ENERGY*SOLUTIONS*

October 24, 2014
ES/NRC 14-018
Docket No. 72-1007

ATTN: Document Control Desk
Director, Division of Spent Fuel Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: **Response to Second Request for Additional Information for the VSC-24 CoC Renewal Application (TAC No. L24694)**

Reference: Letter from Dr. Pamela Longmire (NRC) to Mr. Steven Sisley (Energy*Solutions*), "Second Request for Additional Information for Energy*Solutions*, VSC-24 Storage System, Certificate of Compliance No. 1007 – Renewal Application (TAC No. L24694)," July 25, 2014, ADAMS Accession Number ML14206B075.

Dear Sir or Madam:

By the referenced letter, NRC requested that Energy*Solutions* (ES) provide additional information needed for NRC staff to complete their review of the application to renew the Certificate of Compliance (CoC) No. 1007 for the VSC-24 Storage System. ES hereby provides the additional information requested by NRC in the referenced letter, as described in Enclosure 1. Enclosure 2 contains one (1) paper copy of Revision 3 of the CoC Renewal Application for the VSC-24 Ventilated Storage Cask System (LAR 1007-007), which has been revised in response to the RAI, as described in Enclosure 1. In addition, a summary of changes included in Revision 3 of the CoC Renewal Application is provided in Attachment 1 of this letter. Enclosures 3 and 4 each include one (1) paper copy of additional documents that are provided in response to the RAI.

Should you or any member of your staff have questions, please contact the undersigned at (408) 558-3509.

Sincerely,

Steven E. Sisley
Cask Licensing Manager
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Attachments:

(1) Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Storage Cask System (Docket No. 72-1007), LAR 1007-007, Revision 3 (8 pages)

Enclosures:

1) Response to Second Request for Additional Information (1 paper copy).
2) Certificate of Compliance Renewal Application for the VSC-24 Ventilated Storage Cask System (Docket No. 72-1007), LAR 1007-007, Revision 3, October 24, 2014, Public Version (1 paper copy).
3) Calculation No. 1200250.301, Revision 1, "Flaw Tolerance Evaluation of Spent Fuel Cask MSB#4 for Palisades Power Plant" (1 paper copy).
4) Calculation No. 2007-20168, Revision 00, "Palisades Weld Flaw Analysis for Loaded Spent Fuel Cask MSB No. 4" (1 paper copy).

cc

Dr. Pamela Longmire, Division of Spent Fuel Storage and Transportation
Mr. Dan Shrum, Energy*Solutions*

The following is a summary of the changes incorporated in the Certificate of Compliance Renewal Application for the VSC-24 Ventilated Storage Cask System, LAR 1007-007, Revision 3.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, LAR 1007-007, Revision 3

Section	Page(s)	Change	Purpose
3.2.1.3	3-11	Added paragraph break between 3rd and 4th sentences.	Editorial change.
3.2.1.3	3-11 and 3-12	Deleted 6th and 7th sentences regarding pre-heating of the RX-277 during fabrication to remove moisture and added 3 new sentences discussing moisture off-gassing from RX-277.	Revised in response to RAI-6.
3.2.1.3	3-12	Added paragraph break before the sentence reading "Thus, the potential..."	Editorial change.
3.2.1.3	3-13	Changed "higher *that* the..." to "higher *than* the..." in the last paragraph of the section.	Editorial correction.
3.3.3.4	3-25	Changed "higher *that* the..." to "higher *than* the..." in the paragraph at the top of the page.	Editorial correction.
3.3.3.6	3-26	Revised the final crack sizes in the 2nd paragraph based on the revised crack growth analysis.	Revised in response to RAI-1.
3.4.2.2	3-28 and 3-29	Revised the 1st through 3rd paragraphs of the section to clarify the AMP Scope, Preventative Actions, and Parameters Monitored or Inspected.	Revised in response to RAI-3.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, LAR 1007-007, Revision 3

Section	Page(s)	Change	Purpose
3.4.2.2	3-29	Revised the 3rd paragraph from the top of the page to discuss the revised acceptance criteria for defects on the VCC exterior surface.	Revised in response to RAI-3.
3.4.2.2	3-29	Added paragraph break prior to discussion on corrective actions (before 4th paragraph from top of page). Revised 1st sentence of new paragraph for clarity.	Editorial change.
3.4.2.2	3-29	Deleted "significant" from last sentence at bottom of page.	Deleted non-quantifiable term.
3.4.2.2	3-31	Revised 2nd and 3rd sentences of last paragraph of section to use more generic description of defects.	Editorial change.
3.4.2.3	3-31	Revised 1st paragraph to clarify the AMP scope and require VT-3 visual examination.	Revised in response to RAI-4.
3.4.2.3	3-31 and 3-32	Revised 2nd paragraph (at bottom of page 3-31) and 3rd paragraph to discuss the intended safety functions and revised acceptance criteria.	Revised in response to RAI-4.
3.4.2.3	3-32 and 3-33	Revised 4th, 5th and 6th paragraphs of section to discuss the revised corrective actions, including extent of condition.	Revised in response to RAI-4.
3.4.2.4	3-33	Changed "top interior" to "top end" and "later" to "latter" in the 1st paragraph.	Editorial corrections.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, LAR 1007-007, Revision 3

Section	Page(s)	Change	Purpose
3.4.2.4	3-33 and 3-34	Revised the 2nd, 3rd, and 4th paragraphs of the section to clarify the AMP scope and methods of examination.	Revised in response to RAI-5.
3.4.2.4	3-34	Revised 3rd and 4th paragraphs on page to discuss corrective actions and extent of condition.	Revised in response to RAI-5.
3.4.2.5	3-35	Revised 1st paragraph to require MTC examination to be performed within one year prior to use of MTC.	Revised in response to RAI-7.
3.4.3.3	3-41	Changed "is less *that*..." to "is less *than*..." in the 2nd paragraph.	Editorial correction.
3.4.4	3-45	Added "Cask Selection" sub-header and revised subsection to describe criteria for selecting the "lead cask".	Revised in response to RAI-8.
3.4.4	3-45 and 3-46	Added "Inspection Scope and Methods" sub-header and revised subsection to describe subject AMP elements.	Revised in response to RAI-8.
3.4.4	3-46	Added "Acceptance Criteria and Corrective Actions" sub-header and revised subsection to describe subject AMP elements.	Revised in response to RAI-8.
Table 13	3-59	Revised AMP Section(s) for the VCC Lifting Lug (Optional) to include Section 3.4.4.	Added to scope of Lead Cask Inspection AMP for completeness.
Table 15	3-62 thru 3-65	Revised the number of pages in the table heading.	Editorial change.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, LAR 1007-007, Revision 3

Section	Page(s)	Change	Purpose
Table 15, "Scope", "Preventative Actions", and "Parameters Monitored or Inspected"	3-62	Revised to include the steel-to-concrete interfaces at the openings of the VCC air inlets. Also revised Scope to clarify which portions are subject to examination.	Revised in response to RAI-3.
Table 15, "Acceptance Criteria"	3-63	Revised acceptance criteria for popouts and voids, scaling, and cracks on the concrete exterior, and gaps or voids at the steel-to-concrete interfaces of the VCC air inlets and outlets.	Revised in response to RAI-3.
Table 15, "Corrective Actions"	3-63	Revised Repair of Defects to include the steel-to-concrete interface at the VCC air inlets and allow repair by suitable means.	Revised in response to RAI-3.
Table 15, "Corrective Actions"	3-63	Revised Rebar Corrosion to include corrosion staining as an example of evidence of rebar corrosion.	Editorial change.
Table 15, "Corrective Actions"	3-63 and 3-64	Added Leaching and Porosity to discuss the required corrective actions when evidence of leaching is identified.	Added for completeness.
Table 15, "Corrective Actions"	3-64	Revised 2nd paragraph of Aggregate Reactions to include text suggested in RAI.	Revised in response to RAI-3.
Table 15, "Corrective Actions"	3-64	Added Extent of Conditions discussion.	Added for completeness.
Table 16	3-66 thru 3-68	Revised the number of pages in the table heading.	Editorial change.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, LAR 1007-007, Revision 3

