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10 CFR 72

September 18, 2014

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Director, Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards
Washington, DC 20555

Calvert Cliffs Nuclear Power Plant
Independent Spent Fuel Storage Installation, License No. SNM-2505
NRC Docket No. 72-8

Subject: Response to Fourth Request for Additional Information for Renewal Application to Special Nuclear Materials License No. 2505 for the Calvert Cliffs Site Specific Independent Spent Fuel Storage Installation (TAC No. L24475)

References:
1. Letter from G. H. Gellrich (CCNPP) to Document Control Desk (NRC), dated September 17, 2010, Site-Specific Independent Spent Fuel Storage Installation (ISFSI) License Renewal Application
2. Letter from J. Goshen (NMSS) to G. H. Gellrich, (Exelon), dated June 23, 2014, Fourth Request for Additional Information for Renewal Application to Special Nuclear Materials License No. 2505 for the Calvert Cliffs Site Specific Independent Spent Fuel Storage Installation (TAC No. L24475)
3. Letter from G. H. Gellrich (CCNPP) to Document Control Desk (NRC), dated June 28, 2011, Responses to Request for Additional Information, RE: Calvert Cliffs Independent Spent Fuel Storage Installation License Renewal Application

In Reference 1, Calvert Cliffs Nuclear Power Plant, LLC, submitted a license renewal application to the U.S. Nuclear Regulatory Commission (NRC) for the Calvert Cliffs site-specific independent spent fuel storage installation. In Reference 2, the NRC transmitted a request for additional information to Exelon Generation Company, LLC (EGC) to support the NRC's review of the license renewal application.

Attachment (1) contains EGC's responses to the request for additional information. Attachment (2) contains revised aging management programs (AMP) for the Independent Spent Fuel Storage Installation components. These revised AMPs supersede the AMPs presented in Appendix A of Reference 1. These revised AMPs incorporate the proposed responses EGC

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presented at the July 17, 2014 meeting with the NRC. Attachment (3) contains the revised aging management review result tables which supersede the aging management review result tables contained in Attachment (1) of Reference 1 and in Reference 3.

Attachment (4) contains a revised listing of associated Independent Spent Fuel Storage Installation Updated Safety Analysis Report changes that will supersede Appendix C of Reference 1.

A 120 day implementation time is requested to allow for implementation of the supporting procedure.

This letter contains regulatory commitments as listed in Attachment (5).

Should you have questions regarding this matter, please contact Mr. Douglas E. Lauver at (410) 495-5219.

I declare under penalty of perjury that the foregoing is true and correct. Executed on September 18, 2014.

Respectfully,

George H. Gellrich
Site Vice President

GHG/KLG/bjd

Attachments: (1) License Renewal Request - Fourth Request for Additional Information
(2) Revised Aging Management Programs
(3) Revised Aging Management Review Result Tables
(4) ISFSI Updated Safety Analysis Report Supplement and Changes
(5) Regulatory Commitments

cc: NRC Project Manager, Calvert Cliffs
NRC Regional Administrator, Region I
NRC Resident Inspector, Calvert Cliffs
S. Gray, MD-DNR
J. M. Goshen, NMSS

ATTACHMENT (1)

LICENSE RENEWAL REQUEST - FOURTH REQUEST FOR ADDITIONAL INFORMATION

By letter dated September 17. 2010. as supplemented February 10, March 9, and June 28, 2011; July 27, 2012; and April 24 and June 14, 2013. Calvert Cliffs Nuclear Power Plant (CCNPP), LLC, submitted a license renewal application to the U.S. Nuclear Regulatory Commission (NRC) for the CCNPP site-specific independent spent fuel storage installation. The NRC staff (staff) has reviewed the April 24 and June 14, 2013, request for additional information (RAI) responses and have determined that additional information is required to complete its detailed technical review.

REQUEST FOR ADDITIONAL INFORMATION (RAI)

NUREG 1927. Appendix E: Component Specific Aging Management

RAI-1: *Confinement Integrity*

Revise the evaluation that demonstrates dry storage canisters (DSCs) in the horizontal storage modules (HSMs) at the Calvert Cliffs Nuclear Power Plant (CCNPP) Independent Spent Fuel Storage Installation (ISFSI) will maintain design basis confinement integrity and include (1) relevant information on the minimum chi ride for stress corrosion cracking (SCC), (2) an assessment of the time to develop the minimum chloride concentration for SCC based on results of the surface chloride concentration measurements conducted in 2012, and (3) activation energy for chloride-induced stress corrosion cracking (CISCC) propagation rates.

By letter dated June 14, 2013, (ADAMS Accession No. ML13170A574) in response to the RAI E-1, CCNPP provided a response to the RAI on confinement integrity that addressed the time necessary for CISCC initiation and through wall propagation of the DSCs. The consequences of CISCC during the license renewal period did not consider how CISCC would be addressed in detailed evaluations, including the dose assessments discussed in the "Maintain Doses within 10 CFR 72.104 and 72.106 Requirements" section. In addition, this response used inaccurate information on the critical chloride for SCC initiation, it did not consider the measured chloride concentration on the canisters from the June 2012 collected sample measurements, and it did not consider the effect of temperature on SCC propagation rates.

The critical chloride concentration cited in the June 14, 2013, submittal was 100 mg/m^2 based on NRC sponsored research that has now been published in NUREG/CR-7170 (ADAMS Accession No. ML14051A417). In that study, CISCC was observed on test specimens with deposited simulated sea salt concentrations of 100 mg/m^2. However, NUREG/CR-7170 clearly indicates that concentrations of 100 mg/m^2 were the lowest deposited salt concentrations tested. The relatively short time for the initiation of CISCC for type 304 stainless steel at surface concentrations of 100 mg/m^2 reported in NUREG/CR-7170 suggests that SCC could occur at lower surface concentrations. Because no tests were performed at concentrations less than 100 mg/m^2 where CISCC was not observed, the critical chloride concentration for sec was not established in the NUREG/CR-7170.

Measurements of the critical surface concentration for CISCC have been examined and reported by Tokiwai et al. (1985). This study showed that CISCC of sensitized 304 stainless steel was observed with surface chloride concentrations of 8 mg/m^2.

As indicated in Attachment 2 of the April 24, 2013, submittal the measured surface chloride concentration from x-ray fluorescence of the SaltSmart collection sample was determined to be 5.2 mg/m^2 obtained on DSC 11 after 19 years of storage. The average accumulation rate for *this canister is 0.27 mg/m²/yr. In order to reach the minimum chloride concentration reported by Tokiwai et al. (1985), a total exposure time of just over 29 years would be required assuming an average rate of 0.27 mg/m²/yr.*

The analysis in the response to RAI E-1 assumes that once the environmental conditions for CISCC are reached, a properly oriented crack will initiate and propagate at a constant rate of 9.6 x 10^{-12} m/s without the crack arresting. The constant crack growth rate is based on the mean of CISCC propagation rates in Figure 6 of Kosaki (2008) which were obtained in natural exposure tests of type 304 base metals and welds, type 304L welds and type 316LN welds. The natural exposure conditions used by Kosaki (2008) took place on Miyakojima Island which is located about 250 km east of Taiwan with an average temperature of 23°C. Typical minimum and maximum temperatures on Miyakojima Island range from 14°C to 31°C, respectively.

The CISCC rates measured by Kosaki (2008) on Miyakojima Island at ambient temperatures are comparable to atmospheric CISCC rates determined from operational experience at both domestic and foreign nuclear power plants including events at San Onofre, Turkey Point, St. Lucie, and Koeberg (South Africa) (NRC, 2012). Rates from these events back calculated from time of initial operation to time of detected failure for the thickness of the component range from 3.6 x 10^{-12} m/s to 2.9 x 10^{-11} m/s. However, all of these instances involve components that are exposed at near ambient temperatures.

CISCC propagation rates are known to be strongly temperature dependent. Testing by Hayashibara et al. (2008) reported activation energy for crack growth in type 304 stainless steel of 5.6 to 9.4 kcal/mol (23 to 39 kJ/mol) based on testing conducted at temperatures of 50 to 80°C. Taking the median crack propagation rate reported by Kosaki (2008) of 9.6 x 10^{-12} m/s and assuming that rate was measured under exposure temperatures typical of Miyakojima Island (average temperature of 23°C) and the median activation energy of 31 kJ/mol reported by Hayashibara et al. (2008), the SCC propagation rate increases by 2x at 40°C, 3x at 51°C, and 4x at 60°C. Because the temperature of the canisters will initially be at temperatures well above ambient, the effect of temperature on crack propagation rates must be included in the assessment of the time necessary for through wall cracking.

This information is required to evaluate compliance with 10 CFR 72.24 (d) and 10 CFR 72.122 (b)(1) and (h)(5).

CCNPP Response RAI-1:

Calvert Cliffs does not plan on revising the calculations included in Enclosures 3 and 4 of the June 14, 2013 RAI Response (Reference 16) that respectively address the times to initiate CISCC and propagate an SCC crack through wall (References 17 and 18). The purpose of those calculations was to address the October 31, 2012 request (Reference 19) in RAI E-1 for an evaluation that demonstrates that the loaded dry shielded canisters (DSCs) in horizontal storage modules (HSMs) at the CCNPP ISFSI currently maintain design-basis confinement integrity. The additional information cited by the NRC still supports that conclusion.

As indicated in the current RAI-1, use of a surface chloride concentration of 8 mg/m² as the CISCC initiation threshold value still yields an initiation time greater than the initial 20 year license time given the 5.2 mg/m² chloride concentration measured on DSC-11 in HSM-1 after 19 years of storage. The NRC's cited threshold appears to be taken from Figure 8 of Reference 14 and represents the lowest possible value at 70-75% relative humidity (RH) over a wide range of RH for a weld residual tensile stress of 25 kg/mm^2. The Figure 8 values at that residual stress are taken from Figure 7 of that same Reference. However, the weld residual stress calculations supplied by Calvert Cliffs on June 14, 2013 in Reference 18 (Figures 3-7 and 3-14) indicate that the maximum residual tensile stress for Calvert Cliffs NUHOMS-24P and NUHOMS-32P DSCs at the shell weld OD is 30 ksi (21 kg/mm^2). Using this residual tensile stress, Figure 7 of Reference 14 would suggest threshold values of 170 mg/m^2 at 60-63% RH, 16 mg/m^2 at 70-75% RH, and 50 mg/m^2 at 95-98% RH. Correcting this input alone doubles the NRC estimated initiation time to 58 years. Longer times could likely be estimated by considering the amount of time the surface RH stays within the range of the minimum threshold value for a particular DSC based on information provided in Figures 2-2 (a), (b), (c) and (d) of Reference 17. This initiation time when combined with either the estimates of CISCC crack penetration times of Reference 18, or those proposed by the NRC, still supports the conclusion that penetration of the DSC by CISCC during the period of extended operation is a low probability event.

Aside from the above discussion on the likelihood of penetration of the DSC by CISCC, the References 17 and 18 calculations are also not being revised because Calvert Cliffs is adopting a Learning Aging Management Program (Learning AMP) approach to CISCC for the DSC. While the assessment of chloride concentration on the surface of the DSC will still have a role to play, it will initially be only one of several data points that can trigger toll gates that affect the types of aging management actions that will be performed and/or the frequency of those actions. Collection of data on atmospheric chloride concentrations will no longer be considered as part of this AMP given that surface chloride concentrations will be measured, and the large number of data points that would be required to construct a correlation between atmospheric and surface concentration with a reasonable amount of uncertainty. This AMP will be discussed in additional detail in the response to RAI 2.

Similarly, Calvert Cliffs does not believe that additional dose calculations are required. Existing accident dose calculations (USAR Section 12.8.2.8 and the update for License Renewal provided in Reference 20) treat release from confinement failure as a bounding instantaneous puff release (e.g., no release rate is input). The size of the opening only has an impact on the Reference 20 calculation (see Section 3.3), which assumed a 1 mm^2 opening for the purpose of determining DSC-to-environment release fractions for volatiles and fuel fines. As discussed in Assumption 5 of Reference 20, this size opening was considered to be "consistent with a pit or crack type penetration which might be associated with the unmitigated effects of aging." The doses from this accident case would bound any actual CISCC failure, and were shown to be below the 10 CFR 72.106 accident dose limits. Treating a CISCC induced penetration of the confinement boundary as a normal or off-normal event and comparing against 10 CFR 72.104 dose limits did not seem appropriate given that a penetration of the confinement boundary is defined in the ISFSI USAR as an accident, and the Calvert Cliffs Emergency Plan would require declaration of an Unusual Event upon such an occurrence (see Reference 21 and 22). However, if it is conservatively assumed that a CISCC induced penetration of an otherwise normal DSC occurs at a frequency of once per calendar year, the dose can be estimated from information already in Reference 20 by dividing the off-normal doses in Table 2-1 by the off-normal percent gas release in Table 3-7 (converts to puff release), and dividing by a factor of 10 to account for the difference in fuel failure present in the DSC between normal and off-normal conditions [1% vs. 10% per NUREG-1567 p. 9-11 (Reference 23)]. Performing these operations produces site boundary doses which are all within the 10 CFR 72.104 dose limits.

RAI-2: *Provide a revised aging management plan (AMP) that considers the potential for CISCC at the CCNPP ISFSI.*

Revise the AMP that considers the potential for CISCC at the CCNPP ISFSI to (1) consider the timing of inspections based on corrected minimum chloride concentration for SCC initiation, (2) frequency of inspections considering the effect of temperature on CISCC propagation rates and (3) include all necessary sections of an AMP including specific information methods used for the detection of aging effects, monitoring and trending, acceptance criteria, corrective actions, confirmation process, and administrative controls.

The AMP provided in Jun 14, 2013, response to RAI E-2 indicates that inspections would be conducted once measured surface concentrations reach 100 mg/m^2. Based on NRC sponsored testing documented in NUREG/CR-7170 and information available in the literature (Tokiwai et al., 1985) the critical chloride concentration for SCC is below 100 mg/m^2 even for 300 series stainless steel base materials and may be closer to 8 mg/m^2 for sensitized 300 series stainless steels. The frequency of inspections does not consider the effects of temperature on the expected CISCC propagation rates which may be 3x faster at 51°C assuming an activation energy of 31 kJ/mol reported by Hayashibara et al. (2008), compared to the rate reported by Kosaki (2008).

The June 14, 2013, response to RAI E-2 does not include information on the requested AMP and is not organized in a manner that allows the required components of the AMP to be reviewed. Specifically the inspection methods do not identify requirements for the detection of aging effects such as localized corrosion of CISCC. The RAI response indicates that visual inspection will be performed "in a manner of equal or better quality to that performed in June 2012." The requirements for inspections must consider the degradation process to be detected. Reference to the standardized criteria for visual testing (VT) (e.g. VT-1, EVT-1, VT-3) may be appropriate. Acceptance criteria for visual examination should be included in the AMP. In addition, information on the AMP elements including monitoring and trending, confirmation process, and administrative controls are necessary and were not provided in the response to RAI E-2.

Because visual testing cannot be used to determine the depth of localized corrosion or cracking, volumetric examination methods are necessary to quantify the extent of damage if visual examination indicates the presence of corrosion on the canister surfaces. Volumetric examination methods should be considered for crevice locations such as between the support rail and the canister where the concentration of chlorides may occur and temperatures as a result of heat transfer may be low enough to allow deliquescence of deposited salts. Acceptance criteria, monitoring and trending, confirmation process, and administrative controls for volumetric examination methods are also necessary.

This information is required to evaluate compliance with 10 CFR 72.122 (f) and (h)(4), 10 CFR 72.162 and 10 CFR 72.172.

CCNPP Response RAI-2:

The DSC External Surface Aging Management Program has been revised and is contained in section A1.3 of Attachment 2. The revised AMP structure is consistent with the ten program elements described in NUREG-1927 (Reference 24). The revised AMP also includes a discussion on the visual standard to be used as part of this AMP.

RAI-3: *Transfer Cask Lifting Yoke AMP*

Revise the Transfer Cask Lifting Yoke AMP of the CCNPP ISFSI license renewal application Appendix A, Section A2.3 (ADAMS Accession No. ML102650247) and include (1) standards and acceptance criteria for visual examination methods; and (2) details of magnetic particle testing (MT) as described in response to RAI A-2 in Attachment 1 dated June 28, 2011 (ADAMS Accession No. ML11180A270) including appropriate standards and acceptance criteria.

The Application for Renewal of the Specific License for the CCNPP ISFSI Appendix A (ADAMS Accession No. ML102650247) contains the AMPs for the structures systems and components (SSC) that are important to safety. The AMP for the transfer cask lifting yoke is provided in Section 3.6 and Appendix A Section 2.3 of the application (ADAMS Accession No. ML102650247). The application identifies only visual inspection for evidence of degradation on external surfaces. The requisite standard for the visual inspection is not described. In addition, the acceptance criteria stated, "no unacceptable loss of material that could result in a loss of component intended function(s)," is ambiguous.

Further, the response to RAI A-2 in Attachment 1 dated June 28, 2011 (ADAMS Accession No. ML11180A270), indicates that magnetic particle testing (MT) of the transfer cask lifting yoke will be conducted. The description of the transfer cask lifting yoke MT should be included in the license renewal application AMP along with specific information on the requirements and standards for the MT, acceptance criteria, corrective actions if acceptance criteria are exceeded, how monitoring and trending of the MT results will be conducted.

This information is required to evaluate compliance with 10 CFR 72.122 (f) and (h)(4), 10 CFR 72.162 and 10 CFR 72.172.

CCNPP Response RAI-3:

The Transfer Cask Lifting Yoke Aging Management Program has been revised and is located in Section A1.6 of Attachment (2) to include (a) standards and acceptance criteria for visual examination methods; and (b) details of magnetic particle testing (MT).

Please note that the Section numbering in the AMP has been reformatted to include additional detail IAW NUREG-1927.

RAI-4: *Transfer Cask AMP*

Revise the transfer cask AMP of the CCNPP ISFSI license renewal application Appendix A, Section A2.2 (ADAMS Accession No. ML102650247) and include (1) standards and acceptance criteria for visual examination methods; (2) details of penetrant testing (PT) of the transfer cask trunnions as described in response to RAI A-2 in Attachment 1 dated June 28, 2011 (ADAMS Accession No. ML11180A270) including appropriate standards and acceptance criteria.

The Application for Renewal of the Specific License for the CCNPP ISFSI Appendix A (ADAMS Accession No. ML102650247) contains the AMPs for the SSC that are important to safety. The AMP for the transfer cask is provided in Section 3.5 and Appendix A Section 2.2 of the application (ADAMS Accession No. ML102650247). The application identifies only visual inspection for evidence of degradation on external surfaces. The standard for the visual inspection and how monitoring and trending will be performed is not described. In addition, the *acceptance criteria for the visual inspection in Section A2.2 states, "no unacceptable loss of material that could result in a loss of component intended function(s)," is ambiguous.*

Further, the response to RAI A-2 in Attachment 1 dated June 28, 2011 (ADAMS Accession No. ML11180A270), indicates that penetrant testing (PT) of the transfer cask trunnions will be conducted. The description of the transfer cask trunnion PT should be included in the license renewal application along with specific information on the requirements and standards for the PT, acceptance criteria, and corrective actions if acceptance criteria are exceeded.

This information is needed to determine compliance with 10 CFR 72.42, 72.122(b)(1) and (f), 72.162 and 72.172.

CCNPP Response RAI-4:

The Transfer Cask Aging Management Program has been revised and is located in Section A1.5 of Attachment (2). The revised Transfer Cask Aging Management Program includes (a) standards and acceptance criteria for visual examination methods and (b) details of magnetic particle testing (MT) and details of liquid penetrant testing (PT).

Please note that the Section numbering in the AMP has been reformatted to include additional detail IAW NUREG-1927.

RAI-5:

Revise Section A.2.1 (Reference 1), "HSM Aging Management Program," to manage, at a minimum, the following aging effects/mechanisms, ensuring consistency with ACI 349.3R, "Evaluation of Existing Nuclear Safety-Related Concrete Structures." Address these aging effects/mechanisms for both above-grade (accessible and inaccessible) and below-grade (underground inaccessible areas), or provide detailed justifications for any specific exclusion from the Aging Management Review.

- *Cracking or loss of material (spalling, scaling) due to freeze-thaw degradation*
- *Cracking or loss of material (spalling, scaling) due to chemical attack*
- *Cracking and loss of strength due to cement aggregate reactions*
- *Cracking, loss of material, and loss of bond due to corrosion of embedded steel*
- *Increase in porosity/permeability and loss of strength due to leaching of $Ca(OH)_2$*
- *Cracking due to settlement*

Table 3.4-1, "Aging Management Review Results for the HSM," does not properly identify the applicable aging effects and mechanisms for the concrete components of the horizontal storage module (HSM). More specifically, the table lists "Freeze-Thaw" and "Change in Material Properties" as aging effects. The first term is not an aging effect, but an aging mechanism. The second term "Change in Materials Properties" is also not properly defined, so the adequacy of the AMP cannot be verified. The licensee has stated that ACI 201.1 Rand 349.3R will be used for qualification of inspectors, inspection methods, and acceptance criteria (Response to RAI O-7, Reference 2). Therefore, a complete HSM AMP should address the listed aging effects and mechanisms (all defined in ACI 349.3R). Any exclusion should be justified with a site-specific technical basis (e.g., engineering analysis, operational experience data), which *demonstrates that these aging mechanisms will not adversely affect the ability of the HSM to perform its intended important-to-safety (ITS) functions during the license period of extended operation. If the licensee intends on relying on the degradation of accessible areas as a precursor for degradation in below-grade areas, the justification should demonstrate that such an approach will be sufficient to prevent a loss of ITS function. Note that per ACI 349.3R, testing activities may be used to quantify the environment to which the below-grade or inaccessible structure is exposed. These tests could include a program for analysis of soils and groundwater chemistry, as well as an evaluation of their propensity to cause concrete degradation or steel reinforcement corrosion. Similar guidance and acceptance criteria are provided in ASME Code Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components."*

This information is needed to determine compliance with 10 CFR 72.42, 72.122(b)(1) and (f), 72.162 and 10 CFR 72.172.

CCNPP Response RAI-5:

The HSM Aging Management Program has been revised and is contained in Section A1.4 of Attachment (2). The HSM AMP has been changed to address the aging effects/mechanisms for both above grade and below grade concrete structures.

RAI-6:

Define and justify the use of other codes, standards or quantitative guidelines for the acceptance criteria of stainless and carbon steel components in the HSM.

The "Acceptance Criteria" in Section A.2.1 (Reference 1), "HSM Aging Management Program," states that the inspection attributes and acceptance standards for steel and concrete will be "commensurate with industry codes, standards and guidelines." The licensee later stated that ACI 201.1 Rand 349.3R would be used for acceptance criteria of the concrete (Response to RAI O-7, Reference 2). However, the licensee did not define the industry codes, standards and quantitative guidelines to be used for acceptance criteria of the stainless and carbon steel components in the HSM.

This information is needed to determine compliance with 10 CFR 72.42, 72.122(b)(1) and (f), 72.162 and 72.172.

CCNPP Response RAI-6:

The revised HSM AMP contained in Section A1.4 of Attachment 2 references the section of the ISFSI Updated Safety Analysis Report that lists the code and standard that the HSM steel components were designed and constructed to meet. Should degradations in a steel component be noted, the condition would be entered into the site's CAP. In CAP, the condition would be evaluated against the code requirements by a qualified structural engineer. The resultant course of action could range from continue with existing monitoring activities, a change in the AMP frequency, initiation of new monitoring activities, or corrective action to address the aging mechanism.

RAI-7:

Revise the HSM Aging Management Program to include inspections of the interior (above-grade) and underground foundation (below-grade) at intervals consistent with ACI 349.3R, or provide detailed justifications for any deviations from this criteria.

