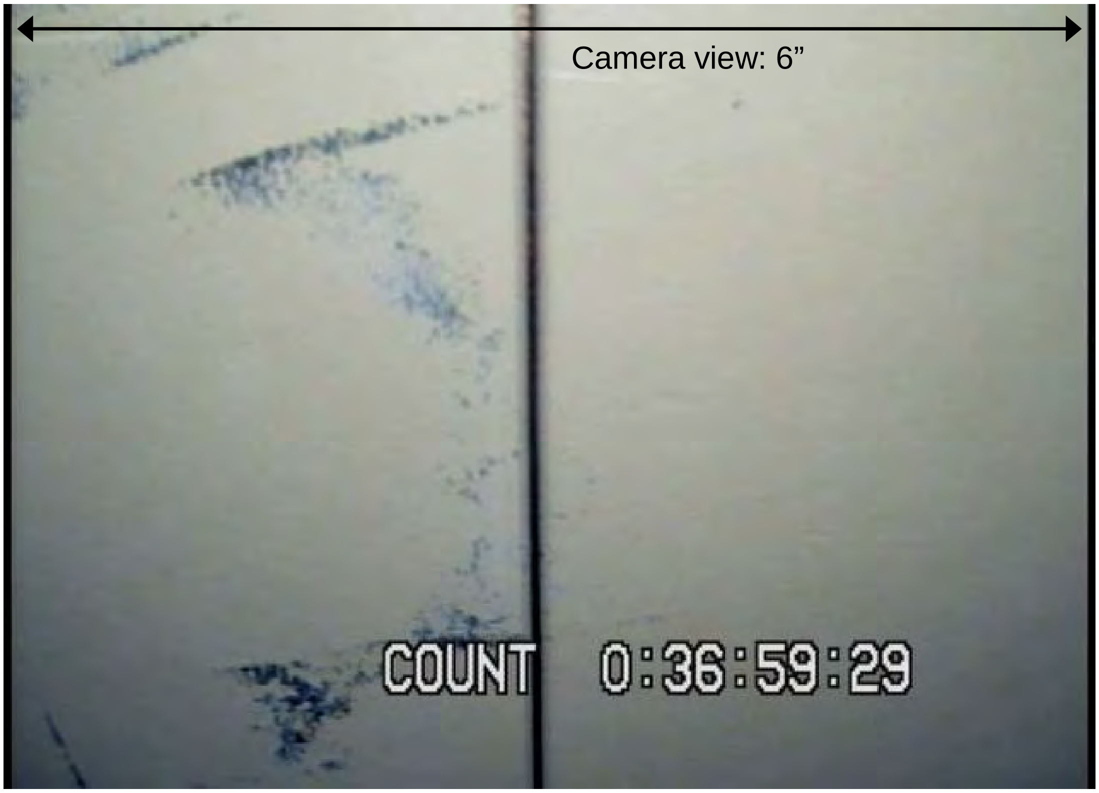
22. Coating chip from photo 21 (next above) after Rustbond epoxy sealer repair

23. Rust staining from drain hole in overpack

24. Scan 5 coating scrape



25. Scan 22 rub mark



26. Scan 22 rub mark

27. Scan 26 coating chip with slight rust discoloration

28. Scan 28 slight rust discoloration

29. Scan 30 slight rust discoloration and black stains

30. Scan 34 (black streaks)

31. Scan 35 coating scrape

32. Scan 38 coating scrape

33. Scan 40 coating scrape

34. Scan 42 coating scrape

35. Scan 55 slight rust discoloration

36. Scan 59 coating chip, no discoloration

37. Scan 77 coating chips, no discoloration

38. Scan 80 coating scrape

39. Scan 1 / Scan 80 area coating scrape

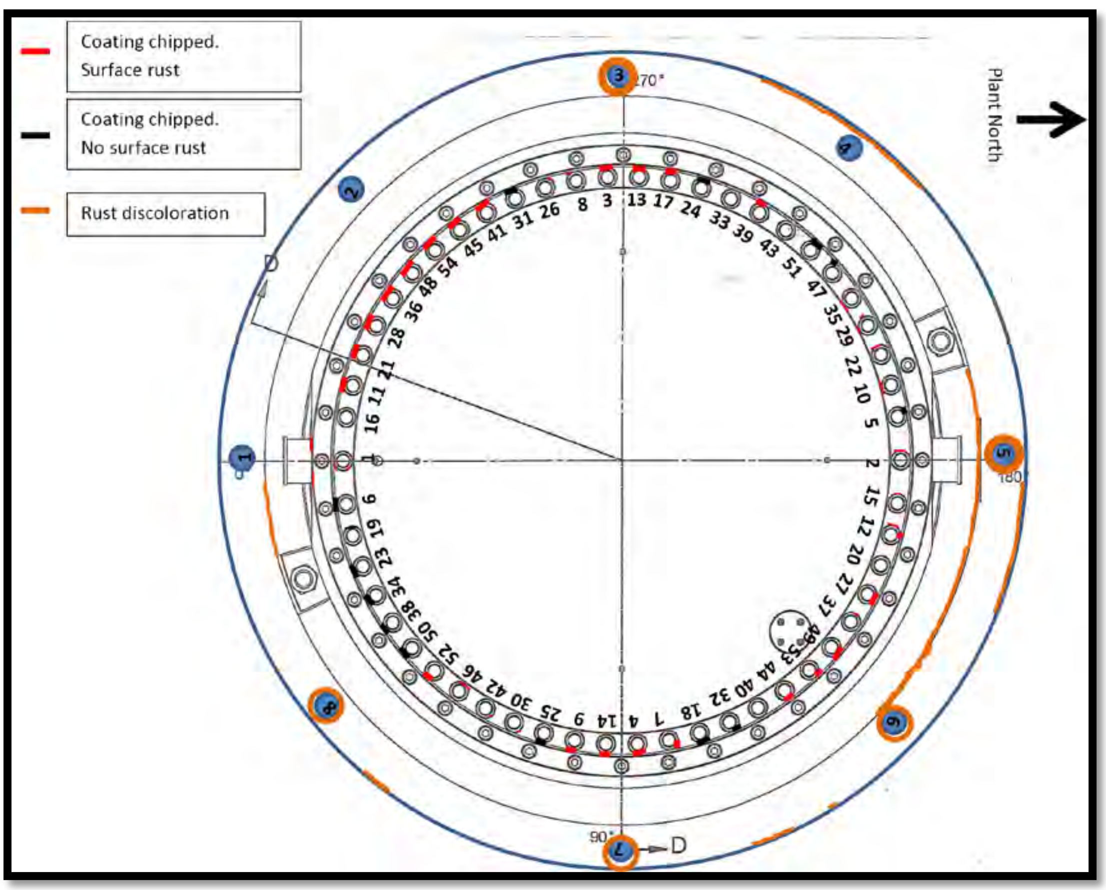
40. Overpack underside northeast section coating chip

41. Overpack north section coating scrape adjacent to seismic shim

42. Overpack south east section coating scrape adjacent to seismic shim

43. Overpack south east section (light rust around set screw)

44. Overpack south section coating scrape adjacent to seismic shim



45. Overview of Cell 2 coatings for overpack lid and vault liner lid ring

2.6, Vault Liner Photos

46. Vault lid ring bolt hole #3 corrosion products

47. Vault lid ring bolt hole #6 corrosion products

48. Rust at vault lid ring to concrete interface

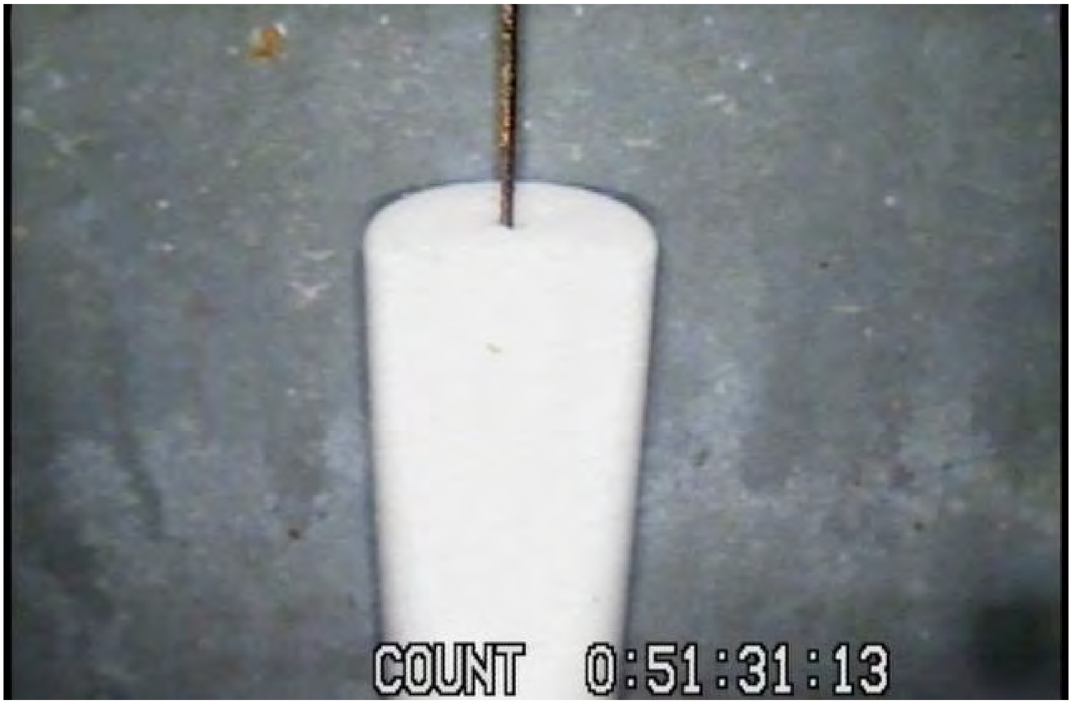
49. Rust staining at vault lid ring to vault liner interface

50. Rust staining at vault lid ring to vault liner interface

51. Rust staining at vault lid ring to vault liner interface

Note: Numbers on the overpack lid are from initial overpack lid torqueing and are not related to this inspection.

52. Rust staining at vault lid ring to vault liner interface
(view looking down along liner with seismic shim in upper portion of the picture)



53. Scan 2 rust spot (for size comparison, the wire cable supporting the plumb bob is 1/32" dia.)

54. Scan 5 rust spot

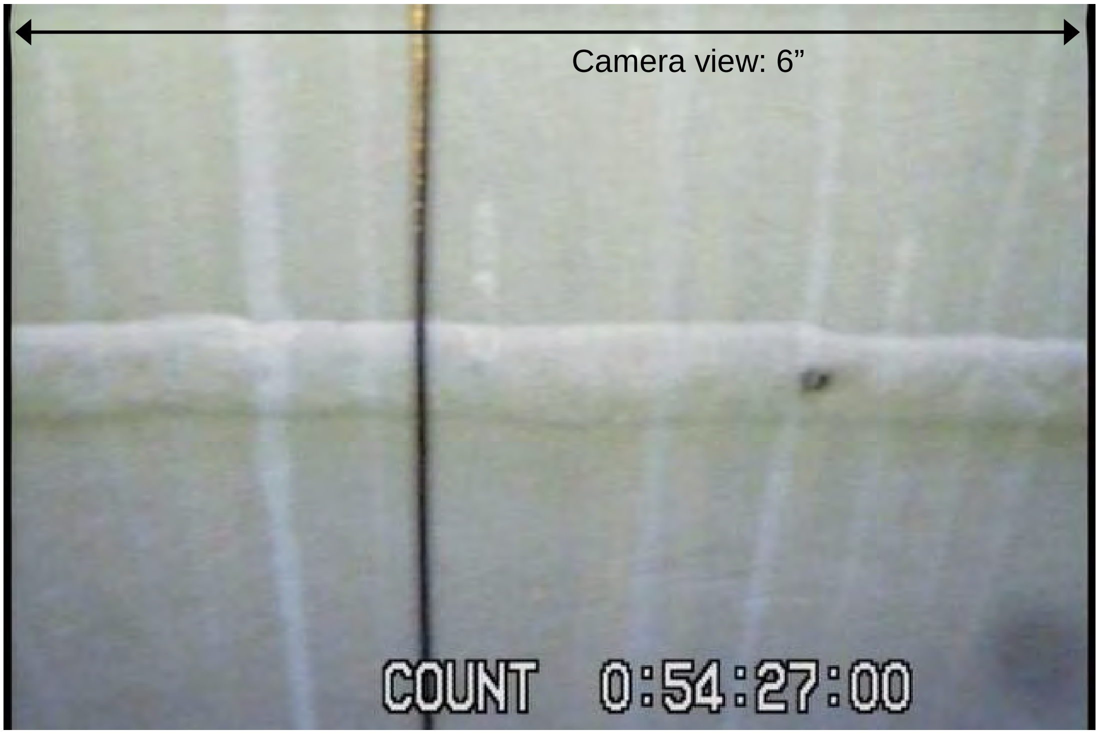
55. Scan 6 rust spot

56. Scan 6 rust spots

57. Scan 8 rust spot

58. Scan 10 rust spot

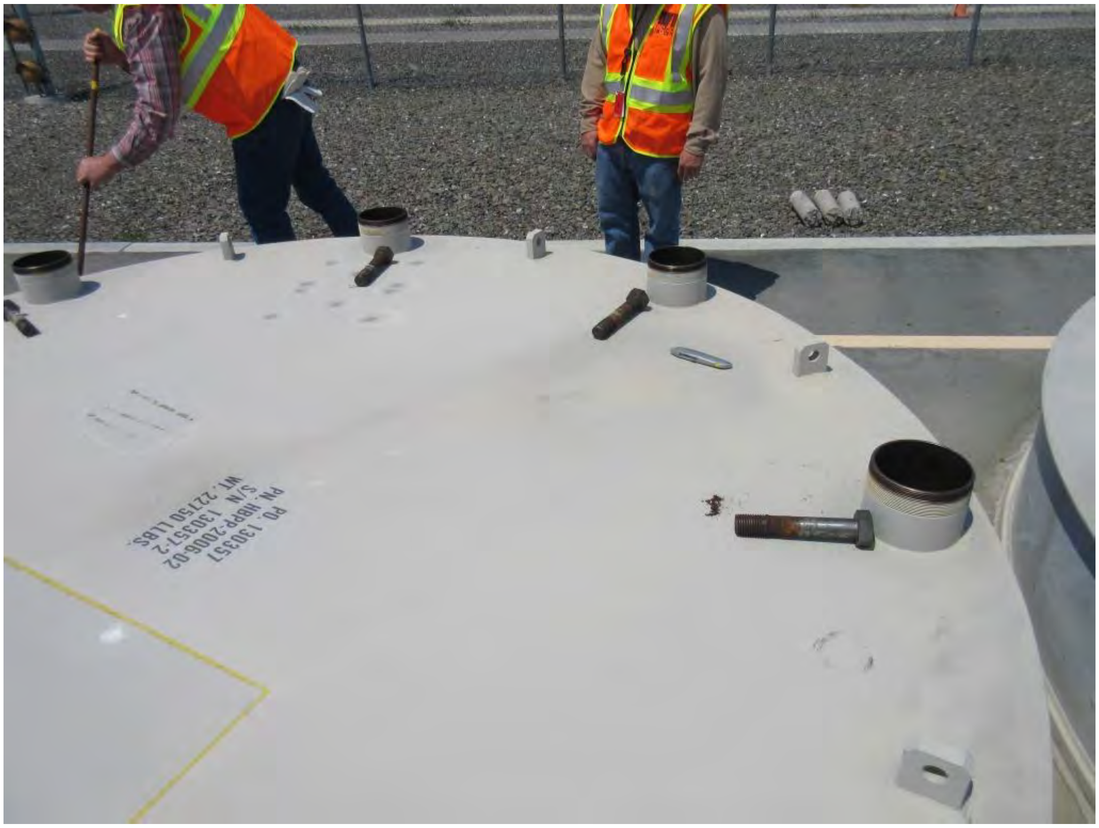
59. Scan 16 rust spot



60. Scan 38 Dark spot – possible coating damage – no rust discoloration

61. Scan 76 rust spots

2.5, Bolting Results



62. Removed hold down bolts lying adjacent to bolt ports

63. Underside of bolting pipe cap showing showing evidence of condensation

64. Inside lid bolting access hole evidence of moisture intrusion

65. Cell 2 all eight removed bolts

66. Removed bolt following cleaning (pitted bolts replaced)

Attachment 3
Vault Closure Lid Caulking Exam As-Found and As-Left Photos

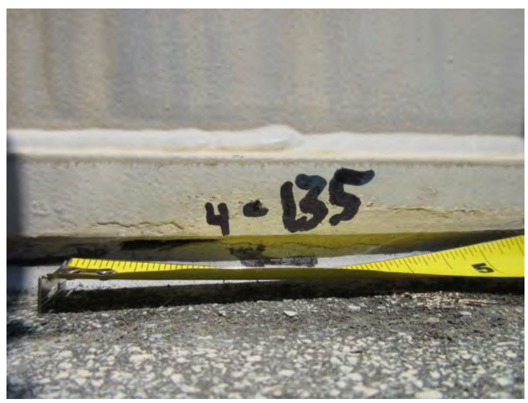
1. Cell 1 Caulking As-Found

2. Cell 2 Caulking As-Found

3. Cell 2 Caulking As-Found

4. Cell 4 Caulking As-Found

5. Cell 4 Caulking As-Found



6. Cell 4 Caulking As-Found

7. Cell 5 Caulking As-Found

8. Cell 5 Caulking As-Found

9.Cell 5 Caulking As-Found

10. Cell 5 Caulking As-Found

11. Cell 5 Caulking As-Found

12. Cell 5 Caulking As-Found

13. Cell 5 Caulking As-Found


14. Cell 5 Caulking As-Found

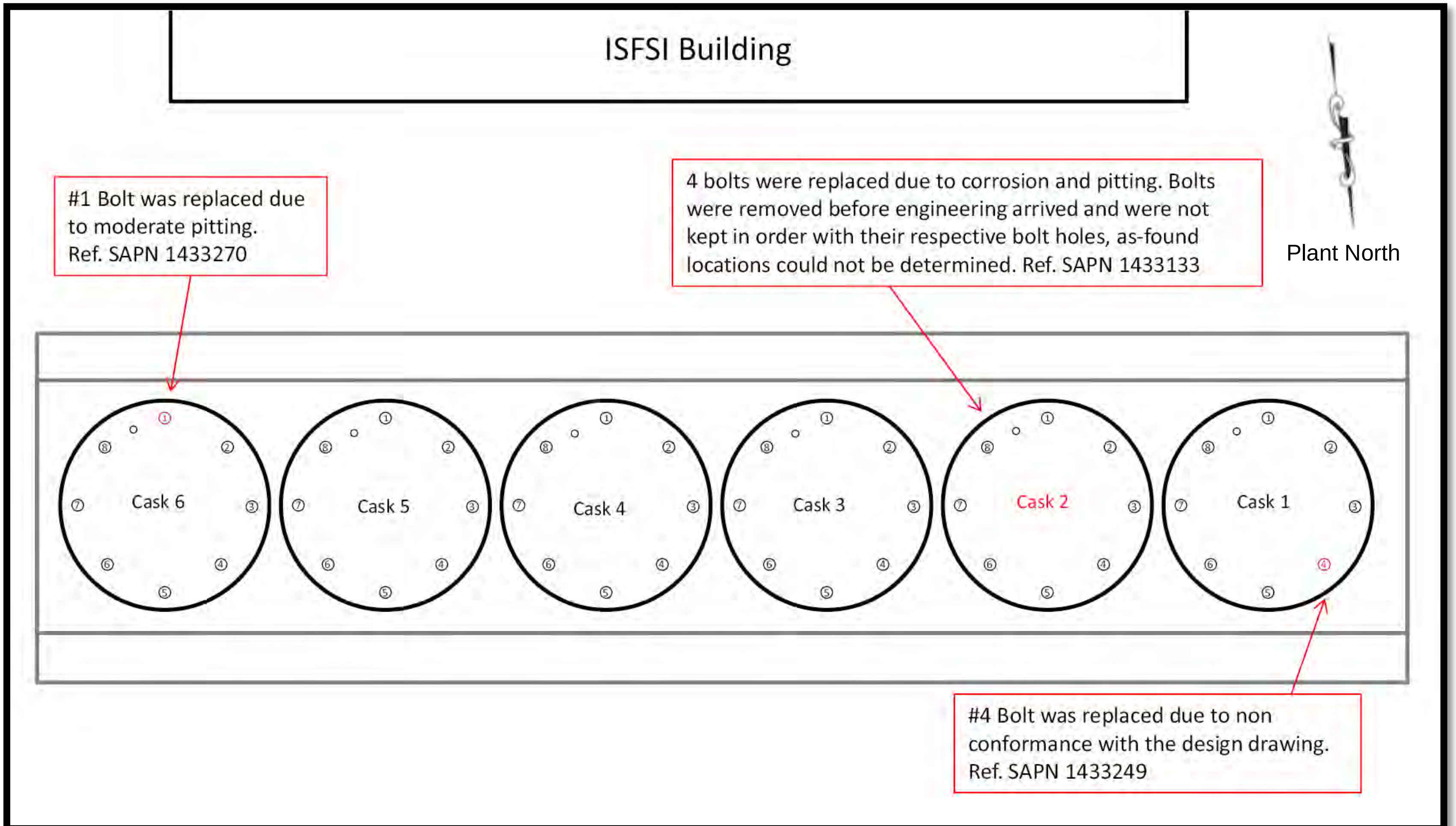

15. Cell 2 Caulking As-Left


16. Cell 2 Caulking As-Left

17. Cell 4 Caulking As-Left


18. Cell 4 Caulking As-Left

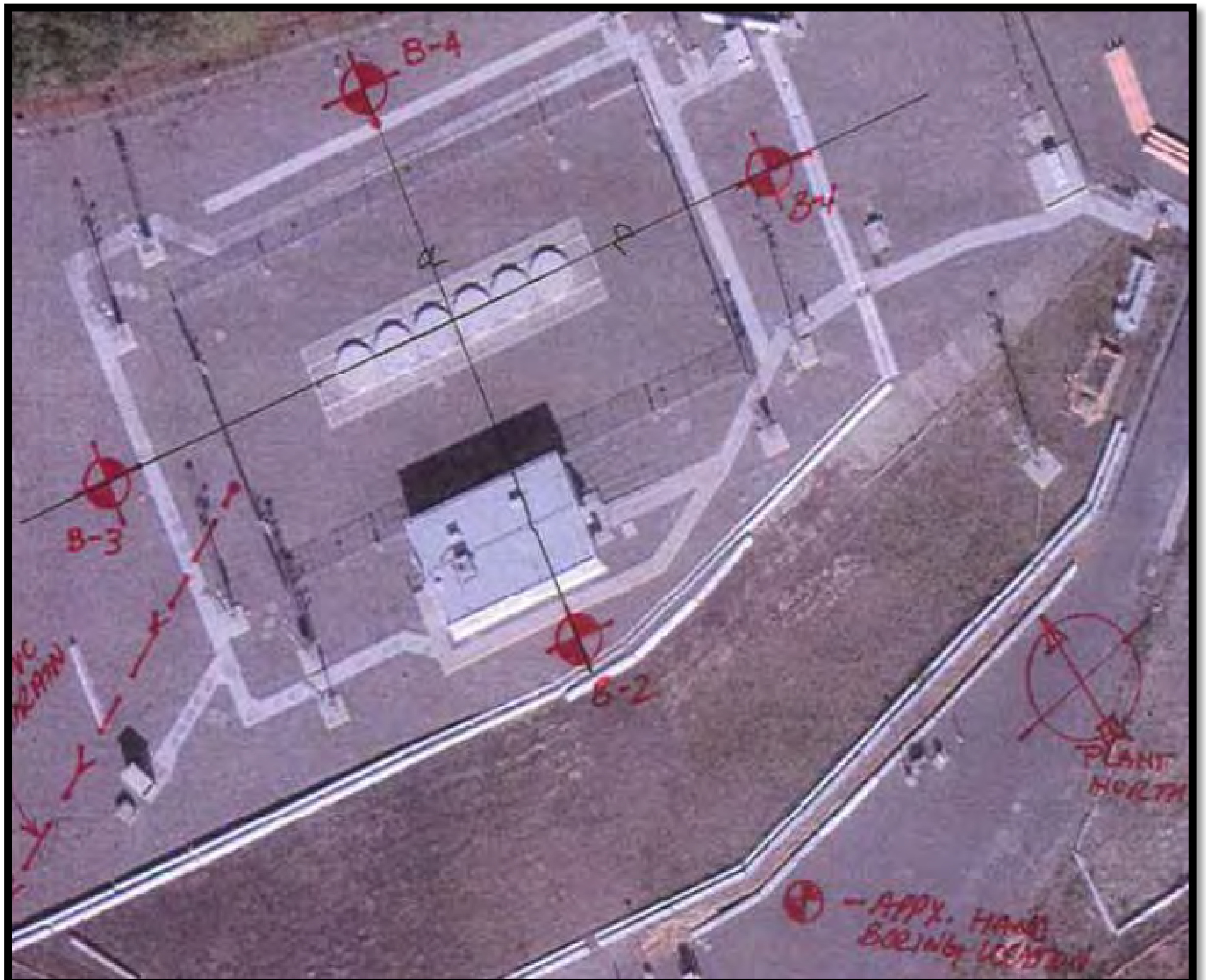
Attachment 4
Humboldt Bay ISFSI License Renewal
Vault Closure Lid Bolting Inspection Summary