Section	Page(s)	Change	Purpose
Table 16, "Scope"	3-66	Clarified components and surfaces that are included in the scope of the AMP.	Revised in response to RAI-4.
Table 16, "Preventative Actions"	3-66	Addressed corrosion of the coated steel surfaces that line the VCC air inlets, outlets, and annulus.	Added for completeness.
Table 16, "Parameters Monitored or Inspected"	3-66	Changed the parameter monitored for the coated carbon steel surfaces from "degradation" to "corrosion".	Added specificity.
Table 16, "Detection of Aging Effects"	3-66	Revised *Method or Technique* to specify VT-3 visual examination to identify blockage and localized corrosion.	Revised in response to RAI-4.
Table 16, "Detection of Aging Effects"	3-66	Revised *Data Collection* to include requirements for documenting degradation of the coated carbon steel surfaces.	Revised in response to RAI-4.
Table 16, "Acceptance Criteria"	3-67	Added sub-headings for Blockage and Coating Degradation and Corrosion.	Added for clarity.
Table 16, "Acceptance Criteria"	3-67	Revised Coating Degradation and Corrosion to replace corrosion acceptance criteria based on depth of corrosion as determined by visual examination with acceptance criteria based on amount of blockage and type of corrosion.	Revised in response to RAI-4.
Table 16, "Corrective Actions"	3-67 and 3-68	Added sub-headings for Blockage and Coating Degradation and Corrosion.	Added for clarity.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, LAR 1007-007, Revision 3

Section	Page(s)	Change	Purpose
Table 16, "Corrective Actions"	3-67	Revised Blockage to include actions for evaluating extent of condition.	Added for completeness.
Table 16, "Corrective Actions"	3-67 and 3-68	Revised Coating Degradation and Corrosion to describe corrective actions required to address unacceptable corrosion on the steel surfaces that line the VCC air inlets, air outlets, and annulus, including extent of condition.	Revised in response to RAI-4.
Table 16, "Notes"	3-68	Added Note 1 to define "readily accessible surfaces" that require inspection.	Revised in response to RAI-4.
Table 17	3-69 thru 3-71	Revised the number of pages in the table heading.	Editorial change.
Table 17, "Scope"	3-69	Clarified components and surfaces that are included in the AMP.	Revised in response to RAI-5.
Table 17, "Detection of Aging Effects"	3-69	Revised *Method or Technique* to specify VT-3 visual examination to identify blockage and localized corrosion.	Revised in response to RAI-5.
Table 17, "Acceptance Criteria"	3-70	Revised to specify quantifiable acceptance criteria for corrosion.	Revised in response to RAI-5.
Table 17, "Corrective Actions"	3-70	Revised to better describe corrective actions required to address coating degradation and corrosion and actions required to evaluate extent of condition.	Revised in response to RAI-5.
Table 17, "Notes"	3-71	Added new Note 1 to discuss additional requirements for visual examination of the VCC Shielding Ring Plate (Shield	Revised in response to RAI-5.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, LAR 1007-007, Revision 3

Section	Page(s)	Change	Purpose
		Ring) outer radial surface if it must be lifted to accomplish the other required visual inspections and renumbered subsequent notes.	
Table 17, "Notes"	3-71	Revised end of Note 2 to read ", regardless of condition."	Revised in response to RAI-5.
Table 18, "Detection of Aging Effects"	3-72	Revised *Frequency* to add a requirement for examination of the MTC assembly within 1-year prior to use.	Revised in response to RAI-7.
Table 19	3-74 thru 3-77	Revised the number of pages in the table heading.	Editorial change.
Table 19, "Scope"	3-74	Clarified the scope of the AMP and added requirement to examine the normally inaccessible surfaces of the MSB bottom plate and VCC cask liner bottom. Added new note 1 and renumbered subsequent notes.	Revised in response to RAI-8.
Table 19, "Preventative Actions"	3-74	Revised to address blockage and editorial corrections.	Added for completeness.
Table 19, "Parameters Monitored or Inspected"	3-74 and 3-75	Revised to use nomenclature for the subcomponents of the VCC and MSB assemblies that is consistent with Tables 5 and 6.	Added for completeness.
Table 19, "Detection of Aging Effects"	3-75	Revised to include blockage.	Revised in response to RAI-8.
Table 19, "Detection of Aging Effects"	3-75	Revised *Method or Technique* to specify VT-3 visual examination and include the MSB bottom plate and VCC cask liner bottom.	Revised in response to RAI-8.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, LAR 1007-007, Revision 3

Section	Page(s)	Change	Purpose
Table 19, "Detection of Aging Effects"	3.75	Renumbered notes in *Sample Size* and *Timing of Inspections*.	Editorial changes.
Table 19, "Acceptance Criteria"	3-75 and 3-76	Added the acceptance criteria for blockage, coating degradation, and corrosion identified in the lead cask inspection.	Revised in response to RAI-8.
Table 19, "Corrective Actions"	3-76 and 3-77	Revised to include the actions required to address blockage, coating degradation and corrosion, and extent of condition.	Revised in response to RAI-8.
Table 19, "Administrative Controls"	3-77	Revised to address requirements for documentation of the evaluation and basis for lead cask selection.	Revised in response to RAI-8.
Table 19, "Notes"	3-77	Added new Note 1 to define "readily accessible surfaces" that require inspection and renumbered subsequent notes.	Revised in response to RAI-8.
Table 19, "Notes"	3-77	Revised end of Note 2 to read ", regardless of condition."	Revised in response to RAI-8.
Table 19, "Notes"	3-77	Revised Note 3 to reference Section 3.4.4 for lead cask selection criteria.	Revised in response to RAI-8.
Table A-1, FSAR Section 9.3.3	A-11 and A-12	Change cross-references for table content of Tables 9.3-5 through 9.5-10 to Tables 14 through 19, respectively.	Editorial correction.

Enclosure 1

Responses to Second Request for Additional Information

(20 pages total)

The responses to the NRC's second Request for Additional Information (RAI) associated with the Energy*Solutions* (ES) request to renew the Certificate of Compliance (CoC) for the VSC-24 Ventilated Dry Cask Storage System for an additional 40 years are provided herein. Each RAI question is repeated herein and followed by the ES response and a summary of the resulting changes to the VSC-24 CoC renewal application.

RAI-1: Provide additional information that supports the MSB#4 calculation of the modified flaw growth depth and length and the comparison to the original calculations by Sargent and Lundy that are reported in Calculation No. 1200250.301 Rev 0., "Flaw Tolerance Evaluation of Spent Fuel Cask MSB#4 for Palisades Power Plant," Table 4, "Fatigue Crack Growth Results" (ML14099A169).

The original calculations performed by Sargent and Lundy for 50 years of operation were revised and extended to 60 years to include the original licensing period of 20 years and the proposed 40 year renewal. The design inputs were modified and documented in calculation package VSC-04-3205.

With the revised inputs and extension of the calculation from 50 to 60 years, the total fatigue crack growth increases in both length and depth. While the total length and depth increases, the modified length and depth calculations for the Off-Normal Ambient Temperature Fluctuations and Seismic/Handling decrease compared to the original Sargent and Lundy calculations.

This information is required to evaluate compliance with 10 CFR 72.236(d) and 10 CFR 72.240(c)(2).