Section A2.1 (Reference 1), "HSM Aging Management Program," states that exterior surfaces of the HSM will be inspected annually, yet interior surfaces are only inspected prior to cask loadings. The proposed inspection frequency for interior surfaces is inconsistent with ACI 349.3R and Calvert Cliffs' lead canister inspection findings (Reference 3). ACI 349.3R states that all safety-related structures should be visually inspected at intervals not to exceed 10 years. Specifically, Table 6.1 in ACI 349.3R, "Frequency of Inspection," states that above-grade (directly and indirectly exposed to a natural environment) and below-grade (underground) structures are to be inspected every five and 10 years, respectively. Reference 3 also identified secondary efflorescence and formation of $CaCO_3$ stalactites at the concrete ceilings of both HSM-15 and HSM-1. The issued condition report (CR-2012-006781) included an action to conduct internal inspections through the rear outlet vents every five years to track the size and appearance of the stalactites. Any deviation from inspection frequencies in ACI 349.3R should include a detailed justification. Note that a revised AMP should include sufficient detail about the 10 program elements, as detailed in NUREG 1927, "Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance." More specifically, sufficient detail should be provided about the adequacy of the system (e.g. fiber optic, camera) to be used for evaluating per acceptance criteria in ACI 349.3R.

This information is needed to determine compliance with 10 CFR 72.42, 72.122(b)(1) and (f), 72.162 and 72.172.

<u>CCNPP Response RAI-7</u>:

The HSM Aging Management Program has been revised and is contained in Section A1.4 of Attachment 2. The revised HSM AMP includes inspections of the interior (above-grade) and underground foundation (below-grade) at intervals consistent with ACI 349.3R-02. Please note that the Section numbering in the AMP has been reformatted to include additional detail IAW NUREG-1927.

RAI-8:

Revise Section A2.1 (Reference 1), "HSM Aging Management Program," to include a groundwater chemistry program. The program should provide results (chloride/sulfate composition, pH) representative of water in the near proximity to the HSM. Otherwise, provide an engineering justification for why it is not required for the management of the following aging effects/mechanisms:

- *Cracking or loss of material (spalling, scaling) due to chemical attack; and*
- *Cracking, loss of material, and loss of bond due to corrosion of embedded steel*

Section A2.1 (Reference 1), "HSM Aging Management Program," does not include a periodic water chemistry program as an aging management activity. Response to RAI 3-4 (Reference 4) provided results from a sample taken in May 2011 to justify not needing to manage below-grade aging effects due to chemical attack of the HSM concrete, or corrosion of the reinforcing steel. These results showed that chloride/sulfate concentrations did not exceed threshold *concentrations and groundwater pH was above the threshold limit for potential degradation (criteria established in IWL-2512, ASME Code Section XI). However, the staff is not convinced that data from one sample can provide reasonable assurance that an aggressive soil/ground water environment will ever be present during the 40 years of extended operation. As stated in ACI 349.3R, chemical attack may occur from exposure to aggressive groundwater, acidic rain/condensation, seawater/salt-spray, exposure to any acids, caustics or other aggressive chemicals (including pesticides for weed and rodent control). The groundwater chemistry program should be included as part of the HSM AMP and sufficient detail about the 10 AMP elements should be provided, as detailed in NUREG 1927, "Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance."*

This information is needed to determine compliance with 10 CFR 72.42, 72.122(b)(1) and (f), 72.162 and 72.172.

CCNPP Response RAI-8:

The HSM Aging Management Program has been revised and is contained in Section A1.4 of Attachment (2). The HSM AMP has been revised to include a groundwater chemistry program and to include sufficient detail about the 10 program elements, as detailed in NUREG-1927. The frequency selected is consistent with guidance contained in NUREG-1801 (Reference 25) and reflects the over 20 years that the ISFSI has been in operation without any signs of degradation indicative of a ground corrosive environment.

RAI-9:

Confirm if HSMs containing SISCO NS-3, or other neutron shielding material, in the cask structure exist while in storage. In addition, if such casks are or will be present, provide clarification regarding how they will be addressed as part of the AMR. Where applicable, provide a valid time-limited aging analysis (TLAA) addressing time-dependent degradation of the neutron shielding material used in the casks or an appropriate aging management program.

Although the LRA does not specify the addition of neutron shielding material within the storage casks (HSM), staff identified information alluding to the possible use of NS-3 neutron shielding material within the door of the HSM for some earlier casks. Table 4.1-1 in Reference 5, "Generic NUHOMS-24P Design Neutron Shielding," states that the HSM door uses 10.75" of concrete as the neutron shield material. However, a subscript reference in this table states: "This HSM door design is an improvement of the one originally presented in the initial submittal of the CCNPP ISFSI SAR." This statement implies that HSM modules might have been constructed and installed with the alternate Phase I design criterion stated in Reference 5, (i.e., 2" of NS-3 material instead of concrete). Reference 6 is cited as a primary reference for the Aging Management Review in Reference 1 (Section 3.1.6, "Documentation of Sources Used for the Aging Management Review"). Reference 7 also lists a condition report (IR-046-040), which references the Phase I design. The licensee is asked to confirm if there are any HSM modules using NS-3 as a neutron shield material, and to provide clarification regarding whether this will be addressed using the appropriate TLAA or AMP.

This information is required to determine compliance with 10 CFR 72.24(d) and (e), 10 CFR 72.104,10 CFR 72.106,10 CFR 72.120a), 10 CFR 72.124(a) and (b), 10 CFR 72.128(a).

CCNPP Response RAI-9:

There is no NS-3 in the HSMs at Calvert Cliffs. The earlier design referenced in Table 4.1-1 which contained NS-3 in the HSM door is that of the original generic Topical Report for the NUTECH Horizontal Modular Storage System for Irradiated Nuclear Fuel, NUH-002 Revision 1A. As can be seen in ISFSI USAR Appendix A, the information in Table 4.1-1 comes from an RAI response (question 7.0-6) during the initial licensing of the Calvert Cliffs ISFSI. The term "Phase I" used in IR3-046-040 refers to the northernmost set of 2x6 module arrays shown on Figure 1.2-1 of the ISFSI USAR, and was actually constructed at the same time as "Phase II". Phase I, II, and III modules are all of the same design.

RAI-10:

Regarding external ISFSI operating experience:

- *Clarify if any of the HSM systems presently in-service have experienced freeze-thaw degradation at the anchor bolts of the outlet vents. If so, provide details of any corrective action or aging management activity implemented as a result of this degradation.*
- *Revise Table 3.4-1 to remove subscript note 1: "Aging effects conservatively included to meet NRC position for 10 CFR Part 54 plant license renewal (ISG-3)."*
- *Revise the Operating Experience subsection of the HSM Aging Management Program with results from review of HSM interior inspections performed at other ISFSI sites.*

Section A2.1 (Reference 1), "HSM Aging Management Program," does not reference any operational experience from other ISFSIs using the HSM system. NRC Information Notice 2013-07 (Reference 8) notified licensees of issues related to freeze-thaw degradation and leaching of $Ca(OH)_2$ near the bolt hole blockouts on the HSM ceilings. The licensee is asked to clarify if similar cracking has been observed at Calvert Cliffs, and any corrective action or AMP implemented as a result. The footnote on Table 3.4-1 should also be removed since it is inconsistent with this external OE and the Calvert Cliffs lead canister inspection (Reference 3), which also identified leaching of $Ca(OH)_2$.

Response to RSI-1 (Reference 7) also states that, prior to the lead canister inspection in June 2012 the licensee would review the results of NUHOMS HSM interior aging management inspections performed by other utilities with designs similar to those used at Calvert Cliffs. The licensee is asked to provide the results and conclusions from such findings in the Operating Experience section of the HSM Aging Management Program.

This information is needed to determine compliance with 10 CFR 72.172, and 72.174.

CCNPP Response RAI-10:

- Clarify if any of the HSM systems presently in-service have experienced freeze-thaw degradation at the anchor bolts of the outlet vents. If so, provide details of any corrective action or aging management activity implemented as a result of this degradation.
  - The following has been added to HSM AMP section A1.4.5(4):

  "The in-service HSMs (#1 through #72) have embedment around the vent areas to which the vent screens are bolted. The new modular HSMs have structural mounting bolts attaching the outlet vent modules. To date there has been no "Freeze-Thaw" degradation on either the in-service or new HSMs."

- Revise Table 3.4-1 to remove subscript note 1: "Aging effects conservatively included to meet NRC position for 10 CFR Part 54 plant license renewal (ISG-3)."
  - Subscript note 1 has been removed from the table and the revised table is provided in Attachment (3).
- Revise the Operating Experience subsection of the HSM Aging Management Program with results from review of HSM interior inspections performed at other ISFSI sites.
  - Section A1.4.5(10) has been revised to include site and industry (Three Mile Island) OE.

RAI-11:

Regarding the CCNPP Corrective Action Program (CAP) and the HSM Aging Management Program:

- *Clarify the criteria applied to determine which inspection results will require either*
  i. an Action Request,
  ii. a modification to the existing AMP, and/or
  iii. official notification to the NRC.
- *Provide details on how the CAP will capture and evaluate operating experience (OE) from other ISFSIs using Horizontal Storage Modules. Clarify the CAP criteria applied to determine which external OE will require any of the action items listed above.*
- *Revise subsection "Monitoring and Trending" in Section A.2.1 (Reference 1), "HSM Aging Management Program," to include details on how the CAP will ensure proper monitoring and trending when an aging effect is identified but not corrected in a previous inspection.*

Section A.2.1, "HSM Aging Management Program" (Reference 1) provides generalized three-tier acceptance criteria, namely (1) acceptable, (2) acceptable with defects, and (3) acceptable without defects. Similarly, ACI 349.3R 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. The staff requires clarification on the CAP criteria used to determine which inspection results categorized under either Tier 2 or Tier 3 acceptance will require either (i) an Action Request, (ii) a modification to the existing AMP (e.g. inspection frequency), and/or (iii) official notification to the NRC. The licensee should clarify any differences in CAP criteria for these same action items based on OE obtained at other ISFSIs using similar HSM designs. The staff also requires details on how the baseline properties for a given HSM component will be updated based on results from previous inspections, to ensure proper monitoring and trending once an aging effect is identified but not corrected (e.g., monitoring of crack growth rates, corrosion rate, pore density).

This information is required to determine compliance with 10 CFR 72.42, 72.170, 10 CFR 72.172, and 10 CFR 72.174.

CCNPP Response RAI-11:

Conditions or degradations noted in regards to Calvert Cliffs ISFSI are, and will continue to be, documented and resolved in accordance with Calvert Cliffs CAP which meets 10 CFR Part 50, Appendix B requirements. As indicated in the revised HSM AMP (see Section A1.4 of

Attachment 2) Calvert Cliffs will use the ACI 349.3R-02 acceptance criteria when evaluating identified ISFSI degradations of applicable components. Those degradations meeting either the ACI 349.3R-02 Tier 2 or 3 criteria will be entered into the CAP for evaluation and resolution. The evaluation of the degradation will determine on a case by case situation the appropriate course of action to be taken to ensure the degraded component will continue to meet its design function. The resultant course of action taken could range from requiring a change in the AMP frequency of monitoring, initiation of new monitoring activities, or corrective action to address the aging mechanism. Calvert Cliffs will continue to provide notification to the NRC when required by existing rules and regulations.

Evaluation of ISFSI operating experience, be it from site or industry operating experience, inspection results, owners group information, or NRC generated communications, will continue to be assessed as part of Calvert Cliffs existing Operating Experience Program. Items initially identified as being applicable to Calvert Cliffs and identified as being a potential vulnerability will be entered into the site's CAP for evaluation and resolution.

RAI-12:

Revise Section A2.1 (Reference 1), "HSM Aging Management Program," to include details of the scope of rebar inspections in the HSMs.

Table A-1 (Reference 1), "ISFSI Aging Management Examination and Inspection Procedures," states the following inspection activity: "To perform HSM rebar inspection and looking for spa lied and cracking concrete." However, the HSM AMP does not include details of the scope, acceptance criteria and frequency of rebar inspections (for both above-grade and below-grade areas). The licensee is asked to provide a revised AMP addressing this inspection activity. The revised AMP should include sufficient detail for all 10 program elements, as detailed in NUREG 1927, "Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance."

This information is needed to determine compliance with 10 CFR 72.42, 72.122(b)(1) and (f), 72.162 and 72.172.

<u>CCNPP Response RAI-12</u>:

The HSM Aging Management Program has been revised and is contained in Section A1.4 of Attachment (2). The HSM Aging Management Program includes the program elements of an effective AMP as detailed in NUREG-1927 (Reference 24).

RAI-13:

Revise the "Operating Experience" in Section A2.1 (Reference 1), "HSM Aging Management Program," to include the results of the engineering evaluation used to determine the concrete degradation mechanisms in the following condition reports (CRs). Identify any corrective action or aging management activity implemented as a result of this evaluation. Justify the assessment that the cause of the identified issues in some of these condition reports is not age related degradation.

Condition Report	*Identified in RSI-3 as age-related degradation*
IR3-028-233	*Yes*
IR3-046-040	*No*
IR3-054-104	*No*
IR3-058-556	*No*
IR3-033-810	*No*
CR-2009-003634	*No*
IRE-022-449	*No*
IRE-000-318	*No*

Response to RSI-3 (Reference 7) provided a list of CRs for the in-service HSMs, some of which were identified as involving issues due to aging degradation. However, no justification was provided for those categorized as not age-related. When referring to Response to RSI-3, the licensee stated in Response to RAI A-3 (Reference 4): "To provide a more thorough assessment of the current conditions, Calvert Cliffs commits to conduct an engineering evaluation of the identified degradations performed by a qualified structural engineer." The licensee is requested to include the findings of this evaluation (e.g., identified degradation mechanisms, number of affected HSMs) and any resulting corrective actions in the "Operating Experience" section of the HSM AMP.

This information is needed to determine compliance with 10 CFR 72.42, 72.122(a), 10 CFR 72.170,10 CFR 72.172, and 10 CFR 72.174.

CCNPP Response RAI-13:

The operating experience section of the HSM AMP has been revised and is contained in Section A1.4.5(10) of Attachment (2). The revised section includes Calvert Cliffs and industry applicable operating experience.

In June 2012, an inspection was conducted by a licensed structural engineering firm in order to provide a more thorough assessment of current HSM conditions. The inspection included inspection of degraded areas which were identified in the Condition Reports listed above. The inspection consisted of an up-close visual examination and hammer soundings of degraded areas. Results of the inspection concluded the HSMs were in good condition and that no further evaluation of the degraded area was necessary at this time. Calvert Cliffs will continue to monitor these areas going forward to trend their condition.

RAI-14:

Clarify the normal and off-normal doses presented on page 7 of the June 2013 Attachment (1) RAI response and confirm that the December 2011 confinement release calculations are correct.

Page 7 of the June 14, 2013, Attachment (1) RAI response stated that the total doses for normal and off-normal conditions were 67 mrem and 16 mrem, respectively. These doses are different from the results of previously submitted confinement release calculations found in Calculation CA07718, dated December 15, 2011.

This information is required to evaluate compliance with 10 CFR 72.104.

CCNPP Response RAI-14:

Page 7 of Attachment (1) in Calvert Cliffs June 14,2013 RAI response contained an editorial error. The units on the Normal and Off-Normal doses indicated should have been μrem rather than mrem. With that change, the results indicated are identical to those provided in the QA'd calculation CA07718 provided in Calvert Cliffs December 15, 2011 RAI response.

RAI-15:

Provide an AMP for the high burnup fuel behavior addressing the elements indicated in Section 3.6 of NUREG-1927 and include it in Appendix A of the LRA which will be incorporated by reference in the license.

It is specified in Reference 14 that storage casks specially designed for the storage of high burnup fuel designs (HSM-HS) will be added into the ISFSI Aging Management Program as referenced in the LRA.

Information regarding the testing of high burnup fuel and cladding should be considered in the development of this AMP. The work being performed as part of the DOE Cask Demonstration test plan (EPRI, 2014) should be considered. Other information such as QA records and corrective action and inspection plans should also be considered where appropriate with specific section references being cited.

This information is needed to meet the requirement of 10 CFR 72.42(a)(2).

CCNPP Response RAI-15:

The Aging Management Program for high burnup fuel is provided in Section A1.8 of Attachment (2).

References

1. Enclosure 1, "Application for Renewal of the Site-Specific License," to letter from G.H. Gellrich (Calvert Cliffs Nuclear Power Plant, LLC) to NRC, dated September 17, 2010 (ADAMS Accession No. ML102650247)
2. Attachment 1, "Second Request for Additional Information for Renewal Application," to letter from G.H. Gellrich (Calvert Cliffs Nuclear Power Plant, LLC) to NRC, "Response to Second Request for Additional Information for Renewal Application to Special Nuclear Materials License No. 2505 for the Calvert Cliffs Independent Spent Fuel Storage Installation," dated December 15, 2011 (ADAMS Accession No. ML11364A024)
3. Enclosure 1, "Calvert Cliffs Independent Spent Fuel Storage Installation Lead and Supplemental Canister Inspection Report," to letter from G.H. Gellrich (Calvert Cliffs Nuclear Power Plant, LLC) to NRC, "Response to Request for Supplemental Information, re: Calvert Cliffs Independent Spent Fuel Storage Installation License Renewal Application," dated July 27,2012 (ADAMS Accession No. ML12212A216)
4. Enclosure 1, "Calvert Cliffs Response to NRC Request for Additional Information," to letter from G.H. Gellrich (Calvert Cliffs Nuclear Power Plant, LLC) to NRC, "Response to Request for Additional Information, re: Calvert Cliffs Independent Spent Fuel Storage Installation License Renewal Application," dated June 28, 2012 (ADAMS Accession No. ML11180A270)

5. Calvert Cliffs Independent Spent Fuel Storage Installation, Updated Safety Analysis Report, Revision 20, September 8, 2011

6. Topical Report for the Nutech Horizontal Modular Storage System for Irradiated Nuclear Fuel NUHOMS®-24P, Volume I, April 1991 (ADAMS Accession No. ML110730769)

7. Enclosure 1, "Response to Request for Supplemental Information," to letter from G.H. Gellrich (Calvert Cliffs Nuclear Power Plant, LLC) to NRC, "Response to Request for Supplemental Information, re: Calvert Cliffs Independent Spent Fuel Storage Installation License Renewal Application," dated February 10, 2011 (ADAMS Accession No. ML110620120)

8. NRC Information Notice 2013-07, "Premature Degradation of Spent Fuel Storage Cask Structures and Components from Environmental Moisture," dated April 16, 2013 (ADAMS Accession No. ML12320A697)

9. H. Hayashibara, M. Mayuzumi, Y. Mizutani, J. Tani, "Effect of Temperature and humidity on atmospheric stress corrosion cracking of stainless steel," Corrosion 2008, paper 08492, Houston, TX: NACE International, 2008

10. Xihua He, Todd S. Mintz, Roberto Pabalan, Larry Miller, and Greg Oberson, "Assessment of Stress Corrosion Cracking Susceptibility for Austenitic Stainless Steels Exposed to Atmospheric

11. Chloride and Non-Chloride Salts," NUREG/CR-7170, U.S. Nuclear Regulatory Commission, February 2014 (ADAMS Accession No. ML14051A417)

12. A. Kosaki, "Evaluation method of corrosion lifetime of conventional stainless steel canister under oceanic air environment," Nuclear Engineering and Design, Vol. 238, pp. 1233-1240, 2008

13. NRC Information Notice 2012-20, "Potential chloride-induced stress corrosion cracking of austenitic stainless steel and maintenance of dry cask storage system containers," NRC, November 14, 2012

14. Tokiwai, M., Kimura, H., and Kusanagi, H., "The Amount of Chlorine Contamination for Prevention of Stress Corrosion Cracking in Sensitized Type 304 Stainless Steel," Corrosion Science, Vol. 25. No. 8/9, pp. 837--844, Pergamon Press Ltd, 1985

15. Calvert Cliffs Nuclear Power Plant Independent Spent Fuel Storage Installation "License Amendment Request: High Burnup NUHOMS-32PHB Dry Shielded Canister," dated December 2013

16. Letter from M. D. Flaherty (CCNPP) to Document Control Desk (NRC), dated June 14, 2013, Response to Request for Additional Information Re: Calvert Cliffs Independent Spent Fuel Storage Installation License Renewal Application (TAC No. L24475)

17. AREVA TN Calculation 10955-EE-00, "Calvert Cliffs Nuclear Power Plant ISFSI: Canister Cask Stress Corrosion Cracking Review for License Renewal"

18. AREVA Calculation 86-9203390-000, "Summary of SCC Assessment of SS Welds in 24P and 32P NUHOMS Dry Storage Casks"

19. Letter from Mr. J. Goshen (NRC) to Mr. G. H. Gellrich (CCNPP), dated October, 31, 2012, Third Request for Additional Information for Renewal Application to Special Nuclear Materials License No. 2505 for the Calvert Cliffs Site Specific Independent Spent Fuel Storage Installation (TAC No. L24475)

20. CCNPP Calculation CA07818, "2011 Update of ISFSI USAR DSC Leakage Dose Analysis"
21. Letter from M. J. Fick (CCNPP) to Document Control Desk (NRC), dated September 23, 2011, Calvert Cliffs, Units 1 & 2, Independent Spent Fuel Storage Installation – Supplemental Information Re: Request to Adopt Revised Emergency Action Levels (ADAMS Accession No. ML11272A199)
22. Letter from E. J. Leeds (NRC) to Mr. G. H. Gellrich (CCNPP), dated February 29, 2012, Emergency Action Level Scheme Change to Nuclear Energy Institute Standard 99-01, Revision 5 - Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2 (TAC Nos. ME5424 and ME5425) (ADAMS Accession No. ML120330565)
23. NUREG-1567, Standard Review Plan for Spent Fuel Dry Storage Facilities, March 2000
24. NUREG-1927, Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance, March 2011
25. NUREG-1801, Revision 2, Generic Aging Lessons Learned (GALL) Report, December 2010

ATTACHMENT (2)

REVISED AGING MANAGEMENT PROGRAMS

A1.1 INTRODUCTION

This appendix is a summary of the activities that manage the effects of aging for subcomponents that have been identified in the license renewal application as being subject to aging management review (AMR). The following aging management programs (AMPs) have been credited for the Calvert Cliffs Independent Spent Fuel Storage Installation (ISFSI):

- Dry Shielded Canister (DSC) External Surfaces Aging Management Program
- Horizontal Storage Module (HSM) Aging Management Program
- Transfer Cask Aging Management Program
- Transfer Cask Lifting Yoke Aging Management Program
- Cask Support Platform Aging Management Program
- High Burnup Fuel Aging Management Program

Each of these AMPs is discussed in Subsections A1.3 through A1.8. These subsections provide a description of the AMP which includes an introduction, an evaluation of the AMP in terms of the attributes of an effective AMP, and a summary.

Each AMP manages the aging effects, or the relevant conditions that could lead to the aging effects, applicable to a subcomponent, and provides reasonable assurance that the integrity of the subcomponent will be maintained under current licensing basis conditions during the renewed license period.

A1.2 AGING MANAGEMENT PROGRAM ELEMENTS

The structure of the AMPs is consistent with the 10 program elements described in NUREG-1927 (Reference 1), as follows:

(1) Scope of the program: The scope of the program should include the specific structures and components subject to an AMR.

(2) Preventive actions: Preventive actions should mitigate or prevent the applicable aging effects.

(3) Parameters monitored or inspected: Parameters monitored or inspected should be linked to the effects of aging on the intended functions of the particular structure and component.

(4) Detection of aging effects: Detection of aging effects should occur before there is a loss of any structure and component intended function. This includes aspects such as method or technique (i.e., visual, volumetric, surface inspection), frequency, sample size, data collection, and timing of new or one-time inspections to ensure timely detection of aging effects.

(5) Monitoring and trending: Monitoring and trending should provide for prediction of the extent of the effects of aging and timely corrective or mitigative actions.

(6) Acceptance criteria: Acceptance criteria, against which the need for corrective action will be evaluated, should ensure that the particular structure and component intended functions are maintained under the existing licensing-basis design conditions during the period of extended operation.

(7) Corrective actions: Corrective actions, including root cause determination and prevention of recurrence, should be timely.

(8) Confirmation process: The confirmation process should ensure that preventive actions are adequate and appropriate corrective actions have been completed and are effective.

(9) Administrative controls: Administrative controls should provide a formal review and approval process.

(10) Operating experience: Operating experience involving the AMP, including past corrective actions resulting in program enhancements or additional programs, should provide objective evidence to support a determination that the effects of aging will be adequately managed so that the structure and component intended functions will be maintained during the period of extended operation.