Attachment 5

Humboldt Bay ISFSI License Renewal

2016 Soil Sampling Locations B-1, B-2, B-3, B-4



Attachment 6

Humboldt Bay ISFSI License Renewal

Pre-Application Inspection

DCPP Procedure NDE VT 3-2, Attachment 1
Form 69-22128, Report of Visual Examination of Component Exterior – Section XI

DCPP Form 69-22128 (02/22/17) **U1&2** **NDE VT 3-2 Attachment 1**
Page 1 of 2

Report of Visual Examination of Component Interior - Section XI

Site	HBPP	Unit	ISFSI	Component	ISFSI Cell 2
Date	8/2/17	Proc Rev	2	Description	Cell 2 Vault Lid, Overpack and Liner
				Drawing	N/A

Resolution	Acuity Card ☒	Meter ☐	Light Meter	Cal Due
Meter fc/Acuity Card Result		Sat		

Technique	Direct ☒		Remote ☒
Flashlight	☒	Camera	☐
Mirror	☒	Videoprobe	☐
Camera	☒	ROV	☒
Other	☐	Other	☐

Sketch

Results	NRI	RI
Cracks	☒	☐
Wear/Wall Thinning	☒	☐
Corrosion/Discoloration	☐	☒
Erosion	☒	☐
Deformed/Damaged	☒	☐
Welded Connections	☒	☐
Bolted Connections	☐	☒
Loose/Missing Parts	☒	☐
Blistering/Delamination	☒	☐
Coating Degradation	☐	☒
Debris	☒	☐
Wear	☒	☐
Other	☒	☐

Remarks/Limitations Direct exam performed on upper 24" portions of cask overpack and vault liner. Mirror used beneath seismic shims. Rust discoloration noted around lid bolts at interface with coating on top flange. Rust colored staining noted around set screws. Minor areas of chipped coating noted on closure lid and on top flange. Rust staining observed at interface between liner wall and vault lid ring. Removed bolting had areas of corrosion caused pitting, four bolts replaced. Maximum pitting depth 3/32". Illumination checks 8/2/17 @ 1040 & 1100. Notification HB 1433133 & HB 1433272 for Recordable Indications (RI). NOTE: shank diameter on pitted BOLTS = 1.3" NOMINAL.

Remote exam of cask overpack performed with an ROV crawler operated from the vault liner surface. A fixture positioning plumb bobs was used to provide guidance and ensure adequate overlap. Upper portion of exam overlaps with direct visual performed from top, lower exam overlaps with pole-mounted camera. Minor areas of coating degradation (scrapes), some minor rust discoloration, no evidence of material loss. Resolution check 8/2/17 @ 1105. Notification HB 1433272 for Recordable Indications (RI).

TGC2_69-22128 HBPP Cell 2 Exam.doc 0830.0747

Remote exam of cell vault liner performed with an ROV crawler operated from the cask overpack surface. A fixture positioning plumb bobs was used to provide guidance and ensure adequate overlap. Upper portion of exam overlaps with direct visual performed from top, lower exam overlaps with pole-mounted camera. Minor rust spots observed, may be external, no coating damage observed. Dried water streaks running down liner wall and water spots in lower portions, no evidence of damage from these streaks and spots. Notification HB 1433273 for Recordable Indications (RI). Resolution check 8/2/17 @ 1100.

Remote exam of cell vault liner and overpack performed with a pole-mounted camera. Coating scrapes in overpack adjacent to some seismic shims, appears to have been caused when cask placed in liner. Minor coating chips on underside of overpack where diameter reduces. No rust discoloration noted in coating degradation areas. Resolution check 8/2/17 @ 1620. Notification HB 1433272 for Recordable Indications (RI).

In addition: 8/1/2017 Examination of as-found caulking around interface between vault lid and lid ring. No service-related degradation noted, cells 1, 2, 4, & 5 had areas of incomplete adhesion between caulking and metallic components. Cell 4 area had measurable depth less than depth to inner interface. Illumination check 8/1/2017 @ 1300.

8/3/2017 Examination of caulking around interface between vault lid and ring. Exam performed on initial caulking application for cell 2 after lid re-installation. Cells 1, 4, & 5 in areas where incomplete application was previously noted after additional caulking added to those areas. Illumination check 8/3/2017 @ 0945.

Light Checks	1040	1100	See Above
Acceptable ☐	Unacceptable ☒	Notification	HB 1433272
Examiner ~~TGC2~~ / DAG1 (handwritten initials)	Level III	Examiner DLW4 / CTB6 (handwritten initials: DLW, CTB)	Level II
Review (signature) LTC	Date 9/12/17	ANII	Date

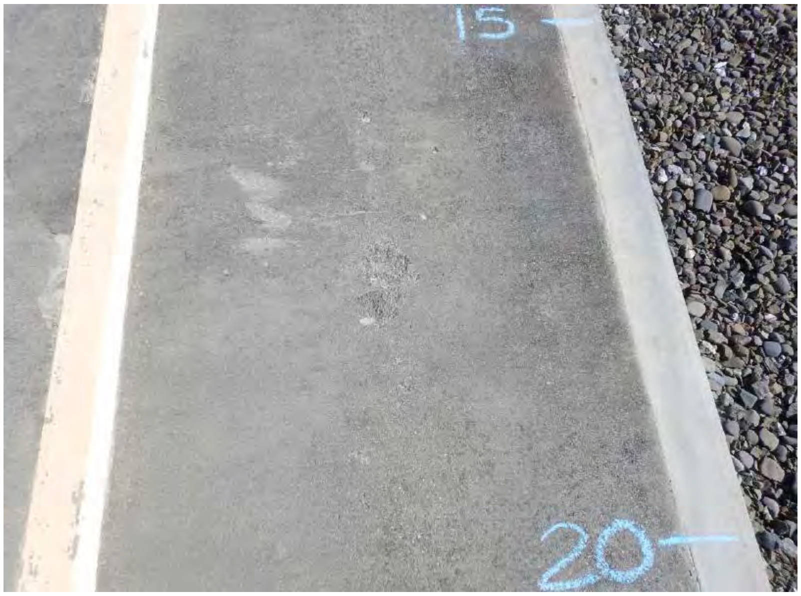
Unacceptable indications noted and reported to site staff.

TGC2_69-22128 HBPP Cell 2 Exam.doc 0830.0747

Attachment 7

Humboldt Bay ISFSI License Renewal

Pre-Application Vault Concrete Inspection Results

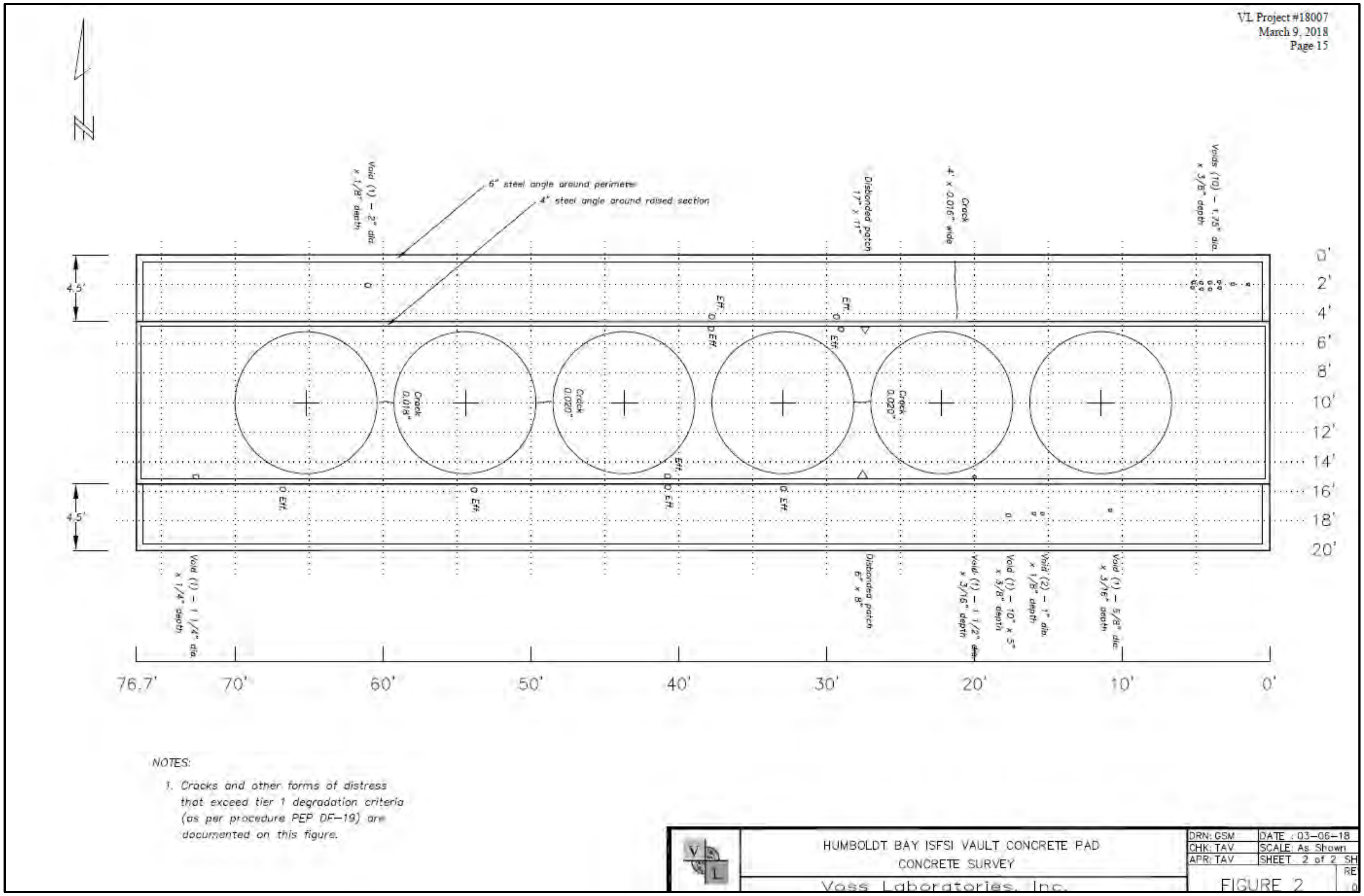


1. South side surface scaling/peeling at (18, 17) that is approximately 5" wide by 10" long by 3/8" deep

2. Center disbanded patch at (27, 5) that is approximately 17" by 11"

3. Center disbanded patch at (27, 15) that is approximately 8” by 6”

4. Photo taken during HB ISFSI concrete placement showing a construction aid most likely used to keep steel angles from moving during construction



Attachment 7, Figure 1

Attachment 8

Humboldt Bay ISFSI License Renewal
Pre-Application Boroscope Inspection Report

Humboldt Bay ISFSI License Renewal

Pre-Application Boroscope Inspection

March 21, 2017

1. Purpose

In accordance with NUREG-1927, Revision 1, Section 3.4.1.2, the applicant for an Independent Spent Fuel Storage Installation (ISFSI) license renewal may choose to verify the condition of the system and demonstrate that structures, systems, and components (SSCs) within the scope of the license renewal application (LRA) have not undergone unanticipated aging and degradation prior to entering the period of extended operation (PEO). If the system inspection reveals unanticipated aging or degradation, then the applicant would need to address the condition of the SSCs in the LRA.

The pre-application inspection is an important element in an operations-focused aging management approach and provides valuable operating experience. The results from the pre-application inspection will be used to develop detailed aging management programs (AMPs), including inspection and maintenance frequencies, and provide a baseline for the monitoring and trending element of AMPs in the PEO.

In response to NUREG-1927 guidance, PG&E plans to perform a pre-application inspection of the Humboldt Bay (HB) ISFSI to support License Renewal efforts. The pre-application inspection will include a detailed inspection of 1 of 6 vault cells at the HB ISFSI. In order to support a technical basis for choosing the "leading" vault cell for detailed inspection, a preliminary boroscope exam was conducted. The purpose of this report is to document the boroscope exam and associated results.

2. Pre-Application Boroscope Inspection Process

The HB ISFSI is comprised of an underground vault with six concrete cells with steel liners. Vault cells 1-5 contain spent fuel stored in HI-STAR 100 HB Overpacks. Vault cell 6 contains greater-than-class C (GTCC) waste stored in a HI-STAR HB GTCC Overpack. The vaults are closed off from weather by bolted, caulked vault lids. Each cell contains a drainage system in the event of water intrusion. The inner surface of the vault cell is covered by a steel liner, except for a small grouted area surrounding the vault drain which provides a slope/funnel to the drain cover.

While the vault lid is installed, overpack access is limited to a 3-inch access port. The 3-inch access port opening is further restricted by a seismic shim just underneath the access port. Because access to the vault is so restricted, the pre-application inspection will include removal of one vault lid and a VT-3 inspection of the accessible portions of the overpack and vault liner. The vault cell that should be chosen for the pre-application inspection would be that which is most-likely to show degradation (i.e., the vault cell that has been stored the longest, with the most aggressive environment, highest heat load, etc.). The following information is known on the vault cells:

- Cells #1-5 are each of the same design and layout, contain HI-STAR 100 HB systems of the same materials, and each contain approximately the same heat load of 1.9 kW. Thus, there are no differences in the material and environments in which potential aging effects may occur.

- Cells #1-5 were each loaded within 8 months of each other. Thus, age is of minimal consideration.

- Operating experience reviews indicate that cell #2 is the only cell that experienced water intrusion since initial loading. Although the water intrusion has been corrected, this cell is the most-likely to have experienced long-term aging effects.

To determine the condition of each vault cell and provide additional insight as to which vault cell may be the most susceptible to degradation, a boroscopic exam was conducted via the access port. The boroscope inspection includes a visual of the components accessible by a standard articulating boroscope of the coated vault interior liners, exterior portions of the coated HI-STAR 100 HB Overpack, and the coated HI-STAR HB GTCC Overpack.

The following acceptance criteria were used during the inspection. See Section 4 for identification of any findings that did not meet the below acceptance criteria.

- no detectable loss of material from the base metal, including uniform wall thinning, localized corrosion pits, and crevice corrosion
- no red-orange-colored corrosion products on the base metal, coatings, or concrete
- no coating defects (e.g., peeling, delamination, blisters, cracking, flaking, and rusting)
- no indications of loose bolts or hardware, displaced parts
- no indications of premature rupture, including bubbling or deformation, of the relief device disk

3. Inspection Results

This limited examination was performed using a 6mm, GE GO+ articulating video probe. The extent of the examination is estimated to be 5% of the exterior surface of the overpack and 5% of the interior surface of the vault liner for each vault cell.[1] The video probe has been demonstrated to resolve lower case characters, 0.105" in height. This visual resolution meets VT-3 requirements.

Photos from each cell inspection are referenced in the sub-sections below. These photos represent the bounding conditions identified during the inspection and are not meant to reflect every indication. The boroscope inspection video is available in its entirety at DCPP ISI.

3.1. Vault Cell #1

Photos from the vault cell #1 boroscope exam are provided in Attachment 1. The findings are listed below:

1. No degradation of the coated metallic surfaces was observed except for orange discoloration around an overpack plug (see Attachment 1, photo 27) and near the lifting trunnion (see Attachment 1, photo 29).

2. The vault liner contained a few black marks oriented vertically. While these markings are difficult to characterize, there was no indication of coating degradation associated with the marks. (see Attachment 1, photo 28)

3. A white deposit was noted around the floor drain. The deposit appearance is crystalline with no apparent discoloration, similar to concrete efflorescence or leaching. The boroscope video does not provide enough detail to establish the condition of the drain. It should be noted that the floor drain is not important to safety because of a defense-in-depth design and is not in the scope of license renewal. (see Attachment 1, photo 21)

[1] 5% equals approximately 15" (circumferential). The axial extent was from the upper horizontal surface to the floor of the vault.

4. There were small amounts of debris on the vault liner floor. The debris is not rust-colored and is not indicative of degradation. Thus, no further action is needed since this debris does not pose an issue.

In summary, although the black markings on the vault liner and the white deposit near the floor drain does not fail acceptance criteria, it will be entered into the Corrective Action Program (CAP) as an observation. In addition, the orange discoloration noted at an overpack plug and on the lifting trunnion indicate that the exam acceptance criteria have not been met for overpack #1 (see Section 4 below).

3.2. Vault Cell #2

Photos from the vault cell #2 boroscope exam are provided in Attachment 2. The findings are listed below:

1) Overpack #2 contained several black marks on the outer surface of the overpack. While these markings are difficult to characterize, there was no indication of coating degradation associated with the marks. Many of the marks were linear and oriented diagonally on the surface of the overpack. (see Attachment 2, photos 7-14)

2) There were several minor isolated rust-like spots on the upper horizontal surface (below the trunnions) of the overpack. These rust-like spots were localized and appear granular in nature. There was no indication of coating degradation adjacent to the spots. The origin of these indications could not be determined without physical access to the surface. (see Attachment 2, photos 19, 21, 22)

   Note: Since these rust-like spots are located directly below the inspection port, it is entirely possible that these are the result of corrosion products which have collected on the horizontal surface from the access port. This port is utilized during the annual special nuclear materials inspections.

3) No degradation of the coated metallic surfaces was observed.

4) A white deposit was noted around the floor drain. The deposit appearance is crystalline with no apparent discoloration, similar to concrete efflorescence or leaching. The boroscope video does not provide enough detail to establish the condition of the drain. It should be noted that the floor drain is not important to safety because of a defense-in-depth design and is not in the scope of license renewal. (see Attachment 2, photo 15)

5) Each vault cell contains a temperature probe (thermocouple) that was used to verify vault temperatures after initial loading. These temperature probes are no longer in service and are not in the scope of license renewal. Minor staining on non-coated temperature probe fittings in vault cell #2. The staining did not extend to vault liner to which the probe is attached. Because these probes are not in the scope of license renewal and are no longer in service, no further action is needed. (see Attachment 2, photos 3-4)

In summary, although there was no degradation observed on the overpack or vault liner themselves, the red-orange corrosion products on the surface indicate that the exam acceptance criteria have not been met for overpack #2 (see Section 4 below). These locations require additional evaluation during the July/August 2017 examination. In addition, the black markings on the overpack and white deposit near the floor drain do not fail acceptance criteria, but will be entered into the CAP as observations.

3.3. Vault Cell #3

Photos from the vault cell #3 boroscope exam are provided in Attachment 3. The findings are listed below:

1. No degradation of the coated metallic surfaces was observed except for orange discoloration on an overpack weld (see Attachment 3, photo 16).

2. A white deposit was noted around the floor drain. The deposit appearance is crystalline with no apparent discoloration, similar to concrete efflorescence or leaching. The boroscope video does not provide enough detail to establish the condition of the drain. It should be noted that the floor drain is not important to safety because of a defense-in-depth design and is not in the scope of license renewal. (see Attachment 3, photos 8, 9)

3. There were small amounts of debris on the overpack. The debris was not rust-colored and was not indicative of degradation. Thus, no further action is needed since this debris does not pose an issue.

In summary, although the white deposit near the floor drain does not fail acceptance criteria, it will be entered into the CAP as an observation. In addition, the orange discoloration noted at an overpack weld indicate that the exam acceptance criteria have not been met for overpack #3 (see Section 4 below).

3.4. Vault Cell #4

Photos from the vault cell #4 boroscope exam are provided in Attachment 4. The findings are listed below:

1. No degradation of the coated metallic surfaces was observed.

2. There were small amounts of debris on the vault liner floor. The debris is not rust-colored and is not indicative of degradation. Thus, no further action is needed since this debris does not pose an issue.