Response to RAI-1

Calculation No. 1200250.301, "Flaw Tolerance Evaluation of Spent Fuel Cask MSB#4 for Palisades Power Plant," has been revised to correct an error in the calculation. Table 3 of the calculation package presents the ratios of the membrane and bending stress range (i.e., $\Delta\sigma$ ratios) that are used to calculate the da/dN ratios, which in turn are used to calculate the Δa_2 crack growth values. The $\Delta\sigma$ ratios are defined as the ratios of the new membrane or bending stress ranges from Table 2 of the calculation package to the old membrane or bending stress ranges from Table 1 of the calculation package (i.e., $\Delta\sigma$ ratio = $\Delta\sigma_{m2}/\Delta\sigma_{m1}$ or $\Delta\sigma_{b2}/\Delta\sigma_{b1}$). In the previous version of the calculation, these $\Delta\sigma$ ratios were inverted in error (i.e., they were incorrectly calculated as $\Delta\sigma_{m1}/\Delta\sigma_{m2}$ and $\Delta\sigma_{b1}/\Delta\sigma_{b2}$). The results of revised calculation package show that the final depth and length of the bounding 1-inch long by ½-inch deep flaw after 60 years of service grow to 1.0000193-inch long by 0.5000203-inch deep, respectively.

<u>Summary of Renewal Application Changes</u>

- Calculation No. 1200250.301, "Flaw Tolerance Evaluation of Spent Fuel Cask MSB#4 for Palisades Power Plant," is revised as noted above. A copy of

Calculation No. 1200250.301, Revision 1 is included in Enclosure 3 of the RAI response letter.

- Section 3.3.3.6: Revised 2nd paragraph to report corrected crack growth values for the 60-year extended storage period.

RAI-2: Provide additional information that supports the revised K_{Ic} and K_{Id} values and the application of these values for the Accident/Faulted case in Table 6 of Calculation No. 1200250.301 Rev 0. In Calculation No. 1200250.301 Rev 0, the revised K_{Ic} and K_{Id} values are larger than the K_{Id} value used in Calculation CPC-06Q-303 Rev 1, "Analysis of Hypothetical Flaws in VSC-24 Shell and Bottom Plate" (ML14099A161). Specifically, parameters in Calculation No. 1200250.301 Rev 0 are K_{Ic} = 153.0105 ksi√in and K_{Id} = 89.2468 ksi√in, whereas Calculation No. CPC-06Q-303 Rev 1 uses a K_{Id} = 75 ksi√in at 0°F.

In addition, Calculation No. 1200250.301 Rev 0 uses a K_{Ic} = 153.0105 ksi√in for the Accident/Faulted case whereas Calculation No. CPC-06Q-303 Rev 1 uses a K_{Id} = 75 ksi√in at 0°F and included a justification for the use of K_{Id} vs. K_{Ic} as follows:

> *"For the emergency/faulted case (horizontal drop), it is still appropriate (and conservative) to use the calculated K_{Id}* as *the evaluation criterion, because* of *the dynamic nature* of *the loading, instead* of *the K_{Ic} (which would be appropriate for static or slow loading rates)."* Source: Calculation No. CPC-06Q-303 Rev. 1, Page 6 of 19.

This information is required to evaluate compliance with 10 CFR 72.236(d) and 10 CFR 72.240(c)(2).

Response to RAI-2

The values of K_{1c} and K_{1d} used in Calculation No. 1200250.301 are correct and justified. Calculation No. 1200250.301 presents a crack growth fracture mechanics analysis of the known flaws in the shell seam welds of Palisades MSB#4, whereas Calculation No. CPC-06Q-303, Revision 1 develops generic acceptance criteria for undocumented weld repairs in the shell and bottom plate for all MSBs at Palisades, Point Beach, and ANO. Thus, different values of K_{1c} and K_{1d} are used in these calculations. The values of K_{1c} and K_{1d} used in Calculation No. 1200250.301 are the same values used in the previous version of the Palisades MSB#4 crack growth analysis (from Section 4.2 of Sargent & Lundy Calculation No. 2007-20168, Revision 00), not those used in Calculation No. CPC-06Q-303. The values of K_{1c} and K_{1d} used in Calculation No. 1200250.301 are based on the weld material properties (i.e., CVN = 54 ft-lb at 0°F) obtained from a Certified Material Test Report (CMTR) of the weld metal for Palisades, whereas the value of K_{1d} used in Calculation No. CPC-06Q-303 is based on a lower bound material toughness value from testing of welded specimens of SA-516, Grade 70 carbon steel plate prepared by Palisades, Point Beach, and ANO (i.e., K_{1d} is based on a lower bound value of CVN = 42 ft-lb at 0°F for the Point Beach specimen). Thus, the values of K_{1c}

and K_{Id} used in Calculation No. 1200250.301 are not "revised values" of those used in Calculation No. CPC-06Q-303. Rather, they are values that are specific to the weld material used for the Palisades MSB#4 shell seam welds as opposed to generic values that apply to all MSBs and all three sites.

For the Palisades MSB#4 flaw stability analysis, it is appropriate to use the lower bound critical crack initiation fracture toughness (K_{Ic}) for the accident/faulted case rather than the lower bound critical crack arrest fracture toughness (K_{Id}) because the crack is shown to be non-propagating. The results of Calculation No. 1200250.301 show that the ½-inch deep by 1-inch long bounding crack size evaluated grows by only 0.0000203 inches in depth and 0.0000193 inches in length over 60 years, which is negligible. Because it is a non-propagating crack, an applied stress intensity factor (K_a) for the horizontal drop that does not exceed K_{Ic} will not cause flaw instability to occur. Furthermore, it should be noted that the since the 2007 Edition of the ASME Code, K_{Id} is no longer used and the acceptance criteria for emergency and faulted conditions is given as $K_{Ic}/\sqrt{2}$, which is consistent with the acceptance criteria used in the Palisades MSB#4 flaw stability analysis. Although it is not appropriate to base the acceptance criteria for the horizontal drop on K_{Id} for the reasons stated above, it should be noted that the calculated stress intensity factor (K_a) for the horizontal drop in the revised Calculation No. 1200250.301 is less than $K_{Id}/\sqrt{2}$ (using the value of K_{Id} from Sargent & Lundy Calculation No. 2007-20168, Revision 00 for the reasons discussed previously).

<u>Summary of Renewal Application Changes</u>

- Section 5.2 of Calculation No. 1200250.301, "Flaw Tolerance Evaluation of Spent Fuel Cask MSB#4 for Palisades Power Plant," has been revised to provide the basis for the fracture toughness values K_{Ic} and K_{Id} used for the flaw stability analysis. A copy of Calculation No. 1200250.301, Revision 1 is included in Enclosure 3 of the RAI response letter.

- A copy of Sargent & Lundy Calculation No. 2007-20168, Revision 00 is included in Enclosure 4 of the RAI response letter.

RAI-3: Provide additional information on the Aging Management Program (AMP) regarding examination of the Ventilated Concrete Cask (VCC) described in Section 3.4.2.2 and Table 15 of the CoC Renewal Application dated April 4, 2014 (ML14099A168).

1. Additional information is needed to clarify the management of concrete cracking using Technical Specification (TS) 1.3.2 that is not related to Aggregate Reactions. Section 3.4.2.2 of the revised CoC Renewal Application (ML14099A 168) states:

   The exterior concrete surfaces of the VCC assembly are visually inspected for damage, such as concrete cracking, scaling, or spalling in accordance with Technical Specification 1.3.2.

The request for additional information RAI-2 (ML14099A167), requested the acceptance criteria for concrete defects cited in TS 1.3.2. The response to RAI-2 states:

"Although the basis for the defect size criteria is not provided, they are generally consistent with the acceptance criteria of ACI 349.3R-02, "Evaluation of Existing Nuclear Safety-Related Concrete Structures," for exposed concrete surfaces. According to Section 5.1.1 of ACI 349.3R-02, popouts and voids less than 3/4-inch in diameter and spalling less than 3/8-inch in depth are "generally acceptable without further evaluation."

Contrary to the response for RAI-2, TS 1.3.2 and the AMP for the VCC do not appear to be consistent with ACI-349-3R-02. ACI 349.3R-02 subsection 5.1.1 states:

Concrete surfaces that are exposed for inspection are generally acceptable without further evaluation with passive cracks that are less than 0.4 mm (0.015 in.) in maximum width.