A1.3 DSC EXTERNAL SURFACES AGING MANAGEMENT PROGRAM

The ISFSI provides for long-term dry interim storage for irradiated fuel assemblies until such time that the irradiated fuel assemblies are shipped off site for final disposition. The fuel assemblies are confined in DSCs. This program is intended to ensure that the structural and pressure/confinement boundary intended functions of those DSCs is maintained for the period of extended operation.

A1.3.1 Materials

The DSC subcomponents described in Section 3.3.1 of Reference 2 that are subject to this AMP are as follows:

- DSC Shell with Bottom Shield Plug
- DSC Cover Plates (Top and Bottom)
- Ram Grapple Ring

All DSC designs presently in use at Calvert Cliffs (NUHOMS-24P and NUHOMS-32P DSC) and future designs (NUHOMS-32PHB DSC) will be covered by this program. As described in Table 3.3-1 of Reference 2 these components are fabricated of stainless steel. While the bottom shield plug contains lead, that material is not exposed to the external environment of concern and does not support the pressure/confinement boundary intended function of the subcomponent.

A1.3.2 Environments

As described in Table 3.3-1 of Reference 2, the DSC is positioned for long term storage inside of the HSM, which is considered a sheltered environment. The internal environment is helium. The external environment is ambient air at a temperature ranging from ambient (70°F normal with a range of -3°F to 103°F) to 60°F above ambient (Technical Specification 3.4.1 maximum air temperature rise). Average ambient relative humidity is 77% in the morning and 55% in the afternoon (Reference 3, Table 1-10). The June 2012 Lead Canister Inspection (Reference 4) also determined that there are deposits on the upper surface of the DSC shell. Samples of these deposits were collected and analyzed by two separate labs (Reference 5 Enclosure 1 and Reference 6 Appendix D). The deposits were found to be composed of large particles (20-40 μm) which were primarily pollen and quartz and finer particles (< 5 μm) that consisted of soluble salts and insoluble minerals (silicates and oxides). The salts were dominantly gypsum and appeared to be continental rather than marine in origin. The predominant elements include silicon, calcium, and iron with somewhat lesser amounts of aluminum and magnesium. The major anion species are sulfate and nitrate. The major cation species are Ca^{2+} with somewhat less amounts of K^{+}, Na^{+}, and Mg^{2+}. The iron is likely from the scraping process used to collect the deposits from the DSC and the calcium is partially due to the high calcium content in the HSM concrete. Chlorides were relatively rare, and the highest surface concentration indicated by any of the samples was 5.2 mg/m^2.

Reference 7 Enclosure 1 provides a thermal analysis to determine temperatures on the outer surface of the Calvert Cliffs NUHOMS-24P and NUHOMS-32P DSCs for various heat loads, to identify the heat load at which the confinement weld temperatures on the outer surface of the DSCs is at 80°C. Dry shielded canisters may be susceptible to chloride induced stress corrosion cracking (CISCC) initiation between 30 and 80°C (The basis for this range is discussed in Reference 7 Enclosure 3). The evaluation was done for the design basis normal ambient condition of 70°F. The thermal evaluation shows that at least one portion of the longitudinal weld located close to the top cover plate, which faces the back wall of the HSM, remains below 80°C for all heat loads between 2 kW and 19 kW. The temperature at this location is 80°C for a heat load of approximately 23.9 kW based on the linear fitting of the data. The maximum design basis heat loads of the DSCs in use at Calvert Cliffs are 15.84 kW for the NUHOMS-24P DSC, and 21.12 kW for the NUHOMS-32P DSC. Even maximum DSC shell temperatures fall below 80°C for the highest heat load NUHOMS-24P DSC in service at Calvert Cliffs (Loading 48 in 2005) after 19.5 years of storage, and after 35.5 years of storage for the highest heat load NUHOMS-32P DSC in service to date (Loading 66 in 2010).

A1.3.3 Aging Effects Requiring Management

As discussed in Section 3.3.6 of Reference 2, the AMR of the DSC in the sheltered air environment inside the HSM did not identify any aging effects/mechanisms that could lead to a loss of intended function. However, it is recognized that since that review, operating experience (Reference 8 and research (References 9 – 11) have surfaced indicating that stress corrosion cracking (SCC) of stainless steel components can occur in humid air environments at specific temperature ranges and surface chloride concentrations. While it appears that the DSCs are presently below the lowest surface chloride concentrations discussed in the above research, it appears prudent to establish a program to monitor the DSCs for the following aging effects associated with SCC:

- Loss of material due to corrosion (e.g., crevice corrosion and/or pitting that may be a precursor to SCC).
- Cracking due to SCC.

A1.3.4 Program Description

The purpose of the DSC AMP is to manage the aging effects on the external surfaces of the DSC shell assembly subject to aging effects that need to be managed for the period of extended operation. The program manages aging effects through inspection of external surfaces for evidence of loss of material due to corrosion, pitting (e.g., crevice corrosion and pitting), and cracking due to SCC.

A1.3.5 Evaluation of Technical Basis

(1) Scope

The scope of the DSC AMP involves monitoring of the exterior surfaces of the DSC shell and cover plate for the effects of aging associated with SCC. The first DSC examined in June 2012 was DSC-6 in HSM-15, which was loaded in November 1996 and contained the "lead canister" identified to have the highest integrated neutron, gamma, and thermal exposure at the time of the inspection (Reference 12) as required by the draft NUREG-1927 Appendix E requirements. The second DSC inspected in June 2012 was DSC-11 in HSM-1 which was loaded in November 1993 (the first loading) and represents one of the lowest heat load canisters ever loaded. Calvert Cliffs may add additional DSCs for subsequent inspections if the HSM AMP requires internal inspections of modules other than those inspected in 2012 (it is expected that the integrated thermal and radiological source terms of the more recently loaded NUHOMS-32P canisters will surpass that of the June 2012 "lead canister" before the next inspection). The population DSCs for each subsequent inspection shall always include the DSCs examined in previous inspections for trending purposes.

(2) Preventive Actions

The DSC external surfaces AMP consists of condition monitoring to confirm there is no degradation of the DSC shell or cover plates that would result in a loss of the structural and pressure/confinement boundary intended function. No new preventive or mitigating attributes are associated with these activities.

(3) Parameters Monitored or Inspected

The DSC external surfaces AMP provides visual inspections to monitor for signs of material degradation on the external surfaces of the DSC shell assembly and cover plate. The visual inspection is intended to identify the following parameters that could be precursors to, or actual signs of, the effects of SCC:

- Crevice and pitting corrosion (loss of material)
- Surface cracking

In addition to visual examination, the AMP will continue to collect and analyze samples of surface deposits on selected DSCs to allow for trending of surface chloride concentration with visual results from inspections at Calvert Cliffs and other sites. Selection of DSCs for surface deposit collection will be done considering the age of the DSC (with preference for the oldest in the population inspected), the availability of access to undisturbed deposits on the surface of the DSC, the personnel dose required to retrieve the samples, and visual examination results (priority may be given to deposit collection on DSCs failing to meet visual acceptance criteria).

(4) Detection of Aging Effects

Aging effects due to loss of material from crevice and pitting corrosion, and cracking due to SCC of stainless steel will be managed using visual inspection in accordance with American Society of Mechanical Engineers (ASME) Section XI and performed by site qualified individuals.

The DSC external surface AMP will be based on proven technology reasonably available at the time the inspection is conducted which is capable of meeting the physical access and environmental constraints of the HSM interior. The June 2012 visual inspection was conducted by remote and direct means with a GE Everest Ca-Zoom 6.2 PTZ100, which is a remote controlled high definition pan-tilt-zoom (PTZ) camera system with a 100mm head, attached 10 watt flood and spot lights capable of providing 240 lumens each, and a resolving power of 0.5 mil (0.0005 inch) diameter wire at 6.0 feet distance (Reference 22). The remote inspection was performed by lowering the camera through the HSM rear outlet vent which allowed for viewing of the majority portion of the DSC, its support structure, and the interior surfaces of the HSM. The direct inspection was performed through the partially open door by mounting the camera on a pole. Based on manufacturer specifications (Reference 22), this camera is capable of handling dose rates up to ~1000 R/hr, which limits its physical location to the plane of the rear outlet vent based on the dose fields calculated for the HSMs inspected to date (Reference 12). This delivery method, and a camera which meets or exceeds the above specifications, will be treated as the baseline means for performing the inspection for the purposes of developing this AMP.

The DSC external surface AMP will take a graded approach to visual inspection of the DSC, with higher standards of inspection applied as needed based on the results of prior inspections. Based on the location, lighting and resolving power of the baseline inspection equipment discussed above, and the known presence of deposits on the shell upper surface, the minimum inspection of the DSC will be performed to ASME Section XI Article IWA-2210 VT-3 standards. Based on ASME Section XI IWA-2213 the VT-3 examination is suitable for determining general mechanical and structural condition of components, including signs of corrosion. Based on ASME Section XI Table IWA-2210-1, the VT-3 method must demonstrate capability to resolve characters that are 2.7mm in height. Based on this the VT-3 examination method is judged to be suitable for identifying signs of pitting corrosion that are considered pre-cursors to SCC (see Figure A1.3-1 below). Cleaning of the DSC surface is not required by VT-3, and will not be performed, since it could invalidate the DSCs use as a lead canister for future inspections by removing accumulated chlorides.

The DSC external surface area covered by each VT-3 examination will be similar to that visible in June 2012, and should include:

- 100% of the bottom end of the DSC visible from the HSM doorway opening including the grapple ring, and excluding areas obstructed by the seismic restraint and the sides of bottom shield plug where access is restricted by the small HSM doorway gap
- 100% of the top cover including the closure weld and excluding areas obstructed by the HSM rail back stops
- 100% of the DSC shell from and including the center circumferential weld (WJ-3) to the top end of the DSC (near the back wall of the HSM), including the longitudinal weld in this region (WJ-2) and excluding the portion of the shell obstructed by the HSM rails. The condition of the DSC shell at the support rail contact region will be accessed based on the appearance of the visible regions immediately adjacent to the crevice location
- The portion of the DSC shell from the center circumferential weld to the bottom end of the DSC (near the HSM doorway), including the longitudinal weld in this region (WJ-1) and excluding the portion of the shell obstructed by the HSM rails, will be imaged. Inspection to VT-3 standards in this region will be performed to the extent allowed by the inspection equipment. The condition of areas outside of the range capable of being inspected to VT-3 standards will be documented to the best of the ability of the inspector.

When the DSC is inspected via the rear HSM outlet vent, the longitudinal welds will be located on the left hand side of the DSC, with WJ-2 located 45-degrees below center (but above the rail), and WJ-1 located 45-degrees above center.

At the discretion of the inspector, unless required by the results of a prior inspection, the inspection of selected areas on the DSC may be upgraded to the standards of ASME Section XI Article IWA-2210 VT-1 if access, dose, lighting and camera resolution allow. The VT-1 examination is specifically conducted to detect cracks per ASME Section IWA-2211, and is capable of resolving characters that are 1.1mm in height. Based on the baseline inspection system and delivery method discussed above, potential candidate areas for this enhanced inspection for DSCs located in an HSM of the design inspected in June 2012 are the DSC top cover plate and closure weld, the section of the longitudinal weld WJ-2 nearest the top end of the DSC shell, the grapple ring, and portions of the DSC bottom shield plug facing the HSM door.

The qualification of inspection personnel shall be accomplished in accordance with site procedures for the type of inspection conducted, and shall meet the requirements of ASME Section XI Article IWA-2300.

The frequency of the inspection shall be as determined by the monitoring/trending discussed in Section A1.3.5.5 and inspection acceptance criteria discussed in Section A1.3.5.6.

(5) Monitoring and Trending

The inspection required by the DSC external surfaces AMP is performed at intervals defined by the toll gate assessments described in Table A1.3-1. The inspection may be completed within a time period of one year before or after the date indicated in Table A1.3-1. The June 2012 inspection is considered to be the baseline inspection for the DSC-6 and DSC-11, and the first inspection of any additional DSC added to the inspection population will be considered the baseline for that DSC. As discussed in Section A1.3.5.1, the population DSCs for each subsequent inspection shall always include the DSCs examined in previous inspections for trending purposes. Trends to be considered include:

- DSC surface chloride concentration.
- Changes in DSC surface appearance with emphasis on increases in pit density or the extent of the pitted/stained area compared to the baseline.

This trending information will feed both the toll gate assessments discussed in Table A1.3-1 and the acceptance criteria discussed in Section A1.3.5.6.

Table A1.3-1, DSC External Surfaces AMP Toll Gate Assessments

Toll Gate	Year	Assessment
1	2017	Starting in this year, perform inspections of the identified population of Calvert Cliffs DSCs. Inspection will be performed at 5-year intervals unless changed by the 2nd toll gate assessment. The 5 year interval ensures that 3 inspections (including the 2012 inspection) will have occurred prior to reaching the 30 years of storage. The 30 year time frame was suggested as the earliest time CISCC might be expected to initiate on a Calvert Cliffs Nuclear Power Plant DSC under shoreline airborne salt concentrations (10 $\mu g/m^3$ in Enclosure 3 of Reference 7 (discounting any reduction in chlorides due to distance from the Bay to the ISFSI). Similarly, a 30 year initiation timeframe is also suggested by the most conservative surface chloride concentration threshold identified in literature 8 mg/m^2 (Reference 25, Figure 8, 70-75% RH) given the 5.2 mg/m^2 chloride concentration measured in 2012 on DSC-11 in HSM-1 after 19 years of storage.
2	2022	Following the 2022 DSC external surfaces inspection, evaluate information obtained from Calvert Cliffs DSC inspections, and information from any other inspections of NUHOMS DSCs at other sites, if available. Also review any new research on minimum chloride concentrations required to initiate SCC on stainless steel in atmospheric environments. IF no acceptance criteria have been failed in prior inspections at Calvert Cliffs, AND DSC surface chloride concentration trends indicate they would remain below threshold values necessary to initiate SCC for the next 10 years, the interval between subsequent inspections may be increased to 10 years. The basis for increasing to 10 years is that more realistic DSC shell weld residual stresses from Enclosure 4 in Reference 7 (Figures 3-7 and 3-14) of 30 ksi (21 kg/mm^2) applied to Figure 7 of Reference 25 would suggest chloride surface concentration CISCC threshold values of 170 mg/m^2 at 60-63% RH, 16 mg/m^2 at 70-75% RH, and 50 mg/m^2 at 95-98% RH. Correcting this input alone doubles the earliest estimated initiation time for CISCC to ~60 years given the 2012 measurements, which would make a ten-year inspection interval more appropriate. If ANY acceptance criteria of subsequent inspections are failed, the inspection interval will be reduced back to five years for the next two inspections.
3	2032	Evaluate any other new information to determine if changes to program frequency or inspection methods are warranted.

(6) Acceptance Criteria

The acceptance criteria for the DSC external surface AMP are defined to ensure that the need for corrective actions will be identified before loss of intended functions. Visual examination via the use of remote digital camera is based on ASME VT-3 examination, or ASME VT-1 examination if required by a prior inspection, or equivalent (ASME Section XI Table IWA-2211-1). Inspection acceptance criteria are as follows:

- Indications of crevice corrosion or heavy pitting corrosion are absent, or have not increased in extent or density from the previously evaluated baseline.

- Discoloration or stains identified in baseline inspections have not increased in extent and new areas of discoloration or staining have not appeared since the prior inspection.
- Cracks are absent within the material.

Based on the inspection, the DSC is determined to be either Acceptable, Acceptable with Defects, or Unacceptable. The following describes conditions that could lead to each determination and the appropriate response:

- Acceptable signifies that a component is free of significant deficiencies or degradation that could lead to the loss of intended function. No further action is required prior to the next inspection.
- Acceptable with Defects signifies that a component contains deficiencies or degradation but will remain able to perform its design basis function until the next inspection. Signs of new or increased areas of pitting, crevice corrosion, or staining, compared to the baseline could lead to such a determination. Figure A1.3-1 below provides a visual example of the extent of pitting observed on a stainless steel mock dry storage canister subjected to accelerated aging under atmospheric conditions (35% relative humidity) and deposited surface chlorides (400 mg/m^2), where SCC (3mm depth; <25% through-wall) was later confirmed to be present on the welds by destructive examination (Reference 24). A condition report will be initiated in the site Corrective Action Program (CAP) to document this evaluation and determine if the subject location should be inspected to ASME Section XI VT-1 standards during the next regularly scheduled AMP inspection. The appearance of pitting in a particular area to an extent similar to that seen in Figure A1.3-1 would be considered a condition that would require a VT-1 examination of that area at the next inspection interval. ASME FFS-1 Section 6 also provides standard method that may be used for evaluating the acceptability of pitting degradation itself in pressurized components based on data obtained from visual inspection.

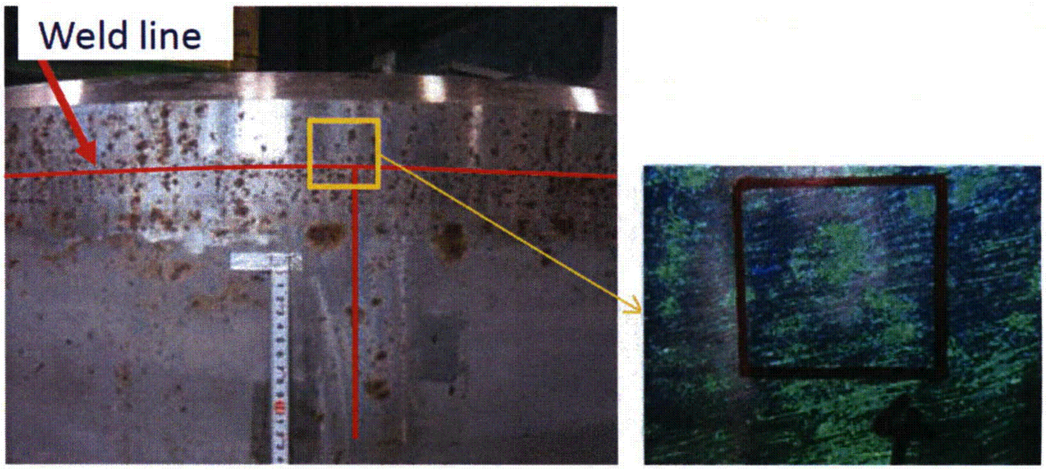

Figure A1.3-1 (Reference 24, page 20)

- Unacceptable signifies a component contains deficiencies or degradation that either prevents (or could prevent prior to the next inspection the ability to perform their intended function. An example would be positive identification of the presence of cracks on the DSC surface with length exceeding the requirements of ASME Section XI Table IWB-3514-2 acceptance criteria for surface examination of in-service austenitic steel components. A condition report will be initiated in the site CAP to drive further evaluation, characterization, and other actions as needed to preserve the DSC intended functions. Description and timing of these actions shall be as described in Section A1.3.5.7.

Acceptance of any degraded condition for continued service is in accordance with facility procedural requirements, includes an engineering evaluation using plant design procedures, industry codes and standards, and conforms to site license.

(7) Corrective Actions

Corrective actions, including apparent or root cause determinations are performed in accordance with the 10 CFR Part 50, Appendix B Program and site corrective action procedures. Corrective actions are taken in a timely manner commensurate with the significance of the defect. Deficiencies are either corrected or are evaluated to be acceptable for continued service through engineering analysis, which provides reasonable assurance that the intended function is maintained consistent with current licensing basis conditions.

In the event that a stress corrosion crack is determined to be present on a DSC confinement/pressure boundary, corrective actions necessary to ensure intended function is maintained or restored shall be completed within 5 years from the time of discovery, provided the DSC heat load at the time of discovery is less than 5 kW for a NUHOMS-24P DSC or 6 kW for a NUHOMS-32P DSC. The basis for this timing is that it provides a factor of 10 safety to the time required for an initiated stress corrosion crack to grow through wall in a Calvert Cliffs DSC based on the results provided in Enclosure 4 of Reference 7. The factor of 10 is intended to account for uncertainties in the crack growth rates used in that analysis. In addition, in the unlikely event that a crack had grown through-wall since the last inspection, this timing also provides substantial margin to the time required for fuel cladding damage to occur on air exposure at this heat load (> 35 years) based on the results of Enclosure 5 of Reference 7. Response times for SCC in the confinement/pressure boundary of higher heat load DSCs requiring corrective action shall be determined based on the above mentioned analysis to ensure that fuel damage due to air exposure does not occur. Corrective actions for SCC on the grapple ring, which does not perform a confinement function, shall not be subject to the above time limits, but must be completed in accordance with site CAP requirements and prior to any removal of the DSC from the HSM.

Corrective actions for confirmed SCC may include further examination of the DSC for the purpose of better characterizing the orientation and/or depth of the cracking if needed. Analyses documented in Enclosure 4 of Reference 7 indicate that cracks on DSC shell welds are unlikely to experience tensile stresses that would allow growth through-wall unless oriented near perpendicular to the direction of the weld. Continued performance of intended functions prior to the next inspection may be demonstrated either through analysis of a thoroughly characterized crack based on accepted industry codes, methods and standards available at the time the crack is identified (ASME FFS-1 Section 9 provides methods which may be used), or by repair or replacement of the DSC.

(8) Confirmation Process

Activities initiated in accordance with the implementing procedures for the DSC AMP, such as corrective actions, are subject to Quality Assurance Program (QAP) controls. Thus, the effectiveness is monitored using CAP procedures, review and approval processes, and administrative controls, which are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. Use of these procedures, processes, and controls ensures that corrective actions are taken and are effective.

(9) Administrative Controls

The DSC external surfaces AMP is subject to corrective action and quality assurance procedures, review and approval processes, and administrative controls. These are implemented in accordance with site procedures and the requirements of 10 CFR Part 50, Appendix B, and will continue to be adequate for the renewed license (extended storage) period.

(10) Operating Experience

The Calvert Cliffs ISFSI has been in operation since 1992. As discussed in Section 3.1.5 of Reference 2, plant-specific and industry operating experience, as well as a review of ISFSI files, did not indicate any aging related deficiencies with the DSC components. Future examinations and inspections are performed in accordance with plant procedures and repetitive maintenance tasks. Operating Experience from other sites will be obtained via the INPO Operating Experience database, Nuclear Regulatory Commission (NRC) Information Notices, Electric Power Research Institute (EPRI) Reports and/or participation in industry groups such as the TransNuclear Users Group and reviewed in accordance with site Operating Experience review procedures for applicability to the Calvert Cliffs ISFSI.

A1.3.6 Conclusion

The DSC external surfaces AMP is credited for the management of conditions that could lead to the degradation of DSC subcomponents from the aging effects and mechanisms shown in Table 3.2-1 of Attachment (4) and for the management of actual degradation.

Based on the above, the continued implementation of the DSC external surfaces AMP provides reasonable assurance that the aging effects will be managed, such that the intended functions of the DSC will be maintained under current licensing basis conditions for the period of extended operation.

A1.4 HSM AGING MANAGEMENT PROGRAM

The ISFSI provides for long-term dry interim storage for irradiated fuel assemblies until such time that the irradiated fuel assemblies are shipped off site for final disposition. The fuel assemblies are confined in stainless steel canisters. Each canister is protected and shielded by a concrete HSM and rests on a steel support rail assembly that is anchored to the walls of the storage module and restrained inside the storage module. Other steel components provide heat shielding, screens, and attachments, both inside and outside the modules. The HSM AMP includes the following:

A1.4.1 Materials

HSM structural components subject to AMR are as follows:

- Reinforced concrete
- Carbon steel members
- Stainless steel

A1.4.2 Environments

HSM structural components subject to AMR are exposed to the following environment:

- Internal (sheltered)
- External
- Embedded (steel)

A1.4.3 Aging Effects Requiring Management

The following aging effects require management:

- Cracking or loss of material (spalling, scaling of concrete) or corrosion of steel due to moisture, chemical attack and leaching.
- Cracking of concrete due to settlement and loss of bond of reinforcing steel.
- Cracking or loss of material (spalling, scaling of concrete) due to freeze-thaw degradation.
- Cracking or loss of material (spalling, scaling of concrete) due to irradiation (concrete).
- Increase in porosity/permeability and loss of strength (of concrete) due to leaching of $Ca(OH)_2$ or cement aggregate reaction (alkali sililca reaction or alkali carbonate reaction).
- Cracking or loss of material (spalling, scaling of concrete) due to cement aggregate reaction.