3.5. Vault Cell #5

Photos from the vault cell #5 boroscope exam are provided in Attachment 5. The findings are listed below:

1. A scrape was identified on the coated overpack surface. While this scrape is difficult to characterize, there was no indication of degradation associated with the scrapes. (see Attachment 5, photo 15)

2. A white deposit was noted around the floor drain. The deposit appearance is crystalline with no apparent discoloration, similar to concrete efflorescence or leaching. The boroscope video does not provide enough detail to establish the condition of the drain. It should be noted that the floor drain is not important to safety because of a defense-in-depth design and is not in the scope of license renewal. (see Attachment 5, photo 5)

3. Each vault cell contains a temperature probe (thermocouple) that was used to verify vault temperatures after initial loading. These temperature probes are no longer in service and are not in the scope of license renewal. Minor staining on non-coated temperature probe fittings in vault cell #5. The staining did not extend to vault liner to which the probe is attached. Because these probes are not in the scope of license renewal and are no longer in service, no further action is needed. (see Attachment 5, photo 3)

4. There were small amounts of debris on the vault liner floor and overpack. The debris is not rust-colored and is not indicative of degradation. Thus, no further action is needed since this debris does not pose an issue.

In summary, although the white deposit near the floor drain does not fail acceptance criteria, it will be entered into the CAP as an observation. In addition, the scrape identified in the overpack coating does not meet exam acceptance criteria for overpack #5 (see Section 4 below).

3.6. Vault Cell #6

Photos from the vault cell #6 boroscope exam are provided in Attachment 6. The findings are listed below:

1. No degradation of the coated metallic surfaces was observed.

2. A white deposit was noted around the floor drain. The deposit appearance is crystalline with no apparent discoloration, similar to concrete efflorescence or leaching. The boroscope video does not provide enough detail to establish the condition of the drain. It should be noted that the floor drain is not important to safety because of a defense-in-depth design and is not in the scope of license renewal. (see Attachment 6, photo 4)

In summary, although the white deposit near the floor drain does not fail acceptance criteria, it will be entered into the CAP as an observation.

4. Corrective Actions

There were two categories of findings that were entered into the Corrective Action Program (CAP) resulting from the boroscope exam: (1) those not meeting the exam acceptance criteria and (2) noted observations that are being documented for future reference. Each category of findings is discussed below.

Acceptance Criteria Not Met

1. As discussed in Section 3.1, orange discoloration was noted at an overpack plug and near the lifting trunnion. Because the discoloration does not meet exam acceptance criteria, this finding was entered into CAP (SAPN 1429074, Task 28) for further evaluation.

2. As discussed in Section 3.2, red-orange corrosion products were noted on the surface of the overpack. Because the corrosion product does not meet exam acceptance criteria, this finding was entered into CAP (SAPN 1429074, Task 29) for further evaluation.

3. As discussed in Section 3.3, orange discoloration was noted at an overpack weld. Because the discoloration does not meet exam acceptance criteria, this finding was entered into CAP (SAPN 1429074, Task 30) for further evaluation.

4. As discussed in Section 3.5, a scrape was identified in the overpack coating. Because the scrape does not meet exam acceptance criteria this finding was entered into CAP (SAPN 1429074, Task 31) for further evaluation.

Observations

1. As discussed in Sections 3.1 and 3.2, markings were identified on the overpack and vault liner. These markings do not fail acceptance criteria, but will be entered into the CAP as observations (SAPN 1429074, Task 32).

2. A discussed in Sections 3.1, 3.2, 3.3, 3.5, and 3.6, white deposits were noted around the floor drains in cells 1, 2, 3, 5 and 6. The deposit appearance is crystalline with no apparent discoloration, similar to concrete efflorescence or leaching. The boroscope video does not provide enough detail to establish the condition of the drain. It should be noted that the floor drain is not important to safety because of a defense-in-depth design and is not in the scope of license renewal. Although identification of the white deposits are not addressed in the exam acceptance criteria, this finding was entered into CAP as an observation (SAPN 1429074, Task 33) for further evaluation.

   A picture from prior to cask loading identified similar white deposits around the floor drain. In addition, no water marks were noted on the vault floors during the boroscope exam and any new water intrusion in the vault would have washed away the white deposits. Thus, it appears that the efflorescence is remaining from the ISFSI construction period when the vaults were directly exposed to weather, resulting in leaching due to rainwater.

The July/August inspection scope has been modified to ensure that that inspection crawler captures as-found and as-left images of the drain in vault #2 so that drain functionality can be further evaluated. Further, provisions will be available to clean the white deposit from the drain screen, to the extent possible, for future trending purposes.

5. Conclusions

The summary of boroscope inspection findings is presented below:

- Coated casks and vault liners are in very good condition
- No rust staining was seen on the vault liner
- The condition was not noticeably different between the cells
- Cell #2 contained slight mechanical markings (such as scuff marks) – more so than the other cells. These markings were entered into CAP as observations even though they met the inspection acceptance criteria.
- No recommended coating touch-ups
- Orange discoloration was noted on overpack #1 at a plug and near the lifting trunnion and on overpack #3 on a weld. These findings were entered into CAP for evaluation.
- The inspection identified some red-orange corrosion products on overpack #2. This finding was entered into CAP for evaluation to determine if they are associated with the overpack or vault lid or from potential debris associated with loading activities or use of the access port. During the lead inspection in July/August 2017, the DCPP foreign material exclusion procedure will be used and the capability of vacuuming and cleaning the vault contents will be available.
- The inspection identified white deposits around the floor drains of cells 1, 2, 3, 5, and 6. The boroscope video does not provide enough detail to establish the condition of the drain. It should be noted that a picture of a vault prior to loading showed similar deposits around at least one of the vault drains. A SAPN task was initiated as an observation for future trending and the July/August inspection scope has been modified to ensure that that inspection crawler captures as-found and as-left images of the drain in vault #2 so that drain functionality can be further evaluated.

Because of the similar condition of all cells, but the additional mechanical markings noted in cell #2, it is recommended that cell #2 be inspected in the July/August inspection (note that cell #2 also has operating experience with previous water intrusion which may have provided an environment more suitable for degradation).

6. Inspection Report Preparers and Reviewers

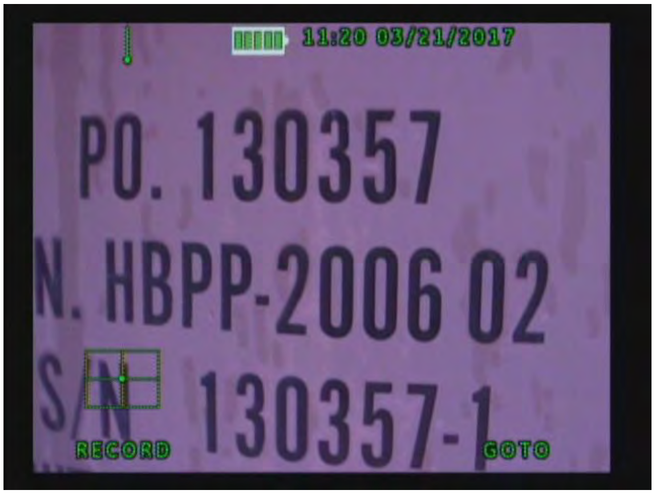
The following personnel were involved in preparing or reviewing this inspection report:

- P. Soenen, HB ISFSI License Renewal Project Manager
- T. Grebel, HB ISFSI License Renewal Project Manager
- M. Olsofsky, HB ISFSI License Renewal Engineer
- R. Hagler, Supervisor, DCPP Dry Fuel Management

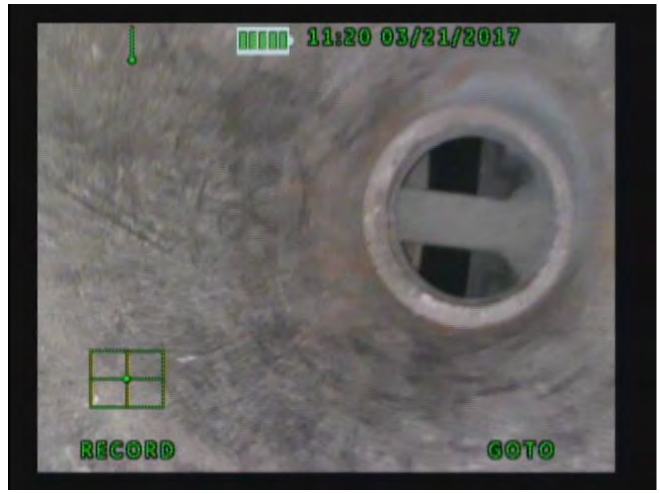
- K. Braico, Engineer, DCPP Dry Fuel Management
- K. Duke, Senior Engineer, DCPP Dry Fuel Management
- D. Wilson, DCPP ISI Inspector
- C. Beard, DCPP ISI Inspector
- J. Cheng, Coatings Inspector

Attachment 1: Vault Cell #1 Inspection Photos

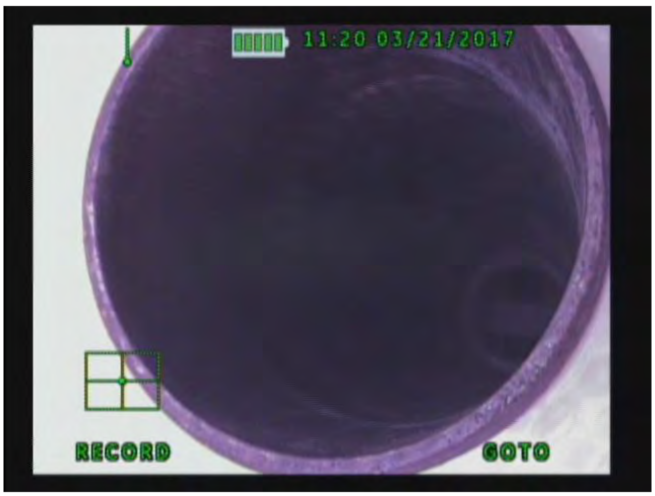
1. Name Plate



2. Access Port



3. Access Port



4. Access Port

6. Relief Device

7. Relief Device

Attachment 1: Vault Cell #1 Inspection Photos

8. Overpack

9. Overpack and lifting trunnion

10. Overpack lifting trunnion

11. Relief Device

12. Close-up of overpack coating

13. Vault liner

14. Looking down overpack at seismic shim

15. Looking down overpack at seismic shim

16. Looking down overpack at seismic shim

17. Looking down overpack at seismic shim

18. Seismic shim and bottom of vault liner

19. Seismic shim and bottom of vault liner

20. Overpack

21. Vault drain

22. Close-up of overpack coating

23. Close-up of overpack coating

24. Close-up of vault liner

25. Close-up of vault liner

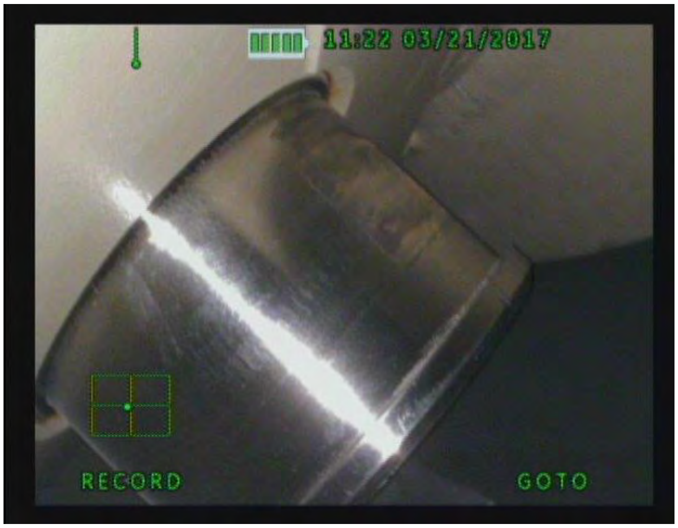
Attachment 1: Vault Cell #1 Inspection Photos

26. Close-up of vault liner

27. Overpack bolt

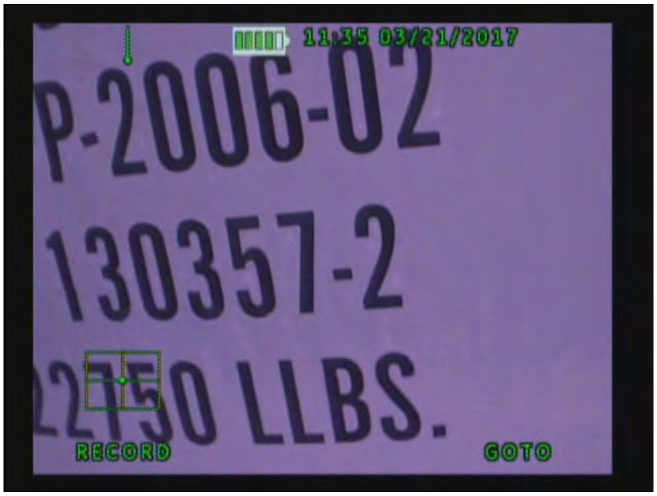
28. Vault liner markings

29. Lifting trunnion



Attachment 2: Vault Cell #2 Inspection Photos

1. Name Plate



2. Overpack and vault liner

3. Temperature probe (no longer in-service)

4. Temperature probe (no longer in-service)

5. Overpack and seismic shim

6. Overpack and seismic shim

Attachment 2: Vault Cell #2 Inspection Photos

7. Overpack with Scuff Marking

8. Overpack with Scuff Marking

9. Overpack with Scuff Marking

10. Overpack with Scuff Marking

11. Overpack with Scuff Marking

12. Overpack with Scuff Marking

Attachment 2: Vault Cell #2 Inspection Photos

13. Overpack with Scuff Marking

14. Overpack with Scuff Marking

15. Vault Drain

16. Overpack with Scuff Marking

17. Overpack with Scuff Markings

18. Overpack with Scuff Markings

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19. Overpack, rust spots

20. Relief Device and Overpack

21. Overpack, rust spots

22. Relief Device and Overpack

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3. Vault Liner, Temperature Probe, Overpack

4. Vault Liner

5. Vault Liner

6. Vault Liner and Seismic Shim

Attachment 3: Vault Cell #3 Inspection Photos

7. Overpack

8. Vault Drain

9. Overpack and Vault Drain

10. Overpack and Seismic Shim

11. Overpack

12. Overpack

Attachment 3: Vault Cell #3 Inspection Photos

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14. Overpack with Debris

15. Overpack with Debris

16. Overpack weld

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1. Name Plate

2. Relief Device

3. Vault Liner

4. Vault Liner Weld

5. Vault Liner Bottom

6. Vault Liner Bottom and Seismic Shim

Attachment 4: Vault Cell #4 Inspection Photos

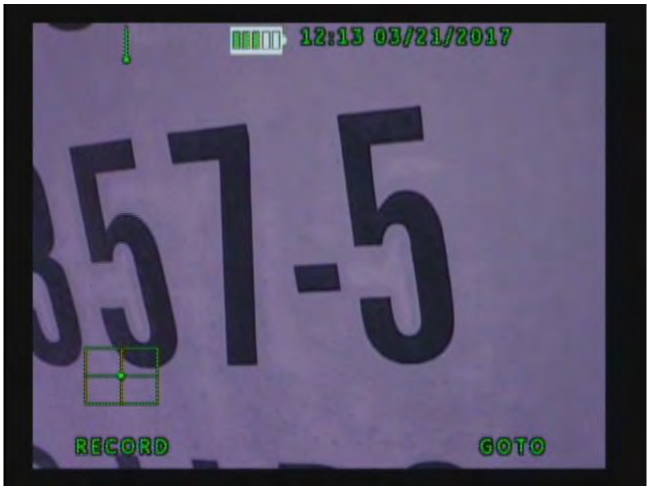
7. Vault Liner Bottom and Vault Drain

8. Overpack

9. Overpack

Attachment 5: Vault Cell #5 Inspection Photos

1. Name Plate



2. Overpack

3. Vault Liner and Temperature Probe

4. Overpack

5. Vault Liner Bottom and Vault Drain

6. Overpack and Vault Liner Bottom

Attachment 5: Vault Cell #5 Inspection Photos

7. Vault Liner Bottom, Vault Drain, Overpack

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9. Overpack

10. Overpack and Seismic Shim

11. Overpack and Vault Liner Bottom with Debris

12. Overpack and Vault Liner Bottom with Debris

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13. Overpack

14. Overpack with Scuff Marking

15. Overpack with Scrapes

16. Overpack with Debris

7. Overpack and Relief Device

8. Overpack and Relief Device

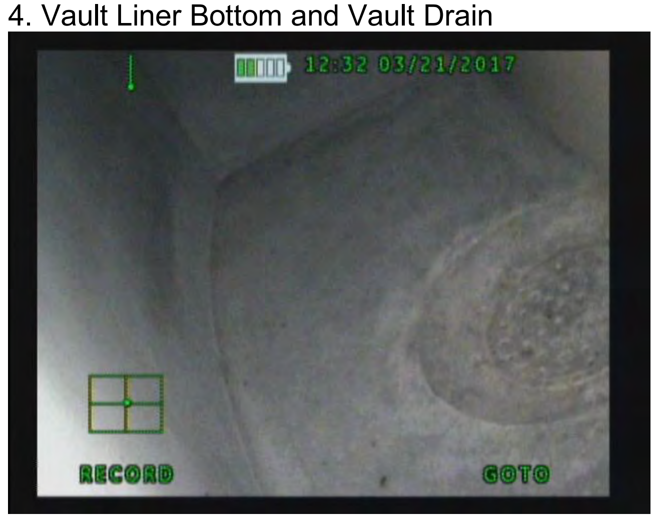
Attachment 6: Vault Cell #6 Inspection Photos

1. Name Plate

2. Vault Liner

3. Overpack

4. Vault Liner Bottom and Vault Drain



5. Overpack and Seismic Shim

6. Overpack and Seismic Shim

Attachment 6: Vault Cell #6 Inspection Photos

7. Overpack

8. Overpack

9. Overpack

APPENDIX F

ENVIRONMENTAL REPORT SUPPLEMENT

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Acronyms and Abbreviations

ALARA	As Low As Reasonably Achievable
APE	Area of Potential Effect
CCC	California Coastal Commission
CDFW	California Department of Fish and Wildlife
CEC	California Energy Commission
CFR	Code of Federal Regulations
CHRIS	California Historical Resources Information System
CISF	Consolidated Interim Storage Facility
DOE	Department of Energy
EA	Environmental Assessment
ER	Environmental Report
GEIS	Generic Environmental Impact Statement
GTCC	Greater Than Class C
HB	Humboldt Bay
HBGS	Humboldt Bay Generating Station
HBPP	Humboldt Bay Power Plant
ISFSI	Independent Spent Fuel Storage Installation
MLLW	Mean Lower Low Water
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NMSS	Nuclear Material Safety and Safeguards
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NRHP	National Register of Historic Places
PG&E	Pacific Gas and Electric
SHPO	State Historic Preservation Officer
SWPPP	Stormwater Pollution Prevention Plan
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
WCS	Waste Control Specialists

F.1 Introduction

Independent Spent Fuel Storage Installations (ISFSI) for storing spent nuclear fuel and associated radioactive materials are licensed by the U.S. Nuclear Regulatory Commission (NRC). ISFSIs are licensed in accordance with the Atomic Energy Act of 1954 (42 United States Code [USC] 2011, et. seq.) and NRC implementing regulations.

Pacific Gas and Electric (PG&E) Company owns and operates the Humboldt Bay (HB) ISFSI in Humboldt County, California. The HB ISFSI operates pursuant to its own site-specific NRC license (SNM-2514), which was issued in November 2005 (Reference F8.1). The HB ISFSI was constructed to store the spent fuel and the greater than class C (GTCC) waste associated with decommissioned HB Power Plant (HBPP) Unit 3, a boiling water reactor shut down in 1976. SNM-2514 currently allows PG&E to store up to 5 HI-STAR 100 HB casks containing spent fuel and 1 HI-STAR 100 HB cask containing GTCC waste within the HB ISFSI. The current site-specific HB ISFSI license will expire on November 17, 2025.

F1.1 Purpose and Need for the Proposed Action

PG&E and the NRC intend for the storage at the HB ISFSI to be interim pending availability of a federal repository. Commercial entities have also expressed interest in establishing a Consolidated Interim Storage Facility (CISF) for away-from-reactor storage of spent nuclear fuel. However, there is uncertainty regarding when a repository or CISF will be available, and the schedule under which such a repository or CISF will accept spent fuel and GTCC waste shipments. The repository and CISF schedules drive the HB ISFSI schedule; the longer it takes for a repository or CISF to begin accepting spent fuel and GTCC waste shipments, the longer the HB ISFSI must store spent fuel and GTCC waste.

In the Nuclear Waste Policy Act of 1982, Congress directed the U.S. Department of Energy (DOE) to construct and operate a geologic repository for the permanent disposal of commercial spent nuclear fuel. In the Amendments of 1987, Congress directed the DOE to study Yucca Mountain as a potential location for a federal repository. In 2002, the President and Congress approved Yucca Mountain as the site for the federal repository. In June 2008, the DOE submitted a license application to the NRC that proposed initial loading of the facility in the 2020 timeframe. In 2009, the President announced plans to terminate the Yucca Mountain program. In 2017, the Government Accountability Office (GAO) released report GAO-17-340, "Resuming Licensing of the Yucca Mountain Repository Would Require Rebuilding Capacity at [Department of Energy] DOE and NRC, Among Other Key Steps," which identified four key steps to resuming the Yucca Mountain licensing review.

In the Agency's 1990 Waste Confidence findings, the NRC previously assessed its degree of confidence that radioactive wastes produced by nuclear power plants could be safely disposed of, and made 5 findings (55 FR 38474, September 18, 1990). These five findings form the basis of the NRC's generic determination of no significant environmental impact from temporary storage of spent nuclear fuel. In 1999, the NRC confirmed these findings (64 FR 68005, December 6, 1999). In 2008, the NRC proposed updated Waste Confidence findings (FR 59551, dated October 9, 2008), including findings that there is reasonable assurance a sufficient mined geologic repository can reasonably be expected to be available within 50-60 years beyond the licensed life for operation of any reactor to dispose of the commercial high-level waste and spent fuel. On September 19, 2014, the NRC published a revised rule at 10 CFR 51.23, "Environmental Impacts of Continued Storage of Spent Nuclear Fuel Beyond the Licensed Life for Operations of a Reactor" [79 FR (Federal Register) 56238]. The rule codifies the NRC's generic determinations in NUREG–2157, "Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel" (Reference F8.2), regarding the environmental impacts of continued storage of spent nuclear fuel beyond a reactor's operating license (i.e., those impacts that could occur as a result of the storage of spent nuclear fuel at at-reactor or away-from-reactor sites after a reactor's licensed life for operation and until a permanent repository becomes available). NUREG–2157, Appendix B provides an assessment of the technical feasibility of a deep geologic repository and continued safe storage of spent fuel. That assessment concluded that a deep geologic repository is technically feasible and that a reasonable timeframe for its development (i.e., candidate site selection and characterization, final site selection, licensing review, and initial construction for acceptance of waste) is approximately 25 to 35 years.

Due to the current timeframe projections for development of a federal geologic repository, the purpose and the need for the proposed action is to provide for continued temporary dry storage of spent nuclear fuel and GTCC waste generated from operation of HBPP Unit 3 at the HB ISFSI until facilities are available for interim or permanent disposal.

