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10 CFR XXX

August 00, 2014

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Independent Spent Fuel Storage Installation
License No. SNM-2505
NRC Docket No. 72-8

Subject: 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, (CCNPP), 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)

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 issued a request for additional information to support their review of Calvert Cliffs' license renewal application.

Attachment (1) contains Calvert Cliffs' responses to the request for additional information. Attachment (2) contains revised aging management plans (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 Calvert Cliffs presented at the July 17, 2014 meeting with the NRC. Attachment (3) contains a revised Table 3.4-1, that supersedes the Table 3.4-1 contained in Attachment 1 of Reference 1.

There are no regulatory commitments contained in this correspondence.

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 August 00, 2014.

Very truly yours,

GHG/KLG/bjd

Attachment: (1) License Renewal Request - Fourth Request for Additional Information
(2) Aging Management Review Results for the HSM
(3) Revised Table 3.4-1

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File #
Electronic Docket

NRC 14-056

COMMITMENTS IDENTIFIED IN THIS CORRESPONDENCE:

- None

Posting Requirements for Responses -- NOV/Order **No**

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/m*^{2}*/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/m*^{2}*/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 ClSCC 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℃. Typical minimum and maximum temperatures on Miyakojima Island range from 14℃ to 31℃, 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℃. 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℃) and the median activation energy of 31 kJ/mol reported by Hayashibara et al. (2008), the SCC propagation rate increases by 2x at 40℃, 3x at 51℃, and 4x at 60℃. 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 that respectively address the times to initiate CISCC and propagate an SCC crack through wall (References 3 and 4). The purpose of those calculations was to address the October 31, 2012 request (Reference 1) 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/m^2 as the CISCC initiation threshold value still yields an initiation time greater than the initial 20 year license time given the 5.2 mg/m^2 chloride concentration measured on DSC-6 in HSM-1 after 19 years of storage. The NRC's cited threshold appears to be taken from Figure 8 of Reference 2 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 4 (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 2 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 95-58% 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 3. This initiation time when combined with either the estimates of CISCC crack penetration times of Reference 4, 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 Reference 3 and 4 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 provide in Reference 6) 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 6 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 6, 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 7 and 8). However, the dose from a CISCC induced penetration of an otherwise normal DSC can be estimated from information already in Reference 6 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). Performing this operation 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 aI., 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 ℃ 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 X). 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 Section A1.5 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 A1.6 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 include the following sections:

"A1.4.3 Aging Effects Requiring Management

The following aging effects require management:

- Cracking or loss of material (spalling, scaling) or corrosion of steel due to moisture, chemical attack and leaching.
- Cracking of concrete due to settlement, loss of bond with reinforcing steel.
- Cracking or loss of material (spalling, scaling) due to freeze-thaw degradation.
- Irradiation (concrete and steel)
- Increase in porosity/permeability and loss of strength due to leaching of Ca(OH)2."

and:

"(3) Parameters Monitored or Inspected

Consistent with the current Nuclear Regulatory Commission position relative to including concrete in an aging management program, the accessible concrete is visually examined for indication of surface deterioration. Degradation could affect the ability of the concrete to provide support to the dry shielded canisters (DSCs), to provide radiation shielding, to provide missile shielding, or to provide a path for heat transfer. The above-grade exterior concrete is accessible. The below-grade exterior concrete surfaces are inaccessible. Interior concrete is accessible for remote exams. The above-grade exterior concrete is a leading indicator for the interior concrete.

ACI 349.3R and ANSI/ASCE 11 provide an acceptable basis for selection of parameters to be monitored or inspected for concrete and steel structural elements.

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

a) Above Ground Concrete

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 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 should be evaluated with other NDE methods.

Surveillances of area radiation levels are made and compared to established limits. Levels exceeding limits are investigated for potential degradation of the HSM

components. Increased 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. Dose rates are measured at predetermined locations on the HSMs.

Daily surveillances 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. Plant procedures are in place for these inspections and surveillances.

- A Monitoring and Trending program will be established under the CAP for Level 2 and 3 inspection results.

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.

- Groundwater sampling of poured in place HSMs in a minimum of 3 locations every 5 years to trend potential for corrosive environment."

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 1.4 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 the 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.

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 ISFSls 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 A1.4.5.1.d:

  "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 A1.4.6.f 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 ISFSls 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 ISFSls 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 1.4 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.