A1.4.4 Program Description

The purpose of the HSM AMP is to:

- Ensure that the HSM structures and components maintain their ability to perform their design function throughout the period of extended operation
- Maintain the air inlets and outlets free from obstructions

A description of the HSM AMP is provided below using the program elements of an effective AMP as listed in Section A1.2.

A1.4.5 Evaluation of Technical Basis

(1) Scope

The scope of the HSM AMP for external and internal surfaces program includes the concrete and steel components including HSM walls, roof, and floor slab, HSM access door, DSC support structure and rail assembly, heat shields, air inlet and outlet vents, embedments and anchorages (i.e., structural connections including anchor bolts, cast-in-place bolts, thru-bolts, and mounting hardware).

The program consists of periodic visual inspections, radiation surveys, groundwater surveys and nondestructive examination (NDE) as determined by personnel qualified to monitor structures and components for applicable aging effects, such as those described in the American Concrete Institute (ACI) Standards 349.3R-02, ACI 201.1R-08, and American National Standards Institute/American Society of Civil Engineers Standard (ANSI/ASCE) 11-99.

(2) Preventive Actions

The AMP is primarily a condition monitoring program. With the exception of daily surveillances to ensure HSM inlets and outlets are not obstructed, no preventive actions are performed. Maintaining the inlets and outlets free from obstruction ensures temperatures are not elevated for prolonged periods, the concrete is not subject to related damage, and overheating of the components inside an HSM is prevented.

(3) Parameters Monitored or Inspected

For each of the aging effects to be managed the specific parameters monitored or inspected depend on the particular HSM component. Parameters monitored or inspected are commensurate with industry codes, standards, and guidelines and take into account industry and site-specific operating experience.

Consistent with the current NRC position relative to including concrete in an AMP, the above grade accessible concrete is visually examined for indication of surface deterioration. Degradation could affect the ability of the concrete to provide support to the DSCs, to provide radiation shielding, to provide missile shielding, or to provide a path for heat transfer.

The condition of below grade concrete, which is not accessible, will be monitored through groundwater sampling. The groundwater sampling will monitor the following parameters:

- pH
- sulfate concentration
- chloride concentration

Steel components (both steel components on the external surface of the HSM and the DSC structural support steel components) will be monitored visually looking for the aging effect of loss of material due to general, pitting and crevice corrosion.

The HSM inlet and outlet vents are monitored by visual inspection to ensure they are not obstructed.

In addition, as an overall means of monitoring of the HSM structure's ability to perform its design function, radiation surveys will be conducted. The surveys will consist of measuring gamma and neutron levels in addition to measuring contamination levels in the vicinity of the HSMs.

American Concrete Institute 349.3R-02 and ANSI/ASCE 11-99 provide an acceptable basis for selection of parameters to be monitored or inspected for concrete and steel structural elements.

(4) Detection of Aging Effects

a) Exterior Above Ground Concrete Structure, Reinforcing Steel, and Embedments

The exterior surfaces of concrete and structural components are visually inspected in order to detect any aging effects. The visual survey should identify the source of any staining or corrosion-related activity and the degree of damage. The visual survey is performed in accordance with Calvert Cliffs site procedure MN-1-319, Attachment 4 (concrete structure walkdown checklist). Observance of exposed steel reinforcement, corroded anchorages and embedments, severe staining, or suspected loss of monolithic behavior would be entered into the site's CAP for further evaluation with other testing methods as determined by an authorized structural engineer.

The above ground concrete structure visual inspection identifies the current condition of the structure and can identify the extent and cause of any aging effect noted.

Steel on the external surface of the HSMs which is subject to wetting/moisture is visually examined for the aging effect of loss of material (corrosion). This aging effect could affect the ability of the steel to perform its intended function. The initial stage of corrosion often produces cracking, spalling and staining in the surrounding concrete. The visual survey performed should identify the source of any staining or corrosion-related activity and the degree of damage. Exposed steel reinforcement, corroded anchorages and embedments, severe staining, or loss of monolithic behavior are conditions that would be entered into the CAP and warrant further evaluation with other NDE methods as determined by a qualified structural engineer.

For coated HSM carbon steel subcomponents, no credit is taken for coating for the prevention of aging effect from the AMR. However, this AMP will manage loss of coating integrity due to blistering, cracking, flaking, peeling, or physical damage.

Visual inspections of the exterior above ground concrete structures and structural components are conducted annually by a qualified individual. This annual inspection will consist of a walk thru around all existing HSMs. As a supplement to this annual inspection, every five years a professional structural engineering firm will conduct a focused inspection of at least five targeted HSMs with areas of degradations that have been identified by the annual inspections.

Another means employed in the detection of aging effects for the HSMs is through area radiation surveillances. Increased radiation levels could indicate a reduction in the ability of the concrete and steel to provide adequate radiation shielding, or could indicate a breach in the containment function of the DSC or irradiated fuel assemblies. The surveillance is conducted annually and consists of measuring dose rate on contact and at 30 cm from the door of each HSM. A swipe of each HSM door is also taken to check for contamination levels. In addition six thermoluminescent detectors (TLDs) are positioned on the ISFSI perimeter fencing. These TLDs are read semiannually and provide a record of radiation exposure at the ISFSI perimeter.

b) Below Ground Concrete:

Exposure of concrete to penetrating water can result in the leaching of salts and chlorides producing a loss of mechanical properties. Because exposure to moisture is required to produce leaching, the concrete below ground is susceptible to this aging mechanism. To help monitor the condition of below ground concrete in the ISFSI area, groundwater sampling will be performed at a minimum of three locations every five years in order to trend the potential for corrosive environment existing in the area of the ISFSI.

c) Inlet and Outlet Vents

A daily surveillance performed by security personnel ensures that the inlet and outlet vents are free from obstruction consistent with the ISFSI Technical Specification Surveillance Requirement 4.4.1.2.

The in-service HSMs (#1 through #72) have embedment around the vent areas to which the vent screens are bolted. The new modular HSMs have structural mounting bolts attaching the outlet vent modules. To date there has been no "Freeze-Thaw" degradation on either the in-service or new HSMs.

d) Interior Concrete and DSC Support Structure

Visual inspections can be conducted by remote and direct methods using a high-resolution remote PTZ camera that is capable of detecting age-related degradation such as loss of material due to corrosion, and cracking of metallic components. Remote inspection is conducted using a camera and/or fiber-optic technology through openings, such as HSM air inlets and outlets. Inspections using this technology produce VT-3 level results and is appropriate for assessing these aging effects. The HSM access door can be removed for direct inspection of the DSC bottom end for signs of aging degradation. This inspection of the interior concrete shall be conducted every five years in concert with the DSC inspection. The inspection will be conducted on the same HSM each time. The first examination of interior concrete was performed on the selected HSM in June 2012. The HSM selected for inspection was one that contained a DSC which had the longest time in service, and/or other parameters that contributed to degradation. Results of this inspection were provided in Reference 13. This inspection provides baseline information that will be used during subsequent examination of the same HSM(s) for trending purposes.

Table 1.4-1 below contains a summary of the inspections performed as part of this HSM AMP.

(5) Monitoring and Trending

The inspections and surveillances described above are all performed periodically in order to identify areas of degradation. The results of the inspections will be used in two ways. First the results will be evaluated by a qualified individual consistent with industry guidelines, standards and regulations. Areas of degradation not meeting established criteria will be entered into the sites CAP for resolution or more detailed evaluation. Second the results of the inspection will be compared against future inspections in order to monitor and trend the progression of the aging effects over time. The trending of aging effects over time is a key element that will help provide aging management so that there will be high confidence the HSM structures remain capable of performing their design function during the period of extended operation.

(6) Acceptance Criteria

a) Above Ground Concrete Structure, Reinforcing Steel, and Embedments

A set of inspection attributes and acceptance standards for steel and concrete that is commensurate with industry codes, standards, and guidelines has been established. American Concrete Institute Standard 349.3R-02 includes a 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 integrity. Acceptable after review signifies that a component contains deficiencies or degradation but will remain able to perform its design basis function until the next inspection or repair. Acceptance requiring further evaluation signifies that a component contains deficiencies or degradation that could prevent (or could prevent prior to the next inspection) the ability to perform their design basis function. Degradations or conditions meeting the ACI 349.3R-02 Tier 2 and 3 criteria will be entered into the site's CAP for evaluation and resolution. Should the site make a determination to deviate from the ACI 349.3R-02 acceptance criteria, a technical justification will be fully documented.

The loss of material due to age-related corrosion of carbon steel components in the HSM shall be evaluated by a Structural Engineer in accordance with ACI 349.3R-02. A technical basis will be provided for any deviation from ACI 349.3R-02 acceptance criteria.

The radiation surveys taken annually are evaluated against the acceptance criteria established in Technical Specification 2.4. In addition as part of the trending aspect of this program, results within Technical Specifications but above normal expected levels would be further evaluated. The TLD results read semiannually are compared against Federal Limits.

Ground water sampling acceptance criteria shall be established as:

pH - >5.5
Chlorides < 500 ppm
Sulfates <1500 ppm

These values are consistent with guidance provided in NUREG-1801 and would demonstrate that ISFSI concrete pad is exposed to a non-aggressive soil and groundwater environment.

b) DSC Support Structure

Loss of material due to age-related corrosion of DSC Support Structure shall be evaluated by a Structural Engineer. Acceptance Criteria for the DSC Support Structure for both stainless and carbon steel components shall be based on the design methodologies defined in Calvert Cliffs Nuclear Power Plant ISFSI Updated Safety Analysis Report (USAR) Section 4.2.1.1. Calvert Cliffs ISFSI USAR Section 4.2.1.1 references "American Institute of Steel Construction (AISC), "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings"' 8th Edition.

c) Inlet and Outlet Vents

The acceptance criterion for the daily surveillance performed by security personnel is to ensure that the inlet and outlet vents are free from obstruction consistent with ISFSI Technical Specification Surveillance 4.4.1.2. Any blockage would be removed and the issue would be captured in the site's CAP.

(7) Corrective Actions

Degradations or conditions meeting ACI 349.3R-02 Tier 2 or Tier 3 acceptance criteria will be entered into the site's CAP. Corrective actions undertaken to resolve the degradation and condition could require (i) a modification to the existing AMP, and/or (ii) official notification to the NRC.

Corrective actions are taken in a timely manner commensurate with the significance of the defect. Deficiencies are either promptly corrected or are evaluated to be acceptable through engineering analysis, which provides reasonable assurance that the intended function is maintained consistent with current licensing basis conditions.

(8) Confirmation Process

Activities initiated in accordance with the implementing procedures for the HSM AMP, such as corrective actions, are subject to QAP controls. Thus, the effectiveness is monitored using CAP procedures, review and approval processes, and administrative controls, which are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. Use of these procedures, processes, and controls ensures that corrective actions are taken and are effective.

(9) Administrative Controls

The HSM AMP is subject to the site's corrective action and quality assurance procedures, review and approval processes, and administrative controls. These are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B, and will continue to be adequate for the renewed license (extended storage) period.

(10) Operating Experience

Calvert Cliffs Operating Experience

The ISFSI has been in operation since 1992. Since that time Calvert Cliffs has conducted examinations and inspections performed in accordance with plant procedures and repetitive maintenance task. Deficiencies when noted have been entered into our CAP for evaluation. While our operating experience has not indicated any significant degradation to any of the HSM component, several minor degradations on external concrete surfaces have been noted. To provide a current assessment of these external degradations Calvert Cliffs, engaged in June 2012, a licensed structural engineering firm to perform a cursory visual inspection of all in use HSMs and an up-close visual survey and hammer sounding of selected HSM units, including those for which earlier minor degradation had been noted. In all cases the crack widths noted during this inspection were less than 0.04 inches and hammer soundings in their vicinity indicated sound concrete in the area. Based on their findings, the structural engineering firm indicated the HSM structures were in good condition and did not identify any issues that currently warranted further evaluation. In addition the structural engineering firm also recommended continued monitoring and inspections in accordance with ACI 349.3R-02.

Also in June 2012, Calvert Cliffs performed an inspection of the interior HSM structure of two HSMs in conjunction with an inspection of the exterior surface of the DSC. Overall the visually accessible surfaces of the HSM concrete walls, roof and floor all appeared to be in good condition with little to no signs of spalling or cracking. There was evidence of localized water intrusion to the interior of the HSM as indicated by a few concrete stalactites. These stalactites were seen only in the vicinity of the rear outlet vents. This suggests the source of the water intrusion came from the outlet vent stack. Broken stalactite debris was also observed on the surface of the heat shields. Water was observed to flow inward along concrete surface cracks. The pure white color of the stalactites observed indicated that water had not penetrated to the rebar. A condition report was initiated to evaluate the possible implications this could have on the HSM capability to perform their function in later years.

A coating of dust/dirt was present on the floors of each HSM but no debris or standing water was observed. In both HSMs the DSC structural support beams and rails were in good condition, with coating intact in most areas. There were no signs of loose or missing bolts or fasteners. There was some general surface corrosion noted on the carbon steel surface and bolting hardware. This general surface corrosion was limited and does not represent a current challenge to the capability of the DSC structural supports to perform their function.

These inspections have served to provide a baseline status that will be used in future periodic inspections to trend HSM material conditions. This will help ensure that accelerated degradation will be detected before the HSM structures are unable to perform their design function and that appropriate corrective actions can be implemented.

Industry Operating Experience

Industry operating experience for the ISFSI is conducted in accordance with site's Operating Experience Program. The Operating Experience program reviews issues identified from a variety of sources including NRC, Institute of Nuclear Power Operations, Industry Owner groups, etc. Issues are evaluated and can result in the issue being entered into the CAP and evaluated for whether there is a need for modifying the AMP.

One significant industry operating experience involved Three Mile Island HSMs. In 2000 cracks were noted in the HSMs and the cracks were considered cosmetic and insignificant. However in 2007 the licensee observed continued cracking, crazing, and spalling as well as increased efflorescence on the HSM surfaces. An evaluation was performed which indicated the HSMs were still capable of performing their design basis function. In 2008 it was noted that 28 of 30 HSMs had cracks of which most were emanating from the anchor bolt blockout holes. At this point it was determined the HSMs were prematurely deteriorating and that continued crack growth could affect the HSMs ability to perform their design basis function for the duration of their service life. It was concluded that the cracks were the result of water entering the anchor bolt blockout holes on the roof of the HSMs. Subsequent freeze and thaw cycles initiated the crack formation.

To date Calvert Cliffs has not experienced any cracking that is due to freeze thaw cycles. Although this has not occurred, the lessons learned from this issue will be factored into our visual inspections of the HSM structures including that personnel performing the inspections or evaluations will meet the qualification requirements of ACI 349.3R-02 and that the visual inspections will be performed in accordance with the requirements of ACI 349.3R-02 and ACI 201.1R-08.

A review of industry operating experience identified a large number of events related to dry storage. Many of these were event-driven incidents, and most were not related to aging management. However for the incidents that involved aging mechanisms, barrier analyses were conducted to assess Calvert Cliffs' susceptibility to these mechanisms. Our review indicated the aging mechanisms are bounded by the AMR performed for the Calvert Cliffs structures, systems, and components.

A1.4.6 Learning AMP

The HSM AMP is a "learning" AMP. This means that this AMP will be updated, as necessary, to incorporate new information on degradation due to aging effects identified from plant-specific inspection findings, related industry operating experience, and related industry research. Future plant-specific and industry operating experience is captured through the site's operating experience review process following the regulatory framework for the consideration of operating experience concerning aging management and age-related degradation in LR-ISG-2011-05.

The ongoing review of both plant-specific and industry operating experience will continue through the period of extended operation to ensure that the program continues to be effective in managing the identified aging effects. Calvert Cliffs reviews of operating experience in the future may identify areas where AMPs should be enhanced or new programs developed.

Calvert Cliffs maintains the effectiveness of this AMP under our QAPs used to meet the criteria of 10 CFR Part 72, Subpart G, and 10 CFR Part 50, Appendix B, respectively.

A1.4.7 Conclusion

Operating experience to date has not indicated any significant degradation to any of the HSM components. Inspections and surveillances that would identify any deficiencies continue to be conducted. A CAP is in place to track and correct deficiencies in a timely manner.

The HSM AMP is credited for the management of conditions that could lead to the degradation of HSM subcomponents from the aging effects and mechanisms shown in Table 3.4-1 in Attachment (4), and for the management of actual degradation. Based on the above, the continued implementation of the ISFSI AMP provides reasonable assurance that the aging effects will be managed, such that the intended functions of the HSM components, particularly the structural concrete and steel of the HSMs, will be maintained under current licensing basis conditions for the renewed license period.

Table A1.4-1

Program	Frequency	Inspection
HSM Aging Management	Every 5 years	• The first examination was performed on the selected DSC in June 2012. The HSM/DSC selected for inspection was one that had the longest time in service, and/or other parameters that contributed to degradation. Results were provided in Reference 4. The HSM shall be inspected for interior concrete surface and steel subcomponents. The same HSM/DSC(s) shall be used for each subsequent examination for trending. • Groundwater sampling of poured in place HSMs in a minimum of 3 locations every five years to trend potential for corrosive environment. • Visual inspections of five targeted HSMs by personnel qualified to monitor structures and components for applicable aging effects, such as those described in the ACI Standards 349.3R-02, ACI 201.1R-08, and ANSI/ASCE Standard 11-99. • ACI 349.3R-02 and ANSI/ASCE 11-99 provide an acceptable basis for selection of parameters to be monitored or inspected for concrete and steel structural elements.
	Annually	• Visual inspection of exterior HSM concrete, reinforcing steel and embedments looking for spalled and cracking concrete on all HSMs. • For exterior coated HSM carbon steel subcomponents, no credit is taken for coating for the prevention of aging effect from the AMR. However, this AMP will manage loss of coating integrity due to blistering, cracking, flaking, peeling, or physical damage. • Radiation survey is conducted involving recording radiation levels at the door of each HSM and measuring contamination levels at various points.
	Semi-annually	• ISFSI perimeter TLD results shall be recorded for trending against Federal Limits.
	Daily	• Daily surveillances on all HSM vents are performed by security personnel to ensure the air inlets and outlets are free from obstructions, thereby preventing reduced air flow and potential overheating of the components located inside an HSM.
	Prior to Loading Cask	• Inspect in accordance with plant procedures.

A1.5 TRANSFER CASK AGING MANAGEMENT PROGRAM

The transfer cask is used to transport the DSCs containing the irradiated fuel assemblies from the spent fuel pool (SFP) to the corresponding HSMs (and back as necessary). The transfer cask subcomponents, materials, environments and aging effects requiring management are described in Attachment (1) Section 3.5 of Reference 2.

The purpose of the transfer cask AMP is to ensure that no significant degradation to the transfer cask occurs, with the focus being on the frequently wetted surfaces, as well as carbon steel surfaces, prior to its use for future retrieval of a DSC from the corresponding HSM.

A description of the transfer cask AMP is provided below using the program elements of an effective AMP as listed in section A1.2.

A1.5.1 Materials

The transfer cask AMP is applicable to the transfer cask and subcomponents. The focus of this AMP is on the stainless steel subcomponents that have frequently wetted surfaces and, conservatively, those external surfaces exposed to outdoor conditions and intermittent wetting. It also conservatively includes carbon steel subcomponents that are exposed to weather and other forms of moisture (e.g., humidity).

The program performs visual inspections of the exterior surfaces.

A1.5.2 Environments

Transfer cask structural components subject to AMR are exposed to the following environments:

- Sheltered
- External
- Borated Water in SFP

The transfer cask and lifting yoke are stored in a dry inside environment while not in use for fuel moves. During fuel moves the cask and yoke are washed down with demineralized water upon removal from the pool water. These steps are contained within the site procedure covering the loading and transfer of a DSC from the SFP.

A1.5.3 Aging Effects Requiring Management

The following aging effects associated with the transfer cask structural components require management:

- Loss of material due to general corrosion
- Loss of material due to pitting and crevice corrosion
- Cracking of material due to stress/strain from lifting

A1.5.4 Program Description

The objective of the program is to manage the aging effects of loss of material due to general, pitting, and crevice corrosion of the external surfaces of the components in the transfer cask and cracking of material due to imposed strains during lifting of the cask. The transfer cask AMP consists of visual inspections and penetrant testing of the components of transfer cask and subcomponents. The program manages aging effects through visual inspection of external surfaces of the transfer cask and subcomponents to ensure they are intact and free from loss of material due to general, crevice or pitting corrosion for intermittent wetted surfaces. In addition liquid penetrant exams will be on the cask trunnions including all welds to the trunnions and approximately 2 inches on the cask surface.

A1.5.5 Evaluation and Technical Basis

(1) Scope

This program inspects and monitors the transfer cask and subcomponents to ensure that they are intact and free from loss of material due to general, crevice, or pitting corrosion for intermittent wetted surfaces.

The program performs visual inspections of the cask exterior to prevent the corrosion of exposed surfaces. The program also performs penetrant test (PT) exams on the trunnion welds including 2 inches on the cask surface.

(2) Preventive Actions

The transfer cask AMP includes guidance and direction for maintaining a suitable environment that precludes the onset or propagation of a loss of material due to crevice or pitting corrosion for continuously wetted surfaces. Following it's use all subcomponents that are immersed in the borated water of the SFP are rinsed off with deionized water.

(3) Parameters Monitored or Inspected

The parameter inspected by the transfer cask AMP is visual evidence of degradation of external surfaces of the transfer cask and trunnions. Visual inspection is conducted of the external cask, upper and lower trunnion assembly, and cask lid surfaces. Penetrant testing is conducted on the trunnions and 2 inches on the cask surface.

(4) Detection of Aging Effects

There are two aging effects managed by the transfer cask AMP. The transfer cask AMP manages loss of material for stainless steel subcomponents due to crevice and/or pitting corrosion in wetted locations and for carbon steel subcomponents due to general corrosion in moist atmospheric environments through the performance of visual inspection. The second aging effect that is managed is cracking of material due to stress/strain from lifting through the performance of penetrant testing.

Visual inspections of external cask, upper and lower trunnion assembly, and cask lid surfaces are performed every 5 years or prior to moving a DSC (if no other inspection has been performed), to ensure that the intended function of the cask subcomponents are not compromised. Visual inspections look for signs of deterioration (corrosion). In accordance with ASME Section XI IWA-2211, the VT-1 visual examination is conducted to detect discontinuities and imperfections on the surface of components, including such conditions as cracks, wear, or corrosion in order to provide confidence the transfer cask remains able to perform its intended function.

Penetrant testing will be performed on the four transfer cask trunnions and 2 inches on cask surface. The repetitive task is performed once every five years or prior to moving a DSC. It includes examination of the entire trunnion surface including 2 inches on the cask surface.

The qualification of personnel conducting the visual and penetrant testing for the transfer cask AMP shall be accomplished in accordance with site procedures and shall meet the requirements of ASME Section XI Article IWA-2300. Personnel performing NDE shall be qualified and certified using a written practice prepared in accordance with ANSI/ASNT [American Society for Non-Destructive Testing] CP-189, Standard for Qualification and

Certification of Nondestructive Testing Personnel, as amended by the requirements of ASME Section XI Article IWA-2300.

(5) Monitoring and Trending

Visual and penetrant inspections will determine the existence of loss of material on the external surfaces of the transfer cask, and observations regarding the material condition are recorded in accordance with inspection procedures and are corrected or evaluated as satisfactory before use of the transfer cask.

Evaluation of this information during the preparations for DSC retrieval and transfers provides adequate predictability and allows for corrective action if necessary prior to the need for the intended function of the component to be performed.

(6) Acceptance Criteria

The transfer cask AMP inspections consist of:

- VT-1 examination or equivalent in accordance with (IAW) ASME XI Table 2211-1 for visual evidence of degradation of external surfaces of transfer cask once every five years or prior to each use.
- PT examination of trunnions and 2 inches on cask surface once every five years or prior to each use. PT examination IAW ASME III Division 1 1986, Paragraph NF-5350 and ANSI N14.6 1978.

If corrosion or cracking of material is detected on any of the subcomponents within the transfer cask AMP, the issue would be entered into CAP and an engineering analysis would be performed to determine the extent and impact of the corrosion on the transfer cask's ability to perform its intended function.