F1.2 The Proposed Action

The proposed action is the renewal of the license for the HB ISFSI. The current site-specific license will expire on November 17, 2025. PG&E proposes to extend the HB ISFSI license for 40 years beyond the current site-specific license term (through November 2065), as allowed by 10 CFR 72.42. No major construction or refurbishment projects are currently planned for the HB ISFSI during the license renewal term. Storage at the HB ISFSI is interim pending the availability of a federal repository for interim or permanent disposal, as discussed in Section F1.1. The HB ISFSI will be subject to aging management activities to ensure the continued integrity of the dry storage casks during the ISFSI license renewal term. The aging management programs are summarized in Appendix A of the license renewal application.

F1.3 Environmental Background

The NRC has previously evaluated environmental impacts from ISFSIs in accordance with the National Environmental Policy Act (NEPA). These evaluations include preparation of an environmental impact statement in conjunction with establishing the ISFSI regulation (10 CFR 72) and two environmental assessments for substantive revisions to the regulation, in addition to a Generic Environmental Impact Statement (GEIS) for plant license renewal (NUREG-1437; Reference F8.3). The NRC has prepared environmental impact statements and environmental assessments for numerous site-specific and general ISFSI licenses. In the course of these evaluations, the NRC has not identified any significant environmental impacts associated with ISFSI operation.

In addition, the NRC has issued and periodically updated its waste confidence decision in 10 CFR 51.23. An update was most recently completed in 2014 via NUREG-2157 (Reference F8.2). The NRC's evaluation of the potential environmental impacts of continued storage of spent fuel presented in NUREG–2157 identifies an impact level, or a range of impacts, for each resource area for a range of site conditions and timeframes. The timeframes analyzed in NUREG–2157 include the short-term timeframe (60 years beyond the licensed life of a reactor), the long-term timeframe (an additional 100 years after the short-term timeframe), and an indefinite timeframe.

In December 2003, PG&E submitted an application for a NRC license to construct and operate the HB ISFSI using the HI-STAR 100 HB. As part of the application, PG&E submitted an ISFSI Environmental Report (ER) (Reference F8.4), as required by 10 CFR 72.34. In November 2005, the NRC issued an Environmental Assessment (EA) related to the construction and operation of the HB ISFSI, which concluded that issuance of a materials license would not significantly affect the quality of the environment (Reference F8.5).

The DOE also has analyzed ISFSI environmental impacts. As part of its evaluation of the impact of constructing a national repository for spent nuclear fuel, the DOE analyzed environmental impacts from a no-action alternative that included leaving spent nuclear fuel in power plant ISFSIs. The analysis accounted for the fuel at all nuclear power plants, including HBPP. The DOE concluded that environmental impacts would be small for at least 100 years (Reference F8.6).

F1.4 Environmental Report Scope and Methodology

10 CFR 72.34 requires that each application for an ISFSI license contain an Environmental Report (ER Supplement) that meets the requirements of 10 CFR 51 Subpart A. This ER Supplement was prepared by PG&E as part of its application to the NRC for HB ISFSI license renewal in accordance with the following NRC regulations:

- 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High Level Radioactive Waste, and Reactor-Related Greater than Class C Waste
    - 10 CFR 72.34, Environmental report; and
    - 10 CFR 72.42, Duration of license, renewal.

- 10 CFR 51, Environmental Protection Requirements for Domestic Licensing and Related Regulatory Functions
    - 10 CFR 51.23, Environmental impacts of continued storage of spent nuclear fuel beyond the licensed life for operation of a reactor,
    - 10 CFR 51.45, Environmental report; and
    - 10 CFR 51.60, Environmental report-materials licenses.

Each environmental resource area discussed in NUREG-2157, and codified in 10 CFR 51.23, is addressed in Sections F.3 and F.4.

10 CFR 51.60 requires that the ER Supplement contain information specified in 10 CFR 51.45. 10 CFR 51.60 directs the applicant to focus on significant environmental changes from the previously submitted ER. Table F1.4-1 indicates which section of the ER Supplement provides information to meet each requirement of 10 CFR 51.60, including 10 CFR 51.45 as adopted by reference.

PG&E reviewed the NRC's Environmental Review Guidance for Licensing Actions Associated with Nuclear Material Safety and Safeguards (NMSS) Programs (NUREG-1748; Reference F8.7) when developing this ER Supplement. PG&E also reviewed environmental reports (as well as the NRC's related requests for additional information) previously submitted to the NRC in support of ISFSI license renewal in order to confirm this ER Supplement contains the information necessary to support the NRC's environmental review.

Table F1.4-1 Cross-Reference Table for Environmental Requirements of 10 CFR 51

Regulatory Requirement	Responsive Environmental Report Supplement Section(s)
10 CFR 51.60(a), submit an ER 10 CFR 51.45(a). submit an ER	Entire ER Supplement
10 CFR 51.45(b), description of proposed action	F1.2, The Proposed Action
10 CFR 51.45(b), statement of purposes	F1.1, Purpose and Need for the Proposed Action
10 CFR 51.45(b), environment affected	F.3, Affected Environment
10 CFR 51.45(b)(1), impact of proposed action on the environment	F.4, Environmental Impacts
10 CFR 51.45(b)(2), adverse environmental effects that cannot be avoided	F7.1, Unavoidable Adverse Impacts
10 CFR 51.45(b)(3), alternatives to the proposed action	F.2, Alternatives
10 CFR 51.45(b)(4), short-term use versus long-term productivity of environment	F7.3, Short-Term Use Versus Long-Term Productivity of the Environment
10 CFR 51.45(b)(5), irreversible and irretrievable commitments of resources	F7.2, Irreversible and Irretrievable Resource Commitments
10 CFR 51.45(c), environmental effects, impact of alternatives, and alternatives for reducing or avoiding effects	F.2, Alternatives F.3, Affected Environment F.4, Environmental Impacts F.5, Mitigation Measures
10 CFR 51.45(d), status of compliance	F1.5, Applicable Regulatory Requirements, Permits, and Required Consultations
10 CFR 51.45(e), adverse information	F.3, Affected Environment F.4, Environmental Impacts

The environmental impacts of the HB ISFSI were first presented in the ER for the HB ISFSI license (Reference F8.4) and NRC issued an Environmental Assessment related to the construction and operation of the HB ISFSI (Reference F8.5). Because these documents have previously defined the impacts of the HB ISFSI, PG&E adopts relevant material from these documents by reference.

F1.5 Applicable Regulatory Requirements, Permits, and Required Consultations

Other than its site-specific NRC license, the HB ISFSI does not require any additional permits, licenses, or approvals to operate during the renewed license term. Table F1.5-1 lists the authorizations and consultations related to the HB ISFSI license renewal application.

Table F1.5-1 Regulatory Requirements, Permits, and Consultations for HB ISFSI License Renewal

Agency	Authority	Requirement	Remarks
U.S. Nuclear Regulatory Commission	Atomic Energy Act (42 USC 2011 et. Seq.)	HB ISFSI License Renewal	ER Supplement submitted by PG&E in support of the HB ISFSI license renewal application.
U.S. Fish and Wildlife Service / National Marine Fisheries Service	Endangered Species Act Section 7 (16 USC 1536)	Consultation	Requires the federal agency issuing a license to consult with this agency regarding impacts of the proposed action.
California Department of Fish and Wildlife	Endangered Species Act Section 7 (16 USC 1536)	Consultation	Requires the federal agency issuing a license to consult with this agency regarding impacts of the proposed action.
California State Office of Historic Preservation	National Historic Preservation Act Section 106 (16 USC 470f)	Consultation	Requires the federal agency issuing a license to consult with the State Historic Preservation Officer regarding impacts of the proposed action.
California Coastal Commission	Federal Coastal Zone Management Act (16 USC 1452 et seq.)	Certification	Requires applicant to obtain a certification that license renewal would be consistent with the Federally approved State Coastal Zone Management program.
North Coast Regional Water Quality Control Board	Clean Water Act Section 401 (33 USC 13411)	Certification	State issuance of NPDES permit constitutes 401 certification.
Humboldt County Department of Environmental Health	California Health and Safety Code Division 20, Chapter 6.95	Hazardous Materials Business Plan	Requires applicant to maintain a business plan on file for all activities at the site.

F1.5.1 Special-Status Species Consultations

Section 7 of the Endangered Species Act (16 USC 1536) requires federal agencies to ensure that agency action is not likely to jeopardize any species that is listed or proposed for listing as threatened or endangered. If review of the proposed action indicates the potential for adversely affecting listed or candidate species, the federal agency must consult with the U.S. Fish and Wildlife Service (USFWS) regarding effects on non-marine species, the National Marine Fisheries Service (NMFS) for marine species, or both. USFWS and NMFS have issued joint procedural regulations at 50 CFR 402, Subpart B, that address consultation, and USFWS maintains the joint list of threatened and endangered species at 50 CFR 17.

F1.5.2 Historic and Cultural Resource Consultations

Section 106 of the National Historic Preservation Act (16 USC 470f) requires federal agencies having the authority to license any undertaking to, prior to issuing the license, take into account the effect of the undertaking on historic properties and to afford the Advisory Council on Historic Preservation an opportunity to comment on the undertaking.

In Section 7.2 of the original EA (Reference F8.5), the California State Historic Preservation Officer (SHPO) concurred with the NRC determination that the HB ISFSI would provide no adverse impact to any historic properties. The proposed action to continue operation of the ISFSI would not involve any new disturbance that would have the potential to affect cultural resources.

F1.5.3 Coastal Zone Management Act

Principal requirements of the Coastal Act applicable to the continued operation of the HB ISFSI are identified and addressed in Attachment A of this ER Supplement.

F.2 Alternatives

This section provides an updated description of alternatives to the proposed action.

F2.1 No-Action Alternative

Under the no-action alternative, the NRC would not renew the site-specific license for the HB ISFSI. The license would expire on November 17, 2025, at which time PG&E would no longer be able to store spent fuel or GTCC waste at the ISFSI. PG&E would need to remove the stored fuel and GTCC waste from the ISFSI, transport the fuel and GTCC waste to another licensed storage facility, and decommission the storage facility associated with SNM-2514. There is no federal repository or other federal disposition path available for the spent fuel or GTCC waste presently stored under SNM-2514; therefore, the no-action alternative is not a reasonable alternative.

F2.2 Other Alternatives

In the original HB ISFSI license application ER, Section 8.2 (Reference F8.4), PG&E evaluated the following alternatives to constructing the HB ISFSI in addition to the no-action alternative:

- Ship Fuel to a Permanent Federal Repository
- Ship Fuel to a Reprocessing Facility
- Ship Fuel to a Private Spent Fuel Storage Facility
- Ship Fuel to Another Nuclear Power Plant

Updated analyses for each of the alternatives from the original ISFSI ER are discussed in the following sections. It was concluded that none of the alternatives are viable at this time as they are either (1) not yet licensed, or (2) are not in compliance with the existing HB ISFSI license (SNM-2514). No additional new alternatives have been identified for consideration.

F2.2.1 Ship Fuel to a Permanent Federal Repository

The ER considered shipment of spent fuel to a DOE repository (specifically, Yucca Mountain) or a monitored retrievable storage facility. At the time neither existed, though the ER postulated that Yucca Mountain could be open as soon as 2010. No permanent federal storage facility or interim monitored retrievable storage facility has been licensed or built and there appears to be no prospect for one available in time to eliminate the need for HB ISFSI license renewal. Therefore, shipping to a federal facility is not a reasonable alternative to renewing the HB ISFSI license.

F2.2.2 Ship Fuel to a Reprocessing Facility

The ER considered shipping the fuel to a reprocessing facility to extract the residual uranium and plutonium for recycling into new fuel assemblies. At that time, no reprocessing facility existed in the United States. No commercial reprocessing facilities currently exist in the United States and there are no prospects for such facilities in the foreseeable future. Therefore, reprocessing is not a reasonable alternative to renewing the HB ISFSI license.

F2.2.3 Ship Fuel to a Private Spent Fuel Storage Facility

Commercial entities have expressed interest in establishing a CISF for away-from-reactor storage of spent nuclear fuel. Development of a CISF would require a specific license from the NRC. As of June 2017, two facilities have been proposed at the following locations:

- Waste Control Specialists LLC (WCS) facility in Andrews County, Texas
- Eddy-Lea Alliance facility in Lea County, New Mexico

WCS submitted a license application to the NRC for a CISF in April 2016 (Reference F8.11) and the NRC accepted the application for review in January 2017 (Reference F8.12) and has not completed its acceptance review of the application (Reference F8.13). The WCS facility does not accept Holtec cask designs. On April 18, 2017, WCS requested the NRC to temporarily suspend all safety and environmental review activities as well as public participation activities associated with WCS' license application until the completion of the sale of WCS to EnergySolutions. As of February 2018, there is no assurance the project will be successfully licensed and built. Because the WCS facility does not accept Holtec casks designs, HB ISFSI casks cannot be stored at this location and it is removed from further review.

In March 2017, Holtec International (Holtec) submitted a CISF license application to the NRC for the Eddy-Lea Alliance facility (Reference F8.14). Holtec anticipates that the Eddy-Lea CISF would be operational in 2022 (Reference F8.14). Presently, there is no assurance the project will be successfully licensed and built. Moreover, even if the Holtec CISF were available, a license amendment and permits would be required to allow for transport of the HB ISFSI spent nuclear fuel and GTCC waste to the CISF. Further, this alternative would involve an extra offsite shipment of the spent nuclear fuel for ultimate disposal at a DOE repository. This is not considered a viable alternative at this time because the option is not yet licensed and not in compliance with the current HB ISFSI license (SNM-2514).

F2.2.4 Ship Fuel to Another Nuclear Power Plant

This alternative would involve shipping the HB ISFSI spent nuclear fuel and GTCC waste to another nuclear power plant with sufficient storage capacity. The receiving utility would have to be licensed for and agree to accept the HB ISFSI spent nuclear fuel and GTCC waste. PG&E does not expect other utilities to be willing to reduce or expand on-site spent nuclear fuel storage capacity to accommodate HB spent nuclear fuel and GTCC waste. There is a recent example of a utility attempting to implement this alternative. Specifically, according to public documents (Reference F8.30), Southern California Edison (SCE) asked the owners of Palo Verde Nuclear Generating Station (PVNGS) to consider expanding the ISFSI at PVNGS to store spent nuclear fuel from San Onofre Nuclear Generating Station (SONGS). Even though SCE is part-owner of PVNGS, the proposal was rejected. Shipment of HB spent nuclear fuel and GTCC waste to the Diablo Canyon Power Plant (DCPP), a site owned by PG&E, is not allowed by the existing Diablo Canyon (DC) ISFSI license or the HB ISFSI license. Even if PG&E obtained the license amendments to allow for shipment and storage of HB ISFSI spent nuclear fuel and GTCC waste at the DC ISFSI, this alternative would require significant involvement with state permitting agencies and agreement from local communities to store non-DCPP spent nuclear fuel in San Luis Obispo County. Based on PG&E's experience with initial DC ISFSI licensing and permitting, PG&E anticipates significant community opposition to storing additional spent nuclear fuel at the DC ISFSI. In summary, shipment of HB spent nuclear fuel and GTCC waste to another nuclear power plant is not a viable alternative because other plants are not licensed to accept HB spent nuclear fuel and GTCC waste, DC and HB ISFSI licenses do not authorize storing HB spent nuclear fuel and GTCC waste at the DC ISFSI, and any proposal to transport and store HB spent nuclear fuel and GTCC waste at DCPP would face significant opposition from the local community. Finally, modification to local permits is discretionary in nature, not ministerial.

F.3 Affected Environment

As discussed in Section F1.4, the environmental impacts of the HB ISFSI were first presented in the ER for the HB ISFSI license (Reference F8.4) and NRC issued an Environmental Assessment (EA) related to the construction and operation of the HB ISFSI (Reference F8.5). Because these documents have previously defined the impacts of the HB ISFSI, PG&E adopts relevant material from these documents by reference.

F3.1 Site Location

The ISFSI is located on the northern California coast in Humboldt County. The ISFSI is located on a small peninsula known as Buhne Point near the coastal community of Fields Landing on the eastern shore of Humboldt Bay. Eureka, the largest city in Humboldt County, is located approximately 3 miles north of the ISFSI site (Figure F3.1-1). The coordinates of the ISFSI site are 40°44’30.6” North, 124°12’39” West (UTM Zone 10, 4,510,592.5 meters North, 397,761.3 meters East). (Reference F8.8)

There are several small residential communities within 5 miles of the ISFSI site, including King Salmon, Humboldt Hill, Fields Landing, and the suburban communities surrounding the City of Eureka. Most of these residences are within 1 mile of the site. Figure F3.1-2 is a 6-mile vicinity map. (Reference F8.8)

The ISFSI is located within the PG&E owner-controlled area at the Humboldt Bay Power Plant (HBPP). The HBPP is undergoing decommissioning and is currently scheduled to be completed in 2019. Since construction of the ISFSI, a new fossil-fueled power plant at the HBPP site, named the Humboldt Bay Generating Station (HBGS), has commenced operation within the PG&E owner-controlled area. The HBGS is a load-following plant consisting of 10 natural gas-fired reciprocating engine-generator sets and associated equipment with a combined generating capacity of 163 MWe (nominal). The HBGS is located approximately 450 ft east of the ISFSI. The HBGS has the capability to be powered by either natural gas or diesel fuel oil. (Reference F8.8)

PG&E owns approximately 143 acres on the northeastern part of Buhne Point of Humboldt Bay opposite the bay entrance. PG&E also owns the water areas extending approximately 500 ft into Humboldt Bay from the land area. The ISFSI is located at an elevation of approximately 44 ft above mean lower low water (MLLW). (Reference F8.8)

The major access in the vicinity of the ISFSI and other communities of Humboldt County is via US Highway 101, which generally traverses north-south through Humboldt County. This highway passes about 0.3 mile east of the ISFSI site and is accessible at approximately 0.35 mile to the southeast of the site. A public trail runs along the shoreline in the ISFSI 100-meter controlled area. (Reference F8.8)

King Salmon serves frequent commercial and recreational boat traffic. Commercial air traffic into and out of Humboldt County is primarily through Eureka/Arcata Airport, located in McKinleyville, approximately 20 miles north of the ISFSI site. (Reference F8.8)

A set of Northwestern Pacific railroad tracks runs generally north-south along the southeastern PG&E property line. Presently, the tracks are not in use and there are no existing plans to rehabilitate and reuse the tracks. (Reference F8.8)

The terrain in the vicinity of the HBPP rises rapidly from the bay on the north side to an elevation of approximately 69 ft MLLW at Buhne Point. Terrain to the north and east of the site is generally flat. To the south and east, the terrain rises rapidly forming Humboldt Hill, which reaches an elevation of over 500 ft MLLW within 2 miles of the ISFSI and is the site of several small neighborhoods. Humboldt County is mostly mountainous except for the level plain that surrounds Humboldt Bay. The coastal mountains extend to the central valley. The ISFSI is located near the top of a small hill, Buhne Point, surrounded by wetlands to the east and Humboldt Bay to the west. (Reference F8.8)

Figure F3.1-1
50 Mile Vicinity Map

Humboldt Bay ISFSI
Humboldt, CA

Figure F3.1-2
6 Mile Vicinity Map

Humboldt Bay ISFSI
Humboldt, CA

0 1 2 4 Miles

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Buhne Pt.
Humboldt Bay ISFSI
Interstates
Highways

F3.2 Land Use

Information regarding land use of the area outside of the HBPP owner-controlled area has not changed from the information presented in the ER (Reference F8.4; Section 2.2.2) or the NRC's EA (Reference F8.5; Section 4.2); therefore, PG&E adopts this information by reference.

The land use within the HBPP owner-controlled area has changed significantly since ISFSI construction. First, the HBPP is currently undergoing final site restoration as part of decommissioning activities. Second, since construction of the ISFSI, a new fossil-fueled power plant at the adjacent HBGS site has commenced operation within the PG&E owner-controlled area (the HBGS is not part of the HBPP NRC license). As discussed in the HBPP License Termination Plan (Reference F8.9; Section 8.5.2.20), final site restoration is to prepare areas of the site for continued use by PG&E operations, including ISFSI security, transmission, substation distribution, and the HBGS. Additionally, to compensate for natural resource impacts from the original construction of the HBGS and completion of decommissioning, PG&E is committed to restore specific areas of the site to preconstruction conditions. The final restoration plans for the decommissioned HBPP site were submitted to the California Coastal Commission (CCC) for approval in April 2015 (Reference F8.19). In April 2016, the CCC approved the HBPP Final Site Restoration (FSR) Plan (Reference F8.20). In July 2017, PG&E transferred Fisherman's Channel to the Humboldt Bay Harbor, Recreation, and Conservation District, totaling 30.94 acres. Figure F3.2-1 provides the land use of the HBPP owner-controlled area after completion of restoration activities in 2019 and during the ISFSI license renewal period.

A petition is currently planned to be filed with the California Energy Commission (CEC) prior to completion of HBPP decommissioning and site restoration to modify the HBGS site boundary to include portions of the HBPP site that will be repurposed to support HBGS following decommissioning and final site restoration.

Figure F3.2-1
HBPP Final Site Restoration Plan – Land Use

F3.3 Transportation

This section updates information previously presented in the ER (Reference F8.4; Section 2.8.2).

A network of roads, including an interstate freeway, state highways and local streets, serves the HB ISFSI area. As of November 2016, approximately 18 full-time personnel commute to HBGS each workday. These employees travel predominantly the highways serving the HB ISFSI area. The following is a description of road facilities in Humboldt County and the HBPP area.

F3.3.1 U.S. Highway 101

U.S. Highway 101 connects Humboldt County north to Interstate 5 via U.S. Highway 299. U.S. Highway 101 also connects the county to areas south along the coast including Ukiah and San Francisco. Most of the highway south of King Salmon Avenue is a four-lane freeway. To the north of King Salmon Avenue, there is a short section of freeway followed by city streets through Eureka. To the north of Eureka, U.S. Highway 101 continues as a two-lane road. Based on 2015 data collected by Caltrans (Reference F8.10), Highway 101 has an annual average daily traffic volume of approximately 34,000 vehicles per day in the vicinity of the HB ISFSI.

F3.3.2 State Highway 299

State Highway 299, which intersects U.S. Highway 101 approximately 13 miles north of the ISFSI site, connects Humboldt County east to Redding where it connects to Interstate 5. Highway 299 in Humboldt County begins as a four-lane freeway for the first 5 miles. The rest of the highway is scenic and winding, with rate congestion. Annual average daily traffic volume on Highway 299, as collected by Caltrans in 2015 (Reference F8.10), is approximately 14,600 vehicles per day at the U.S. Highway 101 junction.