2. Additional information is needed to clarify whether the 3-feet long by 3/8-in wide by 3/8-inch deep void or gap between the VCC bottom plate and the VCC bottom concrete identified in the Lead Cask Inspection Report (ML13050A323) is compliant with TS 1.3.2.

3. Additional information is needed to clarify whether the scope of the AMP for examination of the VCC also includes the steel to concrete interfaces of the VCC inlet assemblies. At present, the information provided does not specifically identify the VCC air inlet duct.

4. Revise Table 15 Corrective Actions on Aggregate Reactions 2nd paragraph 4th sentence, change sentence to read: *After 3 years, the CI measurement frequency may be reduced to <u>once every</u> 5 years if the CI shows no significant increasing trend.* This revision will make the Corrective Actions in Table 15 consistent with the Corrective Actions described in CoC Renewal Application Section 3.4.2.2, Examination of the VCC Assembly Exterior Concrete.

This information is required to evaluate compliance with 10 CFR 72.236(g) and 10 CFR 72.240(c)(3).

Response to RAI-3

1. The acceptance criterion in Section 3.4.2.2 and Table 15 for cracks on the VCC concrete exterior has been revised, based on the second-tier acceptance criteria given in Section 5.2 of ACI 349.3R-02, to allow cracks with a maximum width of 1 mm (0.04 in.) that have no evidence of other degradation mechanisms at the crack (e.g., signs of corrosion). Any VCC with cracks on the concrete exterior surface that exceed 1 mm (0.04 in.) in width or show indications of other degradation mechanisms at the cracks (e.g., signs of corrosion) shall be evaluated for continued

storage in accordance with the GL's corrective action program. Passive cracks (i.e., those that are not growing, as evidenced by monitoring and trending data) that exceed 1 mm (0.04 in.) in width, but show no indications of other degradation mechanisms at the crack, may be accepted as-is, provided they are monitored and trended in subsequent inspections. A VCC with cracks on the concrete exterior surface that exceed 1 mm (0.04 in.) in width and show indications of other degradation mechanisms at the crack shall be repaired as appropriate (e.g., filled with grout or covered with a suitable protective barrier system) or replaced in accordance with the GL's procedures.

In addition, the acceptance criteria for popouts and voids has been revised from "½ inch in diameter (or width) and ¼-inch deep" to "½-inch diameter (or equivalent surface area)". This acceptance criterion is consistent with that given in ACI 349.3R-02, in that it is based only on the surface area (not the depth) of popouts and voids, and it is more restrictive than the acceptance criteria included in TS 1.3.2. Furthermore, this AMP acceptance criteria remains more conservative than the first-tier acceptance criteria (i.e., ¾ inch in diameter or equivalent surface area) given in Section 5.1 of ACI 349.3R-02. The acceptance criteria has also been revised to limit scaling to less than 3/16 inch deep, conservatively based on the first-tier acceptance criteria given in Section 5.1 of ACI 349.3R-02.

2. Inspection of the steel-to-concrete interfaces of the VCC bottom plate and VCC inlet and outlet assemblies is not included in the scope of TS 1.3.2. The Technical Specification Bases for TS 1.3.2 (B.1.3.2) indicate that the actions are intended to maintain the surface condition of the concrete exterior, but it does not discuss the steel-to-concrete interfaces. Therefore, the gap between the VCC bottom plate and the VCC bottom concrete that was identified in the Palisades Lead Cask Inspection Report does not require corrective action per TS 1.3.2. However, the GL has entered this condition into their corrective action program for documentation and evaluation, and will repair the condition, as required by the AMP discussed in Section 3.4.2.2 and Table 15.

3. Section 3.4.2.2 and Table 15 have been revised to clarify that the scope of the AMP requires visual examination of the steel-to-concrete interfaces of the VCC Bottom Plate Assembly, including the interfaces around the bottom end of the VCC and the openings of the air inlets. The VCC Bottom Plate Assembly consists of a plate that is formed to include the openings to the air inlets. It is noted that the VCC Air Inlet Assemblies (Part Nos. VCC-030 thru -038), which are attached to the VCC Bottom Plate Assembly, do not extend to the exterior surface of the concrete.

4. Table 15, Corrective Actions on Aggregate Reactions, 2nd paragraph, 4th sentence, has been revised as suggested.

Summary of Renewal Application Changes

- Section 3.4.2.2: The 1st and 2nd paragraphs have been revised to clarify that the inspection of the steel-to-concrete interfaces includes the openings of the air inlets. The 1st paragraph has also been revised to clarify that the only readily accessible surfaces of the exterior concrete and steel-to-concrete interfaces (i.e., those portions that are not covered by the air inlet and outlet screens or other items, such as monitoring equipment) are included in the scope of the inspection.

- Table 15: The Scope, Parameters Monitored or Inspected, and Corrective Actions/Repair of Defects sections of the AMP have been revised to clarify that the inspection of the steel-to-concrete interfaces includes the openings of the air inlets. The Scope of the AMP has also been revised to clarify that the only readily accessible surfaces of the exterior concrete and steel-to-concrete interfaces (i.e., those portions that are not covered by the air inlet and outlet screens or other items, such as monitoring equipment) are included in the scope of the inspection.

- Section 3.4.2.2 and Table 15: The Acceptance Criteria section of the AMP has been revised to specify acceptance criteria for concrete cracks based on the second-tier acceptance criteria give in Section 5.2 of ACI 349.3R-02. Furthermore, the acceptance criteria for depth of popouts and voids have been deleted and a scaling depth acceptance criterion has been added, as discussed above.

- Table 15: The Corrective Actions section of the AMP has been revised to include the required corrective actions for Leaching and Porosity.

- Table 15, Corrective Actions: Revise the 2nd paragraph, 4th sentence, of Aggregate Reactions as suggested.

- Table 15: The Corrective Actions section of the AMP has been revised to clarify that no actions are required for Extent of Condition Evaluation because the extent of condition is known since examinations are required to be performed annually on all casks.

RAI-4: Provide additional information on the AMP for the Examination of VCC Assembly Ventilation Ducts and Annulus in Section 3.4.2.3 and Table 16 of the CoC Renewal Application (ML14099A168).

1. Additional information is needed to support the use of remote visual inspection to determine that corrosion of the MSB shell does not exceed 0.003 in/year multiplied by the number of years since the cask was placed into service as stated. No credit is taken for coating and the MSB shell is assumed to have a corrosion rate of 0.003 in/year based on corrosion rates of carbon steels in marine environments. The acceptance criteria for the maximum material loss of the MSB shell in the Examination of the VCC Assembly Ducts and Annulus is stated as 0.003 in/year multiplied by the number of years since the cask was placed into service. For inspections that occur in 5 year intervals, the additional allowable loss of material thickness will be 0.015 inches. It is not evident that the proposed remote visual inspection method proposed is qualified to detect the loss of material indicated in the

Examination of VCC Assembly Ventilation Ducts and Annulus AMP and demonstrated to be adequate to verify that no unanticipated degradation has occurred.

2. Additional information is needed to clarify how Corrective Actions will be applied for the MSB bottom plate. The Examination of the VCC Assembly Ventilation Ducts and Annulus AMP specifically states that an MSB shell with corrosion that exceeds the acceptance criteria shall be evaluated for continued use and extent of condition. It is not clear if the extent of condition evaluation will also include the MSB bottom plate that is assumed to have the same corrosion rate that does not exceed 0.003 in/yr.

3. Additional information is needed on the actions to evaluate the extent of condition for the VCC liner. Specifically, identify whether other VCC liner plates will be examined to assess the extent of condition if unanticipated corrosion is observed.

4. Additional information is needed that quantifies significant corrosion for the VCC liner plate, including method used for the Detection of the Aging Effect, Acceptance Criteria and Corrective Actions. The present Acceptance Criteria of no corrosion on the VCC inlet ducts, outlet ducts or liner that prevents the VCC from performing its intended functions is ambiguous. The corrective actions in Section 3.4.2.3 and Table 16 Revision 2 of the CoC Renewal Application (ML14099A168) do not identify actions to be performed to assess the extent of condition for the VCC assemblies but Section 3.4.2.3 states that VCC assemblies that are determined to not be acceptable for continued storage shall be repaired or replaced.