CCNPP Response RAI-12:

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

The following statement has been added to the Parameters Monitored or Inspected section of the HSM AMP:

"(3) Parameters Monitored or Inspected

Consistent with the current Nuclear Regulatory Commission position relative to including concrete in an aging management program, the accessible concrete is visually examined for indication of surface deterioration. Degradation could affect the ability of the concrete to provide support to the dry shielded canisters (DSCs), to provide radiation shielding, to provide missile shielding, or to provide a path for heat transfer. The above-grade exterior concrete is accessible. The below-grade exterior concrete surfaces are inaccessible. Interior concrete is accessible for remote exams. The above-grade exterior concrete is a leading indicator for the interior concrete.

ACI 349.3R and ANSI/ASCE 11 provide an acceptable basis for selection of parameters to be monitored or inspected for concrete and steel structural elements.

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

a) Above Ground Concrete

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 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 should be evaluated with other NDE methods.

Surveillances of area radiation levels are made and compared to established limits. Levels exceeding limits are investigated for potential degradation of the HSM components. Increased 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. Dose rates are measured at predetermined locations on the HSMs.

Daily surveillances 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. Plant procedures are in place for these inspections and surveillances.

- A Monitoring and Trending program will be established under the CAP for Level 2 and

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 A1.4.6.f 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 1.9 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, 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. M. Tokiwai, H. Kimura, H. Kusanagi, "The amount of chlorine contamination for prevention of stress corrosion cracking in sensitized type 304 stainless steel," Corrosion Science, Vol. 25 Issue 8-9, pp. 837-844, 1985

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

1. 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)

2. 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

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

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

4. M. Yajima and A. Arii, “Chloride Stress Corrosion Cracking of AISI 304 Stainless Steel in Air” Materials Performance, Vol. 19, December 1980. pp. 17-19

5. CCNPP Calculation CA07818, “2011 Update of ISFSI USAR DSC Leakage Dose Analysis”

X. NUREG-1927, Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance, March 2011

ATTACHMENT (3)

REVISED TABLE 3.4-1

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

Subcomponent	Intended Function	Material Group	Environment	Aging Effects Requiring Management	Aging Management Activities
Reinforced Concrete Walls, Roof, and Foundation	HT, SH, SS	Concrete Steel	Yard-Salt, Air	Loss of Material Spalling, Scaling and Cracking / Freeze-Thaw Change in Material Properties	ISFSI Aging Management Program
Reinforced Concrete Walls, Roof, and Foundation (Underground)	HT, SH, SS	Concrete Steel	Embedded / Undergroun d	None Identified	None Required
DSC Structural Steel Support Assembly	SS	Carbon Steel	Sheltered	Loss of Material	ISFSI Aging Management Program
		Nitronic 60 Stainless Steel	Sheltered	None Identified	None Required
DSC Seismic Retainer for HSMs	SS	Carbon Steel	Sheltered	Loss of Material	ISFSI Aging Management Program
Cask Docking Flange and Tie Restraints	SS	Carbon Steel	Sheltered	Loss of Material	ISFSI Aging Management Program
			Yard	Loss of Material	ISFSI Aging Management Program
Heat Shield	HT	Stainless Steel	Sheltered	None Identified	None Required
Shielded Front Access Door and Door Supports	SH, SS	Carbon Steel	Yard	Loss of Material	ISFSI Aging Management Program
		Concrete	Embedded	None Identified	None Required
Ventilation Air	HT	Stainless Steel	Yard	None Identified	None Required

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

Subcomponent	Intended Function	Material Group	Environment	Aging Effects Requiring Management	Aging Management Activities
Openings (One Inlet / Two Outlets)					
Shielded Ventilation Air Inlet Plenum (Concrete)	HT	Concrete	Yard	Loss of Material, Spalling, Scaling and Cracking / Freeze-Thaw Change in Material Properties	ISFSI Aging Management Program
Shielded Ventilation Air Inlet Plenum (Stainless Steel)	HT	Stainless Steel	Embedded / Yard	None Identified	None Required
Ventilation Air Outlet Shielding Blocks (Concrete)	HT	Concrete	Yard	Loss of Material, Spalling, Scaling and Cracking / Freeze-Thaw Change in Material Properties	ISFSI Aging Management Program
Ventilation Air Outlet Shielding Blocks (Stainless Steel)	HT	Stainless Steel	Embedded / Yard	None Identified	None Required
Lightning 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
Ladder and Attachments	None	N/A	N/A	N/A	N/A
Caulk, Sealants, Expansion Joint	None	N/A	N/A	N/A	N/A

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

Subcomponent	Intended Function	Material Group	Environment	Aging Effects Requiring Management	Aging Management Activities
Fillers					
Dry Film Lubricants	None	N/A	N/A	N/A	N/A
Polyvinyl Chloride Drain Pipe	None	N/A	N/A	N/A	N/A
Electrical Conduit, Boxes, and Cable	None	N/A	N/A	N/A	N/A
Alignment Targets	None	N/A	N/A	N/A	N/A

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