F3.3.3 King Salmon Avenue

King Salmon Avenue is a county-maintained road between Highway 101 and the community of King Salmon. It is also the main access road to the entrance of the HBGS and the ISFSI site. King Salmon Avenue is lightly traveled by passenger cars and trucks. Heavy trucks are limited to those associated with HBGS operation and HBPP decommissioning. After HBPP decommissioning is complete, prior to the period of extended operation for HB ISFSI, the number of heavy trucks will decline.

According to the Humboldt County Public Works Department, traffic surveys for King Salmon Avenue showed 1,273 vehicles per day in June 1968, 2,290 vehicles per day in June 1970, and 2,355 vehicles per day in June 1973 (Reference F8.4; Section 2.8.2.1.3). Employment at HBPP has declined since 1973, even with the introduction of HBGS, and the population of the King Salmon community had been relatively stable since 1973. Therefore, PG&E believes the traffic volume of 2,355 vehicles per day measured in 1973 is conservative and representative of traffic volumes on King Salmon

Avenue that will exist during the HB ISFSI period of extended operation.

F3.3.4 Railroad Service

A set of Northwestern Pacific railroad tracks runs generally north-south along the southeastern PG&E property line. Presently, the tracks are not in use and the North Coast Railroad Authority has no plans to rehabilitate and reuse the tracks. (Reference F8.8; Section 2.1.2)

F3.3.5 Shipping

The ISFSI site is located within 200 ft of the shoreline of Humboldt Bay. Humboldt Bay is a land bound bay that is open to the Pacific Ocean through a maintained shipping entrance channel northwest of the ISFSI site. The bay has two main channels, a North Channel and a South Channel. The North Channel was dredged to a minimum depth of 40 ft in 2001 and is used mostly by private yachts and recreational vessels. However, it is also used by large cargo vessels and passenger vessel cruise ships having gross tonnage of approximately 45,000 tons (up to 650 ft in length). The South Channel is a smaller channel, which was also dredged to a minimum of 40 ft in 2001 and the vessels using this South Channel are limited to mostly private yachts, recreational vessels, and occasionally barges off-loading lumber or logs. The edge of the South Channel at its closest point is approximately 850 yards from the ISFSI site. (Reference F8.8; Section 2.1.2) The U.S. Army Corps of Engineers dredges the navigation channels annually, removing up to three million cubic yards of material (Ref. F8.28).

F3.3.6 Airport

The air transportation system in Humboldt County serves a range of aircraft types and aeronautical uses. Nine public use airports are located in Humboldt County. Scheduled passenger services are only available from the Arcata-Eureka Airport, located north of Arcata at McKinleyville approximately 20 miles to the north of the ISFSI.

F3.4 Demography and Socioeconomics

This section updates information previously presented in the ER (Reference F8.4; Sections 2.2.3 and 2.7).

F3.4.1 Socioeconomics

This section provides a description of the local economic characteristics of the area surrounding the HB ISFSI. The information is for Humboldt County, the county in which the ISFSI is located, and the nearest adjoining county, Trinity County, the closest boundary of which lies about 35 miles east of the ISFSI.

Economy
An economic profile of Humboldt County is shown in Table F3.4-1. The estimated population for Humboldt County in 2010 was 134,623 (Reference F8.15). The population employed within the county was approximately 58,449 in 2010 with an unemployment rate of 10.5 percent (Reference F8.16). The unemployment rate of 10.5

percent was higher than the state's rate of 9.9 percent for 2010.

Income

The median family income in Humboldt County for 2015 was $53,407, compared with $70,720 for the state of California. In 2015, 21.4 percent of the population in Humboldt County was considered to have incomes below the poverty level, compared with 16.3 percent in California and 15.5 percent in the U.S. (Reference F8.16)

Table F3.4-1 Humboldt County Economic Profile – 2010

A. Estimated Population	134,623
B. Median Family Income	$53,407
C. Estimated Employment	
Private Wage/Salary	37,262
Government	12,837
D. Unemployment Rate	10.5%
E. Income Below Poverty Level	21.4%

Source: Reference F8.15; Reference F8.16

F3.4.2 Demography

Population Distribution and Trends

The population distribution and projections for areas around the HB ISFSI site are based on the 2010 census and on estimates prepared by the California Department of Finance. The population data presented in this section for the ISFSI are based on distances from the ISFSI site.

The area within 50 miles of the ISFSI includes most of Humboldt County, and a small sparsely populated portion of Trinity County (see Figure F3.1-1). Approximately 50 percent of the area within the radius is on land, with the balance being Humboldt Bay and the Pacific Ocean. In general, the portion of California that lies within 50 miles of the ISFSI is relatively sparsely populated, with the exception of a few urbanized areas along the coast.

Regional Population

According to the State of California Department of Finance, the 2010 population of Humboldt County was 134,623 and the 2010 population of Trinity County was 13,786. Table F3.4-2 shows the population trends of the State of California and Humboldt and Trinity Counties from 1940 to 2010 and projections from 2020 to 2060. Humboldt County has seven incorporated cities ranging in size from approximately 367 to 27,191 persons. Approximately 47 percent of Humboldt County's residents live in incorporated communities, and 59 percent of the County population lives in the area surrounding Humboldt Bay. This area includes the cities of Arcata, Ferndale, Fortuna, and Eureka. (Reference F8.15)

Table F3.4-2 Population Trends of the State of California and of Humboldt and Trinity Counties

Year	California	Humboldt County	Trinity County
1940	6,907,387	45,812	3,970
1950	10,586,233	69,241	5,087
1960	15,717,204	104,892	9,706
1970	19,970,069	99,692	7,615
1980	23,667,764	108,525	11,858
1990	29,760,021	119,118	13,063
2000	33,871,653	126,518	13,022
2010	37,253,956	134,623	13,786
2020	40,719,999	138,433	13,381
2030	44,019,846	141,501	13,314
2040	46,884,801	141,958	13,224
2050	49,158,401	141,193	13,311
2060	51,056,510	140,489	14,143

Source: References F8.15, F8.29

According to the State Department of Finance, the cities of Eureka and Arcata together contain about 33 percent of Humboldt County's population, while 14 percent of the population is scattered among five other incorporated cities.

Approximately 72,000 of county residents reside in unincorporated communities. Table F3.4-3 shows the growth since 1970 of the incorporated cities and other major communities within 50 miles of the ISFSI site and provides distance and direction from the site (Reference F8.15).

Table F3.4-3 Population Centers Within 50 Miles of ISFSI Site

Community	Distance and Direction from Site	Population				
		2010	2000	1990	1980	1970
Arcata	15 miles NE	17,231	16,651	15,197	12,340	8,985
Bayview	3 miles NNE	2,510	2,359	1,318	N/A	N/A
Blue Lake	16 miles NE	1,253	1,135	1,235	1,201	1,112
Cutten	5 miles ENE	3,108	2,933	1,516	2,375	2,228
Eureka	4 miles NNE	27,191	26,128	27,025	24,153	24,337
Ferndale	12 miles SSW	1,371	1,382	1,331	1,367	1,352
Fortuna	11 miles SSE	11,926	10,497	8,788	7,591	4,203

Community	Distance and Direction from Site	Population				
		2010	2000	1990	1980	1970
Humboldt Hill	2 miles SE	3,414	3,246	2,865	N/A	N/A
Hydesville	15 miles SSE	1,237	1,209	1,131	N/A	N/A
McKinleyville	18 miles NNE	15,177	13,599	10,749	7,772	N/A
Myrtletown	9 miles ENE	4,675	4,459	4,413	3,959	N/A
Pine Hills	3 miles NE	3,131	3,108	2,947	2,686	N/A
Redway	45 miles SSE	1,225	1,188	1,212	1,094	N/A
Rio Dell	18 miles SSE	3,368	3,174	3,012	2,687	2,817
Trinidad	30 miles N	367	311	362	379	300
Westhaven-Moonstone	21 miles NNE	1,205	1,044	1,109	N/A	N/A
Willow Creek	35 miles ENE	1,710	1,743	1,576	N/A	N/A
Total		100,099	94,166	85,786	67,604	45,334

Source: Reference F8.17
N/A = not available

Table F3.4-4 provides the distribution of population by race as reported in the 2010 census. (Reference F8.18)

Table F3.4-4 Percent of 2010 Population by Race for the State of California and for Humboldt and Trinity Counties

Race	Percent of Total Population		
	California	Humboldt County	Trinity County
Hispanic or Latino	37.6	9.8	7.0
White	40.1	77.2	83.5
Black or African American	5.8	1.0	0.3
Native American	0.4	5.2	4.0
Asian	12.8	2.1	0.7
Pacific Islander	0.3	0.2	0.1
Some other race	0.2	0.3	0.1
Two or more races	2.6	4.1	4.2

Source: Reference F8.18

Population Between 10 and 50 Miles

Figure F3.4-1 shows the 2010 census population distribution between 10 and 50 miles, within the sectors of 22.5 degrees, with part circles of radii of 10, 20, 30, 40, and 50 miles. Populations in each sector were estimated by determining the ratio of a given sector area to the census blocks that enter the sector. The 2010 U.S. Census reported 134,763 people living within 50 miles of the ISFSI site. In 2010, some 74 percent of Humboldt County's total population resided in the population centers listed in Table F3.4-3.

Population within 10 Miles
Figure F3.4-2 shows the 2010 census population distribution between 0 and 10 miles, within the sectors of 22.5 degrees, with part circles of radii of 1, 2, 3, 4, and 5 miles. Populations in each sector were estimated by determining the ratio of a given sector area to the census blocks that enter the sector. The 2010 census counted approximately 53,043 residents within 10 miles of the ISFSI site. The nearest residence is about 0.15 mile southwest of the ISFSI site. There are approximately 38,617 residents within 5 miles of the ISFSI site.

The nearest population center is the City of Eureka located approximately 4 miles north-northeast of the ISFSI site. The California State Department of Finance shows the city to have a population of 27,191 (Reference F8.17).

There are numerous schools located within 10 miles of the ISFSI site, particularly in the population centers listed in Table F3.4-3. Several K-12 schools are located within 5 miles of the site, serving the City of Eureka and neighboring communities. Humboldt State University, with an enrollment of approximately 8,500 students, is located in the City of Arcata approximately 15 miles northeast of the ISFSI site. The College of the Redwoods is located within 5 miles of the site just south of the City of Eureka and has an enrollment of approximately 8,500 full and part-time students.

Several parks and recreation areas are located within 10 miles of the ISFSI site. The beaches around Humboldt Bay and the Pacific Ocean are popular with local residents as well as visitors from outside the local area. The City of Eureka has several municipal parks and there is a municipal golf course located approximately 3 miles northeast of the ISFSI site.

Transient Population
In addition to the resident population presented in the tables and population distribution figures, there is a seasonal influx of vacation and weekend visitors within a 50-mile radius, especially during the summer months. The influx is heaviest in the area around Humboldt Redwoods State Park and along the Pacific Ocean coast to the north of the site in the area around the City of Trinidad.

Reference F8.4, Table 2.2-5 lists state and county recreation areas and public lands within 50 miles of the site.

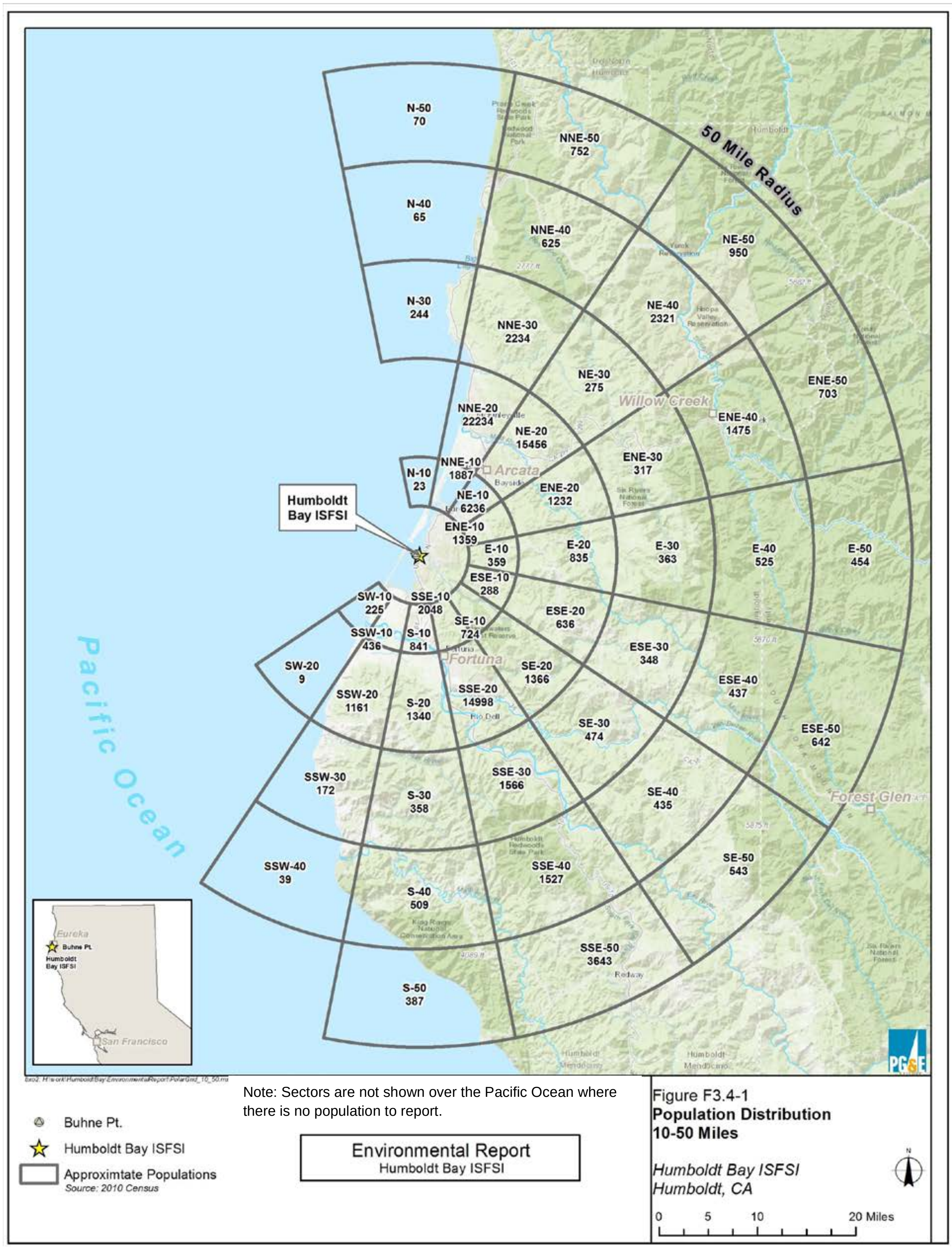
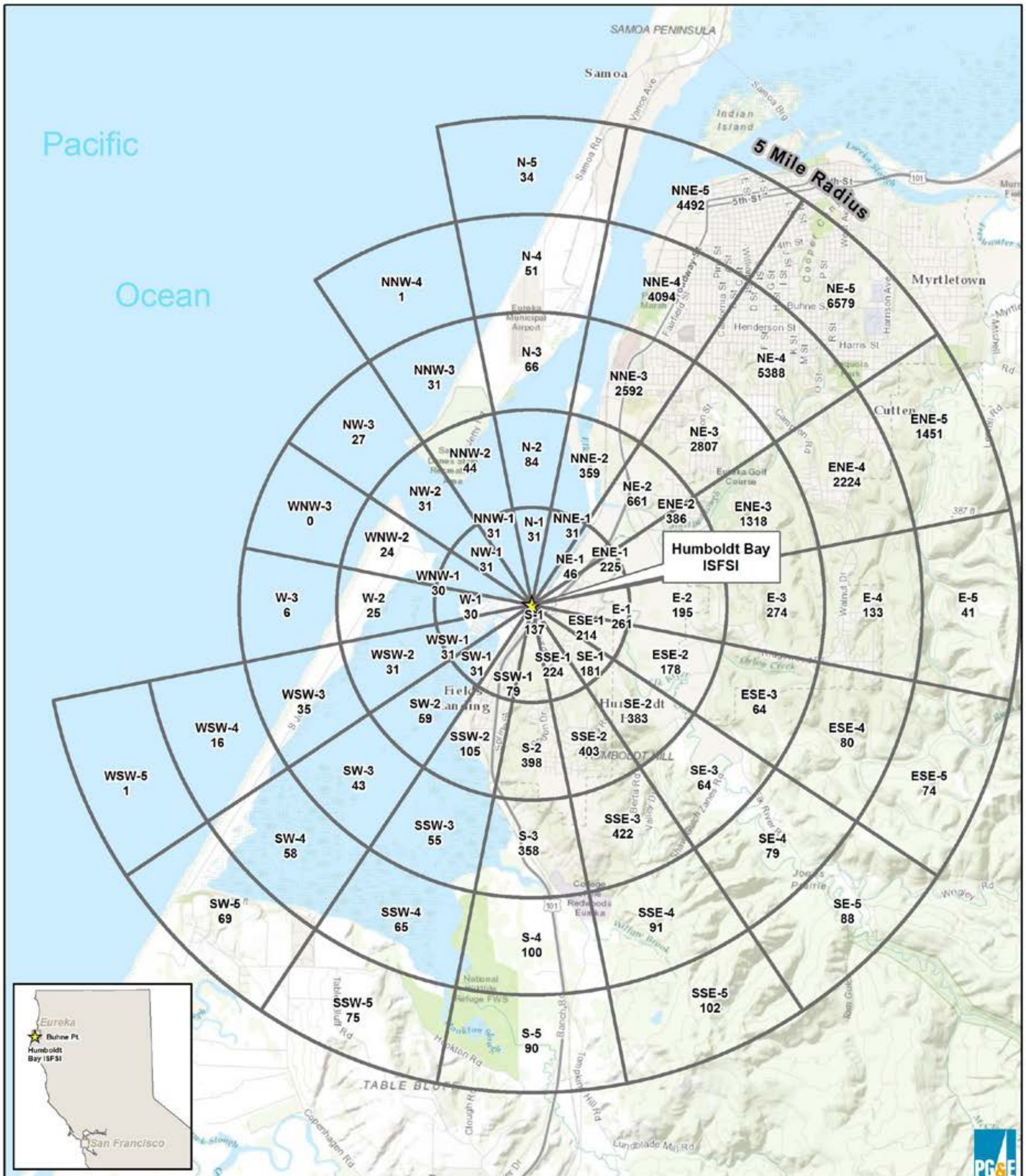


Figure F3.4-1
Population Distribution 10-50 Miles



Note: Sectors are not shown over the Pacific Ocean where there is no population to report.

☆ Humboldt Bay ISFSI

Approximtate Populations
Source: 2010 Census

Environmental Report
Humboldt Bay ISFSI

Figure F3.4-2
Population Distribution Less Than 10 Miles

Humboldt Bay ISFSI
Humboldt, CA

0 0.5 1 2 Miles

F3.5 Climatology, Meteorology, and Air Quality

Information regarding climatology and meteorology has not changed from the information presented in the ER (Reference F8.4; Section 2.4) or the NRC's EA (Reference F8.5; Section 4.4); therefore, PG&E adopts this information by reference. Below is updated information regarding air quality.

The HB ISFSI site is located within the North Coast Unified Air Quality Management District (NCUAQMD). This agency monitors the air quality in the area and publishes air quality information pertinent to the ISFSI. U.S. Environmental Protection Agency and California Air Resources Board have set ambient air quality standards for criteria pollutants to protect human health; the listed criteria pollutants are ozone, sulfur dioxide, nitrogen dioxide, particulate PM10, carbon monoxide, sulfates, lead, hydrogen sulfide, and vinyl chloride. Based on information from the NCUAQMD, the ambient air quality at the ISFSI site meets national and state standards for all criteria pollutants except particulate PM10. Particulate PM10 is matter less than 10 microns in size and is regulated by air quality standards (Reference F8.21). Ambient air concentrations of particulate PM10 would not impact the operation of the ISFSI facility.

F3.6 Geology and Soils

Information regarding geology, soils, and seismology of the HB ISFSI area has not changed from the information presented in the ER (Reference F8.4; Section 2.6) or the NRC's EA (Reference F8.5; Section 4.6); therefore, PG&E adopts this information by reference.

F3.7 Water Resources

The ER (Reference F8.4; Section 2.5) accurately describes the present condition of the surface and groundwater use at the HB ISFSI; therefore, unless discussed below, this information is incorporated by reference.

F3.7.1 Surface Water

Several rivers and creeks drain the region around the HB ISFSI site, including the Mad River, which flows west approximately 24.1 km (15 mi) northeast of the site, and the Eel River, which discharges into the Pacific Ocean approximately 12.9 km (8 mi) south of the site. Of the four major creeks that drain into Humboldt Bay, Salmon Creek and Elk River are the ones nearest to the site; both within 1.6 km (1 mi) south and north, respectively, of the ISFSI site. Salmon Creek and Elk River are used for watering livestock, but are not used as a potable water supply. (Reference F8.8; Section 2.4.1)

With respect to the ISFSI site, the watersheds of Humboldt Bay and the bay itself are the most relevant surface water bodies. Humboldt Bay is a large, shallow body of water with deep channels, separated from the ocean by two long, narrow spits. It is a tidal bay, receiving and discharging ocean water through the inlet between the spits. The bay is approximately 22.5 km (14 mi) long, its width ranging from 0.8 km (0.5 mi) near its middle to over 3.2 km (2 mi) at the south end and 6.4 km (4 mi) at the north end, with an average depth of 3.7 m (12 ft) MLLW. Very little fresh water discharges into Humboldt Bay. (Reference F8.8; Section 2.4.1.1)

Wetlands also are present in the vicinity of the HB ISFSI, to the east and south. Those closest to the site are classified as “freshwater emergent” or “estuarine and marine wetland” under the National Wetlands Inventory classification (Reference F8.22).

As discussed in PG&E Responses to Comments on the Initial Study and Mitigated Negative Declaration for the HBPP FSR Plan (Reference F8.24), PG&E will develop new stormwater detention basins. These basins will be in place during the HB ISFSI license renewal period. In conjunction with the existing Stormwater Pollution Prevention Plan (SWPPP), in the long-term, these new basins will greatly improve the quality of water leaving the site by filtering sediments from stormwater. In the unlikely event that there is a spill of hazardous materials from the developed portions of the site, the stormwater basins will have control valves that can keep water from flowing directly into the adjacent wetlands, further protecting these areas. The culvert that will be replaced between the Buhne Point Wetlands Preserve and the Intake Canal will be replaced with a structure that can be closed if needed to prevent water from discharging into the Intake Canal (and thereby to Fisherman’s Channel and Humboldt Bay).

The current construction NPDES permit and SWPPP for the decommissioning program govern stormwater management on the site and once decommissioning is complete, the HBGS’s industrial NPDES permit and SWPPP will govern the entire site, thereby providing further protection to the adjacent natural areas and receiving waters. The proposed stormwater detention basin system will have a long-term positive effect on water quality on the site’s wetlands and other habitat areas as well as receiving waters.