5. Additional information is needed to clarify what parts of the cast-in-place formwork including the ¼ in thick carbon steel plate secured to the VCC concrete that forms the VCC air inlet ducts and VCC annulus (including the VCC liner bottom plate) will be examined.

This information is required to evaluate compliance with 10 CFR 72.236(g) and 10 CFR 72.240(c)(3).

Response to RAI-4

1. Section 3.4.2.3 and Table 16 are revised to remove the reliance on remote visual examination to confirm the depth of corrosion on the MSB shell.

   As discussed in the response to the previous RAI-12 (ML14099A167), general corrosion of the MSB shell and bottom plate is evaluated and addressed using TLAA, and it is not necessary to verify the corrosion rate on the MSB shell and bottom plate through an AMP. As discussed in Section 3.2.1.1, of the VSC-24 CoC Renewal Application under Loss of Material, general corrosion is the only type of corrosion that is expected to occur on the MSB shell and bottom plate. Galvanic corrosion of the MSB shell and bottom plate is not possible because it does not contact any dissimilar metals. Crevice corrosion of the MSB bottom plate is not possible because it is separated from the VCC Cask Liner Bottom by ¼-inch thick ceramic tiles.

Although the primary objective of the remote visual examination of the VCC ventilation ducts and annulus is to monitor for blockage, it also allows the condition of the coated carbon steel surfaces that line the ventilation ducts and annulus to be monitored. Any coating degradation or corrosion identified during the remote visual examination of the ventilation ducts and annulus shall be evaluated by personnel that are qualified for VT-3 visual examination in accordance with industry guidelines for implementing the requirements of the Maintenance Rule (10 CFR 50.56), such as ASME, Section XI, IWE-2330, to determine the type of corrosion. General corrosion (e.g., atmospheric corrosion) is acceptable based on the TLAA and does not require any corrective actions. However, any other types of localized corrosion (i.e., galvanic, crevice, or pitting) are not anticipated, and therefore unacceptable.

2. Section 3.4.2.3 and Table 16 are revised to clarify the additional actions required to address extent of condition for corrosion on the MSB bottom plate should unacceptable corrosion be identified on the MSB shell.

   As discussed in the response above, general corrosion (e.g., atmospheric corrosion) on the MSB shell and bottom plate is acceptable based on the TLAA and does not require any corrective actions. However, localized corrosion (i.e., galvanic, crevice, or pitting corrosion) on the MSB shell and bottom plate is not anticipated, and therefore considered unacceptable. If localized corrosion is identified on the MSB shell, the condition shall be evaluated in accordance with the GL's corrective action program, including extent of condition. Corrective actions shall consider the need for additional non-destructive examination (NDE), such as eddy current or ultrasonic measurement, to determine the depth of the corrosion, if that information is required by the qualified VT-3 inspector to evaluate the condition. NDE methods used to determine the depth of corrosion shall be qualified for use by the GL.

   In the event that localized corrosion is identified on the MSB shell, the evaluation of the extent of condition shall include additional remote visual examination of the MSB bottom. In addition, remote visual examination shall be performed on at least two additional MSB shells at the site for unanticipated corrosion on the MSB shell. This examination should also include the normally inaccessible area of the MSB bottom if unacceptable corrosion is identified in the MSB bottom in the first cask. If examination of the additional casks also identifies unacceptable corrosion of the MSB shell, then the GL should expand the scope of the AMP to include remote visual examination of all MSB shells at the site.

   It should be noted that even though crevice corrosion of the MSB bottom is not anticipated because of the ¼-inch separation between the MSB bottom and VCC cask liner bottom that is provided by the ceramic tiles, the Lead Cask Inspection

AMP discussed in Section 3.4.4 and Table 19 has been revised to include remote visual examination of the MSB bottom for coating degradation and corrosion.

3. Section 3.4.2.3 and Table 16 are revised to describe the required actions to address the extent of condition if unacceptable corrosion is identified on the VCC Cask Liner Shell and/or Bottom.

   The extent of condition evaluation shall include additional visual examination of the normally inaccessible surface of the VCC Cask Liner Bottom (i.e., the area normally covered by the MSB assembly) for coating degradation and corrosion. This may be accomplished by remote visual examination if the MSB assembly is lifted by a few inches to expose the normally inaccessible area of the VCC Cask Liner Bottom. Alternatively, the MSB assembly may be removed from the VCC assembly to allow direct access to the VCC Cask Liner Bottom for visual inspection and repair, if necessary. In addition, the GL should perform remote visual examination of the VCC Cask Liner Shell and Bottom of at least two additional VSC-24 casks at the site for coating degradation and corrosion. The two additional casks shall be selected on the basis of maximum susceptibility to the form of degradation in question. This examination should also include the normally inaccessible area of the VCC Cask Liner Bottom if unacceptable corrosion is identified on the normally inaccessible area of the VCC Cask Liner Bottom of the first cask. If examination of the additional casks also identifies unacceptable corrosion of the VCC Cask Liner Shell and/or Bottom, then the GL should expand the scope of the AMP to include all VSC-24 casks at the site.

4. Section 3.4.2.3 and Table 16 are revised to provide additional information needed to quantify significant corrosion of the VCC liner plates, including the method(s) used to detect corrosion, quantifiable corrosion acceptance criteria, and corrective actions for unacceptable corrosion, including actions required to evaluate extent of condition.

   Method or Technique: Section 3.4.2.3 and Table 16 have been revised to require VT-3 remote visual examination of the VCC ventilation ducts and annulus to identify blockage of the ventilation flow path and degradation of the coated steel surfaces that line the ventilation flow path. VT-3 visual examinations must be performed and evaluated by personnel that are qualified in accordance with industry guidelines for implementing the requirements of the Maintenance Rule (10 CFR 50.56), such as ASME, Section XI, IWE-2330. Remote visual examinations provide information that can be used by qualified inspectors to identify the type of corrosion, but they are generally not suitable for determining the depth of corrosion.

   Acceptance Criteria: Section 3.4.2.3 and Table 16 have been revised to clarify the acceptance criteria for corrosion on the steel surfaces that line the VCC ventilation ducts and annulus. The acceptance criterion was previously stated as no corrosion that prevents the components from performing their intended safety functions. The intended safety functions of the steel plates that line the VCC air inlets and outlets include only heat transfer (HT). Natural convection (i.e., air flow through the ventilation ducts and annulus) is the primary means of heat transfer for the VSC-24 casks. The steel plates that line the VCC air inlets and outlets are only relied upon to form the geometry of the ventilation ducts when the concrete is poured, and serve no other heat transfer safety function. Thus, coating degradation and any type of corrosion on the steel plates that line the VCC air inlets and outlets is acceptable provided that it does not result in significant blockage (i.e., > 10%) of the nominal cross-section flow area of the affected duct/annulus segment.

The intended safety functions of the VCC Cask Liner Shell and VCC Cask Liner Bottom are heat transfer, radiation shielding, and structural support. General corrosion on the VCC Cask Liner Shell and VCC Cask Liner Bottom will not prevent these components from performing their intended heat transfer and radiation shielding safety functions because the decay of radiological and thermal source terms more than offsets the effects from the rate of general corrosion. Furthermore, general corrosion of the VCC Cask Liner Shell and VCC Cask Liner Bottom over the extended storage period (60 years) is conservatively predicted to result in a reduction of the plate thicknesses of approximately 10% or less (based on the conservative corrosion rate of 0.003 in/year for uncoated carbon steel in a marine environment used for the MSB corrosion TLAA). The structural evaluation shows that the highest stresses in the VCC liner shell and bottom result from live load (i.e., MTC stack-up during MSB transfer). For this condition, the design margin is much greater than 10%, and therefore, general corrosion will not prevent the VCC Cask Liner Shell and VCC Cask Liner Bottom from performing their intended structural support safety function. Therefore, the corrosion acceptance criteria for the VCC Cask Liner Shell and VCC Cask Liner Bottom is no generalized corrosion that results in significant blockage (i.e., > 10%) of the nominal cross-section flow area of the annulus and no localized corrosion (i.e., galvanic, crevice, or pitting corrosion).