(7) Corrective Actions

If indications that exceed acceptance criteria are observed, the issue will be entered into the corrective action process. The issue would be evaluated and may result in supplemental inspections, such as ultrasonic examinations, being performed.
Corrective actions, including root cause determinations are performed in accordance with the CAP. Corrective actions are taken in a timely manner commensurate with the significance of the defect. Deficiencies are either promptly corrected or are evaluated to be acceptable through engineering analysis, which provides reasonable assurance that the intended function is maintained consistent with current licensing basis conditions. Each of the implementing procedures associated with the transfer cask AMP is within the scope of the CAP.

(8) Confirmation Process

Activities initiated in accordance with the implementing procedures for the transfer cask AMP, such as corrective actions, are subject to QAP controls. Thus, the effectiveness is monitored using CAP procedures, review and approval processes, and administrative controls, which are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. Use of the procedures, processes, and controls ensures that corrective actions are taken and are effective.

(9) Administrative Controls

The transfer cask AMP is subject to Corrective Action and QAP procedures, review and approval processes, and administrative controls. These are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B, and will continue to be adequate for the renewed license (extended storage) period.

(10) Operating Experience

The ISFSI has been in operation since 1992. The transfer cask has been in use since the initial loading of the ISFSI.

Inspections have been performed on the transfer cask prior to each movement to the ISFSI. These examinations and inspections are currently performed in accordance with a combination of procedures. The overall effectiveness of these inspections in maintaining the condition and functionality of the cask is confirmed by the continued use of the cask. Any deficiencies identified are promptly corrected prior to moving fuel. This same process will be followed, as applicable, for moving the DSCs from the HSM back to the Calvert Cliffs SFP.

A discussion of pertinent operating experience is contained in Section 3.1.5 of Reference 2. Furthermore, the lack of identification of cask degradation through the existing inspections is evidence that transfer cask activities have been effective in maintaining its condition and functionality.

A review of the operating experience provided objective evidence that the effects of aging have, and will continue to be, adequately managed during the extended period of operation.

A1.5.6 Learning AMP

The transfer cask AMP is a "learning" AMP. This means that this AMP will be updated, as necessary, to incorporate new information on degradation due to aging effects identified from plant-specific inspection findings, related industry operating experience, and related industry research. Future plant-specific and industry operating experience is captured through the licensee's operating experience review process following the regulatory framework for the consideration of operating experience concerning aging management and age-related degradation in LR-ISG-2011-05.

The ongoing review of both plant-specific and industry operating experience will continue through the period of extended operation to ensure that the program continues to be effective in managing the identified aging effects. Reviews of operating experience by the licensee in the future may identify areas where AMPs should be enhanced or new programs developed.

Calvert Cliffs maintains the effectiveness of this AMP under our QAPs used to meet the criteria of 10 CFR Part 72, Subpart G, and 10 CFR Part 50, Appendix B, respectively.

A1.5.7 Summary

The transfer cask AMP is credited for the management of conditions that could lead to degradation of transfer cask subcomponents from the aging effects and mechanisms shown in Table 3.5-1 in Attachment (4), and for the management of actual degradation. Based on the above, the continued implementation of the transfer cask AMP activities shown in Table A1.5-1 will provide reasonable assurance that aging effects will be managed, such that the transfer cask subcomponents within the scope of license renewal will continue to perform their intended functions consistent with the current licensing basis throughout the renewed license period.

Table A1.5-1

Program	Frequency	Inspection
Transfer Cask Aging Management	Every five years and prior to each use IAW ANSI/ASME III Division 1 1986 and ANSI N14.6 1978	• To perform visual inspection of transfer cask exterior surfaces and of carbon steel bolts/washers looking for signs of significant degradation (corrosion) every five years as a minimum and before every fuel move. • To perform PT examination on trunnions and all attachment welds to trunnions including 2 inches on the cask surface and follow up with ultrasonic testing examination if indications are found.

A1.6 TRANSFER CASK LIFTING YOKE AGING MANAGEMENT PROGRAM

The transfer cask lifting yoke is used to move the transfer cask between the SFP and the transport trailer. The transfer cask lifting yoke, materials, environments and aging effects requiring management are described in Attachment (1), Section 3.6, of Reference 2.

The purpose of the transfer cask lifting yoke AMP is to ensure that no significant degradation to the transfer cask lift yoke occurs, with the focus being on the repeatedly and intermittently wetted surfaces prior to its use for movement of the transfer cask.

A description of the transfer cask lifting yoke AMP is provided below using the program elements of an effective AMP as listed in Section A1.2.

A1.6.1 Materials

Transfer cask lifting yoke structural components subject to AMR are constructed of the following material:

- Carbon Steel
- Stainless Steel

A1.6.2 Environments

Transfer cask lifting yoke structural components subject to AMR are exposed to the following environments:

- Sheltered
- Treated water (SFP borated water)

The transfer cask and lifting yoke are stored in a dry inside environment while not in use for fuel moves. During fuel moves the cask and lifting yoke are washed down with demineralized water upon removal from the pool water. These steps are contained within the site procedure covering the loading and transfer of a DSC from the SFP.

A1.6.3 Aging Effects Requiring Management

The following aging effects associated with the transfer cask lifting yoke structural components require management:

- Loss of material due to general corrosion from wetting
- Loss of material due to pitting and crevice corrosion from wetting
- Cracking of material due to stress/strain from lifting

A1.6.4 Program Description

The objective of the program is to manage the aging effects of loss of material due to the consequences of wetting and cracking of the yoke due to imposed strains during lifting of the cask. The transfer cask lifting yoke AMP is based on visual inspections and magnetic test exams. This program consists of visual inspections of the yoke and volumetric exams. The program manages aging effects through visual inspection of external surfaces of the transfer cask lifting yoke and subcomponents and ensures they are intact and free from loss of material due to corrosion for intermittent wetted surfaces and strain of material due from lifting of the cask.

A1.6.5 Evaluation and Technical Basis

(1) Scope

The transfer cask lifting yoke AMP is applicable to the transfer cask lifting yoke. The focus of this AMP is on the components that have external surfaces exposed to intermittent wetting and critical lifting components subject to strain.

The program performs visual inspections of the exterior surfaces for corrosion as a result of periodic wetting from normal use that includes exposures to SFP water and cracking as a result of applied loads during lifting operations.

(2) Preventive Actions

The transfer cask lifting yoke AMP includes guidance and direction for maintaining a suitable environment that precludes the onset or propagation of a loss of material due to corrosion for intermittently wetted surfaces. Following its use all subcomponents that are immersed in the borated water of the SFP are rinsed off with deionized water.

(3) Parameters Monitored or Inspected

The parameter inspected by the transfer cask lifting yoke AMP is visual evidence of degradation of external surfaces of the transfer cask lifting yoke. This is done via visual inspection of the subcomponents of the transfer cask lifting yoke and through magnetic particle testing of the lifting hooks and areas around the lifting pin hole.

(4) Detection of Aging Effects

Loss of material due to corrosion in wetted locations or due to general corrosion in moist atmospheric environments is an aging effect that is managed by this AMP. The transfer cask lifting yoke inspection consists of both magnetic particle testing and visual testing of the transfer cask lifting yoke. This repetitive task is performed annually or prior to moving a DSC (if no other inspection has been performed). As part of the inspection, yoke dimensions are checked and areas of flaking paint are identified and repainted. During this latest inspection no issues that would impact the ability of the transfer cask lifting yoke to perform its intended function were identified.

The qualification of personnel conducting the visual and magnetic particle testing for the transfer cask lifting yoke AMP shall be accomplished in accordance with site procedures and shall meet the requirements of ASME Section XI Article IWA-2300. Personnel performing NDE shall be qualified and certified using a written practice prepared in accordance with ANSI/ASNT CP-189, Standard for Qualification and Certification of Nondestructive Testing Personnel, as amended by the requirements of ASME Section XI Article IWA-2300.

(5) Monitoring and Trending

Visual inspections will determine the existence of loss of material on the external surfaces of the transfer cask lifting yoke, and observations regarding the material condition are recorded in accordance with inspection procedures. These issues are corrected or evaluated as satisfactory before use of the transfer cask lifting yoke.

Evaluation of this information during the preparations for DSC retrieval and transfers provides adequate predictability and allows for corrective action, if necessary, prior to the need for the intended function of the component to be performed.

(6) Acceptance Criteria

The acceptance criteria for the transfer cask lifting yoke AMP for exterior surfaces is no unacceptable loss of material that could result in a loss of component intended function(s).

- Perform NDE Inspections IAW ANSI/ASME III Division 1 1986 and ANSI N14.6 1978 (refer to MPM10151G-Hook and Yoke Baseline data).
- Perform magnetic test IAW ANSI/ASME Section III, 1986 Paragraph NF-5340.

Unsatisfactory results in accordance with baseline data and Code requirements will be entered in the CAP for evaluation and resolution.

(7) Corrective Actions

Corrective actions, including root cause determinations and prevention of recurrence, are performed in accordance with the CAP. Corrective actions are taken in a timely manner commensurate with the significance of the defect. Deficiencies are either promptly corrected or are evaluated to be acceptable through engineering analysis, which provides reasonable assurance that the intended function is maintained consistent with current licensing basis conditions. Each of the implementing procedures associated with the transfer cask lifting yoke AMP is within the scope of the CAP.

(8) Confirmation Process

Activities initiated in accordance with the implementing procedures for the transfer cask lifting yoke AMP, such as corrective actions, are subject to QAP controls. Thus, the effectiveness is monitored using CAP procedures, review and approval processes, and administrative controls, which are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. Use of the procedures, processes, and controls ensures that corrective actions are taken and are effective.

(9) Administrative Controls

The transfer cask lifting yoke AMP is subject to Corrective Action and QAP procedures, review and approval processes, and administrative controls. These are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B, and will continue to be adequate for the renewed license (extended storage) period.

(10) Operating Experience

The ISFSI has been in operation since 1992. The transfer cask lifting yoke has been in use since the initial loading of the ISFSI.

Inspections are performed on the transfer cask lifting yoke annually. These examinations and inspections are currently performed in accordance with a combination of procedures. Any deficiencies identified are promptly corrected prior to shipping fuel.

A discussion of pertinent operating experience is contained in Section 3.1.5 of Reference 2. Furthermore, the lack of identification of transfer cask lifting yoke degradation through the existing inspections is evidence that transfer cask lifting yoke activities have been effective in maintaining the condition and functionality of the transfer cask lifting yoke.

A review of the operating experience provided objective evidence that the effects of aging have, and will continue to be, adequately managed during the extended period of operation.

A1.6.6 Learning AMP

The Transfer Cask Lifting Yoke AMP is a "learning" AMP. This means that this AMP will be updated, as necessary, to incorporate new information on degradation due to aging effects identified from plant-specific inspection findings, related industry operating experience, and related industry research. Future plant-specific and industry operating experience is captured through the licensee's operating experience review process following the regulatory framework for the consideration of operating experience concerning aging management and age-related degradation in LR-ISG-2011-05.

The ongoing review of both plant-specific and industry operating experience will continue through the period of extended operation to ensure that the program continues to be effective in managing the identified aging effects. Reviews of operating experience by the licensee in the future may identify areas where AMPs should be enhanced or new programs developed.

Calvert Cliffs maintains the effectiveness of this AMP under our respective QAPs used to meet the criteria of 10 CFR Part 72, Subpart G, and 10 CFR Part 50, Appendix B, respectively.

A1.6.7 Conclusion

The transfer cask lifting yoke AMP is credited for the management of relevant conditions that could lead to degradation of transfer cask lifting yoke subcomponents from the associated aging effects/mechanisms as shown in Table 3.6-1 of Attachment (4), and for the management of actual degradation. Based on the above, the continued implementation of the transfer cask lifting yoke AMP activities shown in Table A1.6-1 will provide reasonable assurance that aging effects will be managed, such that the transfer cask lifting yoke subcomponents within the scope of license renewal will continue to perform their intended functions consistent with the current licensing basis throughout the renewed license period.

Table A1.6-1

Program	Frequency	Inspection
Transfer Cask Lifting Yoke Aging Management	Annually	• To perform visual inspection focusing on subcomponents that which external surfaces are exposed to intermittent wetting. o Loss of material due to pitting and crevice corrosion from wetting • Cracking due to stress/strain from lifting o Perform NDE Inspections IAW ANSI/ASME III 1986 and ANSI N14.6 1978 (refer to MPM10151G-Hook and Yoke Baseline data). o Perform magnetic test IAW ANSI/ASME Section III, 1986 Paragraph NF-5340.

A1.7 CASK SUPPORT PLATFORM AGING MANAGEMENT PROGRAM

The cask support platform sits in the SFP cask loading pit area which positions the transfer cask at the appropriate elevation for loading irradiated fuel assemblies into the DSC. The cask support platform materials, environments and aging effects requiring management are described in Attachment (1), Section 3.7 of Reference 2.

The purpose of the cask support platform AMP is to ensure that no significant degradation occurs while the cask support platform is in the borated water environment of the SFP.

A description of the cask support platform aging management is provided below using the program elements of an effective AMP as listed in section A1.2.

A1.7.1 Materials

- Stainless Steel

A1.7.2 Environments

- Borated water in the SFP

The chemistry of the SFP is maintained to control leachable chlorides and fluorides in order to maintain a non-corrosive environment for the stainless liner, fuel racks, and components and cask support platform and other structures stored in the pool.

A1.7.3 Aging Effects Requiring Management

The cask support platform AMP includes guidance and direction for maintaining a suitable environment that precludes the onset or propagation of a loss of material and cracking due to pitting and/or stress corrosion for stainless steel components in the SFP.

A1.7.4 Program Description

The cask support platform AMP credits the Chemistry Control Program which monitors chlorides in the SFP water.

A1.7.5 Evaluation and Technical Basis

(1) Scope

The cask support platform AMP is applicable to the cask support platform and the pertinent subcomponents. The focus of this AMP is on the stainless steel subcomponents that are continuously exposed to borated water.

(2) Preventive Actions

The cask support platform AMP credits the Chemistry Control Program which monitors chlorides in the SFP water.

(3) Parameters Monitored or Inspected

The parameter inspected by the cask support platform AMP is the chloride concentration in the SFP water. Samples are taken on a monthly basis.

(4) Detection of Aging Effects

Loss of material and cracking for stainless steel subcomponents, due to pitting and/or stress corrosion in borated water, and for stainless steel subcomponents, is an aging effect that is managed by this AMP.

The cask support platform AMP relies on our Chemistry Control Program to monitor chloride levels in the SFP to ensure conditions that would be conducive to the onset or propagation of loss of material and cracking due to pitting and/or stress corrosion in this stainless steel platform do not occur. Under our Chemistry Control Program, a chloride sample of the SFP water is taken monthly and compared to the target threshold value (<100 ppb). The target value selected by Calvert Cliffs is more conservative than the target recommendation specified in the EPRI PWR Primary Guidelines of <150 ppb.

A review of the SFP chloride sample values taken during the last three years showed no instances where our conservative threshold value was exceeded. Furthermore, the SFP ion exchanger effluent is sampled and analyzed once a month. Trending is routinely performed to identify any degrading trends. The SFP ion exchanger resin is replaced annually prior to the refueling outage to ensure adequate cleanup capacity exists.

(5) Monitoring and Trending

Chloride sampling will determine whether conditions favorable for development of this aging effect have developed. In that event, additional inspections would be required before use of the cask support platform.

(6) Acceptance Criteria

The acceptance criterion for the cask support platform AMP is SFP chlorides within acceptable limits. Unsatisfactory conditions would be entered into CAP for resolution and monitoring.

Since initial operation, and continuing through present day operation, Calvert Cliffs has maintained a well-defined Chemistry Control Program for fluid systems. A key aspect of the Chemistry Control Program is the sampling and analysis of fluid systems to determine the concentration of chemical impurities and chemical additives. Fluid systems at Calvert Cliffs are sampled and analyzed by procedure. Parameters monitored, frequency of sampling, acceptance criteria (i.e., specifications), and corrective actions for out-of-specification results are similarly addressed by procedure. Chemistry data for monitored parameters is routinely trended to identify subtle trends in the data which may be indicative of an underlying operational problem. In many cases, this allows correction prior to a parameter becoming out-of-specification.

(7) Corrective Actions

Corrective actions, including root cause determinations and prevention of recurrence, are performed in accordance with the CAP. Corrective actions are taken in a timely manner commensurate with the significance of the defect. Deficiencies are either promptly corrected or are evaluated to be acceptable through engineering analysis, which provides reasonable assurance that the intended function is maintained consistent with current licensing basis conditions. Each of the implementing procedures associated with the cask support platform AMP is within the scope of the CAP.

(8) Confirmation Process

Activities initiated in accordance with the implementing procedures for the cask support platform AMP, such as corrective actions, are subject to QAP controls. Thus, the effectiveness is monitored using CAP procedures, review and approval processes, and administrative controls, which are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. Use of the procedures, processes, and controls ensures that corrective actions are taken and are effective.

(9) Administrative Controls

The cask support platform AMP is subject to corrective action and QAP procedures, review and approval processes, and administrative controls. These are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B, and will continue to be adequate for the renewed license (extended storage) period.

(10) Operating Experience

A review of plant operating experience for the cask support platform was conducted as part of our license renewal application. This review did not identify any occurrences of unsatisfactory degradation associated with the cask support platform. These results further support that maintaining and monitoring of the SFP water conditions provides reasonable assurance that the cask support platform will be able to continue to perform its intended function throughout the license renewal period.

A1.7.6 Learning AMP

The Cask Support Platform AMP is a "learning" AMP. This means that this AMP will be updated, as necessary, to incorporate new information on degradation due to aging effects identified from plant-specific inspection findings, related industry operating experience, and related industry research. Future plant-specific and industry operating experience is captured through the licensee's operating experience review process following the regulatory framework for the consideration of operating experience concerning aging management and age-related degradation in LR-ISG-2011-05.

The ongoing review of both plant-specific and industry operating experience will continue through the period of extended operation to ensure that the program continues to be effective in managing the identified aging effects. Reviews of operating experience by the licensee in the future may identify areas where AMPs should be enhanced or new programs developed.

Calvert Cliffs maintains the effectiveness of this AMP under our QAPs used to meet the criteria of 10 CFR Part 72, Subpart G, and 10 CFR Part 50, Appendix B, respectively.

A1.7.7 Summary

The overall effectiveness of the chemistry program is supported by the excellent operating experience for those systems, structures, and components influenced by the Chemistry Control Program.

The cask support platform AMP credits the Chemistry Control Program for the management of relevant conditions that could lead to degradation of cask support platform subcomponents from the associated aging effects/mechanisms as shown in Table 3.7-1 of Reference 2, and for the management of actual degradation. Based on the above, the continued implementation of the cask support platform AMP activities shown in Table A1.7-1 will provide reasonable assurance that aging effects will be managed, such that the cask support platform subcomponents within the scope of license renewal will continue to perform their intended functions consistent with the current licensing basis throughout the renewed license period.

Table A1.7-1

Program	Frequency	Inspection
Cask Support Platform Aging Management	Monthly	• The Chemistry Control Program monitors chloride concentration in SFP to ensure favorable conditions for stress corrosion/ pitting do not occur.

A1.8 HIGH BURNUP FUEL AGING MANAGEMENT PROGRAM

The Calvert Cliffs ISFSI provides for long-term dry fuel interim storage for high burnup spent fuel assemblies, i.e., fuel assemblies with discharge burnups greater than 45 GWd/MTU, until such time that the spent fuel assemblies may be shipped off-site for final disposition.

A1.8.1 Materials

As discussed in Section 3.2.2. of Reference 2, the materials of construction for the subcomponents of each irradiated fuel assemblies that are subject to AMR are zirconium-based alloy (presently Zircaloy-4 or Zirlo), stainless steel, and nickel-based alloy (Inconel). This program will also be designed to cover future NUHOMS-32PHB DSC loadings (Reference 15) which may also include fuel assemblies using the zirconium-based alloy M5.

A1.8.2 Environments

The environments normally experienced by the irradiated fuel assembles while in the DSCs are described in Section 3.2.3 of Reference 2.

External Environment

For irradiated fuel assemblies, external environment refers to the internal DSC atmosphere. The internal DSC atmosphere is predominantly helium with trace amounts of water vapor and air. The DSC external surfaces AMP (see section A1.3) provides for the maintenance of the DSC intended function of confinement, thereby ensuring that this environment is maintained during the period of extended operation.

Additionally, residual boron may coat the irradiated fuel assemblies surfaces since they were exposed to a borated water environment in the SFP prior to storage. Any boric acid residue remaining on the irradiated fuel assemblies will have no deleterious effects due to the minimal amount of water present in the storage atmosphere and the materials of construction for the irradiated fuel assemblies.

Temperatures experienced by fuel assembly cladding materials during loading and transfer operations are below the 752°F (400°C) temperature limit for high burnup fuel recommended in Interim Staff Guidance (ISG)-11 Revision 3 (Reference 14), and repeated thermal cycling of the fuel does not occur. Following initial cask loading, the temperature of the fuel cladding was limited to less than 635°F (335°C) for normal storage conditions (ISFSI USAR Table 1.2-1). Fuel cladding temperature will then decrease over time while in dry storage.

Internal Environment

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

A1.8.3 Aging Effects Requiring Management

As discussed in Section 3.2.6 of Reference 2, the AMR of the spent fuel assemblies in a dry inert environment did not identify any aging effects/mechanisms that could lead to a loss of intended function. However, it is recognized that there has been relatively little operating experience, to date, with dry storage of high burnup fuel. Reference 16 provides a listing of a significant amount of scientific analysis examining the long term performance of high burnup spent fuel. These analyses provide a sound foundation for the technical basis that long term storage of high burnup fuel, i.e., greater than 20 years, may be performed safely and in compliance with regulations. However, it is also recognized that scientific analysis is not a complete substitute for confirmatory operating experience. This AMP will provide confirmatory data needed to validate these analyses for high burnup fuel in a manner similar to the way that References 17 and 18 provided data to confirm that low burnup fuel (≤45 GWd/MTU) would maintain its integrity in dry cask storage over extended time periods.

A1.8.4 Program Description

A description of the High Burnup Fuel AMP is provided in Section A1.8.5 below. Although the program is a confirmatory program, the description below uses each attribute of an effective AMP as described in NUREG-1927 for the renewal of a site-specific Part 72 license to the extent possible.

A1.8.5 Evaluation of Technical Basis

(1) Scope

The High Burnup Fuel AMP relies upon the joint EPRI and Department of Energy "High Burnup Dry Storage Cask Research and Development Project" (HDRP) or an alternative program meeting the guidance in ISG-24, Reference 19, as a surrogate program to monitor the condition of high burnup spent fuel assemblies in dry storage.

The HDRP is a program designed to collect data from a spent nuclear fuel storage system containing high burnup fuel in a dry helium environment. The program entails loading and storing a TN-32 bolted lid cask (the Research Project Cask) at Dominion Virginia Power's North Anna Power Station with intact high burnup spent nuclear fuel (with nominal burnups ranging between 53 GWd/MTU and 58 GWd/MTU). The fuel assemblies to be used in the program include four different kinds of cladding (Zircaloy-4, low-tin Zircaloy-4, Zirlo, and M5), which cover the range of fuel cladding materials in use at Calvert Cliffs (discussed in Section A1.8.1). The Research Project Cask is to be licensed to the temperature limits recommended in Reference 14, and loaded such that the fuel cladding temperature is as close to the limit as practicable. Aging effects will be determined for material/environment combinations per Reference 19 or the "High Burnup Dry Storage Cask Research and Development Project" (HDRP).

The Calvert Cliffs ISFSI Technical Specification 3.1.1(3) limits the maximum assembly average burnup to 47 GWd/MTU for the NUHOMS-24P DSC and 52 GWd/MTU for the NUHOMS-32P DSC. As can be seen in Figure 1-1 of Reference 5, the majority (99.7%) of fuel assemblies loaded in the NUHOMS-24P DSCs have assembly average burnups below 45 GWd/MTU, and would therefore be considered low burnup fuel. The four assemblies which have burnups above 45 GWd/MTU, exceed this value by only 0.09 to 0.82 GWd/MTU, and can essentially be considered low burnup fuel as well. The 24 NUHOMS-32P DSCs loaded as of November 2012 do however contain significant amounts of high burnup fuel. As can be seen in Figure 1-2 of Reference 5, ~49% of the fuel stored in these NUHOMS-32P DSCs exceeds 45 GWd/MTU, and every DSC contains at least one assembly in this range. However, 98.7% of the fuel stored in the NUHOMS-32P DSCs has a burnup less than 49 GWd/MTU, and only one assembly exceeds 50 GWd/MTU (50.564 GWd/MTU specifically). No fuel exceeding 46.25 GWd/MTU was loaded prior to the September 2010 approval of License Amendment 9 which increased the burnup limit for the NUHOMS-32P DSC from 47 to 52 GWd/MTU. Therefore, the HDRP will be representative of the assembly average burnup of high burnup fuel in dry storage at Calvert Cliffs.