F3.7.2 Groundwater

PG&E investigated groundwater in the ISFSI area over a several-year period during the mid- to late-1980s and has more recently confirmed the hydrology in groundwater investigations performed in support of HBPP decommissioning. Based on information taken from borings and analysis of the stratigraphy and aquifer characteristics, several aquifers and zones of perched groundwater in the ISFSI area are evident. Groundwater level and flow direction at the Humboldt Bay ISFSI is influenced by several factors, including topography, proximity to Humboldt Bay, stratigraphy, and tectonic tilting and faulting of the Hookton Formation. (Reference F8.8; Section 2.5.2.2)

Beneath the ISFSI site, the first aquifer encountered is the upper Hookton aquifer. The top of this aquifer is located at approximately 1.8 m (6 ft) above MLLW or approximately 6.7 m (22 ft) below the base of the proposed ISFSI. Localized perched water zones are also found beneath the previous HBPP site. (Reference F8.8; Section 2.5.2.2)

F3.8 Ecological Resources

The ER (Reference F8.4; Section 2.3) contains detailed information on the biotic communities and ecosystems of the HB site. The ER provided lists of plants, birds, mammals, amphibians and reptiles, terrestrial, aquatic invertebrates, fishes, aquatic species that could potentially occur in Humboldt County, including the status of the species. To support the HBPP Final Restoration Plan, a desktop literature review was conducted for known occurrences of sensitive natural communities, critical habitat, and special-status plant and wildlife species within the following 8 USGS quadrangles that surround the HBPP site: Fields Landing (main), Cannibal Island, Eureka, Arcata South, McWhinney Creek, Ferndale, Fortuna, and Hydesville (Analysis Area). The following sources were queried (Reference F8.23; Section 4.3.IV):

- The California Department of Fish and Wildlife (CDFW) California Natural Diversity Database (CNDDB)
- The California Native Plant Society (CNPS) List of Rare and Endangered Plants
- The USFWS online database of USFWS and National Marine Fisheries Service (NMFS) critical habitat designations

PG&E adopts the findings from Reference F8.23 for use in this Environmental Supplement. The results of special-status plant and wildlife species queries were combined into preliminary lists (Reference F8.23, Table 4-5, Appendix C) that include those species that have been documented to occur within the Analysis Area and have the following status designations:

- State or federally threatened, endangered, candidate, proposed threatened, or proposed endangered
- State species of concern
- Plant species with a California Rare Plant Rank (CRPR) of 1A, 1B, 2A, 2B, or 4 by the CNPS

In addition, numerous field surveys have been conducted of the HBPP site as part of the HBPP FSR Plan. As shown by Figure F3.8-1 (Reference F8.24, Figure CCC3-1), there are no species listed as threatened or endangered that are known to currently occupy the ISFSI site.

F3.9 Visual and Scenic Resources

Section 2.2.2 of the ER (Reference F8.4) contains detailed information about land uses and human activities in the vicinity of the HBPP site and indirectly provides a summary of landscape conditions near the site. Section F3 .2 of this Supplemental ER provides updated information about land use conditions, and Section F3.4 provides updated information about human communities near the site. The ER does not provide a specific description of the affected environment relative to visual resources.

As discussed in Section F3.1, the HB ISFSI is located near the top of a small hill, Buhne Point, surrounded by wetlands to the east and Humboldt Bay to the west (Reference F8.8). Buhne Point is the highest elevation in the HBPP site area. Due to the HBPP decommissioning efforts, plant buildings no longer hinder the view of either Buhne Point or the HB ISFSI from U. S. Highway 101 and King Salmon Avenue. Although view of the HB ISFSI from Humboldt Bay is blocked by vegetation, as discussed in Section F3.1, a public trail runs along the shoreline in the ISFSI 100-meter controlled area (Reference F8.8). Although the HB ISFSI is visible, it is minimized due to the underground vault design, with the top of the vault approximately flush with the ground surface and the top of the vault closure lids are less than 20 inches above the ground level. The associated ISFSI security building and ISFSI fencing are the only visible portions.

Figure F3.8-1
Wetlands, special-status plants, and existing mitigation areas on the HBPP property

F3.10 Noise

The ER (Reference F8.4; Section 2.8) discussed the impacts of construction noise on construction workers, the public, and surrounding fauna. In all cases, the impact of noise on sensitive receptors was determined to be acceptable (Reference F8.5; Section 5.1.1, 5.1.2). Noise levels at HBGS include those from operation of equipment, cooling towers, and vehicles. No noise is directly attributable to the operation of the HB ISFSI, other than the vehicle traffic to and from the site during routine maintenance activities and periodic testing of the on-site back-up diesel generator.

F3.11 Historical and Cultural Resources

The ER (Reference F8.4; Section 2.9) provided ethnogrgaphic, historic, and archaeological overviews of the HB ISFSI site and surrounding area. This section provides information that has changed since previously presented in the ER.

Several cultural resources surveys have been conducted for the HBPP property. The 2003 cultural resources study for the ISFSI found no previously recorded cultural resources within the ISFSI area of potential effect (APE) (Reference F8.4; Section 2.9). A National Register evaluation of HBPP Unit 3, including a detailed context statement, was also conducted at this time. This evaluation found HBPP Unit 3 to meet the criteria for exceptional significance under National Register of Historic Places (NRHP) Criterion Consideration G, for its place in the history of the nuclear power industry, and under Criteria A and C at the national level. It found that HBPP Unit 3 would be considered exceptionally important and NRHP-eligible because of its unique and pioneering place in the history of commercial nuclear power and its highly innovative design and construction techniques. The 2003 ISFSI cultural resources study also concluded that, although HBPP Unit 3 was clearly a significant historic property, the ISFSI project would have no adverse impact on it. As discussed in Section 7.2 of the original EA (Reference F8.5), the California SHPO concurred with the NRC determination that the HB ISFSI would provide no adverse impact to any historic properties.

A comprehensive cultural and archaeological resources investigation of the HBPP site was conducted for the 2006 Application for Certification for the proposed HBGS (initially called Humboldt Bay Repowering Project) (Reference F8.26). This investigation surveyed the portions of the HBPP site that had not been surveyed for the ISFSI. The investigation provided a brief cultural background of the project area (that is, prehistory, ethnography, and history); discussed the results of a records search from the North Coastal Information Center of the California Historical Resources Information System (CHRIS); summarized the contacts made with the California Native American Heritage Commission regarding traditional cultural properties and correspondence with local tribes, individuals, and the local historical society; discussed the methods and results of the archaeological field survey of the project area; reported on the cultural resources identified within the project area, their potential significance, and the potential effects of the proposed project on the resources; and presented applicable laws, ordinances, regulations, and standards along with agency contacts, permit requirements, and schedules. The records search identified five previously recorded native cultural sites within a mile of the project area; no sites were identified within the HBPP APE.

The HBPP site was judged on the basis of the 2006 cultural resources investigation to be potentially sensitive for prehistoric cultural resources due to its location and proximity to known Native American cultural sites. The HBPP site is shown on aerial photographs that pre-date HBPP to have been a marshy lowland adjacent to Buhne Slough and the uplands of Buhne Point. Construction of the HBGS and decommissioning of the HBPP involved onsite cultural resources monitoring of excavation and other ground-disturbing activities. Artifacts found during construction included one human tooth, one prehistoric lithic scatter, two historic refuse scatters, two historic road remnants, three combination sites consisting of both a sparse lithic scatter and a historic refuse scatter, a small burnt historic trash scatter, and an unimproved road feature. None were determined eligible for either the NRHP or the California Register of Historical Resources. In addition, the Humboldt County Coroner determined the tooth was not prehistoric.

Coordination with local tribal groups has been ongoing. Outreach as part of previous studies did not identify any traditional cultural properties or other items of concern within the APE of the ISFSI or the power plant site as a whole. An informational field visit to the HBPP site in 2014 with representatives from the Table Bluff Wiyot, Blue Lake Rancheria, and Bear River Band of Rohnerville Rancheria also did not identify any specific tribal cultural resource areas of concern.

In summary, as a result of the numerous studies completed for the various decommissioning projects at HBPP, only one NRHP-eligible resource was identified within the HBPP campus: HBPP nuclear generating Unit 3, which was determined eligible for listing on NRHP through survey evaluation in 2003 (Reference F8.27). The fossil fuel-generating Units 1 and 2 and appurtenant structures were determined ineligible for the NRHP in 2006 (Reference F8.26). No significant archaeological or tribal resources have been identified within the APE. Nevertheless, during the licensing of the HBGS the CEC identified the HBPP as a historic district eligible for listing in the California Register of Historical Resources. Documentation of the site to the standards of the Historic American Engineering Record was required prior to HBPP decommissioning activities. The documentation has been completed and submitted to the appropriate agencies and entities as required by the CEC.

Renewal and operation of the ISFSI license does not require any new construction or other ground disturbance. Given the extensive cultural resources monitoring, testing, consultation, and mitigation conducted for the HBGS construction and HBPP decommissioning, it is highly unlikely that additional cultural resources would be encountered in support of ISFSI operations during the license renewal period. No historic properties will be affected by ISFSI operations or license renewal.

F3.12 Waste Management

As discussed in the HB ISFSI FSAR (Reference F8.8; Section 3.3.1.5.3), the dry spent fuel storage casks used at the HB ISFSI emit no solid, liquid, or gaseous effluents under normal or off-normal conditions of storage. PG&E maintains a back-up diesel generator on-site and the cask transport vehicle at another PG&E site (DCPP). The small amounts of wastes, such as ethylene glycol (antifreeze) or drips of lubricating fluid produced as a result of maintenance, would be cleaned up and disposed of at the HB ISFSI and DCPP facilities, respectively. Other waste generated at the HB ISFSI may include small amounts of cleaning and maintenance waste products, such as would be used for equipment repair/replacement. Sanitary sewage is produced at the HBPP site and will continue to be produced to support the HB ISFSI during the period of extended operation.

Because the HB ISFSI loading is complete, there are no additional loading campaigns as part of the period of extended operation, or the resulting small quantities of low-level solid radioactive waste generated during the loading and transfer cask decontamination.

F3.13 Environmental Justice

The ER (Reference F8.4; Section 2.7.2) addressed environmental justice; however, new NRC-issued guidance is now available on the methodology that should be used to perform an environmental justice review. Thus, this section updates the environmental justice methodology and input data previously presented in the ER.

In 2003, the NRC issued guidance for Office of Nuclear Materials Safety and Safeguards (NMSS) staff conducting environmental justice reviews for proposed actions as part of NRC's compliance with NEPA (Reference F8.25; Appendix C). The guidance document also contains a 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.

USCB demographic data provide the necessary information on race, ethnicity, and poverty. ArcGIS® Desktop 10.5 software and USCB American Community Survey (ACS) 2015 5-Year Estimate data was used to determine minority characteristics by block group and low-income characteristics by census tract[1] within 4 miles of the ISFSI site. A census block group is a geographic unit used by the USCB that is between the census tract and the census block. A block group was included if any part of its occupied area fell within 4 miles of the site. A total of 31 block groups were identified within the 4-mile radius. Consistent with NRC guidance, the geographic areas for comparative analysis was defined as the state of California and the counties of Humboldt County and Trinity County. Block groups in each state were analyzed separately against their respective state's and county's data.

F3.13.1 Minority Populations

NMSS guidance 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) (Reference

[1] Low income information was not available at the census block level for the area of interest; thus, census tract information was used.

F8.25). There is also a "Multiracial" category. This includes individuals that identify themselves as more than one race. The guidance also indicates that a block group has a significant minority population if either of the following two conditions is met:

- The minority population of the block group or environmental impact area exceeds 50 percent of the total population for that census block group.
- The minority population percentage of the environmental impact area is significantly greater (typically at least 20 percentage points) than the minority population percentage in the geographic areas chosen for comparative analysis.

The percentage of a block group's population represented by each minority category was calculated for each of the 31 block groups within the 4-mile radius, using the USCB ACS data, and calculated the percentage of each minority category in the block group's corresponding state and county. If the percentage of any block group minority category exceeded 50 percent of the total block group population or exceeded its corresponding state or county percentage by more than 20 percent, it was identified as containing a significant minority population. Table F3.13-1 provides minority percentages for each of the geographic comparison areas (state and counties). The results of the analysis indicate that no census block groups within the 4-mile radius have significant percentages of minority populations, as identified above.

F3.13.2 Low-Income Populations

The NRC guidance defines low-income households based on USCB statistical poverty thresholds (Reference F8.25). A block group[2] has a significant low-income population if either of the following two conditions is met:

- The low-income population in the census block group exceeds 50 percent of its total population.
- The percentage of households below the poverty level in a block group is significantly greater (typically at least 20 percentage points) than the low-income population percentage in the geographic areas chosen for comparative analysis.

USCB low-income households in each census tract were divided by the total number of households for that tract to obtain the percentage of low-income households per tract. The same geographic comparison areas were used. Table F3.13-1 provides low-income percentages for each of the geographic comparison areas (states and counties). If the percentage of any tract low-income category exceeded 50 percent of the total tract population or exceeded its corresponding state or county percentage by more than 20 percent, it was identified as containing a significant low-income population. The results of the analysis indicate that no census tracts within the 4-mile radius have significant percentages of low-income households.

[2] Low income information was not available at the census block level for the area of interest; thus, census tract information was used.

Table F3.13-1 Minority and Low-Income Percentages, by Geographic Comparison Area

Geographic Comparison Area	Total Population	American Indian or Alaskan Native	Asian	Native Hawaiian or Pacific Islander	Black/ African American	All Other Single Minorities	Multi-Racial Minorities	Hispanic or Latino Ethnicity	Low-Income
Humboldt County	135,034	5.2%	2.6%	0.3%	1.3%	3.6%	11.4%	11.2%	21.0
California State	38,421,464	0.8%	13.7%	0.4%	5.9%	13.0%	9.0%	38.4%	15.3

Source: Reference F8.16

F.4 Environmental Impacts

The following sections discuss environmental consequences associated with continued operations of the HB ISFSI. PG&E considered the specific resource areas that have potential impacts associated with the ISFSI operations over the extended license term.

On September 19, 2014, the NRC published a revised rule at 10 CFR 51.23, "Environmental Impacts of Continued Storage of Spent Nuclear Fuel Beyond the Licensed Life for Operations of a Reactor" [79 FR (Federal Register) 56238]. The rule codifies the NRC's generic determinations in NUREG–2157, "Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel" (Reference F8.2), regarding the environmental impacts of continued storage of spent nuclear fuel beyond a reactor's operating license (i.e., those impacts that could occur as a result of the storage of spent nuclear fuel at at-reactor or away-from-reactor sites after a reactor's licensed life for operation and until a permanent repository becomes available). The updated Continued Storage Rule and NUREG-2157 provide the NEPA 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 HB ISFSI license.

The analysis in NUREG-2157 concludes that the potential impacts of at-reactor storage during the long-term time frame (no more than 160 years after the expiration of the reactor's license to operate) would be small, except for historic and cultural resources and nonradioactive waste management (Reference F8.2; Section 4.20). PG&E is requesting renewal of the HB ISFSI license through 2065, which is greater than 60 years, but less than 160 years after the HBPP Unit 3 license was terminated in 1976. As described in the following sections, impacts from the proposed renewal of SNM-2514 are primarily occupational and public health impacts associated with radiological exposure.

NRC determined in the initial licensing of the HB ISFSI (Reference F8.5; Section 8) that "storage of spent nuclear fuel in an in-ground ISFSI at the Humboldt Bay Power Plant would not significantly affect the quality of the human environment," including those from historic and cultural resources and nonradioactive waste management. In light of NRC's findings in NUREG-2157 (Reference F8.2) and those in the remaining subsections of this chapter, PG&E concludes that the conclusions of NRC's 2005 HB ISFSI EA remain unchanged.

F4.1 Impacts from Refurbishment and Construction

The Proposed Action does not include refurbishment or new construction. Impacts for construction of the HB ISFSI were addressed in the original licensing evaluation (Reference F8.5; Section 5.1.1). As described in Section F1.2, no refurbishment is planned. Only routine monitoring and maintenance is expected over the proposed 40-year period of extended operation. Therefore, there are no environmental impacts from refurbishment or construction beyond those analyzed in the original 2005 HB ISFSI EA (Reference F8.5).

The following is a description of the routine monitoring and maintenance for the license renewal period. Over the proposed 40-year license renewal period, PG&E anticipates continuation of existing monitoring and maintenance activities for the HI-STAR 100 HB storage casks and reinforced concrete vault structure, including upkeep of security monitoring equipment, quarterly radiation monitoring, and periodic inspections of the vault drainage system and ISFSI concrete. ISFSI security monitoring equipment is maintained operable on a continuous basis and replaced on an as-needed basis.

Aging management activities to be carried out over the 40-year license renewal period include the External Surfaces Monitoring Aging Management Program and the Reinforced Concrete Structures Aging Management Program described in Appendix A of the license renewal application. As described in Appendix A, these programs are condition monitoring programs and include periodic visual inspection, radiation monitoring, and soil sampling.

Environmental impacts from existing monitoring and maintenance and aging management activities over the 40-year license renewal period could include the generation of limited quantities of non-radioactive cleanup or replacement materials, such as would be used for equipment repair/replacement (see Section F3.12). Accordingly, the environmental impacts of maintenance or aging management activities over the proposed 40-year license renewal period are expected to be SMALL. Any dose associated with occupational exposure will be monitored, maintained, and mitigated in accordance with the station's Radiological Protection Program.

F4.2 Occupational and Public Health Impacts

Risks to occupational health and safety include exposure to industrial hazards (i.e., moving heavy objects, working outside, and working with heavy equipment during cask transfer operations), hazardous materials, and radioactive materials. Industrial hazards for the HB ISFSI are typical for similar industrial facilities and include accidents ranging from minor cuts to industrial machinery accidents.

ISFSIs in the United States are licensed by the NRC and must comply with NRC regulations and conditions specified in the license in order to operate. The licensees are required to comply with Title 10 of the Code of Federal Regulation (CFR) Part 20, Subpart C, “Occupational Dose Limits for Adults”; 10 CFR Part 20, Subpart D, “Radiation Dose Limits for Individual Members of the Public”; and 10 CFR 72.104, “Criteria for Radioactive Materials in Effluents and Direct Radiation from an ISFSI or MRS.”

Radiological protection and doses from HB ISFSI operations (including cask transport, surveillance and maintenance, etc.) are discussed in Section 7 of the FSAR (Reference F8.8). The major aspects of the radiological protection program are summarized in the following sections. There are no other potential health impacts other than those associated with moving heavy objects, working outside, and working with heavy equipment during cask transfer operations.

F4.2.1 Policy Considerations

The HB ISFSI utilizes the DCPP ALARA program to maintain radiation exposures to HB ISFSI personnel, visitors, and the general public below regulatory limits and as low as reasonably achievable (ALARA). The DCPP ALARA Program complies with 10 CFR 20.1101, Radiation Protection Programs, and is consistent with Regulatory Guides and publications that deal with ALARA concepts and practices, including 10 CFR 20. In addition, PG&E regularly reviews operational experience from throughout the industry and incorporates relevant lessons learned into HB ISFSI operations.

The Radiation Protection Program identifies the organizations participating in the programs, the positions involved, and the responsibilities and functions of the various positions in conducting the programs. Adequately trained personnel develop and conduct the health physics programs. Radiation Protection personnel receive Institute of Nuclear Power Operations-certified training and obtain process experience to carry out the Radiation Protection programs in an efficient manner to assure that company and regulatory requirements are met.

A discussion of the ALARA policy considerations can be found in Section 7.1.1 of the HB ISFSI FSAR (Reference F8.8).

F4.2.2 Design Considerations

The HB ISFSI storage vault is located in near proximity to an unrestricted area. ALARA considerations associated with this location are as follows:

- The edge of the ISFSI vault is located approximately 53 ft from a public access trail. The use of a vault minimizes radiation exposure to members of the public that occasionally use this trail.
- An underground ISFSI storage vault provides substantial shielding for onsite personnel and the general public.
- The MPC is constructed from stainless steel. This material is resistant to corrosion and the damaging effects of radiation, and is well proven in spent nuclear fuel storage cask service.
- The loaded HI-STAR HB cask is decontaminated prior to being removed from the HBPP refueling building.

The HB ISFSI is surrounded by an access control gate to prevent unauthorized access. Thermoluminescent dosimeters (TLDs) have been installed along the controlled access fence.

A discussion of the ALARA design considerations can be found in Section 7.1.2 of the HB ISFSI FSAR (Reference F8.8).

F4.2.3 Operational Considerations

Operational considerations at the HB ISFSI that promote the ALARA philosophy include determination of the origins of radiation exposures, the proper training of personnel, the preparation of radiation protection procedures, and implementing these procedures.

The HB ISFSI vault is considered a radiologically control area. Operational radiation protection objectives deal with access to radiation areas, exposure to personnel, and decontamination. Procedures and techniques are based upon operational criteria and experience that have worked to keep radiation exposure ALARA.

A discussion of the ALARA operational considerations can be found in Section 7.1.3 of the HB ISFSI FSAR (Reference F8.8).

F4.2.4 Sources of Radiation

Neutron and gamma radiation emanating from the spent fuel and the shielded casks is the primary source of radiation exposure. Descriptions of the fuel that the casks are designed to store are provided in Section 7.2.1 of the FSAR (Reference F8.8). The GE Type III fuel assembly is the design basis fuel for shielding purposes for the HI-STAR 100 HB cask design because it has the highest uranium mass loading and therefore will have a higher source term for the same burnup and cooling time than the other HBPP fuel designs. Initial enrichment of 2.09 weight percent U-235, assembly average burnup of 23 gigawatt days per metric ton of uranium, and cooling time of 29 years complete the specification of the design basis fuel. The source terms include the irradiated fuel and activated portions of the fuel assembly structural materials. Detailed information regarding the radiation source terms for the HI-STAR 100 System can be found in Section 7.2 of the HB ISFSI FSAR (Reference F8.8).

The exterior surfaces of the casks are decontaminated prior to transfer to the HB ISFSI. (Reference F8.8; Section 7.2.2.1)

F4.2.5 Occupational Dose

This section establishes the expected cumulative dose delivered to site personnel during the fuel handling and transfer activities associated with one cask. Chapter 5 of the FSAR (Reference F8.8) describes in detail the HB ISFSI operational procedures, a number of which involve radiation exposure to personnel.