<u>Corrective Actions</u>: If unacceptable blockage is identified in the ventilation ducts and/or annulus, the GL must evaluate the VCC for continued storage, and remove any blockage that can be removed by reasonable means. If unacceptable corrosion is identified on the steel plates that line the ventilation ducts and annulus, the GL must evaluate the VCC for continued storage, and repair or replace the VCC if required. In addition, if unacceptable corrosion is identified on the VCC Cask Liner Shell and/or Bottom the extent of condition should be addressed as discussed in the response to Item 3 above.

5. Section 3.4.2.3 and Table 16 are revised to clarify that the scope of the remote visual examination includes all readily accessible surfaces of the cast-in-place formwork.

   The surfaces that are examined include all readily accessible duct-facing surfaces of all VCC air inlets and outlets, all readily accessible exposed annulus-facing surfaces of the VCC Cask Liner Bottom (i.e., those surfaces not obstructed by the MSB assembly), and all readily accessible exposed annulus-facing surface of the VCC Cask Liner Shell (i.e., from the bottom end of the cavity up to the bottom of the

Shielding Ring Plates). In addition, the scope of the remote visual examination includes the readily accessible annulus-facing surfaces (i.e., bottom surfaces) of the VCC Shield Ring Plates (Liner Assembly) and the VCC Shield Ring Plates (Shield Ring). The AMP has also been revised to clarify that surfaces that require inspection are those that may be inspected using reasonable means given the specified method or technique, considering the inspection equipment used. A surface that cannot be viewed with sufficient resolution or lighting for a qualified inspector to evaluate is not considered readily accessible.

Summary of Renewal Application Changes

- Section 3.4.2.3 and Table 16: Revised in response to RAI-4 as follows: Changed the purpose of the remote visual examination of the VCC air inlets and outlets and VCC annulus from confirmation of corrosion depth to identification of unacceptable types of corrosion (i.e., localized); Revised corrective actions to address required actions for unacceptable blockage and corrosion; Revised acceptance criteria to eliminate non-quantifiable terms; Revised the scope of AMP to clarify which parts of the cast-in-place formwork will be visually examined and to add requirement to perform visual examination of the annulus-facing (bottom) surfaces of the inner and outer VCC shielding rings; Revised AMP Method or Technique to specify VT-3 visual examination.

- Section 3.4.4 and Table 19: Revised scope to include remote visual examination of the normally inaccessible MSB bottom plate and VCC cask liner bottom.

RAI-5: Provide additional information on the Examination of VSC Top End Steel Components AMP described in Section 3.4.2.4 and Table 17 of the CoC Renewal Application (ML14099A168).

1. a) Additional information is needed on the Detection of Aging Effects and Acceptance Criteria for the VCC gasket identified in the AMP. The scope of this AMP indicates that the VCC gasket will be replaced as a matter of practice. In addition, the Corrective Actions states that if the VCC gasket does not meet the acceptance criteria, the extent of condition must be determined, including examination and replacement of VCC gaskets on other casks, as needed. Although the Corrective Action for the VCC gasket is stated, the method used for the Detection of Aging Effects and the Acceptance Criteria for the VCC gasket are not identified.

   b) Clarify whether the VCC lid cover gasket is an Important to Safety component and whether a non-functioning VCC lid cover gasket would be entered into a Corrective Action Program even if the applicable acceptance criteria for the top end steel components in Table 17 are satisfied.

2. Additional information is needed on the method used for the Detection of the Aging Effect, Acceptance Criteria and Corrective Actions, that quantifies the assessment of significant corrosion for the MSB lid and the MSB closure weld in the AMP on

Examination of VSC Top End Steel Components described in Section 3.4.2.3 and Table 16 of the CoC Renewal Application (ML14099A168). The VSC-24 CoC Renewal Application Section 3.4.2.4 Examination of the VSC Top End Steel Components states:

> *"Significant corrosion of the MSB structural lid, valve covers, lifting lugs (if present), and closure weld (i.e., corrosion resulting in loss of material, such* as *scaling) could diminish their ability to perform the intended safety functions. However, corrosion that results only in discoloration of the steel surface finish (i.e., rust blooms) is not considered to be significant since it will not result in the loss of intended functions."*

The definition of significant corrosion is not quantified in terms of loss of material that would affect the intended safety function of the MSB.

3. Additional information is needed that clarifies the examination of the shield ring plates. Table 13 of the CoC Renewal Application (ML14099A168) identifies two components that make up the shield ring, the Shielding Ring Plates (Liner Assembly) and Shielding Ring Plates (Shield Ring). It is unclear if both the Liner Assembly and the Shield Ring will be examined as part of this AMP. In addition, provide additional information on the amount of corrosion that is permissible for the shield rings.

This information is required to evaluate compliance with 10 CFR 72.236(g) and 10 CFR 72.240(c)(3).

Response to RAI-5

1. a) The discussion of Corrective Actions in Table 17 has been revised to delete the last sentence related to extent of condition for the VCC lid gasket. As explained in the response below, examination of the VCC lid gasket for degradation is not included in the scope of the AMP, and therefore, the acceptance criteria and corrective actions are not applicable to the VCC lid gasket.

   b) As shown in Table 6 of the VSC-24 CoC Renewal Application, the VCC lid gasket does not have any intended safety functions. The VCC lid gasket is only intended to minimize the potential for water leakage into the VCC. However, as explained in the response to the previous RAI-3 (ML14099A167), the design of the VCC shielding ring plates assures that any water that leaks into the VCC through the VCC lid gasket will not accumulate on the top of the MSB assembly. Instead, it will be directed down the VCC annulus and out the VCC air inlet vents. Therefore, the VCC lid gasket is not important to safety. As such, the AMPs for Examination of VSC Top End Steel Components and Lead Cask Inspections do not require examination of the VCC lid gasket for degradation and they do not include acceptance criteria or corrective actions related to degradation of the VCC lid gasket. However, both AMPs require replacement of the VCC lid gasket prior to re-installation of the VCC cask lid to minimize the potential for water leakage into the VCC.

2. Section 3.4.2.4 and Table 17 are revised to include additional information on the methods used for examination, acceptance criteria, and corrective actions for corrosion on the VSC top end steel components.

   As discussed in Section 3.4.2.4 and Table 17, VT-3 visual examination methods are used to examine the readily accessible surfaces of the VCC cask lid, VCC liner flange, VCC shield ring plates, VCC lid bolts, MSB structural lid, MSB valve covers, and MSB closure weld for coating degradation and corrosion. If the visual examination identifies degraded coating that indicates potential corrosion on the underlying steel (e.g., coating that is blistered, bubbled, or peeling) the degraded coating shall be removed by appropriate means (e.g., wire brush, grinding, or machining) to reveal underlying metal surface, which shall be visually examined for corrosion. Any corrosion identified on the underlying metal surface shall be removed by appropriate means (e.g., wire brush, grinding, or machining), to reveal clean metal and the depth of corrosion (relative to the adjacent uncoated surfaces) shall be measured using a depth gauge. The measured corrosion depth must not exceed 1/16-inch on any readily accessible steel surfaces of the VCC cask lid, VCC liner flange, VCC shield ring plates, MSB structural lid, MSB valve covers, and MSB closure weld. For the VCC lid bolts, corrosion must not reduce the bolt cross-section area by more than 5%.