Fuel to be loaded in the future NUHOMS-32PHB DSCs will also be covered by this AMP upon NRC approval of that license amendment request. While the NUHOMS-32PHB will have an assembly average burnup limit of 62 GWd/MTU (Reference 15) the 10 CFR Part 50 license conditions of the plant limit the peak rod burnup to less than 62 GWd/MTU. This means that actual assembly average burnups will be less than the 58 GWd/MTU burnup being loaded in the HDRP.

(2) Preventive Actions

The High Burnup Fuel Monitoring Program consists of condition monitoring to confirm there is no degradation of a high burnup fuel assembly that would result in a loss of intended function(s). No new preventive or mitigating attributes are associated with these activities.

However, the existing design limits placed on loading operations constitute preventative actions against aging of high burnup fuel assemblies. During the initial loading operations of the DSCs in use at Calvert Cliffs, the design and ISFSI Technical Specifications require that the fuel be stored in a dry inert environment. Technical Specification 2.2.1, "DSC Vacuum Drying," demonstrates that the cask cavity is dry by maintaining a cavity absolute pressure less than or equal to 3 torr for a 30 minute period with the cask isolated from the vacuum pump. Per ISFSI USAR Section 4.3.1, when the pressure can be held at 3 torr for at least 30 minutes, this indicates that all liquid water has evaporated in the DSC cavity, and that the resulting inventory of oxidizing gases is less than 0.25% (Vol%). Technical Specification 2.2.2, "DSC Helium Backfill Pressure," requires that the cask then be backfilled with helium. These two Technical Specifications requirements ensure that the high burnup fuel is stored in an inert environment thus preventing cladding degradation due to oxidation mechanisms.

Furthermore, the actual conditions of loading and storage also constitute actions to prevent age-related degradation of high burnup fuel cladding. As described in Section A1.8.2, design basis calculations demonstrate that peak cladding temperatures (PCTs) are maintained below the Reference 14 recommended limit of 400°C established to protect high burnup fuel cladding from aging mechanisms such as creep or embrittlement due to redissolution and precipitation of hydrides in a radial orientation. In practice, the actual NUHOMS-32P loadings at Calvert Cliffs have generally maintained substantial additional margin to the 400°C PCT limit due to less than design basis heat loads, milder ambient conditions than design basis, and the limited durations of the loading and transfer stages. As described in Reference 5, it is estimated that 96% of the NUHOMS-32P DSCs (which are the only DSCs loaded with high burnup fuel to date at Calvert Cliffs) have maintained at least 50°C margin to the Reference 14 limit during the loading and transfer process, and over half have maintained greater than 100°C of margin. The margin afforded by these lower PCTs in terms of the degree of radial hydride precipitation was evaluated in detail during the period 2000 to 2002 as a result of interactions between Nuclear Energy Institute, EPRI, and the NRC. These evaluations are compiled in Reference 20, and eventually were used as part of the supporting basis for the 400°C limit that first appeared in Reference 14. One of the principal developments of Reference 20 was a radial hydride precipitation model as a function of cladding hoop stress and PCT at the beginning of storage. Reference 21, Table 2-2, provides the latest analyses using that model, and indicate that the concentration of radial hydrides for a given cladding hoop stress is a factor 4 times lower than the 400°C value with 50°C of margin, and almost a factor of 10 times lower with 100°C of margin. It is expected that the high burnup fuel AMP will provide positive confirmation of the effectiveness of this preventative measure during the renewal period.

(3) Parameters Monitored or Inspected

Either the surveillance demonstration program as described in the HDRP or an alternative program should meet the guidance of Reference 19.

(4) Detection of Aging Effects

Either the surveillance demonstration program as described in the HDRP or an alternative program should meet the guidance of Reference 19.

(5) Monitoring and Trending

As information/data from a fuel performance surveillance demonstration program becomes available, Calvert Cliffs will monitor, evaluate, and trend the information via its Operating Experience Program and/or the CAP to determine what actions should be taken to manage fuel and cladding performance, if any.

Similarly, Calvert Cliffs will use its Operating Experience Program and/or CAP to determine what actions should be taken if it receives information/ data from other sources than the demonstration program on fuel performance

Formal evaluations of the aggregate feedback from the HDRP and other sources of information will be performed at the specific points in time during the period of extended operation delineated in the Table A1.8-1 below. These evaluations will include an assessment of the continued ability of the high burnup fuel assemblies to continue to perform their intended function(s) at each point.

The Table A1.8-1 assessments are not, by definition, stopping points. No particular action, unless noted in this AMP, other than performing an assessment is required to continue cask operation. To proceed, an assessment of aggregated available operating experience (both domestic and international), including data from monitoring and inspection programs, NRC-generated communications, and other information will be performed. The evaluation will include an assessment of the ability of the high burnup fuel assemblies to continue to perform their intended function(s).

Table A1.8-1, High Burnup Fuel AMP Toll Gate Assessments

Toll Gate	Year*	Assessment
1	2028	Evaluate information obtained from the HDRP loading and initial period of storage along with other available sources of information. If the HDRP NDE (i.e., cask gas sampling, temperature data) has not been obtained at this point and no other information is available then Calvert Cliffs has to provide evidence to the NRC that no more than 1% of the high burnup fuel has failed.
2	2038	Evaluate, if available, information obtained from the destructive and nondestructive examination of the fuel placed into storage in the HDRP along with other available sources of information. If the aggregate of this information confirms the ability of the high burnup fuel assemblies to continue to perform intended function(s) for the remainder of the period of extended operations, subsequent assessments may be cancelled. If the HDRP destructive examination of the fuel has not been examined at this point and no other information is available then Calvert Cliffs has to provide evidence to the NRC by opening a cask or single effects surrogate experiments that the fuel performance acceptance criteria 1-4 in Section A1.8.5.6 continue to be met.

Toll Gate	Year*	Assessment
3	2048	Evaluate any other new information.

* Assessments are due by April 4 of the year identified in the table.

(6) Acceptance Criteria

- The HDRP or any other demonstration used to provide fuel performance data should meet the acceptance criteria guidance of Reference 19.
- If any of the following fuel performance criteria are exceeded in the HDRP or alternative program, a corrective action is required:
  1. Cladding Creep: total creep strain extrapolated to the total approved storage duration based on the best fit to the data, accounting for initial condition uncertainty shall be less than 1%
  2. Hydrogen – maximum hydrogen content of the cover gas over the approved storage period shall be extrapolated from the gas measurements to be less than 5%
  3. Drying – The moisture content in the cask, accounting for measurement uncertainty, shall indicate no greater than one liter of residual water after the drying process is complete
  4. Fuel rod breach – fission gas analysis shall not indicate more than 1% of the fuel rod cladding breaches
- While it is not a fuel performance criteria, the spatial distribution and time history of the cladding temperature must be known to evaluate the relationship between the performance of the rods in the HDRP and the high burnup fuel rod behavior expected in the DSCs in use at Calvert Cliffs. If the results of the HDRP or other any other demonstration used to provide data are found to be not representative of the temperature history of high burnup fuel in storage at Calvert Cliffs, a corrective action will be initiated to drive an update to the aging management approach for this subset of the high burnup fuel population.

(7) Corrective Actions

The Calvert Cliffs CAP commensurate with 10 CFR 50, Appendix B will be followed.

In addition, at each of the assessments in Section A1.8.5.5, the impact of the aggregate feedback will be assessed and actions taken when warranted. These evaluations will address any lessons learned and take appropriate corrective actions, including:

- Perform repairs or replacements
- Modify this confirmatory program in a timely manner
- Adjust age-related degradation monitoring and inspection programs (e.g., scope, frequency)
- Actions to prevent reoccurrence
- An evaluation of the DSCs to perform it's safety and retrievability functions
- Evaluation of the effect of the corrective actions on this component to other safety components.

(8) Confirmation Process

The confirmation process is part of the Calvert Cliffs CAP and ensures that the corrective actions taken are adequate and appropriate, have been completed, and are effective. The focus of the confirmation process is on the follow-up actions that must be taken to verify effective implementation of corrective actions. The measure of effectiveness is in terms of correcting the adverse condition and precluding repetition of significant conditions adverse to quality. Procedures include provisions for timely evaluation of adverse conditions and implementation of any corrective actions required, including root cause evaluations and prevention of recurrence where appropriate. These procedures provide for tracking, coordinating, monitoring, reviewing, verifying, validating, and approving corrective actions, to ensure effective corrective actions are taken.

(9) Administrative Controls

The Calvert Cliffs QAP, associated formal review and approval processes, and administrative controls applicable to this program and Aging Management Activities, are implemented in accordance with the requirements of the Calvert Cliffs Quality Assurance Topical Report and 10 CFR Part 50, Appendix B. The administrative controls that govern aging management assets at Calvert Cliffs are established in accordance with Exelon Fleet Procedures.

(10) Operating Experience

Surrogate surveillance demonstration programs with storage conditions and fuel types similar to those in the dry storage system that satisfies the acceptance criteria recommended in ISG-24 are a viable method to obtain operating experience. Calvert Cliffs intends to rely on the information from the HDRP with similar types of high burnup fuel. The HDRP is viable as a surrogate surveillance program. Additional data/research to assess fuel performance from both domestic and international sources that are relevant to the fuel in the Calvert Cliffs DSCs will also be used.

A1.8.6 Conclusion

The High Burnup Fuel AMP is a "Learning AMP" that is designed to update/revise the approach to aging management of high burnup fuel to reflect the findings of the HDRP as they become available, as well as incorporate other sources of operational experience and research conducted by industry, Department of Energy, or NRC.

A1.9 REFERENCES

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ATTACHMENT (3)

REVISED AGING MANAGEMENT REVIEW RESULT TABLES

Table 3.2-1, Aging Management Review Results for the Irradiated Fuel Assemblies

Subcomponent	Intended Function	Material Group	Environment	Aging Effects Requiring Management	Aging Management Activities
Fuel Rod (Cladding and End Caps)	CC, HT, PB, SS	Zircaloy-4, Zirlo,M5[4]	Air and Gas[1,2] Residual Boron Coating[3]	None Identified	None Required[4]
Guide Tubes	SS	Zircaloy-4 Stainless Steel (Chrome Plated)	Air and Gas[1]	None Identified	None Required[4]
Spacer Grid Assemblies	CC, SS	Zircaloy-4	Air and Gas[1]	None Identified	None Required[4]
Lower End Fitting (and Connectors)	SS (CC, SS)	Stainless Steel Inconel	Air and Gas[1]	None Identified	None Required[4]
Upper End Fitting (Connectors and Holddown Spring)	SS	Stainless Steel Inconel X-750	Air and Gas[1]	None Identified	None Required[4]
Holddown Spring Retainer and Upper End Plugs	None	N/A	N/A	N/A	N/A
Fuel Assembly Control Components	None	N/A	N/A	N/A	N/A
Fuel Rod Pellets and Other Internal Portions	None	N/A	N/A	N/A	N/A

Table 3.2-1, Aging Management Review Results for the Irradiated Fuel Assemblies

Notes:

[1] Air and gas environment outside the fuel rods (inside the DSC) is helium at atmospheric pressure with trace amounts of air and water vapor. Minimal amounts of fission product gases may also be present. Temperature and radiation have been considered as described in Section 3.2.3, Environments for the Irradiated Fuel Assemblies.

[2] Air and gas environment inside the fuel rods is pressurized helium and fission product gases. Temperature and radiation have been considered as described in Section 3.2.3, Environments for the Irradiated Fuel Assemblies.

[3] Residual boron may coat the irradiated fuel assemblies surfaces since they were exposed to a borated water environment in the SFP prior to storage. Any boric acid residue remaining on the irradiated fuel assemblies will have no deleterious effects due to the minimal amount of water remaining on the irradiated fuel assembles and the materials of construction for the irradiated fuel assemblies.

[4] A confirmatory program for high burnup fuel is being performed by the Department of Energy which will monitor the condition of high burnup fuel assemblies in dry storage. This confirmatory program includes Zircaloy-4, Zirlo, and M5 cladding materials that have been used at Calvert Cliffs but may not yet have been placed into dry storage at the time of ISFSI license Renewal.

CC Provides criticality control of spent fuel
HT Provides heat transfer
PB Directly or indirectly maintains a pressure boundary (confinement)
SS Provides structural support and/or functional support of important to safety equipment (structural integrity)
N/A Not applicable

Table 3.3-1, Aging Management Review Results for the DSCs (NUHOMS-24P and 32P)

Subcomponent[1]	Intended Function	Materials	Environment	Aging Effect/Mechanism	Aging Management Activities
Basket	SS, CC	Stainless Steel	Air and Gas[2,4]	None Identified	None Required
Guide Sleeves (Basket)	SS, CC	Stainless Steel	Air and Gas[2,4]	None Identified	None Required
Spacer Disks (Basket)	SS,CC	Stainless Steel / Aluminum Coated Carbon Steel	Air and Gas[2,4]	None Identified	None Required
Support Rods (Basket)	SS, CC	Stainless Steel / Aluminum Coated Carbon Steel	Air and Gas[2,4]	None Identified	None Required
Rails (Basket)	SS	Stainless Steel	Air and Gas[2,4]	None Identified	None Required
Rail Inserts (Basket)	SS	Aluminum	Air and Gas[2,4]	None Identified	None Required
Fixed Neutron Absorbers (Basket)	CC	Borated Aluminum Alloy	Sheltered[3]	None Identified	None Required
DSC Shell w/ Bottom shield Plug	PB, SH, SS, HT	Stainless Steel and Lead	Air and Gas[2] Sheltered[3]	Loss of Material due to Crevice and Pitting Corrosion Cracking from Stress Corrosion Cracking	DSC External Surfaces Aging Management Program
Top Shield Plug	PB, SH, SS, HT	Stainless Steel and Lead	Air and Gas[2,4] Sheltered[3]	None Identified	None Required
Cover Plates (Top and Bottom)	PB, SH, SS, HT	Stainless Steel	Sheltered[3]	Loss of Material due to Crevice and Pitting Corrosion Cracking from Stress Corrosion Cracking	DSC External Surfaces Aging Management Program
Siphon and Vent Ports	PB, SH	Stainless Steel	Air and Gas[2,4]	None Identified	None Required
Ram Grapple Ring	SS	Stainless Steel	Sheltered[3]	Loss of Material due to Crevice and Pitting Corrosion Cracking from Stress Corrosion Cracking	DSC External Surfaces Aging Management Program
Dry Film Lubricant	none	N/A	N/A	N/A	none
Swagelok Quick Disconnects	none	N/A	N/A	N/A	none
Siphon Tube	none	N/A	N/A	N/A	none

Table 3.3-1, Aging Management Review Results for the DSCs (NUHOMS-24P and 32P)					
Subcomponent[1]	**Intended Function**	**Materials**	**Environment**	**Aging Effect/Mechanism**	**Aging Management Activities**
Aluminum coating (Carbon Steel Spacer Discs and Top Shield Plug)	none	N/A	N/A	N/A	none
Nickel Based Thread Lubricant; thread tape or sealant	none	N/A	N/A	N/A	none
Stainless steel plugs/bolts (non-Structural)	none	N/A	N/A	N/A	none
DSC Lifting Lugs	none	N/A	N/A	N/A	none

Notes:

1 Each individual DSC may not contain all of the listed subcomponents.

2 Air and gas environment is helium inside DSC cavity, with possible trace amounts of air, water vapor and fission product gases. Temperature and radiation have been considered as described in Section 3.3.3, Environments for the DSCs.

3 Sheltered environment for DSC interior/exterior surfaces that are not part of helium filled DSC cavity.

4 One time short exposure to borated water during loading operations is not considered an environment that impacts long term aging management.

CC Provides criticality control of spent fuel
HT Provides heat transfer
PB Directly or indirectly maintains a pressure boundary (confinement)
SH Provides radiation shielding
SS Provides structural support and/or functional support of important to safety equipment (structural integrity)
N/A Not applicable

Table 3.4-1, Aging Management Review Results for the HSM

Subcomponent	Intended Function	Materials	Environment	Aging Effect/Mechanism	Aging Management Activities
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Cracking due to freeze-thaw degradation	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Loss of material (spalling, scaling) due to freeze-thaw degradation	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Cracking due to moisture, chemical attack, or leaching	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Loss of material (spalling, scaling) due to moisture, chemical attack, or leaching	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	SS	Embedded Steel	Yard, Air	Corrosion due to moisture, chemical attack, or leaching	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Increase in porosity/permeability due to leaching of $Ca(OH)_2$	HSM Aging Management Program

Table 3.4-1, Aging Management Review Results for the HSM

Subcomponent	Intended Function	Materials	Environment	Aging Effect/Mechanism	Aging Management Activities
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Loss of strength due to leaching of $Ca(OH)_2$	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Increase in porosity/permeability due to cement aggregate reactions	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Loss of strength due to cement aggregate reactions	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Cracking due to settlement or loss of bond with embedded steel	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Cracking due to irradiation	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Loss of material (spalling, scaling) due to irradiation	HSM Aging Management Program

Table 3.4-1, Aging Management Review Results for the HSM

Subcomponent	Intended Function	Materials	Environment	Aging Effect/Mechanism	Aging Management Activities
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Cracking due to cement aggregate reaction	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Loss of material due to cement aggregate reaction	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Cracking due to freeze-thaw degradation	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Loss of material (spalling, scaling) due to freeze-thaw degradation	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Cracking due to moisture, chemical attack, or leaching	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Loss of material due to moisture, chemical attack, or leaching	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	SS	Embedded Steel	Embedded/ Underground	Corrosion due to moisture, chemical attack, or leaching	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Increase in porosity/permeability due to leaching of $Ca(OH)_2$	HSM Aging Management Program

Table 3.4-1, Aging Management Review Results for the HSM

Subcomponent	Intended Function	Materials	Environment	Aging Effect/Mechanism	Aging Management Activities
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Loss of strength due to leaching of $Ca(OH)_2$	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Cracking due to irradiation	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Cracking due to cement aggregate reaction	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Loss of material due to cement aggregate reaction	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Loss of material (spalling, scaling) due to irradiation	HSM Aging Management Program
DSC Structural Steel Assembly	SS	Carbon Steel	Sheltered	Loss of material due to corrosion	HSM Aging Management Program
DSC Structural Steel Assembly	SS	Nitronic 60 Stainless Steel	Sheltered	None Identified	None Required
DSC Seismic Retainer	SS	Carbon Steel	Sheltered	Loss of material due to corrosion	HSM Aging Management Program
Cask Docking Flange and Tie Restraints	SS	Carbon Steel	Sheltered	Loss of material due to corrosion	HSM Aging Management Program
Cask Docking Flange and Tie Restraints	SS	Carbon Steel	Yard	Loss of material due to corrosion	HSM Aging Management Program
Heat Shield	HT	Stainless Steel	Sheltered	None Identified	None Required

Table 3.4-1, Aging Management Review Results for the HSM

Subcomponent	Intended Function	Materials	Environment	Aging Effect/Mechanism	Aging Management Activities
Shielded Front Access Door and Door Supports	SH, SS	Concrete	Embedded	None Identified	None Required
Shielded Front Access Door and Door Supports	SH, SS	Carbon Steel	Yard	Loss of material due to corrosion	HSM Aging Management Program
Ventilation Air Openings (One Inlet/ Two Outlets)	HT	Stainless Steel	Yard	None Identified	None Required
Shielded Ventilation Air Inlet Plenum	HT	Stainless Steel	Yard	None Identified	None Required
Ventilation Air Outlet Shielding Blocks	HT	Stainless Steel	Yard	None Identified	None Required
Lighting Protection System	SS .	Copper	Yard	None Identified	None Required
Threaded Fasteners and Expansion Anchors	HT, SS	Stainless Steel	Yard Embedded/ Yard	None Identified	None Required
Handrail	SS	Carbon Steel	Yard	None Identified	None Required

HT – Provides heat transfer
SH – Provides radiation shielding
SS – Provides structural support and/or functional support of important to safety equipment (structural integrity)

Table 3.5-1, Aging Management Review Results for the Transfer Cask

Subcomponent	Intended Function	Materials	Environment[1,2]	Aging Effect/Mechanism	Aging Management Activity
Structural Shell (Cask Body)	SS, HT, SH	Carbon Steel	Embedded/Borated Water	Loss of Material due to General Corrosion Loss of Material due to Pitting or Crevice Corrosion	Transfer Cask Aging Management Program
Bottom Support Ring (Cask Body)	SS	Stainless Steel	Sheltered/Borated water	None Identified	None Required
Bottom Cover Plate (Cask Body)	SS	Stainless Steel	Sheltered/Borated water	None Identified	None Required
Top Flange (Cask Body)	SS	Stainless Steel	Sheltered/Borated water	None Identified	None Required
Inner Shell (Cask Body)	SS,HT, SH	Stainless Steel	Sheltered/Borated water	None Identified	None Required
Lead (Cask Body)	SS,HT	Lead	Embedded	None Identified	None Required
Rails (Cask Attachments)	SS	Stainless Steel (Nitronic 60)	Sheltered	None Identified	None Required
Upper Trunnions (Cask Attachments)	SS	Stainless Steel	Sheltered/Borated water	Cracking of material due to stress/strain from lifting	Transfer Cask Aging Management Program
Upper Trunnion Sleeves (Cask Attachments)	SS	Stainless Steel	Embedded/Borated Water	Cracking of material due to stress/strain from lifting	Transfer Cask Aging Management Program
Upper Trunnion Nickel Alloy (Cask Attachments)	SS	Inconel	Sheltered/Borated water	Cracking of material due to stress/strain from lifting	Transfer Cask Aging Management Program
Upper Trunnion Neutron Shielding (Cask Attachments)	HT, SH	Bisco NS-3	Embedded	None Identified	None Required
Upper Trunnion Cover Plate (Cask Attachments)	SS, SH	Stainless Steel	Sheltered/Borated water	Cracking of material due to stress/strain from lifting	Transfer Cask Aging Management Program

Table 3.5-1, Aging Management Review Results for the Transfer Cask

Subcomponent	Intended Function	Materials	Environment[1,2]	Aging Effect/Mechanism	Aging Management Activity
Lower Trunnions (Cask Attachments)	SS	Stainless Steel	Sheltered/Borated water	Cracking of material due to stress/strain from lifting	Transfer Cask Aging Management Program
Lower Trunnion Sleeves (Cask Attachments)	SS	Stainless Steel	Embedded/Borated Water	Cracking of material due to stress/strain from lifting	Transfer Cask Aging Management Program
Lower Trunnion Sleeve Nickel Alloy Weld Overlay (Cask Attachments)	SS	Stainless Steel	Embedded/Borated Water	Cracking of material due to stress/strain from lifting	Transfer Cask Aging Management Program
Lower Trunnion Neutron Shielding (Cask Attachments)	HT,SH	Bisco NS-3	Embedded/Borated Water	None Identified	None Required
Ram Access Penetration Ring (Cask Penetration)	SS	Stainless Steel	Sheltered/Borated water	None Identified	None Required
Upper and Lower Rings, Outer Shell, Relief Valve Support Plates (Cask Neutron Shield)	SH,HT	Stainless Steel	Sheltered/Borated water	None Identified	None Required
Inner and Outer Support Angle (Cask Neutron Shield)	SH, HT	Stainless Steel	Sheltered/Borated water	None Identified	None Required
Shielding Material (Cask Neutron Shield)	SH, HT	Bisco NS-3	Embedded	None Identified	None Required

Table 3.5-1, Aging Management Review Results for the Transfer Cask

Subcomponent	Intended Function	Materials	Environment[1,2]	Aging Effect/Mechanism	Aging Management Activity
Inner, Outer, and Side Plates (Top Cover Assembly)	SS	Stainless Steel	Sheltered	None Identified	None Required
Ring; Eye Bolt Stand-offs (Top Cover Assembly)	SS	24 Hot Galvanized Finish	Sheltered	None Identified	None Required
Neutron Shielding (Top Cover Assembly)	SH	Bisco NS-3	Embedded	None Identified	None Required
Inner, Outer, and Side Plates (Bottom Cover Assembly)	SH	Stainless Steel	Sheltered/Borated water	None Identified	None Required
Bottom Cover O-ring Seals	HT, SH	Polymer (Ethylene Propylene)	Sheltered	Materials Property Change	N/A – subject to routine replacement
Neutron Shielding (Bottom Cover Assembly)	SH	Bisco NS-3	Embedded	None Identified	None Required
Cask Bottom Cover Plate	SH	Stainless Steel	Sheltered	None Identified	None Required
Neutron Shielding (Cask Bottom)	SH	Bisco NS-3	Embedded	None Identified	None Required
Bolts, Washers, and Threaded Fasteners for Top Cover Plate and Ram Access Plate	SH	Carbon Steel	Sheltered	Loss of Material due to General Corrosion Loss of Material due to Pitting or Crevice Corrosion	Transfer Cask Aging Management Program
Misc Subcomponents	none	N/A	N/A	N/A	N/A

Table 3.5-1, Aging Management Review Results for the Transfer Cask

Notes:

[1] Sheltered environment represents ambient conditions on the interior of the transfer cask, conservatively including connecting and embedded surfaces. Some subcomponents may have interior surfaces that are considered embedded. No aging effects are identified for the embedded surfaces and no aging management is required. Temperature and radiation were considered, as described in Section 3.5.3, Environments for the Transfer Cask.