Personnel involved in HB ISFSI operations will incur the highest occupational dose from the HB ISFSI because of their proximity to the casks. Due to the distance between the HB ISFSI and the site boundary, much smaller doses are incurred by members of the public. The estimated occupational exposure to HB ISFSI personnel from HB ISFSI operations is presented in Section 7.4 of the FSAR (Reference F8.8) and is summarized as follows:

- The estimated occupational exposures to PG&E personnel during the loading, transport, and emplacement of the storage casks to be 568 millirem for each cask.[3]
- The estimated occupational exposures during the unloading of an overpack and MPC-HB is approximately 328 millirem. The loading and unloading estimated exposures are based on industry experience with the Holtec HI-STAR and HI-STORM casks and casks from other vendors. The dose rates used for this

[3] Actual total dose for loading the five casks containing spent fuel was 0.623 person-rem (623 millirem).

analysis are conservatively estimated using design-basis fuel, yet are still very low due to the long cooling time of the HBPP fuel.

- The estimated annual occupational exposure as a result of ISFSI walkdowns and occasional maintenance/inspections is approximately 112 millirem for those years where a license renewal inspection is performed with the vault lid removed (on a 5-year frequency). The estimated dose is based on a total occupancy time of 79 hours per year, with 9 hours being with the vault lid removed. The dose rates used in the vault lid removal estimate are based on the measured dose rate over background exposure for the ISFSI vault of 1000 microrem/hour. The dose rates used in the estimate for non-lid removal activities are based on the measured dose rate over background exposure for the ISFSI vault of 2 microrem/hour.
- For those years where a license renewal inspection is not performed with the vault lid removed, the estimated annual occupational exposure as a result of ISFSI walkdowns and occasional maintenance/inspections is approximately 0.153 millirem. The estimated dose is based on a total occupancy time of 60 hours per year. The dose rates used in the estimate are based on the measured dose rate over background exposure for the ISFSI vault of 2 microrem/hour.
- The estimated annual occupational exposure as a result of overpack repairs is approximately 0.36 millirem. The doses for the repair operations assume one repair operation per month of one-hour duration with two people performing the operation. The dose rates were conservatively based on the contact dose rate for the ISFSI vault.

The conservative dose rates demonstrate that the estimated occupational exposures from the Humboldt Bay ISFSI meet the regulatory requirements of 10 CFR 20. The actual doses from the ISFSI are expected to be considerably less than the conservatively estimated values. (Reference F8.8; Section 7.4)

F4.2.6 Dose to the Public

The only dose to members of the public during normal operations will result from the gamma and neutron radiation that is emitted from the cask surfaces. The dose rate decreases rapidly as a function of distance from the HB ISFSI, as indicated in Table 7.5-1 of the FSAR (Reference F8.8).

Because the casks provide containment, yielding no radioactive effluents, assessment of off-site collective dose is limited to one of direct radiation to the nearest residence. At a distance of 0.15 miles (the nearest resident location), the total annual dose rate estimate, as provided in the FSAR, is 4.48 millirem/year. Using dose rates closer to actual measurements (2 microrem/hour (above background) as the exposure rate and 8,760 hours/year), the more realistic annual exposure value is <0.1 millirem/year.

F4.3 Other Impacts

The routine operation of the ISFSI involves dry storage of spent nuclear fuel and GTCC waste in sealed containers within an underground storage vault. 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 F4.2. Each resource area discussed in Section F3 is briefly addressed below. Conclusions drawn from the original ISFSI EA (Reference F8.5) 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 former HBPP developed area. No additional land use impacts are expected from continued operation. Furthermore, the land use impacts of repurposing existing HBPP structures for long-term use to support ISFSI operations were evaluated as part of the HBPP FSR Plan (Reference F8.23, Section 4.X) and were determined to have no impact.

Transportation
No significant changes in staffing are anticipated to manage the ISFSI during the term of the renewed license, and no new radwaste shipments or related activities are expected. The impact of ISFSI operations on transportation and traffic was also evaluated as part of the HBPP FSR Plan (Reference F8.23, Section 4.XVI) and was determined to have little to no impact. Therefore, for the ISFSI license renewal term, no impacts to transportation are expected.

Demography and Socioeconomics
Any changes to the local economy as a result of the construction and operation of the ISFSI occurred when the ISFSI was constructed. In the original EA, NRC concluded the operational workforce would not impact socioeconomics (Reference F8.5; Section 5.1.2). Thus, no socioeconomic impacts are expected from continued operation.

Climatology, Meteorology, Air Quality
The ISFSI does not release airborne emissions. In the original EA, NRC concluded the ISFSI operation would not impact climate (Reference F8.5; Section 5.1.2). No adverse air quality impact is expected from continued operation.

Geology and Soils
Impacts to geology and soils occurred when the HB ISFSI was constructed. No additional impacts to geology or soils are expected from continued operation.

Water Resources
The ISFSI does not require water for its operation and does not discharge effluents to surface or groundwater. Furthermore, as discussed in Section F3.7, development of a new stormwater detention basin system as part of HBPP FSR will accommodate stormwater runoff associated with the ISFSI and support structures. No impact to water resources is expected from continued operation beyond those described in the original EA (Reference F8.5; Section 5.1.2).

Ecological Resources
Any ecological impacts occurred when the ISFSI was constructed. The original EA asserted that ISFSI operation is not expected to adversely impact terrestrial and aquatic environments or their associated plant and animal species (Reference F8.5; Section

5.1.2). As discussed in Section F3.8, there are no species listed as threatened or endangered that are known to currently occupy the HB ISFSI site. Continued operation of the HB ISFSI would not alter any wildlife or plant habitat and is not expected to affect listed species or critical habitat. Furthermore, the ecological impacts associated with retaining structures for long-term use to support ISFSI operations were evaluated and mitigated as part of the HBPP FSR Plan (Reference F8.23, Section 4.IV). Therefore, the applicant expects that the NRC would make a no-effect determination for the license renewal period, in which case consultation with USFWS and NMFS would not be required.

Visual and Scenic Resources

As discussed in Section F3.9, although the HB ISFSI is visible from the major U.S. Highway and public access trail, it is minimized due to the underground vault design, with the top of the vault approximately flush with the ground surface and the top of the vault lids less than 20 inches above the ground level. The associated ISFSI security building and ISFSI fencing are the only visible portions. Therefore, no adverse visual impact is expected from continued operation of the HB ISFSI (Reference F8.5; Section 5.1.1).

Noise

Storage of spent fuel and GTCC waste 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 and routine operations and maintenance activities. Thus, no adverse noise impact is expected from continued operation of the HB ISFSI.

Historical and Cultural Resources

As described in Section F3.11, no historic or archaeological resources have been identified in the Area of Potential Effect for the HB ISFSI. It is possible, though unlikely, that unidentified historic or archaeological resources may be buried in the project vicinity. However, the continued management of spent fuel and GTCC waste at the HB ISFSI involves use of the existing dry fuel storage system, and no structural modifications or construction are anticipated that would result in new ground disturbance. Based on these considerations, no adverse cultural resource impact is expected from continued operation of the HB ISFSI.

Waste Management

As discussed in Section F3.12, the dry spent fuel storage casks used at the HB ISFSI emit no solid, liquid, or gaseous effluents under normal or off-normal conditions of storage. Therefore, no waste management impacts are expected from continued ISFSI operation.

Environmental Justice

As discussed in Section F3.13, the minority and low-income populations are located more than 4 miles away from the ISFSI-beyond the range of any public dose effects. Furthermore, NRC has determined that overall human health and environmental impacts from at-reactor spent fuel storage during the long-term timeframe are small for all populations. Therefore, minority or low-income populations are not expected to experience disproportionately high and adverse impacts during this timeframe (Reference F8.2; Section 4.3.2). There are no site-specific conditions associated with extended operation of the HB ISFSI that would alter NRC's generic conclusion.

F4.4 Impacts from Potential Accidents

PG&E has evaluated the potential radiological impacts resulting from a suite of postulated accidents for the HB ISFSI in the FSAR (Reference F8.8; Section 8). 10 CFR 72.70(c)(6) requires PG&E to update the FSAR every 24 months from the date of issuance of the license. The following are the current FSAR accidents:

- Off-normal pressures
- Off-normal environmental temperatures
- Confinement boundary leakage – not credible
- Cask drop less than allowable height – not credible
- Loss of electric power
- Cask transporter off-normal operation
- Earthquake
- Tornado
- Flood
- Tsunami
- Fire
- Explosion

As discussed in the FSAR, for those accidents deemed credible, there are no radiological impacts since the confinement barrier is not breached and shielding is not affected.

F.5 Mitigation Measures

As presented in Section F4, the only impact of the proposed action is radiological dose to workers and the public. PG&E adopted measures to mitigate for those potential impacts in conjunction with construction and operation of the ISFSI under the original license, as discussed below. PG&E will continue to implement these measures throughout the license renewal term.

Workers in the ISFSI Radiologically Controlled Area wear personnel radiation monitoring devices and dose is recorded and tracked for analysis. Radiation outside the ISFSI Security Area Fence is continually measured at the Security Boundary Fence surrounding the ISFSI. If measured doses were to significantly exceed historical levels, PG&E would perform analyses to determine the cause and would establish mitigation measures. The PG&E Radiological Protection 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, as discussed in Appendix A to this License Renewal Application, inspections and maintenance of the ISFSI casks are performed to ensure that no degradation of equipment could lead to increased radiation levels.

F.6 Environmental Measurements and Monitoring

Given that the HBPP Units will have been dismantled and removed from the site prior to the ISFSI period of extended operation and that the ISFSI is a passive operation that does not release radioactive effluents into the environment, the only environmental measurements required are related to direct radiation. PG&E has placed environmental dosimeters at locations on the Security Area Fence.

The regulatory agencies with jurisdiction have prescribed no other physical, chemical, or ecological monitoring requirements, beyond those described above, to support operations of the ISFSI, except for measures to minimize impacts to biological resources and stormwater runoff associated with retaining additional structures/areas to support ISFSI operations. These measures include implementation of a stormwater management plan to minimize long-term stormwater runoff and maintaining restoration areas in an open space deed restriction. 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 license renewal period, and no additional environmental measurements or monitoring would be required.

F.7 Summary of Environmental Consequences

This Supplemental ER describes the proposed action, which is renewal of the license of the HB ISFSI for 40 years, and the associated impacts. Table F7-1 identifies the non-radiological and radiological environmental impacts of HB ISFSI license renewal. Based on this evaluation, HB ISFSI license renewal would involve no significant environmental impact.

Table F7-1 Environmental Impacts of HB ISFSI License Renewal

Issue	Environmental Impact
Land Use	None
Transportation	None
Demography and Socioeconomics	None
Climatology, Meteorology, and Air Quality	None
Geology and Soils	None
Water Resources	None
Ecological Resources	None
Visual and Scenic Resources	None
Noise	None
Historical and Cultural Resources	None
Waste Management	None
Environmental Justice	None
Occupational Health and Safety from Normal Operations	SMALL. HB ISFSI operations workers could receive an annual collective dose of up to 112 millirem.
Other Occupational Health Effects	SMALL. Any other health effects would be the result of normal workplace hazards (moving heavy objects, etc.).
Dose to the Public from Normal Operations	SMALL. The closest resident to the HB ISFSI could receive an annual collective dose of up to 4.48 millirem.
Dose to the Public from Accidents	None

F7.1 Unavoidable Adverse Impacts

As presented in Section F4, the only adverse impacts of the proposed action are radiological dose to workers and radiological dose to the public. Although PG&E employs inspections, maintenance, monitoring, and ALARA principles (Section F5) to mitigate these impacts, some impact is unavoidable. However, as indicated in Section F4, NRC concluded that the impact of the ISFSI to both occupational workers and members of the public is within regulatory limits (radiation protection standards of 10 CFR 72.104(a)) (Reference F8.5; Section 8.0).

F7.2 Irreversible and Irretrievable Resource Commitments

The continued operation of the HB ISFSI for the license renewal term would result in no additional irreversible and irretrievable resource commitments beyond those materials committed during the initial licensing of the ISFSI that cannot be recovered or recycled or that are consumed or reduced to unrecoverable forms. As noted in the original license application for the ISFSI and NRC's corresponding EA; those resources committed to this facility, whether irreversibly or for the life of the facility, represent small portions of the total amount of such resources available for use in any particular category. No resources would be irretrievably committed as a result of continued ISFSI operations for the license renewal term.

F7.3 Short-Term Versus Long-Term Productivity of the Environment

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 HB ISFSI. The ISFSI is a temporary storage facility. Once the spent nuclear fuel and GTCC waste are moved to a permanent repository, the concrete pads and fencing could be removed and the land used for another purpose. Extended operation of the ISFSI would postpone restoration of the site and its potential availability for uses other than spent fuel and GTCC waste storage for up to an additional 40 years.

F.8 References

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F.9 List of Preparers

Table F9-1 HB ISFSI ER Supplement List of Preparers

Name	Title	Responsibility
Cimino, Stephanie	Cultural Resource Specialist, Senior	Subject Matter Expert Review
Olsofsky, Michelle	Licensing Engineer	Document Preparation/Review
Post, Jennifer	Chief Counsel, Nuclear	Subject Matter Expert Review
Salmon, James	HBPP Environmental Manager	Subject Matter Expert Review
Soenen, Philippe	DCPP Environmental Management Manager, Decommissioning	Project Manager, Document Review
Sun, Joseph	Geosciences, Manager	Subject Matter Expert Review
Vardas, Kris	DCPP Site Restoration, Supervisor	Subject Matter Expert Review
Wright, Martin	Radiation Protection Engineer, Senior	Subject Matter Expert Review

ATTACHMENT A
STATEMENT OF COMPLIANCE WITH THE CALIFORNIA COASTAL ACT OF 1976

PG&E is seeking renewal of the HB ISFSI license for an additional 40 years. The Federal Coastal Zone Management Act (16 USC 1452 et seq.) requires ISFSI license renewal applicants to obtain a certification that license renewal would be consistent with the Federally approved State Coastal Zone Management program. The California Coastal Management Program (CCMP) policies are contained in Division 20, Chapter 3 of the California Public Resource Code and require persons seeking approval for activities which may impact the Coastal Zone to demonstrate that the activity is consistent with all enforceable policies in Division 20, Chapter 3 of the California Public Resource Code.

The statement of compliance with California Coastal Act of 1976 for construction and initial operations of the Humboldt Bay (HB) Independent Spent Fuel Storage Installation (ISFSI) were first presented in the Environmental Report (ER) for the HB ISFSI license (Reference 1, Appendix A) and Coastal Development Permit (CDP) Application (Reference 2, Attachment B). The California Coastal Commission (CCC) issued a Staff Report on the CDP Application (Reference 3) which evaluated the conformity of HB ISFSI construction and operations to applicable policies of the Coastal Act. The CCC Staff Report evaluation assumed “long-term presence of the HB ISFSI due to the lack of offsite alternatives available to store spent nuclear fuel and no certainty as to when or if such locations might be available” (Reference 3, page 2).

Because these documents have previously defined the impacts of the HB ISFSI, Pacific Gas and Electric Company (PG&E) adopts relevant material from these documents by reference.

The following is a discussion of the proposed project’s compliance with policies contained in Division 20, Chapter 3 of the California Public Resource Code. This discussion will identify only those sections which are pertinent to the proposed project and how the project will comply with those sections.

Section 30211:

> *Development shall not interfere with the public’s right of access to the sea where acquired through use or legislative authorization, including, but not limited to, the use of dry sand and rocky coastal beaches to the first line of terrestrial vegetation.*

Adjacent to Buhne Point and along the north-northeast boundary of the HB Power Plant (PP) property is the HB shoreline, which is fronted by very large rip-rap boulders placed there for shoreline protection. As part of CDP E-05-001 (Special Condition #5) to construct the HB ISFSI, PG&E constructed a public trail along the shoreline (Shoreline Trail), between the rip-rap and the Buhne Point bluffs that will at some point in the future become a segment of the HB Trail. The trail extends past the HBPP property to the east and is incomplete between this point and the Elk River to the northeast (Redwood Community Action Agency 2001). As required by the NRC, PG&E has gates, fences, or security personnel at points on the trail where the Buhne Point bluffs approach the ISFSI in case the ISFSI Support personnel need to close the trail near the ISFSI for security reasons. (Reference 4)

No changes are being proposed to the Shoreline Trail as part of HB ISFSI license renewal. Therefore, because the Shoreline Trail provides adequate public access, as determined by the CCC in CDP E-05-001, the proposed project is consistent with this section of the CCA.

Section 30214(a):

> *The public access policies of this article shall be implemented in a manner that takes into account the need to regulate the time, place, and manner of public access depending on the facts and circumstances in each case including, but not limited to, the following:*
>
> *(1) Topographic and geologic site characteristics.*
> *(2) The capacity of the site to sustain use and at what level of intensity.*
> *(3) The appropriateness of limiting public access to the right to pass and repass depending on such factors as the fragility of the natural resources in the area and the proximity of the access area to adjacent residential uses.*
> *(4) The need to provide for the management of access areas so as to protect the privacy of adjacent property owners and to protect the aesthetic values of the area by providing for the collection of litter.*

As discussed above in response to Section 30211, as required by NRC regulations, PG&E has gates, fences, or security personnel at points on the trail where the Buhne Point bluffs approach the ISFSI in case the ISFSI Support personnel need to close the trail near the ISFSI for security reasons (e.g., in the event of an ISFSI emergency, if casks need maintenance or inspection, or during the time that the casks are being permanently removed from the HB ISFSI site to a permanent storage facility). The closure of the trail is an infrequent, rare event.

No changes are being proposed to the Shoreline Trail as part of HB ISFSI license renewal. Therefore, because the Shoreline Trail provides adequate public access, with minor access restrictions based on NRC regulations, the proposed project is consistent with this section of the CCA.

Section 30220:

> *Coastal areas suited for water-oriented recreational activities that cannot readily be provided at inland water areas shall be protected for such uses.*

As with Sections 30211 and 30214(a), this section applies to the public Shoreline Trail, which traverses the PG&E property and 100-meter control area around the ISFSI facility. As discussed above, HB ISFSI license renewal will not adversely impact public access in the area. Access along the trail will only be curtailed during limited, brief activities for security reasons. Therefore, the proposed project is in compliance with this section of the CCA.

Section 30230:

> *Marine resources shall be maintained, enhanced, and where feasible, restored. Special protection shall be given to areas and species of special biological or economic significance. Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes.*

The HB ISFSI was constructed on an existing and disturbed industrial site with no onsite biological resources. PG&E-owned land in the vicinity of the ISFSI was inventoried for threatened or endangered species prior to ISFSI construction and, most recently, to support the HBPP Final Site Restoration (FSR) Plan. No state or federally proposed or listed, threatened or endangered plant, terrestrial wildlife, or aquatic species have been identified within the immediate ISFSI area. Refer to Section F3.8 of this Environmental Supplement for more a more detailed discussion of ecological resources.

Continued HB ISFSI operations during the license renewal term will result in no impacts to marine resources near the site. In addition, as discussed in Section F3.10 of this Environmental Supplement, no noise is directly attributable to the operation of the HB ISFSI, other than the vehicle traffic to and from the site during routine maintenance activities and periodic testing of the on-site back-up diesel generator. Runoff is controlled through Best Management Practices required as part of the HBPP and HB Generating Station (HBGS) NPDES permits, as discussed further in the response to Section 30231 below. Runoff impacts are addressed as part of the HBPP FSR Plan by development of a new stormwater detention basin system.

The proposed project is in compliance with this section of the CCA

Section 30231:

> *The biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes appropriate to maintain optimum populations of marine organisms and for the protection of human health shall be maintained and, where feasible, restored through, among other means, minimizing adverse effects of waste water discharges and entrainment, controlling runoff, preventing depletion of ground water supplies and substantial interference with surface water flow, encouraging waste water reclamation, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alteration of natural streams.*

As discussed in Reference 1, 2, and 3, there are no liquid industrial waste discharges from operations of the HB ISFSI. Operation of the HB ISFSI site is currently addressed by an existing industrial National Pollutant Discharge Elimination System (NPDES) Permit No. CAS000002, Order No. 2009-0009-DWQ as amended by 2010-0014-DWQ and 2012-0006-DWQ, for the HBPP site. Once HBPP decommissioning and site restoration is complete, an application will be submitted to include the operation of the HB ISFSI site under the HBGS NPDES permit, as needed.

As discussed in the HBPP FSR Plan, PG&E will develop new stormwater detention basins. In conjunction with the existing Stormwater Pollution Prevention Plan (SWPPP), these new basins will greatly improve the quality of water in the long-term leaving the site by filtering sediments from stormwater. In the unlikely event that there is a spill of hazardous materials from the developed portions of the site, the stormwater basins will have control valves that can keep water from flowing directly into the adjacent wetlands, further protecting these areas. The culvert that will be replaced between the Buhne Point Wetlands Preserve and the Intake Canal will be replaced with a structure that can be closed if needed to prevent water from discharging into the Intake Canal (and thereby to Fisherman's Channel and HB). The current construction NPDES permit and SWPPP for the decommissioning program govern stormwater management on the site and once decommissioning is complete, the HBGS's industrial NPDES permit and SWPPP will govern the entire site, thereby providing further protection to the adjacent natural areas and receiving waters. The proposed stormwater detention basin system will have a long-term positive effect on water quality on the site's wetlands and other habitat areas as well as receiving waters.

Because HB ISFSI license renewal does not include refurbishment, new construction, or changes to ISFSI operations, the proposed project is in compliance with the requirements of this section of the CCA.

Section 30240:

(a) Environmentally sensitive habitat areas shall be protected against any significant disruption of habitat values, and only uses dependent on those resources shall be allowed within those areas.

(b) Development in areas adjacent to environmentally sensitive habitat areas and parks and recreation areas shall be sited and designed to prevent impacts which would significantly degrade those areas, and shall be compatible with the continuance of those habitat and recreation areas.

The HB ISFSI was constructed on an existing and disturbed industrial site with no onsite biological resources. PG&E-owned land in the vicinity of the ISFSI was inventoried for threatened or endangered species prior to ISFSI construction and, most recently, to support the HBPP FSR Plan. No state or federally proposed or listed, threatened or endangered plant, terrestrial wildlife, or aquatic species have been identified within the immediate ISFSI area. Refer to Section F3.8 of this Environmental Supplement for more a more detailed discussion of ecological resources.

Continued HB ISFSI operations during the license renewal term will result in no impacts to environmentally sensitive habitat areas near the site. In addition, as discussed in Section F3.10 of this Environmental Supplement, no noise is directly attributable to the operation of the HB ISFSI, other than the vehicle traffic to and from the site during routine maintenance activities and periodic testing of the on-site back-up diesel generator. Runoff is controlled through Best Management Practices required as part of the HBPP and HBGS NPDES permits. Runoff impacts are addressed as part of the HBPP FSR Plan by development of a new stormwater detention basin system.

The proposed project is in compliance with this section of the CCA.