   If the corrosion acceptance criteria are not satisfied, the GL shall evaluate the condition in accordance with their Corrective Action Program. Any VCC lid bolts that do not satisfy the corrosion acceptance criteria must be replaced. An MSB or VCC assembly with corrosion on the VCC cask lid, VCC liner flange, VCC shield ring plates, VCC lid bolts, MSB structural lid, MSB valve covers, and/or MSB closure weld that exceeds the acceptance criteria shall be evaluated for continued storage, and repaired or replaced, if necessary. To determine the extent of condition, remote visual examination of at least two additional VSC-24 casks at the site shall be performed. If examination of the additional casks also identifies unacceptable corrosion, then the GL should expand the scope of the AMP to include all VSC-24 casks at the site. Following the completion of the examination and prior to re-installation of the VCC Cask Lid, the coating on all steel surfaces with that have been exposed for examination shall be repaired in accordance with the GL's procedures.

3. Section 3.4.2.4 and Table 17 have been revised to clarify which surfaces of the VCC shielding ring plates are examined and to provide quantitative acceptance criteria for corrosion on these surfaces.

   All readily accessible surfaces of the Shielding Ring Plate (Liner Assembly) and Shielding Ring Plate (Shielding Ring) are examined for coating degradation and corrosion. Specifically, this AMP requires visual examination of the top surfaces of both the Shielding Ring Plate (Liner Assembly) and Shielding Ring Plate (Shielding Ring) and the inside diameter of the Shielding Ring Plate (Shielding Ring). The top surfaces of the inner and outer VCC Shielding Ring Plates are also examined for evidence for crevice corrosion in the gap between the plates.

The acceptance criterion for corrosion on the VCC shielding ring plate surfaces listed above is a measured corrosion depth of no more than 1/16-inch, as discussed in the response to Item 2 above. In the event that unacceptable corrosion is identified on the VCC shielding ring plates, the GL must evaluate the cask for continued storage in accordance with their corrective action program.

Summary of Renewal Application Changes

- Table 17, Correction Actions: Deleted corrective actions for the VCC lid gasket in response to RAI-5, Part 1(a).
- Section 3.4.2.4 and Table 17: Revised to include additional information on the methods used for examination, acceptance criteria, and corrective actions for corrosion on the VSC top end steel components.
- Section 3.4.2.4 and Table 17: Revised to clarify which VCC shield ring surfaces are examined and to provide quantitative acceptance criteria for corrosion on these surface.

RAI-6: Provide additional information on the potential effects of outgassing of the RX-277 shielding material in the MSB shield lid and the possible effects on corrosion of the fuel cladding. Information provided in several sections of the CoC Renewal Application (ML14099A168) appears to be inconsistent.

Section 2.2.1.2 MSB Assembly states: The shield plug assembly consists of an RX-277 neutron shield core that is fully encased in carbon steel.

Section 3.1.2 Environments-Embedded Environment states: The RX-277 neutron shield material inside the MSB shield lid and the MTC assembly shells are embedded environments.

Section 3.2.1.3 Spent Nuclear Fuel Assemblies - Corrosion states: Potential sources of moisture in the MSB cavity are residual water in the MSB cavity and fuel assemblies following MSB loading operations and off-gassing of the of the RX-277 neutron shielding material in the MSB shield lid.

Section 3.3.3.7 MSB Lid RX-277 Neutron Shielding Degradation Evaluation states: The loss of significant amount of RX-277 material bulk mass (out of the sealed, steel MSB lid chamber) is not considered credible, especially given that most of the mass of the RX- 277 material is in the form of solids that are not subject to loss through off-gassing.

The response to RAI-6 (ML14099A167) indicates that for unbaked RX-277, lack moisture availability in the shield lids will not be a limiting factor for corrosion of the carbon steel that surrounds the RX-277 material. Corrosion prediction models indicate the corrosion of the carbon steel MSB shield lid will be limited to approximately 0.005 in.

This information is required to evaluate compliance with 10 CFR 72.236(g) and 72.240(c).

Response to RAI-6

The information provided in Sections 2.2.2.1, 3.1.2, 3.2.1.3, and 3.3.3.7 and the response to RAI-6 (ML14099A167) are not inconsistent.

As indicated in Sections 2.2.2.1 and 3.1.2, the RX-277 neutron shielding material in the MSB shield lid is fully encased and sealed by the surrounding carbon steel plates that are welded to form a sealed chamber (i.e., an embedded environment.) During fabrication, the MSB shield lid welds are subjected to visual examination. While visual examination provides assurance that the RX-277 is sealed, it is possible that some of the MSB shield lid welds may have flaws that allow the passage of gas or water vapor. For those MSB shield lids that do not leak, moisture due to off-gassing from the RX-277 neutron shielding material will be contained inside the MSB shield lid cavity and have no effect on the fuel cladding. However, a potential leak in the MSB shield plug casing could allow off-gas (i.e., water vapor) from the RX-277 to escape the shield plug and enter the MSB cavity, as discussed in Section 3.2.1.3. The possible effects of water in the MSB cavity from off-gassing from the RX-277 neutron shielding material on corrosion of the fuel cladding are discussed below.

The statement regarding mass loss in the RX-277 material that is made in Section 3.3.3.7 is in the context of gamma (vs. neutron) shielding properties of the material. Gamma attenuation scales with bulk mass (or density) of the shield. The statement that the shield will not lose a significant fraction of its overall bulk mass does not imply that no hydrogen (or moisture) loss is possible. Any potential moisture loss would correspond to a bulk mass loss of only a few percent, which would have no significant impact on gamma dose rates.

Finally, the response to the previous RAI-6 (ML14099A167) addressed the potential for corrosion on the uncoated carbon steel surfaces of the inside of the MSB shield lid that are in contact with the RX-277 neutron shielding material. That response is valid whether or not a potential leak path exists in the MSB shield plug casing.

The total amount of water that could potentially result from off-gassing of unbaked RX-277 neutron shielding material in the MSB shield plug and escape to the helium filled MSB cavity in the form of water is a function of temperature. Test data for RX-277 material (Bulletin S-73N) shows that the amount of hydrogen loss from the material (assumed to be in the form of water) increases with higher temperatures, and that only a small amount of hydrogen is re-absorbed into the material upon cooling. Furthermore, hydrogen loss occurs over a relatively short period (24 to 48 hours) at a given temperature.

As shown in the Table 4.1-1 of the VSC-24 FSAR, the vacuum drying condition results in the highest temperatures for the fuel cladding and MSB shell, and therefore, the highest temperatures in the RX-277 neutron shielding material in the MSB shield lid. Therefore, the hydrogen loss in the RX-277 material will be driven/governed by the vacuum drying condition. Any moisture that escapes from the MSB lid neutron shield cavity (due to a weld leak) during the vacuum drying process will be removed from the MSB cavity by the vacuum, and therefore, it will not cause corrosion of the fuel cladding during storage.

Since the amount of total moisture loss (over an indefinite time period) is purely a function of material temperature, no further moisture loss will occur if the RX-277 material cools down to a lower temperature, after being exposed to some maximum temperature over a significant (24-48 hour) time period. Thus, no significant amount of hydrogen would be released from the RX-277 into the MSB cavity after vacuum drying, since the maximum RX-277 material temperatures occur during the vacuum drying process.

According to a report from the Center for Nuclear Waste Regulatory Analyses (CNWRA), cladding oxidation during dry storage is not a concern for up to one liter of residual water in a canister. Any moisture released into the MSB cavity after vacuum drying by the RX-277 material will be insignificant, and far less than one liter, for the reasons given above.

It should also be noted that the CNRWA's determination that one liter of canister cavity water is acceptable is based upon 60 GWd/MTU fuel, whereas the VSC-24 cask system has low burnup (< 45 GWD/MTU) fuel. According to the CNWRA report, 60 GWd/MTU fuel has up to 100 μm of initial cladding oxidation (from reactor operation), and one liter of canister cavity water may result in an additional ~7.5 μm of cladding oxidation during dry storage. As shown in the CNWRA report, 45 GWd/MTU fuel has an initial oxide layer thickness of only 40 μm. This suggests that a far larger amount of cladding oxidation during storage, and therefore a far larger amount of canister cavity water (than one liter), would be acceptable for the low burnup fuel present in the VSC-24 system.