[2] All subcomponents that are immersed in the borated water of the SFP are rinsed off with deionized water after use.

HT Provides heat transfer
SH Provides radiation shielding
SS Provides structural support and/or functional support of important to safety equipment (structural integrity)
N/A Not applicable

Table 3.6-1, Aging Management Review Results for the Transfer Cask Lifting Yoke

Subcomponent	Intended Function	Materials	Environment[1]	Aging Effect/Mechanism	Aging Management Activity
Lifting Hook Plates	SS	Carbon Steel	Sheltered/Borated Water	Loss of Material due to General Corrosion Loss of Material due to Pitting or Crevice Corrosion Cracking of material due to stress/strain from lifting	Transfer Cask Lifting Yoke Aging Management Program
Lifting Beam Plates	SS	Carbon Steel	Sheltered/Borated Water	Loss of Material due to General Corrosion Loss of Material due to Pitting or Crevice Corrosion Cracking of material due to stress/strain from lifting	Transfer Cask Lifting Yoke Aging Management Program
Later Brace Plates	SS	Carbon Steel	Sheltered/Borated Water	Loss of Material due to General Corrosion Loss of Material due to Pitting or Crevice Corrosion	Transfer Cask Lifting Yoke Aging Management Program
Support Brace Plates	SS	Carbon Steel	Sheltered/Borated Water	Loss of Material due to General Corrosion Loss of Material due to Pitting or Crevice Corrosion	Transfer Cask Lifting Yoke Aging Management Program
Pin (Round Bar)	SS	Stainless Steel	Sheltered/Borated Water	Loss of Material due to General Corrosion Loss of Material due to Pitting or Crevice Corrosion	Transfer Cask Lifting Yoke Aging Management Program
Pin Handle	None	N/A	N/A	N/A	N/A

Table 3.6-1, Aging Management Review Results for the Transfer Cask Lifting Yoke

Subcomponent	Intended Function	Materials	Environment[1]	Aging Effect/Mechanism	Aging Management Activity
Pin Cradle Pipe	None	N/A	N/A	N/A	N/A
Rear Pin Stop	None	N/A	N/A	N/A	N/A
Pin Lock	None	N/A	N/A	N/A	N/A
Main Assembly Bolts, Nuts, Washers	SS	Carbon Steel	Sheltered/Borated Water	Loss of Material due to General Corrosion Loss of Material due to Pitting or Crevice Corrosion	Transfer Cask Lifting Yoke Aging Management Program
Support angles and misc hardware	None	N/A	N/A	N/A	N/A
Hook Bearing Plate	SS	Bronze	Sheltered	None Identified	None Required

Notes:
[1] All subcomponents that are immersed in the borated water of the SFP are rinsed off with deionized water after use.

SS Provides structural support and/or functional support of important to safety equipment (structural integrity)
N/A Not applicable

Table 3.7-1, Aging Management Review Results for the Cask Support Platform

Subcomponent	Intended Function	Materials	Environment	Aging Effect/Mechanism	Aging Management Activity
Base Plate	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
Web Plates	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
Mid Plate	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
Top Plate	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
Honeycomb Energy Absorber	SS	Aluminum	Compressed Air	None Identified	None Required
Honeycomb Base Plate	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
Honeycomb Casing Plate	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
Honeycomb Outer Plate	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
Bottom Location Plates	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
Lifting Lugs	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
**Tubing Manifold, Relief Valve, Pressure Gauge, Quick-Connect	none	N/A	N/A	N/A	N/A

SS Provides structural support and/or functional support of important to safety equipment (structural integrity)
N/A Not applicable

ATTACHMENT (4)

ISFSI UPDATED SAFETY ANALYSIS REPORT SUPPLEMENT AND CHANGES

1.0 INTRODUCTION

This appendix provides a supplement and identifies pertinent changes to the Calvert Cliffs Independent Spent Fuel Storage Installation (ISFSI) Updated Safety Analysis Report (USAR). Section 2.0 of this appendix contains proposed changes to the existing ISFSI USAR. Section 3.0 of this appendix contains a proposed new section for the ISFSI USAR to be added under Chapter 9, Conduct of Operations. The new Section 9.6, Aging Management Programs, provides a summarized description of the activities for managing the effects of aging of ISFSI systems, structures, and components. This proposed new ISFSI USAR section will also present the evaluations of time-limited aging analyses (TLAAs) for the renewed license period.

2.0 CHANGES TO EXISTING ISFSI USAR INFORMATION

The following is a listing of changes to the ISFSI USAR to support the renewal of Material License SNM-2505.

- Add the following text to the last paragraph is Section 1.1

  ", or for a maximum of 40 years under the renewed license period (60 years, total)"

The revised paragraph will read as follows (The text to be added is shown in bold underline font):

> "The fuel assemblies to be stored in the ISFSI are located in the Calvert Cliffs spent fuel pool and were irradiated only in the Calvert Cliffs reactors. Twenty-four fuel assemblies are stored in each NUHOMS-24P DSC, 32 fuel assemblies are stored in each NUHOMS - 32P DSC, and one DSC is stored in each concrete module. The license allows construction and operation of a total of 120 modules. These modules will be built incrementally, as needed, to match BGE's requirements for additional storage. The first 72 modules built were poured in placed (HSM) and the remaining will be of modular construction (HSM-HB). Operation of the facility will continue for up to 20 years under the initial license and continue under license renewal as necessary until a permanent facility is available for spent fuel disposal**<u>, or for a maximum of 40 years under the renewed license period (60 years, total)</u>**. As defined in Table 1.2-2 of Reference 1.2, the minimum design life of the facility is 50 years."

- Delete the following text in the second paragraph of Subsection 1.2.1

  "Despite Department of Energy's obligations under the Nuclear Waste Policy Act of 1982, as amended, to begin accepting fuel on January 31, 1998, BGE's current best estimate for the earliest date to ship spent fuel for permanent disposal is the year 2013."

  and

  "The provision for 120 HSMs will provide the minimum storage capacity needed to carry Calvert Cliffs to approximately 2026."

- Revise the only remaining sentence in the second paragraph in Subsection 1.2.1 to read

  "The initial license limits spent fuel storage capacity to 1,111.68 TeU of spent fuel assemblies."

The revised paragraph will read as follows:

"The initial license limits spent fuel storage capacity to 1,111.68 TeU of spent fuel assemblies."

- The Chapter 9 LIST OF EFFECTIVE PAGES will be revised to list the new Section 9.6 pages and to note the page number changes for Section 9.6 now Section 9.7 and Section 9.7 now Section 9.8.
- The Chapter 9 TABLE OF CONTENTS will be revised to list the new Section 9.6 subsections and to revise Section 9.6 now Section 9.7 and Section 9.7 now Section 9.8.
- The Chapter 9 LIST OF TABLES will be revised to list the new Tables 9.6-1 through 9.6-6.
- The following acronyms will be added to the Chapter 9 LIST OF ACRONYMS

"CLB	Current Licensing Basis"
"LRA	CCNPP License Renewal Application"
"SER	Safety Evaluation Report"
"TLAAs	Time-Limited Aging Analyses"

- A new Section 9.6 ISFSI LICENSE RENEWAL ACTIVITIES will be added to the Calvert Cliffs ISFSI USAR. See Section 3.0 of this attachment for the new text.
- Section 9.6 DECOMMISSIONING PLAN will be renumbered as Section 9.7 and the page numbers will be revised.
- Section 9.7 REFERENCES will be renumbered as Section 9.8 and the page numbers will be revised.
- The following references will be added to the Chapter 9 reference section. The section will be numbered as 9.8 (was Section 9.7 REFERENCES)

9.16 AREVA Technical Report 10955-0101, Revision 1, May 21, 2010, ISFSI Time-Limited Aging Analysis Report

9.17 U.S. Nuclear Regulatory Commission Regulatory Guide 1.99, Revision 2, May 1988, Radiation Embrittlement of Reactor Vessel Materials

9.18 NUH-002, Revision 2, March 1990, Topical Report for the NUTECH Horizontal Modular Storage System for Irradiated Nuclear Fuel, NUHOMS®-24P, Submitted to the United States Nuclear Regulatory Commission by Pacific Nuclear Fuel Services, Inc., San Jose, California

9.19 Letter from R. J. Lewis (NRC) to G. Vanderheyden (CCNPP), dated June 10, 2005, Amendment 6 to Material License No. SNM-2505 for the Calvert Cliffs Independent Spent Fuel Storage Installation, Safety Evaluation Report

9.20 American Society of Mechanical Engineers (ASME), Boiler & Pressure Vessel Code, Section III, Division I, Subsection NB, July 1, 2009, Class 1 Components, Rules for Construction of Nuclear Facility Components

9.21 Letter from G. H. Gellrich (Exelon) to Document Control Desk (NRC), dated September 18, 2014, Response to Fourth Request for Additional Information for

Renewal Application to Special Nuclear Materials License No. 2505 for the Calvert Cliffs Site Specific Independent Spent Fuel Storage Installation (TAC No. L24475)

3.0 NEW ISFSI USAR SECTION

The following text will be integrated into the ISFSI USAR Chapter 9 to document the ISFSI license renewal review activities conducted to address the potential aging effects that must be managed during the period of extended operation. These activities include the aging management reviews conducted, the aging management programs developed and TLAAs evaluated to demonstrate acceptability during the period of extended operation. The following text will be numbered sequentially within the new ISFSI USAR Section 9.6, ISFSI License Renewal Activities.

9.6 ISFSI LICENSE RENEWAL ACTIVITIES

As part of ISFSI license renewal application an aging management assessment of the HSMs, DSCs [Nutech Horizontal Modular Storage] (NUHOMS-24P and NUHOMS-32P), transfer cask, transfer cask lifting yoke, the cask support platform, and high burnup fuel was performed. The assessment identified existing activities necessary to provide reasonable assurance that ISFSI and transfer cask components within the scope of license renewal will continue to perform their intended functions consistent with the current licensing basis for the renewal period. . This section describes these aging management activities that were performed.

9.6.1 AGING MANAGEMENT REVIEW

The purpose of the aging management review is to address the aging effects that could adversely affect the ability of the components and subcomponents to perform their intended function during the period of extended operation. The aging management review involves the following four major steps:

- Identification of in-scope subcomponents requiring aging management reviews
- Identification of materials and environments
- Identification of aging effects requiring management
- Determination of the activities/programs required to manage the effects of aging

The results of this aging management review of the in-scope components are contained in Tables 9.6-1 thru 9.6-6. These tables are the tables developed and submitted in Attachment (3) of Reference 9.21 as part of the license renewal application.

9.6.2 TIME-LIMITED AGING ANALYSIS

Time-Limited Aging Analyses (TLAA) were conducted to identify and evaluate the effect of time-limited aging in order to demonstrate safe operation of the applicable components over the entire period of extended operation. This section discusses the results for each of the TLAAs evaluated for license renewal. The evaluations have demonstrated that the analyses have been projected to the end of the renewed license period.

9.6.2.1 DSC Time-Limited Aging Analysis

AREVA Technical Report 10955-0101 (Reference 9.16) was prepared to identify and evaluate the effect of TLAA, to demonstrate safe operation over the extended service life of the ISFSI. The report evaluated the DSCs stored in the HSMs. This section describes the finding of the TLAA.

DSC Materials:

Stainless Steel

The NUHOMS-24P and NUHOMS-32P DSC construction uses Stainless Steel 304 material and compatible weld metal. Since the DSC is filled with the inert helium gas there is no significant corrosion of the DSC shell and other components. Neutron fluence can affect mechanical properties of steels. However, studies on fast neutron damage in stainless steel and low alloy steels rarely evaluate damage at fluence levels below 10^{17} neutrons/cm^2 because they are not significant (Reference 9.17). For the DSC, the neutron fluence (10^{14} neutrons/cm^2) is much less than this level for the intended storage period and hence, a TLAA is not required.

The DSC and weld stresses due to temperature and pressure inside the DSC are an important aspect of the design. Per Reference 9.16, the NUHOMS-24P DSC normal operating design temperature and pressure are 400°F and 10 psig and the accident temperature and pressure are 460°F and 50 psig.

Per Reference 9.16, the NUHOMS-32P DSC normal operating design temperature is 460°F for the DSC shell and 380°F for the welds, top and bottom shield plug/cover plate assembly and the design pressure is 30 psig. The design temperatures for the accident conditions for the NUHOMS-32P DSC shell is 575°F and 475°F for the welds, top and bottom shield plug/cover plate assembly and the design pressure is 100 psig. The accident pressure values are established using 100% cladding breach.

The design temperatures are calculated at the beginning of NUHOMS storage. This calculation is bounding since the DSC temperatures are shown to monotonically decrease as a function of time.

Therefore, the heating effect (and hence, the internal pressure effect) on the DSC for the future 40 years of service will be much less severe than that during the past 20 years of service. Hence, the stresses in the DSC components will be acceptable for the extension period.

The service life for the NUHOMS-24P DSC system is documented in Table 1.2-2, Reference 9.18 as 50 years. Sufficient clearances are provided in both the radial and axial direction between the DSC internal components to permit free thermal expansion for NUHOMS-24P and NUHOMS-32P DSCs. This design feature acts to minimize the thermal cycling and fatigue on the DSC. There will be more room for free thermal expansion as the decay heat from the fuel decreases causing the DSC internal component temperatures to decrease as the storage time is increased from 50 years to 60 years. Therefore, thermal cycling and fatigue on the DSC will not be impacted when the storage period is increased from 50 years to 60 years.

Lead in the Shield Plugs

The DSC uses lead in the shield plugs. The lead shielding function is not affected by the radiation level in the DSC.

Poison Plates (NUHOMS-32P DSC Only)

Since the NUHOMS-32P DSC uses fixed neutron absorbers in the DSC basket, calculations were performed to assure criticality safety. Time dependency for criticality calculations may result due to depletion of boron in the poison plates utilized in the NUHOMS-32P DSC baskets.

Reference 9.19, Section 6.3, states that "The continued efficacy of the neutron absorber materials over a 20-year storage period is assured by the design of the NUHOMS-32P canister which ensures that the neutron absorbers will remain in place during accident conditions. Additionally, the neutron flux from the irradiated fuel will result in negligible depletion of the Boron 10 content in the neutron absorber materials over the life of the storage system."

Per Reference 9.16, the total neutron activity in the NUHOMS-32P DSC is 4.175×10^{8} n/s/assembly. To estimate the total flux a conservative final assembly surface area of 25,000 cm^2 is considered in Reference 9.16. The total scalar flux is estimated to be 8.65×10^{4} n/cm^2-s. Using the thermal cross section for Boron 10, (3,837 barn), the fraction of the original Boron 10 depleted after 60 years is 2.3E-6, which is negligible. The actual neutron flux is mostly fast and epithermal, and will be declining with time, so the actual depletion during dry storage will be less than the depletion calculated in Reference 9.16. Therefore, continued efficacy of the neutron poison is assured for an additional 40 years of fuel storage.

DSC Fatigue Evaluation

The fatigue evaluation of the NUHOMS-24P DSC is documented in Appendix C.4.1 of Reference 9.16 for a 50 year operational life of the ISFSI. The fatigue effects on the DSC were addressed using the criteria contained in Section III NB-3222.4 of the ASME Code (Reference 9.20, The 1983 Edition). The analysis evaluated the DSC under six criteria and concluded that the DSC and other components satisfy these criteria and that no consideration of fatigue is required for a service life of 50 years.

In order to extend the operational life by another 10 years, it is necessary to re-evaluate the DSC against these six criteria using an approach that is consistent with that utilized in Reference 9.18. A fatigue analysis for the NUHOMS-24P and NUHOMS-32P DSCs was performed for a 60 year service life. This analysis uses the six criteria in NB-3222.4(d) of ASME Code (Reference 9.20, the 1998 Edition including the 1999 Addenda) and determines that the DSC service loads of the NUHOMS-24P DSC and NUHOMS-32P DSC systems do not create any potential risk of the DSC design fatigue failure and that no detailed fatigue evaluation is necessary.

9.6.2.2 HSM Time-Limited Aging Analysis

Reference 9.16 was prepared to identify and evaluate the effect of TLAA, to demonstrate safe operation over the extended service life of the ISFSI. The report evaluated the HSMs. This section describes the finding of the TLAA.

HSM Concrete

The HSM is a reinforced concrete structure. The effect of radiation on the HSM concrete is evaluated in Section 8.1.1.5.D and Section 12.8.1.1.5.D. These evaluations demonstrate that the magnitude of the neutron fluence incident on the concrete is low enough to not affect the properties of the concrete. These evaluations also demonstrate that the magnitude of the gamma-ray energy deposition on the HSM concrete is not sufficient to cause any radiation heating in the concrete of the HSM. Therefore, the thermal analyses documented in Sections 8.1.1.5D and 12.8.1.1.5D implicitly considered the radiation heat effects adequately for the HSM concrete.

NUHOMS-24P DSC

The maximum predicted temperature of concrete at the beginning of storage was estimated to be below 150°F in Reference 9.16 using a bounding decay heat at the beginning of storage life.

NUHOMS-32P DSC

The maximum temperature of the concrete at beginning of storage with a NUHOMS-32P DSC is 157°F per Reference 9.16.

The maximum concrete temperatures for the additional 40 years of service (as shown in Figure 8.1-27 of Reference 9.18) will be lower because the decay heat reduces monotonically as a function of time. Hence, the heating effect on the HSM concrete, for an additional 40 years of service, will be much less severe than the past 20 years of service.

The environmental degradation of reinforced concrete will not be significant, as proper concrete cover has been provided to the reinforcing bars made of carbon steel.

Reference 9.18, Section 8.2.10.6 documents the analysis of thermal cycling of the HSM based on the 50 year storage life. The number of cycles will increase from 18,250 to 21,900 when the design life is extended from 50 years of storage to 60 years of storage. These are still significantly below the limit of 10,000,000 (See Section 8.2.10.6 of Reference 9.18). Therefore, thermal cycling will have negligible impact on the HSM reinforced concrete for an additional 40 years of service.

DSC Support Rail Steel in the HSMs

The DSC support structure inside the HSM is designed to support the DSC during normal, off-normal and accident conditions. Since the DSC support rails are fabricated from Nitronic 60 austenitic stainless steel, it is expected that there would be no corrosion of the rail material and is expected to maintain its function for the additional 40 years of service.

DSC Support Rail Lubricant in the HSMs

The HSM and transfer cask support rails are coated with a dry film lubricant Perma-Slik to minimize friction during insertion and retrieval of the DSC. The material specification of the lubricant indicates that it is suitable for very high and cryogenic temperature applications. The presence of a non-corrosive environment due to the absence of a formal sea breeze and relatively milder temperature fluctuations at ISFSI site ensure that the lubricant does not degrade with age. The effect of radiation on these lubricants is not specified, however, it is expected that it is minimal since these are inorganic and consist entirely of graphite, a moderating material. As stated above once the DSC is in place within the HSM, the lubricant performs no function during storage of the DSC.

NUHOMS-24P DSC

The coefficient of friction associated with these lubricants is below 0.05 while the design basis calculations employed a coefficient of friction of 0.25 (Section 8.1.1.1 D of Reference 9.18). The mechanical system to be used for DSC transfer is capable of exerting a force equal to the loaded weight of a DSC and this condition has been evaluated in Section 8.1.2.1 of Reference 9.18 for the NUHOMS-24P DSC. A coefficient of friction of 1.0 has been used (for these "jammed DSC" analyses) without relying on the solid film lubricant. The support structure is designed for this loading. Hence, no further analysis is required.

NUHOMS-32P DSC

The coefficient of friction associated with these lubricants is below 0.05 while the design basis calculations employed a coefficient of friction of 0.25 (Reference 9.16). The mechanical system to be used for DSC transfer is capable of exerting a force equal to the loaded weight of a DSC and this condition has been evaluated for the NUHOMS-32P DSC. A coefficient of friction of 1.0 has been used (for these "jammed DSC" analyses) without relying on the solid film lubricant. The support structure is designed for this loading. Hence, no further analysis is required.

9.6.2.3 Transfer Cask Fatigue Evaluation

The fatigue evaluation for the transfer cask is performed in accordance with ASME code criteria listed in Section NC-3219.2 to determine whether the transfer cask service loads of NUHOMS-24P DSC and NUHOMS-32P DSC systems create potential risk of the design fatigue failure. The criteria evaluation shows that transfer cask service loads of NUHOMS-24P and NUHOMS-32P DSC systems do not create potential risk of the transfer cask design fatigue failure, for 600 cycles in 60-year transfer cask life, and that detailed fatigue evaluation is not necessary.

Transfer Cask Trunnions Fatigue Evaluation

The fatigue evaluation of transfer cask trunnions shows that the transfer cask operations do not pose potential risk of fatigue failure of trunnion or trunnion sleeve throughout the planned 60-year service time.

NS-3 in Transfer Cask

The transfer cask contains 3 inches of NS-3 neutron shielding sandwiched between the cask outer shell material and neutron shield jacket. Per Reference 9.16, the gamma and neutron dose at 1 inch from the cask surface for the accident conditions is 135 mrem/hr and 1000 mrem/hr, respectively for the NUHOMS-24P DSC and 85 mrem/hr and 1433 mrem/hr, respectively for the NUHOMS-32P DSC. Also, the dose rates at 1 inch from the transfer cask surface for the accident conditions with the NS-3 at the side of the transfer cask replaced with air bounds the dose rates at the inner surface of NS-3 in the transfer cask during normal conditions and that the transfer cask is only subjected to this gamma exposure when a fuel-loaded DSC is in the transfer cask during loading and transfer operations which are short term durations. This results in a gamma dose of approximately 3.0×10^{5} Rads over the service life of 60 years. This is based on an assumption that 1 Rad = 1 Rem and is considered reasonable for gamma radiation for hydrogenous materials. This is significantly below the exposure limit of 1.5×10^{10} Rads for the material as stated in Reference 9.16.

Per Reference 9.16, to estimate the neutron fluence, a neutron dose to flux factor of 1 mrem/hr = 100 n/cm^2-s is used. The dose to flux factor for neutrons is based on dose rate spectra results from various NUHOMS ISFSI evaluations. The integrated fluence is estimated to be approximately 3.16×10^{14} neutrons/cm^2 over the service life of 60 years for the NS-3 in the transfer cask. Reference 9.16 noted that the thermal neutron exposure limit 1.5×10^{19} neutrons/cm^2 for the NS-3 material. Therefore, it is concluded that there is no significant degradation to the NS-3 material for the additional 40 years of operations of the transfer cask.