<u>Section 30244</u>:

> *Where development would adversely impact archaeological or paleontological resources as identified by the State Historic Preservation Officer, reasonable mitigation measures shall be required.*

As discussed above and in Reference 1, 2, and 3, the HB ISFSI was constructed on land that was occupied by the HBPP, which is an existing and disturbed industrial site. There are no registered scenic, natural landmarks or cultural resources that will be impacted by the proposed project because HB ISFSI license renewal does not include refurbishment or new construction. Refer to Section F3.11 of this Environmental Supplement for more a more detailed discussion of ecological resources. The proposed project is in compliance with this section of the CCA.

<u>Section 30250(a)</u>:

> *New residential, commercial, or industrial development, except as otherwise provided in this division, shall be located within, contiguous with, or in close proximity to, existing developed areas able to accommodate it or, where such areas are not able to accommodate it, in other areas with adequate public services and where it will not have significant adverse effects, either individually or cumulatively, on coastal resources. In addition, land divisions, other than leases for agricultural uses, outside existing developed areas shall be permitted only where 50 percent of the usable parcels in the area have been developed and the created parcels would be no smaller that the average size of surrounding parcels.*

The HB ISFSI is located on the HBPP site within the PG&E property boundary and is adjacent to existing industrial activities. As such, the proposed project complies with this section of the CCA.

<u>Section 30250(b)</u>:

> *Where feasible, new hazardous industrial development shall be located away from existing developed areas.*

As discussed above, the HB ISFSI is located on land that as previously occupied by the HBPP, which is an existing and disturbed industrial site. All HB ISFSI operation-related activities will take place wholly within the HBPP site and will not occur in any neighboring developed areas or on public roadways. Thus, the proposed project is in compliance with this section of the CCA.

<u>Section 30251</u>:

> *The scenic and visual qualities of coastal areas shall be considered and protected as a resource of public importance. Permitted development shall be sited and designed to protect views to and along the ocean and scenic coastal areas, to minimize the alteration of natural landforms, to be visually compatible with the character of the surrounding areas, and, where feasible, to restore and enhance visual quality in visually degraded areas. New development in highly*

> *scenic areas such as those designated in the California Coastline Preservation and Recreation Plan prepared by the Department of Parks and Recreation and by local government shall be subordinate to the character of its setting.*

As discussed in Reference 1, 2, and 3, the HB ISFSI site is situated on a bluff overlooking HB. The storage structure is below-grade and is not visible from nearby public areas or coastal waters; however, the ancillary ISFSI equipment and structures (required to comply with NRC requirements) are visible from nearby public areas.

In Reference 3 (Sections 4.5.2 and 4.5.6), the CCC concluded that the location of the HB ISFSI on the visually prominent bluff is not consistent with the requirement of Section 30251. However, although the location of the HB ISFSI results in an inconsistency with Section 30251, the CCC concluded that an alternate location would result in inconsistencies with other CCA policies (i.e., marine resources and water quality, environmentally sensitive habitat areas). Therefore, the CCC approved the construction and operation of the HB ISFSI, notwithstanding its inconsistencies with several Coastal Act policies, as “most protective of coastal resources” for purposes of the conflict resolution provisions of Coastal Act Section 30007.5. PG&E complied with CDP E-05-001 Special Condition 3 to minimize visual impacts.

HB ISFSI license renewal does not include refurbishment, new construction, or changes to the conditions of CDP E-05-001, and thus, does not result in any changes to the visual impacts. Furthermore, an additional 40 years of HB ISFSI operations does not change the CCC original conclusion because the evaluation assumed long-term presence of the HB ISFSI.

In conclusion, although the continued presence of the HB ISFSI does not comply with Section 30251 of the CCA, as previously determined by the CCC, the impacts have been fully mitigated per the CDP requirements.

Section 30253:

> *New development shall:*
>
> *(1) Minimize risks to life and property in areas of high geologic, flood, and fire hazard.*
> *(2) Assure stability and structural integrity, and neither create nor contribute significantly to erosion, geologic instability, or destruction of the site or surrounding area or in any way require the construction of protective devices that would substantially alter natural landforms along bluffs and cliffs.*
> *(3) Be consistent with requirements imposed by an air pollution control district or the State Air Resources Control Board as to each particular development.*
> *(4) Minimize energy consumption and vehicle miles traveled.*
> *(5) Where appropriate, protect special communities and neighborhoods which, because of their unique characteristics, are popular visitor destination points of recreational uses.*

Subsections (1) and (2):

As discussed in References 1, 2, and 3, detailed geologic and geotechnical investigations were conducted in support of original design and licensing of the HB ISFSI. These investigations concluded that there were no geologic hazards or adverse geologic or geotechnical conditions that would preclude construction and operation of an ISFSI. HB ISFSI license renewal does not include refurbishment or new construction, and thus, does not result in any changes to the geologic and geotechnical conclusions.

Although the NRC concluded the HB ISFSI design is adequate to withstand hazards at the HB ISFSI site, the CCC concluded that the HB ISFSI does not fully conform with the requirements of Section 30251 (1) and (2) (Reference 3, Sections 4.5.1 and 4.5.6) based on the potential future need for shoreline protective structures due to bluff erosion and sea level rise. Although deemed inconsistent with the CCA sections, the CCC concluded that an alternate location would result in inconsistencies with other CCA policies (i.e., marine resources and water quality, environmentally sensitive habitat areas). Therefore, the CCC approved the construction and operation of the HB ISFSI, notwithstanding its inconsistencies with several Coastal Act policies, as “most protective of coastal resources” for purposes of the conflict resolution provisions of Coastal Act Section 30007.5. PG&E complies with CDP E-05-001 Special Conditions 1 and 2 to monitor bluff slopes and shoreline erosion. As discussed in PG&E letter dated June 21, 2017 to the CCC, initial horizontal and vertical movements of more than two feet were identified along the bluff edge in 2012. However, the average rate of bluff retreat has been essentially zero for the period from April 2012 to May 2017. In addition, no measureable shoreline retreat has taken place since the placement of riprap embankment along the toe of the bluff in 1952.

HB ISFSI license renewal does not include refurbishment, new construction, or changes to the conditions of CDP E-05-001, and thus, does not result in any changes to the geologic and geotechnical impacts. Furthermore, an additional 40 years of HB ISFSI operations does not change the CCC original conclusion because the evaluation assumed long-term presence of the HB ISFSI.

In conclusion, although the continued presence of the HB ISFSI does not comply with Section 30253 (1) and (2) of the CCA, as previously determined by the CCC, the impacts have been fully mitigated per the CDP requirements.

Subsection (3):
HB ISFSI license renewal does not include refurbishment or new construction. No air permits are required for continued operations. Thus, the proposed project complies with Subsection (3).

Subsection (4):
The HB ISFSI is a stationary and passive facility. The only energy needs for the HB ISFSI are for the security building, site lighting, and ancillary functions. As such, the proposed project complies with Subsection (4).

Subsection (5):
As discussed above, the HB ISFSI is located on land that as previously occupied by the HBPP, which is an existing and disturbed industrial site. All HB ISFSI operation-related activities will take place wholly within the HBPP site and will not occur in any neighboring developed areas or on public roadways. Thus, the proposed project is in compliance with Subsection (5).

Attachment A References

1. Humboldt Bay Independent Spent Fuel Storage Installation Environmental Report, December 15, 2003, Pacific Gas and Electric. Humboldt Bay ISFSI Letter HIL-03-001. ADAMS Accession Nos. ML033640441, ML033640453, and ML033640677.

2. PG&E Letter HIL-03-001, Coastal Development Permit Application for the Humboldt Bay Independent Spent Fuel Storage Installation, dated January 14, 2005.

3. Staff Report Coastal Development Permit Application, Application No. E-05-001, Pacific Gas and Electric Company. August 31, 2005. California Coastal Commission. Available online at: https://documents.coastal.ca.gov/reports/2005/9/Th6a-9-2005.pdf

4. Initial Study and Mitigated Negative Declaration for the Humboldt Bay Power Plant Final Site Restoration Plan Implementation. Submitted to Humboldt Bay Harbor, Recreation and Conservation District. Prepared for Pacific Gas and Electric Company. CH2M HILL Engineers, Inc. August 2015. Available online at: http://humboldtbay.org/sites/humboldtbay2.org/files/Humboldt%20Bay%20Power%20Plant%20-%20Final%20Initial%20Study%20and%20Negative%20Declaration.pdf

APPENDIX G

DECOMMISSIONING FUNDING PLAN

G.1 Introduction

As discussed in License Renewal Application Section 1.4, pursuant to 10 CFR 72.30(b), PG&E submitted its most recent decommissioning funding plan for the HB ISFSI on December 17, 2015 (ADAMS Accession No. ML15351A510).

10 CFR 72.30(c) requires each holder of a license under Part 72 to resubmit the decommissioning funding plan at the time of license renewal and at intervals not to exceed three (3) years with adjustments as necessary to account for changes in costs and the extent of contamination. In accordance with 10 CFR 72.30 (c), this appendix provides PG&E's update to the HB ISFSI decommissioning funding plan at the time of license renewal.

G.2 PG&E's Response to the Four Events in 10 CFR 72.30(c)

The four events in 10 CFR 72.30(c) are identified below, as well as PG&E's response to each event.

The decommissioning funding plan must specifically consider the effect of the following events on decommissioning costs:

(1) *Spills of radioactive material producing additional residual radioactivity in onsite subsurface material.*

PG&E Response: There have not been any spills of radioactive material in the HB ISFSI area that is surrounded by the ISFSI security boundary fence. In addition, spills of radioactive material in the HB ISFSI area are not expected to occur because radioactive material that could spill will not be brought into the ISFSI area. (NOTE: The explosive detector sources containing radioactive material have been replaced with non-radioactive explosive detectors inside the ISFSI area..) Furthermore, the all-welded construction of the MPCs in conjunction with the extensive inspections and testing performed during closing operations ensures that no release of radioactive effluents will occur.

The HB ISFSI FSAR Update, Section 7.3.1, states that there are no radioactive systems at the ISFSI other than the GTCC cask and overpacks containing MPCs. FSAR Update, Section 7.3.1 further states, "The fuel is stored dry inside the MPC so that no radioactive liquid is available for leakage."

In the NRC Safety Evaluation Report (SER) dated November 2005, Section 13.1.2.1, the NRC concurred with PG&E's assessment that the Humboldt Bay ISFSI design will "minimize contamination and facilitate decommissioning." The SER states, "The confinement design of the MPCs…and the passive design of the storage system, minimize the potential for radioactive contamination to occur and to spread."

(2) *Facility modifications.*

PG&E Response: There have been no modifications to the HB ISFSI vault design that could impact decommissioning costs, and no modifications are expected in the future. See response to item (3) below for more details.

(3) *Changes in authorized possession limits.*

PG&E Response: The HB ISFSI vault design consists of five storage casks containing spent fuel, and one storage cask containing GTCC waste. The five spent fuel casks have been loaded into the ISFSI vault with spent fuel from the HBPP Unit 3 (HBPP3).

HBPP3 is currently being decommissioned and no more spent fuel will be generated. The GTCC waste cask has been loaded into the ISFSI vault with GTCC waste that was generated in the operation of HBPP3. There will be no additional spent fuel casks nor GTCC waste casks placed in the Humboldt Bay ISFSI beyond that of the original design.

(4) *Actual remediation costs that exceed the previous cost estimate.*

PG&E Response: PG&E will not begin to decommission the HB ISFSI until after the U.S. DOE takes possession of the spent fuel and GTCC waste. Currently, this is estimated to begin in 2028. Therefore, there have been no actual remediation costs that exceed previous cost estimates.

The CPUC requires PG&E to update the ISFSI decommissioning cost estimate every three years. If a revised cost estimate exceeds a previous cost estimate, PG&E will submit a request to the CPUC requesting approval of increased funding based on a justifiable reason. In the NRC Safety Evaluation Report dated November 2005, Section 13.1.1.2, the NRC concludes "…that the CPUC will likely approve justifiable requests for additional rate recovery as necessary to fully fund the decommissioning trust for circumstances that could not be foreseen or reasonably avoided by PG&E."

G.3 10 CFR 72.30 Humboldt Bay Independent Spent Fuel Storage Installation Decommissioning Cost Estimate

1. Background and Introduction

The NRC issued its final rule on Decommissioning Planning on June 17, 2011,[1] with the rule becoming effective on December 17, 2012. Subpart 72.30, "Financial assurance and recordkeeping for decommissioning," requires that each holder of, or applicant for, a license under this part must submit for NRC review and approval a decommissioning funding plan that contains information on how reasonable assurance will be provided that funds will be available to decommission the ISFSI.

In accordance with the rule, a detailed cost estimate for decommissioning the ISFSI at HBPP3 is provided in an amount reflecting:

1. the work is performed by an independent contractor;
2. an adequate contingency factor; and
3. release of the facility and dry storage systems for unrestricted use, as specified in 10 CFR Part 20.1402.

This document also provides:

[1] U.S. Code of Federal Regulations, Title 10, Parts 20, 30, 40, 50, 70 and 72 "Decommissioning Planning," Nuclear Regulatory Commission, Federal Register Volume 76, Number 117 (p 35512 et seq.), June 17, 2011

1. identification of the key assumptions contained in the cost estimate; and
2. the volume of onsite subsurface material containing residual radioactivity, if any, that will require remediation to meet the criteria for license termination.

2. Spent Fuel Management Strategy

HBPP3 shut down on July 2, 1976, and is currently in a decommissioning status. All of the spent fuel generated during operations, 390 spent fuel assemblies, are currently in storage in the on-site ISFSI. The ISFSI is operated under a Part 72 Site Specific License.

Completion of the ISFSI decommissioning process is dependent upon the DOE's ability to remove spent fuel and GTCC waste from the site. DOE's repository program assumes that spent fuel allocations will be accepted for disposal from the nation's commercial nuclear plants, with limited exceptions, in the order (the "queue") in which it was discharged from the reactor.[2] PG&E's current spent fuel management plan for the HBPP3 spent fuel is based in general upon: 1) a 2028 start date for DOE initiating transfer of commercial spent fuel to a federal facility, and 2) completion of spent fuel receipt by year 2029.

3. ISFSI Decommissioning Strategy

At the conclusion of the spent fuel and GTCC transfer process to an offsite federal repository, the ISFSI will be promptly decommissioned (similar to the power reactor DECON alternative) after surveying for any unexpected residual radioactivity, by removing and disposing of any residual radioactivity and verifying that remaining materials satisfy NRC release criteria.

For purposes of providing an estimate for a funding plan, financial assurance is expected to be provided on the basis of a prompt ISFSI decommissioning scenario. In this estimate the ISFSI decommissioning is considered an independent project, regardless of the decommissioning alternative identified for the nuclear power plant.

4. ISFSI Description

The HB ISFSI is a unique design. Spent fuel is stored in the Holtec International (Holtec) HI-STAR HB system, located inside an underground steel-lined concrete vault. The HI-STAR HB system is comprised of an all-welded multi-purpose canister (MPC-HB) designed to store up to 80 HBPP fuel assemblies inside a bolted-lid steel overpack. The HI-STAR HB system is a shortened version of the HI-STAR 100 System. The system is designed such that both the MPC and steel overpack are expected to be transferred to the DOE at the time of spent fuel transfer. As a result there are not expected to be any remaining HI-STAR overpacks at the time of decommissioning.

PG&E's spent fuel management project for the HBPP3 spent fuel has resulted in 390 spent fuel assemblies being placed in five HI-STAR HB storage casks.

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2 U.S. Code of Federal Regulations, Title 10, Part 961.11, Article IV – Responsibilities of the Parties, B. DOE Responsibilities, 5.(a) … DOE shall issue an annual acceptance priority ranking for receipt of SNF and/or HLW at the DOE repository. This priority ranking shall be based on the age of SNF and/or HLW as calculated from the date of discharge of such materials from the civilian nuclear power reactor. The oldest fuel or waste will have the highest priority for acceptance, except as …"

In addition to the spent fuel casks located in the ISFSI vault after shutdown there is one additional cask used for GTCC waste storage. The storage overpack used for this GTCC waste canister is expected to be transferred to the DOE at the time of GTCC waste and spent fuel transfer.

The cask storage vault is comprised of six below-grade, cylindrical storage cells that are structural units constructed of steel-reinforced concrete with a carbon steel liner. Each storage cell is approximately 9 feet in diameter by 11 feet, 7 inches deep. The vault bottom is 3 feet thick reinforced concrete. There is an approximate 7 feet thickness of concrete on each end of the vault and 5-1/2 feet on the longitudinal sides of the vault. The concrete wall thickness varies around the circumference of the storage cells and has a minimum thickness of approximately 1 foot - 9 inches of concrete between adjacent cells. Each of the storage cells accommodates one cask (either a loaded HI-STAR HB overpack or the GTCC cask). The top of the vault elevation (without the storage cell lids installed) is approximately flush with grade. The lids are approximately 16-1/4 inches high, not including the height of the lid bolt caps.

The remaining vault structure is not expected to contain residual radioactivity.

Table 1 provides the significant quantities and physical dimensions used as the basis in developing the ISFSI decommissioning estimate.

5. Key Assumptions / Estimating Approach

The decommissioning estimate is based on the configuration of the ISFSI expected after all spent fuel, GTCC waste and storage overpacks have been removed from the site, and the assumptions associated with DOE's spent fuel acceptance, as previously described.

Since HBPP3 is not operating, and all spent fuel is currently in storage, the current configuration of the ISFSI vault is the expected configuration at the time of decommissioning. The nominal vault dimensions (concrete poured areas) are approximately 20 feet in width, and 77 feet in length.

The decommissioning estimate is based on the premise the steel overpack will be transferred to the DOE along with the spent fuel and GTCC waste.

It is not expected that the remaining storage cell surfaces will have any interior radioactive surface contamination. This assumption would be confirmed as a result of good radiological practice of surveying potentially impacted areas after each spent fuel transfer campaign. Any neutron activation of the steel and concrete is expected to be extremely small. To validate this assumption, the estimate accounts for the characterization of two of the storage cells; it is likely that some of this characterization will take place before the last of the fuel is removed from the ISFSI in order to establish a more definitive decommissioning scope.

It is not expected that there will be any residual contamination left on any exterior surfaces of the concrete vault. It is expected that this assumption would be confirmed as a result of good radiological practice of surveying potentially impacted areas after each spent fuel and GTCC waste transfer campaign. Therefore, it is assumed for this analysis that the ISFSI vault will not be contaminated.

Based on radiological data from ISFSI construction and HBPP decommissioning surveys, there is no known subsurface material in the proximity of the ISFSI area containing residual radioactivity that will require remediation to meet the criteria for License Termination.

To support an application for License Termination, the estimate assumes that a Final Status Survey will be performed, analyzed, and submitted to the NRC in accordance with NRC regulation requirements. This will likely include a 20 percent survey of the concrete storage cell and lid surfaces, and a fraction of the immediate area surrounding the vault.

For the purposes of meeting 10 CFR 20.1402 requirements, only the costs of characterizations and surveys are included in the decommissioning cost estimates because of the expected absence of radioactive material and need for remediation.

Decommissioning is assumed to be performed by an independent contractor. As such, essentially all contractor labor, equipment, and material costs are based on national averages, i.e., costs from national publications such as R.S. Means' Building Construction Cost Data (adjusted for regional variations), and laboratory service costs are based on vendor price lists. Those craft labor positions that are expected to be provided locally, are consistent with fully burdened contractor labor rates used in the most recently developed HBPP decommissioning cost estimate, escalated to 2017 dollars. These craft labor rates are assumed to be representative of contractor rates charged in the HB geographical area. PG&E, as licensee, will oversee the site activities; the estimate includes PG&E's labor and overhead costs.

Costs are reported in 2017 dollars.

Contingency has been added at an overall rate of 25 percent. This is consistent with the contingency evaluation criteria referenced by the NRC in NUREG-1757.[3]

The estimate is limited to costs necessary to terminate the ISFSI's NRC license and meet the §20.1402 criteria for unrestricted use. Disposition of released non-contaminated material and structures is outside the scope of the estimate.

6. Cost Estimate

The estimated cost to decommission the ISFSI and release the facility for unrestricted use is provided in Table 2. The cost has been organized into three phases, including:

- An initial planning phase – Empty storage cells are characterized.
- The remediation phase – There is no expected remediation therefore the estimate does not include any costs during this phase.
- The final phase – License termination surveys, independent surveys are completed, and an application for license termination submitted.

[3] "Consolidated Decommissioning Guidance, Financial Assurance, Recordkeeping, and Timeliness," U.S. Nuclear Regulatory Commission's Office of Nuclear Material Safety and Safeguards, NUREG-1757, Volume 3, Revision 1, February 2012

In addition to the direct costs associated with a contractor providing the decommissioning services, the estimate also contains costs for the NRC (and NRC contractor), PG&E's oversight staff, site security (industrial), and other site operating costs.

For estimating purposes it should be conservatively assumed that all expenditures will be incurred in the year 2030, the year following all spent fuel removal.

Table 1
Significant Quantities and Physical Dimensions

ISFSI Vault

Item	Length (ft)	Width (ft)	Residual Radioactivity
ISFSI Vault	77	20	No

ISFSI Storage Cell

Item	Value	Notes (all dimensions are nominal)
Overall Height (inches)	160	From base of cell to the top of the lid
Diameter (inches)	107	Inner diameter of storage cell
Lid Diameter (inches)	120	
Lid Thickness (inches)	16	
Quantity (total)	6	Spent Fuel (5) GTCC (1)
Quantity (with residual radioactivity)	0	
Surface Area of an Individual Storage Cell and Lid (square feet)	570	

Table 2
ISFSI Decommissioning Costs[1] and Waste Volumes

	(thousands, 2017 dollars)						Waste Volume	Person-Hours		
	Removal	Packaging	Transport	Disposal	Other	Total	(ft3)	Contractor	Licensee	NRC / NRC Contractor
Decommissioning Contractor										
Planning (characterization, specs and procedures)	-	-	-	-	80.6	80.6	-	312	-	-
Remediation (no expected remediation)	-	-	-	-	-	-	-	-	-	-
License Termination (radiological surveys)	-	-	-	-	474.9	474.9	-	3,098	-	-
Subtotal	-	-	-	-	555.5	555.5	-	3,410	-	-
Supporting Costs										
NRC and NRC Contractor Fees and Costs	-	-	-	-	124.3	124.3		-	-	536
Insurance	-	-	-	-	26.6	26.6		-	-	-
Security (industrial)	-	-	-	-	69.6	69.6		1,881	-	-
PG&E Oversight Staff	-	-	-	-	186.9	186.9		-	1,881	-
Subtotal	-	-	-	-	407.4	407.4	-	1,881	1,881	536
Total (w/o contingency)	-	-	-	-	962.9	962.9	-	5,291	1,881	536
Total (w/25% contingency)						1,203.6				

Note 1: For funding planning purposes decommissioning costs can be assumed to be incurred in year 2030
Note 2: Columns may not add due to rounding