Summary of Renewal Application Changes

- The Section 3.2.1.3 text is revised to remove reference to an RX-277 pre-heating process. Instead, a statement is made that significant moisture off-gassing of the RX-277 material is not expected, given the temperatures the material is exposed to during service. It is also stated that gas leakage out of the RX-277 chamber is unlikely.

RAI-7: Provide additional information to support extending the MTC inspection frequency. In the original CoC Renewal Application (ML12290A139), Section 3.4.2.5 and Table 17 indicated that an annual inspection of the MTC shall be performed or if the MTC has not been used in the past year then examination must be performed prior to the next use. In the CoC Renewal Application (ML14099A168), inspection of the MTC was changed to a 10 year frequency (± 1 year).

In addition, the response to RAI-16 (ML14099A167) indicated that the revised 10 year frequency was based on the inspection program requirements of ASME Section XI Article IWE-2000. However, Table IWE-2411-1 in ASME Section XI Article IWE-2000 identifies that in addition to a 10 year inspection interval to complete 100% of the required inspections, there are minimum percent completion requirements and maximum percent credited limitations at 3 and 7 years. Therefore the statement that the 10 year inspection frequency is based on ASME Section XI Article IWE-2000 is inaccurate.

This information is required to evaluate compliance with 10 CFR 72.240(c)(3).

Response to RAI-7

In Revision 1 of the VSC-24 CoC Renewal Application, the frequency for the MTC Examination AMP was specified as annually, or within one-year prior to use if the MTC is not being used. This permitted an MTC that is not being used to remain in a sheltered environment for long period of time (e.g., 40 years) without inspection. However, the basis for the MTC inspection frequency was questioned in the previous RAI-16. In response to the previous RAI-16 (ML14099A167), the MTC inspection frequency was changed to 10-years, based on the inspection program requirements of ASME Section XI, Article IWE-2000, and the provision that allowed the inspection of an MTC that was not being used to be deferred to within one year prior to use was deleted.

The 10-year inspection frequency is sufficient to assure that the intended safety functions of the MTC assembly are maintained during the extended storage period. When not being used, the MTC assembly is stored in a sheltered environment. After use and prior to being placed into long-term storage, the MTC assembly is decontaminated and dried. Thus, a clean and dry MTC assembly stored in a sheltered environment has minimal potential for accelerated degradation over a 10-year period.

As noted in the RAI, IWE-2000 requires inspection of a minimum percentage of the components to be completed at years 3 and 7 of the 10-year period. This requirement is applicable to nuclear power plant systems which include multiple components that require inspection. However, this requirement is not applied to the MTC assembly, since it is a single component, and it is not practical, or necessary, to perform a partial examination of a single component. Furthermore, performing multiple, partial inspections as opposed to a single, complete inspection is unlikely to provide any benefit since the frequency of each specific inspection task remains the same (i.e., once every 10 years).

When an MTC assembly is in use, it is subjected to a pre-operational inspection before every cask loading operation. Although the pre-operational inspections are not included in the scope of the AMP, they are also intended to identify potential degradation of the cask and assure that it is functioning properly before use. The AMP is revised, however, to require the user to perform an inspection, covering the full scope defined in the AMP, before resuming the use of the MTC. That pre-use inspection shall be performed within the one year period before resuming use of the MTC.

Summary of Renewal Application Changes

- The MTC Examination AMP is revised to require that the AMP scope be performed within one year prior to resuming use of the MTC. Section 3.4.2.5 and Table 18 are revised accordingly.

RAI-8: Provide additional information on lead cask inspections described in Section 3.4.4 and in Table 19 of the CoC Renewal Application (ML14099A168) to address:

1. Additional information is needed on the criteria used to determine the bounding conditions for lead cask inspections including details on the process describing how the general licensee justifies that casks at their site are bounded by lead cask inspections of system at other site(s) for the purpose of fulfilling the lead cask inspection; the criteria for justifications of bounding conditions of similar storage systems at other sites; and how these justifications will be documented, reviewed and approved.

2. Provide additional information on the Scope, Detection of Aging Effects, Acceptance Criteria, and Corrective Actions for the AMPs on VCC Concrete Exterior Surfaces (Section 3.4.2.2) and Examination of the VCC Assembly Ventilation Duct and Annulus (Section 3.4.2.3) referenced in the Lead Cask Inspection described in Section 3.4.4 and Table 19. In addition identify which, if any, portions of the Examination of the VSC Top End Steel Components (Section 3.4.2.4) will be included in the Lead Cask Inspection. Include specific information on actions that will be performed to assess the extent of condition if unanticipated degradation is identified.

This information is required to evaluate compliance with 10 CFR 72.236(g) and 10 CFR 72.240(c)(3).

Response to RAI-8

1. Section 3.4.4 and Table 19 of the CoC renewal application have been revised to describe the criteria used by the GL to determine the bounding conditions for the lead cask inspections. These factors include cask age and heat load (as discussed in NUREG-1927), as well as any cask component fabrication variations that could render any given component more susceptible to aging. If the licensee wishes to rely on lead cask inspections performed at other sites, site environmental variations such as ambient temperatures, salinity, any significant local pollution, and humidity

must also be considered. In addition, Section 3.4.4 and Table 19 have been revised to clarify that the GL may rely on inspections performed at other sites for specific parts of the overall lead cask inspection scope. Thus, a lead cask inspection, at a given site, with reduced scope is acceptable if the GL's evaluation demonstrates that certain aspects of the lead cask inspection are bounded by the lead cask inspection(s) performed at other sites.

The selection of casks for the lead cask inspection, as well as any justifications for the use of inspections performed at other sites for some or all of the lead cask inspection scope, will be documented by the GL in the 10 CFR 72.212 report in accordance with the GL's QA programs.

2. Section 3.4.4 and Table 19 are revised to clarify that the scope of the lead cask inspection includes the examination of the VCC air inlets and outlets and the VCC annulus and the visual examination of the VSC top end steel components, but it does not include the visual examination of the VCC exterior concrete surfaces (this examination is already required to be performed annually on all loaded casks at each site, as discussed in Section 3.4.2.2 and Table 15 for the Examination of VCC Exterior Concrete AMP). Furthermore, Table 19 is revised to provide the specific requirements for these examinations, including the actions that will be performed to address extent of condition, as part of the lead cask inspection AMP rather than cross referencing the other AMPs for requirements.

   Section 3.4.4 and Table 19 are also revised to include the applicable information in the other elements of the AMP, consistent with the AMPs for Examination of the VCC Ventilation Ducts and Annulus (Table 16) and Examination of the VSC Top End Steel Components (Table 17). In the event that the AMP acceptance criteria are not satisfied, the GL shall evaluate the unacceptable condition(s) in accordance with their Corrective Action Program. Any VCC lid bolts that do not satisfy the corrosion acceptance criteria must be replaced. A lead cask with corrosion on the VCC cask lid, VCC liner flange, VCC shield ring plates, VCC lid bolts, MSB structural lid, MSB valve covers, and/or MSB closure weld that exceeds the acceptance criteria shall be evaluated for continued storage, and repaired or replaced, if necessary. If unacceptable corrosion (i.e., galvanic, crevice, or pitting corrosion) is identified on the MSB shell and/or bottom plate, the corrective actions shall consider the need for additional NDE, such as eddy current or ultrasonic measurement, to determine the depth of the corrosion. NDE methods used to determine the depth of corrosion shall be qualified for use by the GL. The evaluation of the extent of condition shall include additional examination of at least two additional casks at the site for similar unanticipated degradation. If examination of the additional casks also identifies similar unacceptable degradation, then the GL should expand the scope of the AMP to include examination of all casks at the site for similar unanticipated degradation.

Summary of Renewal Application Changes

- The Section 3.4.4 text is revised as discussed above.
- Table 19 is revised as discussed above.