The exposure to radiation sources for an additional 40 years of service is shown to have no significant impact on the shielding capability of the NS-3 in the transfer cask. No significant hydrogen loss in the NS-3 material is expected due to radiation exposure.

9.6.2.4 Time-Limited Aging Analysis of the Transfer Cask Lifting Yoke

Lifting Yoke Fatigue Evaluation

The fatigue evaluation of transfer cask trunnions and lifting yoke system shows that the transfer cask operations do not pose potential risk of fatigue failure of trunnion or trunnion sleeve throughout the planned 60-year service time.

In the case of the transfer cask lifting yoke assembly, the structural adequacy against fatigue failure is secured for up to 286 transfer cask loading/unloading operations in the planned 60-year service time.

9.6.3 AGING MANAGEMENT PROGRAMS

Aging management programs are developed to identify the activities to be implemented to address the possible aging effects such that no aging effect results in the loss of intended function of the in-scope components. An aging management program is considered effective if it meets one of the following conditions:

- Provides for timely discovery of the effects of aging to be managed
- Mitigates the effects of aging to be managed

Calvert Cliffs will implement and maintain the aging management programs submitted in Attachment 2 of Reference 9.21 for the duration of the ISFSI renewed license operating period.

9.6.3.1 HSM Aging Management Program

The HSM aging management program credits the Calvert Cliffs Part 50 programs credited for managing the effects of aging in the Calvert Cliffs Nuclear Power Plant as described in Chapter 16 of Reference 9.1. The HSM aging management program involves monitoring the exterior surfaces of the HSMs, including visual inspection of the accessible concrete; any exposed steel subcomponents, embedments, and attachments; and the lightning protection system. Interior inspections are conducted upon loading of a cask. Exterior inspections are conducted annually.

The HSM monitored conditions include, but not limited, to the following:

- Concrete - spalling, cracking, delaminations, honey combs, leaching, discoloration, loss of material, or any other property that would be noted by visual inspection
- Structural Steel - corrosion, peeling paint, deflection, lost or missing anchors /fasteners, missing or degraded grout under base plates, twisted beams, cracked welds
- Equipment Foundations - settlement, cracked concrete
- Equipment Supports - cracked concrete, loose connections, corroded steel
- Roof Systems - structural integrity, deteriorated penetrations (i.e., drains, vents, etc.), signs of water infiltration, cracks, ponding, and flashing degradation
- Seismic Gaps - gaps or loss of joint filler material

- Lightning Protection System (above grade) - corrosion

9.6.3.2 Transfer Cask Aging Management Program

The transfer cask aging management program credits periodic inspections performed on the transfer cask. The procedure includes visual and penetrant test inspections of the carbon steel subcomponents. Monitored aging effects by the aging management program include loss of material due to various forms of corrosion.

9.6.3.3 Transfer Cask Lifting Yoke Aging Management Program

The transfer cask lifting yoke aging management program credits the transfer cask lifting yoke annual inspection. This procedure includes visual and magnetic particle test inspections of the transfer cask lifting yoke carbon steel subcomponents. Monitored aging effects by the aging management program include loss of material due to various forms of corrosion and cracking of material due to stress/strain from lifting.

9.6.3.4 Cask Support Platform Aging Management Program

The cask support platform aging management program credits the Calvert Cliffs power plant Chemistry Control Program, as described in Chapter 16 of Reference 9.1. Loss of material and cracking are prevented through control of specified limits on chloride in the spent fuel pool water.

9.6.3.5 DSC External Surfaces Aging Management Program

The DSC external surfaces AMP consists of condition monitoring activities to confirm there is no degradation of the DSC shell or cover plates that would result in a loss of the pressure/confinement boundary function.

9.6.3.6 High Burnup Fuel Aging Management Program

The high burnup fuel AMP will rely upon joint EPRI and Department of Energy research program as a surrogate program to monitor the condition of high burnup spent fuel assemblies. The results from the research programs will be relied upon to provide reasonable assurance that the high burnup fuel assemblies at Calvert Cliffs would not experience degradation that would result in a loss of intended functions.

Table 9.6-1, Aging Management Review Results for the Irradiated Fuel Assemblies

Subcomponent	Intended Function	Material Group	Environment	Aging Effects Requiring Management	Aging Management Activities
Fuel Rod (Cladding and End Caps)	CC, HT, PB, SS	Zircaloy-4, Zirlo,M5[4]	Air and Gas[1,2] Residual Boron Coating[3]	None Identified	None Required[4]
Guide Tubes	SS	Zircaloy-4 Stainless Steel (Chrome Plated)	Air and Gas[1]	None Identified	None Required[4]
Spacer Grid Assemblies	CC, SS	Zircaloy-4	Air and Gas[1]	None Identified	None Required[4]
Lower End Fitting (and Connectors)	SS (CC, SS)	Stainless Steel Inconel	Air and Gas[1]	None Identified	None Required[4]
Upper End Fitting (Connectors and Holddown Spring)	SS	Stainless Steel Inconel X-750	Air and Gas[1]	None Identified	None Required[4]
Holddown Spring Retainer and Upper End Plugs	None	N/A	N/A	N/A	N/A
Fuel Assembly Control Components	None	N/A	N/A	N/A	N/A
Fuel Rod Pellets and Other Internal Portions	None	N/A	N/A	N/A	N/A

Notes:

1 Air and gas environment outside the fuel rods (inside the DSC) is helium at atmospheric pressure with trace amounts of air and water vapor. Minimal amounts of fission product gases may also be present. Temperature and radiation have been considered as described in Section 3.2.3, Environments for the Irradiated Fuel Assemblies.

2 Air and gas environment inside the fuel rods is pressurized helium and fission product gases. Temperature and radiation have been considered as described in Section 3.2.3, Environments for the Irradiated Fuel Assemblies.

Table 9.6-1, Aging Management Review Results for the Irradiated Fuel Assemblies

[3] Residual boron may coat the irradiated fuel assemblies surfaces since they were exposed to a borated water environment in the SFP prior to storage. Any boric acid residue remaining on the irradiated fuel assemblies will have no deleterious effects due to the minimal amount of water remaining on the irradiated fuel assembles and the materials of construction for the irradiated fuel assemblies.

[4] A confirmatory program for high burnup fuel is being performed by the Department of Energy which will monitor the condition of high burnup fuel assemblies in dry storage. This confirmatory program includes Zircaloy-4, Zirlo, and M5 cladding materials that have been used at Calvert Cliffs but may not yet have been placed into dry storage at the time of ISFSI license Renewal.

CC Provides criticality control of spent fuel
HT Provides heat transfer
PB Directly or indirectly maintains a pressure boundary (confinement)
SS Provides structural support and/or functional support of important to safety equipment (structural integrity)
N/A Not applicable

Table 9.6-2, Aging Management Review Results for the DSCs (NUHOMS-24P and 32P)

Subcomponent[1]	Intended Function	Materials	Environment	Aging Effect/Mechanism	Aging Management Activities
Basket	SS, CC	Stainless Steel	Air and Gas[2,4]	None Identified	None Required
Guide Sleeves (Basket)	SS, CC	Stainless Steel	Air and Gas[2,4]	None Identified	None Required
Spacer Disks (Basket)	SS,CC	Stainless Steel / Aluminum Coated Carbon Steel	Air and Gas[2,4]	None Identified	None Required
Support Rods (Basket)	SS, CC	Stainless Steel / Aluminum Coated Carbon Steel	Air and Gas[2,4]	None Identified	None Required
Rails (Basket)	SS	Stainless Steel	Air and Gas[2,4]	None Identified	None Required
Rail Inserts (Basket)	SS	Aluminum	Air and Gas[2,4]	None Identified	None Required
Fixed Neutron Absorbers (Basket)	CC	Borated Aluminum Alloy	Sheltered[3]	None Identified	None Required
DSC Shell w/ Bottom shield Plug	PB, SH, SS, HT	Stainless Steel and Lead	Air and Gas[2] Sheltered[3]	Loss of Material due to Crevice and Pitting Corrosion Cracking from Stress Corrosion Cracking	DSC External Surfaces Aging Management Program
Top Shield Plug	PB, SH, SS, HT	Stainless Steel and Lead	Air and Gas[2,4] Sheltered[3]	None Identified	None Required
Cover Plates (Top and Bottom)	PB, SH, SS, HT	Stainless Steel	Sheltered[3]	Loss of Material due to Crevice and Pitting Corrosion Cracking from Stress Corrosion Cracking	DSC External Surfaces Aging Management Program
Siphon and Vent Ports	PB, SH	Stainless Steel	Air and Gas[2,4]	None Identified	None Required
Ram Grapple Ring	SS	Stainless Steel	Sheltered[3]	Loss of Material due to Crevice and Pitting Corrosion Cracking from Stress Corrosion Cracking	DSC External Surfaces Aging Management Program
Dry Film Lubricant	none	N/A	N/A	N/A	none
Swagelok Quick Disconnects	none	N/A	N/A	N/A	none
Siphon Tube	none	N/A	N/A	N/A	none

Table 9.6-2, Aging Management Review Results for the DSCs (NUHOMS-24P and 32P)

Subcomponent[1]	Intended Function	Materials	Environment	Aging Effect/Mechanism	Aging Management Activities
Aluminum coating (Carbon Steel Spacer Discs and Top Shield Plug)	none	N/A	N/A	N/A	none
Nickel Based Thread Lubricant; thread tape or sealant	none	N/A	N/A	N/A	none
Stainless steel plugs/bolts (non-Structural)	none	N/A	N/A	N/A	none
DSC Lifting Lugs	none	N/A	N/A	N/A	None

Notes:

1 Each individual DSC may not contain all of the listed subcomponents.

2 Air and gas environment is helium inside DSC cavity, with possible trace amounts of air, water vapor and fission product gases. Temperature and radiation have been considered as described in Section 3.3.3, Environments for the DSCs.

3 Sheltered environment for DSC interior/exterior surfaces that are not part of helium filled DSC cavity.

4 One time short exposure to borated water during loading operations is not considered an environment that impacts long term aging management.

CC Provides criticality control of spent fuel
HT Provides heat transfer
PB Directly or indirectly maintains a pressure boundary (confinement)
SH Provides radiation shielding
SS Provides structural support and/or functional support of important to safety equipment (structural integrity)
N/A Not applicable

Table 9.6-3, Aging Management Review Results for the HSM

Subcomponent	Intended Function	Materials	Environment	Aging Effect/Mechanism	Aging Management Activities
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Cracking due to freeze-thaw degradation	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Loss of material (spalling, scaling) due to freeze-thaw degradation	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Cracking due to moisture, chemical attack, or leaching	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Loss of material (spalling, scaling) due to moisture, chemical attack, or leaching	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	SS	Embedded Steel	Yard, Air	Corrosion due to moisture, chemical attack, or leaching	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Increase in porosity/permeability due to leaching of $Ca(OH)_2$	HSM Aging Management Program

Table 9.6-3, Aging Management Review Results for the HSM

Subcomponent	Intended Function	Materials	Environment	Aging Effect/Mechanism	Aging Management Activities
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Loss of strength due to leaching of $Ca(OH)_2$	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Increase in porosity/permeability due to cement aggregate reactions	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Loss of strength due to cement aggregate reactions	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Cracking due to settlement or loss of bond with embedded steel	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Cracking due to irradiation	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Loss of material (spalling, scaling) due to irradiation	HSM Aging Management Program

Table 9.6-3, Aging Management Review Results for the HSM

Subcomponent	Intended Function	Materials	Environment	Aging Effect/Mechanism	Aging Management Activities
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Cracking due to cement aggregate reaction	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation; Shielded Ventilation Air Inlet Plenum; Ventilation Air Outlet Shielding Blocks	HT, SH, SS	Concrete	Yard, Air	Loss of material due to cement aggregate reaction	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Cracking due to freeze-thaw degradation	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Loss of material (spalling, scaling) due to freeze-thaw degradation	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Cracking due to moisture, chemical attack, or leaching	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Loss of material due to moisture, chemical attack, or leaching	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	SS	Embedded Steel	Embedded/ Underground	Corrosion due to moisture, chemical attack, or leaching	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Increase in porosity/permeability due to leaching of $Ca(OH)_2$	HSM Aging Management Program

Table 9.6-3, Aging Management Review Results for the HSM

Subcomponent	Intended Function	Materials	Environment	Aging Effect/Mechanism	Aging Management Activities
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Loss of strength due to leaching of $Ca(OH)_2$	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Cracking due to irradiation	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Loss of material (spalling, scaling) due to irradiation	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Cracking due to cement aggregate reaction	HSM Aging Management Program
Reinforced Concrete Walls, Roof and Foundation	HT, SH, SS	Concrete	Embedded/ Underground	Loss of material due to cement aggregate reaction	HSM Aging Management Program
DSC Structural Steel Assembly	SS	Carbon Steel	Sheltered	Loss of material due to corrosion	HSM Aging Management Program
DSC Structural Steel Assembly	SS	Nitronic 60 Stainless Steel	Sheltered	None Identified	None Required
DSC Seismic Retainer	SS	Carbon Steel	Sheltered	Loss of material due to corrosion	HSM Aging Management Program
Cask Docking Flange and Tie Restraints	SS	Carbon Steel	Sheltered	Loss of material due to corrosion	HSM Aging Management Program
Cask Docking Flange and Tie Restraints	SS	Carbon Steel	Yard	Loss of material due to corrosion	HSM Aging Management Program
Heat Shield	HT	Stainless Steel	Sheltered	None Identified	None Required

Table 9.6-3, Aging Management Review Results for the HSM

Subcomponent	Intended Function	Materials	Environment	Aging Effect/Mechanism	Aging Management Activities
Shielded Front Access Door and Door Supports	SH, SS	Concrete	Embedded	None Identified	None Identified
Shielded Front Access Door and Door Supports	SH, SS	Carbon Steel	Yard	Loss of material due to corrosion	HSM Aging Management Program
Ventilation Air Openings (One Inlet/ Two Outlets)	HT	Stainless Steel	Yard	None Identified	None Required
Shielded Ventilation Air Inlet Plenum	HT	Stainless Steel	Yard	None Identified	None Required
Ventilation Air Outlet Shielding Blocks	HT	Stainless Steel	Yard	None Identified	None Required
Lighting Protection System	SS	Copper	Yard	None Identified	None Required
Threaded Fasteners and Expansion Anchors	HT, SS	Stainless Steel	Yard Embedded/ Yard	None Identified	None Required
Handrail	SS	Carbon Steel	Yard	None Identified	None Required

HT – Provides heat transfer
SH – Provides radiation shielding
SS – Provides structural support and/or functional support of important to safety equipment (structural integrity)

Table 9.6-4. Aging Management Review Results for the Transfer Cask

Subcomponent	Intended Function	Materials	Environment[1,2]	Aging Effect/Mechanism	Aging Management Activity
Structural Shell (Cask Body)	SS, HT, SH	Carbon Steel	Embedded/Borated Water	Loss of Material due to General Corrosion Loss of Material due to Pitting or Crevice Corrosion	Transfer Cask Aging Management Program
Bottom Support Ring (Cask Body)	SS	Stainless Steel	Sheltered/Borated water	None Identified	None Required
Bottom Cover Plate (Cask Body)	SS	Stainless Steel	Sheltered/Borated water	None Identified	None Required
Top Flange (Cask Body)	SS	Stainless Steel	Sheltered/Borated water	None Identified	None Required
Inner Shell (Cask Body)	SS,HT, SH	Stainless Steel	Sheltered/Borated water	None Identified	None Required
Lead (Cask Body)	SS,HT	Lead	Embedded	None Identified	None Required
Rails (Cask Attachments)	SS	Stainless Steel (Nitronic 60)	Sheltered	None Identified	None Required
Upper Trunnions (Cask Attachments)	SS	Stainless Steel	Sheltered/Borated water	Cracking of material due to stress/strain from lifting	Transfer Cask Aging Management Program
Upper Trunnion Sleeves (Cask Attachments)	SS	Stainless Steel	Embedded/Borated Water	Cracking of material due to stress/strain from lifting	Transfer Cask Aging Management Program
Upper Trunnion Nickel Alloy (Cask Attachments)	SS	Inconel	Sheltered/Borated water	Cracking of material due to stress/strain from lifting	Transfer Cask Aging Management Program
Upper Trunnion Neutron Shielding (Cask Attachments)	HT, SH	Bisco NS-3	Embedded	None Identified	None Required
Upper Trunnion Cover Plate (Cask Attachments)	SS, SH	Stainless Steel	Sheltered/Borated water	Cracking of material due to stress/strain from lifting	Transfer Cask Aging Management Program

Table 9.6-4. Aging Management Review Results for the Transfer Cask

Subcomponent	Intended Function	Materials	Environment[1,2]	Aging Effect/Mechanism	Aging Management Activity
Lower Trunnions (Cask Attachments)	SS	Stainless Steel	Sheltered/Borated water	Cracking of material due to stress/strain from lifting	Transfer Cask Aging Management Program
Lower Trunnion Sleeves (Cask Attachments)	SS	Stainless Steel	Embedded/Borated Water	Cracking of material due to stress/strain from lifting	Transfer Cask Aging Management Program
Lower Trunnion Sleeve Nickel Alloy Weld Overlay (Cask Attachments)	SS	Stainless Steel	Embedded/Borated Water	Cracking of material due to stress/strain from lifting	Transfer Cask Aging Management Program
Lower Trunnion Neutron Shielding (Cask Attachments)	HT,SH	Bisco NS-3	Embedded/Borated Water	None Identified	None Required
Ram Access Penetration Ring (Cask Penetration)	SS	Stainless Steel	Sheltered/Borated water	None Identified	None Required
Upper and Lower Rings, Outer Shell, Relief Valve Support Plates (Cask Neutron Shield)	SH,HT	Stainless Steel	Sheltered/Borated water	None Identified	None Required
Inner and Outer Support Angle (Cask Neutron Shield)	SH, HT	Stainless Steel	Sheltered/Borated water	None Identified	None Required
Shielding Material (Cask Neutron Shield)	SH, HT	Bisco NS-3	Embedded	None Identified	None Required

Table 9.6-4. Aging Management Review Results for the Transfer Cask

Subcomponent	Intended Function	Materials	Environment[1,2]	Aging Effect/Mechanism	Aging Management Activity
Inner, Outer, and Side Plates (Top Cover Assembly)	SS	Stainless Steel	Sheltered	None Identified	None Required
Ring; Eye Bolt Stand-offs (Top Cover Assembly)	SS	24 Hot Galvanized Finish	Sheltered	None Identified	None Required
Neutron Shielding (Top Cover Assembly)	SH	Bisco NS-3	Embedded	None Identified	None Required
Inner, Outer, and Side Plates (Bottom Cover Assembly)	SH	Stainless Steel	Sheltered/Borated water	None Identified	None Required
Bottom Cover O-ring Seals	HT, SH	Polymer (Ethylene Propylene)	Sheltered	Materials Property Change	N/A – subject to routine replacement
Neutron Shielding (Bottom Cover Assembly)	SH	Bisco NS-3	Embedded	None Identified	None Required
Cask Bottom Cover Plate	SH	Stainless Steel	Sheltered	None Identified	None Required
Neutron Shielding (Cask Bottom)	SH	Bisco NS-3	Embedded	None Identified	None Required
Bolts, Washers, and Threaded Fasteners for Top Cover Plate and Ram Access Plate	SH	Carbon Steel	Sheltered	Loss of Material due to General Corrosion Loss of Material due to Pitting or Crevice Corrosion	Transfer Cask Aging Management Program
Misc Subcomponents	none	N/A	N/A	N/A	N/A

Table 9.6-4. Aging Management Review Results for the Transfer Cask

Notes:

[1] Sheltered environment represents ambient conditions on the interior of the transfer cask, conservatively including connecting and embedded surfaces. Some subcomponents may have interior surfaces that are considered embedded. No aging effects are identified for the embedded surfaces and no aging management is required. Temperature and radiation were considered, as described in Section 3.5.3, Environments for the Transfer Cask.

[2] All subcomponents that are immersed in the borated water of the SFP are rinsed off with deionized water after use.

HT Provides heat transfer
SH Provides radiation shielding
SS Provides structural support and/or functional support of important to safety equipment (structural integrity)
N/A Not applicable

Table 9.6-5 Aging Management Review Results for the Transfer Cask Lifting Yoke

Subcomponent	Intended Function	Materials	Environment[1]	Aging Effect/Mechanism	Aging Management Activity
Lifting Hook Plates	SS	Carbon Steel	Sheltered/Borated Water	Loss of Material due to General Corrosion Loss of Material due to Pitting or Crevice Corrosion Cracking of material due to stress/strain from lifting	Transfer Cask Lifting Yoke Aging Management Program
Lifting Beam Plates	SS	Carbon Steel	Sheltered/Borated Water	Loss of Material due to General Corrosion Loss of Material due to Pitting or Crevice Corrosion Cracking of material due to stress/strain from lifting	Transfer Cask Lifting Yoke Aging Management Program
Later Brace Plates	SS	Carbon Steel	Sheltered/Borated Water	Loss of Material due to General Corrosion Loss of Material due to Pitting or Crevice Corrosion	Transfer Cask Lifting Yoke Aging Management Program
Support Brace Plates	SS	Carbon Steel	Sheltered/Borated Water	Loss of Material due to General Corrosion Loss of Material due to Pitting or Crevice Corrosion	Transfer Cask Lifting Yoke Aging Management Program
Pin (Round Bar)	SS	Stainless Steel	Sheltered/Borated Water	Loss of Material due to General Corrosion Loss of Material due to Pitting or Crevice Corrosion	Transfer Cask Lifting Yoke Aging Management Program
Pin Handle	None	N/A	N/A	N/A	N/A

Table 9.6-5 Aging Management Review Results for the Transfer Cask Lifting Yoke

Subcomponent	Intended Function	Materials	Environment[1]	Aging Effect/Mechanism	Aging Management Activity
Pin Cradle Pipe	None	N/A	N/A	N/A	N/A
Rear Pin Stop	None	N/A	N/A	N/A	N/A
Pin Lock	None	N/A	N/A	N/A	N/A
Main Assembly Bolts, Nuts, Washers	SS	Carbon Steel	Sheltered	Loss of Material due to General Corrosion Loss of Material due to Pitting or Crevice Corrosion	Transfer Cask Lifting Yoke Aging Management Program
Support angles and misc hardware	None	N/A	N/A	N/A	N/A
Hook Bearing Plate	SS	Bronze	Sheltered	None Identified	None Required

Notes:

1 All subcomponents that are immersed in the borated water of the SFP are rinsed off with deionized water after use.

SS Provides structural support and/or functional support of important to safety equipment (structural integrity)
N/A Not applicable

Table 9.6-6. Aging Management Review Results for the Cask Support Platform

Subcomponent	Intended Function	Materials	Environment	Aging Effect/Mechanism	Aging Management Activity
Base Plate	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
Web Plates	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
Mid Plate	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
Top Plate	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
Honeycomb Energy Absorber	SS	Aluminum	Compressed Air	None Identified	None Required
Honeycomb Base Plate	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
Honeycomb Casing Plate	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
Honeycomb Outer Plate	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
Bottom Location Plates	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
Lifting Lugs	SS	Stainless Steel	Borated Water	Loss of material due to pitting or stress corrosion cracking	Cask Support Aging Management Program
**Tubing Manifold, Relief Valve, Pressure Gauge, Quick-Connect	none	N/A	N/A	N/A	N/A

SS Provides structural support and/or functional support of important to safety equipment (structural integrity)
N/A Not applicable

ATTACHMENT (5)

REGULATORY COMMITMENTS

ATTACHMENT (5)

REGULATORY COMMITMENTS

The table below lists the actions committed to in this submittal. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments.

Regulatory Commitments	Date
Exelon Generation will implement and maintain throughout the period of the renewed license the Aging Management Programs submitted in the letter from G. H. Gellrich to U.S. NRC dated September 18, 2014 letter. A description of these Aging Management Programs will be incorporated in Calvert Cliffs Independent Spent Fuel Storage Installation Updated Safety Analysis Report.	120 days after issuance of Renewed License
Exelon Generation will incorporate into Calvert Cliffs Independent Spent Fuel Storage Installation Updated Safety Analysis Report the Aging Management Review result tables submitted in the letter from G. H. Gellrich to U.S. NRC dated September 18, 2014 letter.	120 days after issuance of Renewed License