ENERGYSOLUTIONS

April 4, 2014
ES/NRC 14-006
Docket No. 72-1007

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

Subject: **Response to 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*), "Request for Additional Information for Energy*Solutions*, VSC-24 Storage System, Certificate of Compliance No. 1007 – Renewal Application (TAC No. L24694)," October 31, 2013, ADAMS Accession Number ML13282A643.

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 six (6) paper copies of Revision 2 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 2 of the CoC Renewal Application is provided in Attachment 1 of this letter. Enclosures 3 through 9 each include one (1) paper copy of additional documents that were either requested in the RAI or referenced in the RAI response.

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
Energy*Solutions*

NMSS01

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Additional copies of Enclosure 2 were sent to the PM

Attachments:
(1) Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Storage Cask System (Docket No. 72-1007), Revision 2 (14 pages)

Enclosures:
1) Response to 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), Revision 2, April 4, 2014, Public Version (6 paper copies).
3) Calculation No. 1200250.301, Revision 0, "Flaw Tolerance Evaluation of Spent Fuel Cask MSB#4 for Palisades Power Plant" (1 paper copy)
4) Calculation No. CPC-06Q-303, Revision 1, "Analysis of Hypothetical Flaws in VSC-24 Shell and Bottom Plate" (1 paper copy)
5) Calculation No. WEP-109-003.12, Revision 1, "Generation of a Heat Load vs. Fuel Temperature Curve" (1 paper copy)
6) Calculation No. VSC-04.3101, Revision 3, "VSC-24 CoC Renewal Aging Management Review" (1 paper copy)
7) Reactor Experiments, Inc., Sunnyvale, CA, Catalog No. 277 Shielding, Bulletin S-73N, August 1991 (1 paper copy)
8) Serco Technical Consulting Services, "A Survey of Steel and Zircaloy Corrosion Data for Use in the SMOGG Gas Generation Model," Report No. SA/ENV-0841, Issue 3, August 2010 (1 paper copy)
9) Calculation No. VSC-04.3200, Revision 1, "MSB-24 Corrosion Calculation" (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, Revision 2.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, Revision 2

Section	Page(s)	Change	Purpose
Front Matter	ix	Added new acronym.	Added in response to RAI-1.
1.	1-1	Changed "licensing conditions" to "CoC conditions".	Editorial correction.
1.	1-1	Deleted last sentence of second bullet.	Revised in response to RAI-30.
1.	1-1	Added third bullet.	Added in response to RAI-4.
1.	1-1	Added fourth bullet.	Added in response to RAI-11.
1.1.2	1-5	Added footnote 2.	Added in response to RAI-4.
1.1.2	1-5	Revised footnote 3.	Editorial correction to section cross-reference and terms of proposed CoC condition.
2.2	2-1	Changed first sentence to refer to the "latest" FSAR and corrected reference number accordingly.	Editorial correction.
2.2.1.1	2-3	Added paragraph break.	Editorial correction.
2.2.1.1	2-3	Added "is limited" to first sentence of 2nd paragraph.	Editorial correction.
2.2.1.1	2-3	Revised 4th and 5th sentences of 2nd paragraph to discuss maximum heat load of loaded casks and proposed condition to reduce the maximum heat load for casks loaded under the renewed CoC.	Revised in response to RAI-4.
2.2.1.2	2-4	Changed to refer to the "latest" FSAR and corrected reference number accordingly.	Editorial correction.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, Revision 2

Section	Page(s)	Change	Purpose
2.2.1.3	2-4	Revised sentence in 1st paragraph to clarify what surfaces of the VCC are coated.	Revised in response to RAI-22.
2.2.1.4	2-6	Revised to clarify that most, but not all, of the exposed MTC surfaces are coated.	Revised in response to RAI-17.
2.2.1.5	2-6	Revised two sentences to refer to the "latest" FSAR and corrected reference number accordingly.	Editorial correction.
Table 6	2-15	Added new row for "Shielding Ring Plates (Liner Assy.)".	Added in response to RAI-5(a).
Table 6	2-15	Added "(Shield Ring)" to the description for Shielding Ring Plates, Part No. VCC-039 thru -042 from Drawing VCC-24-008 to differentiate from the Shielding Ring Plates for the Liner Assembly.	Added in response to RAI-5(a).
Table 6	2-15	Revised the "Part or I.D. No." column entry for the "VSC Lifting Lugs (Optional)" to include the word "Latest" before "FSAR" and corrected reference number accordingly.	Editorial correction.
3.2.1.1, "Loss of Material"	3-6	Revised to address operating experience discussed in NRC Information Notice 2013-07.	Revised in response to RAI-14.
3.2.1.2, "Cracking, Pitting, and Spalling"	3-8	Revised to address operating experience discussed in NRC Information Notice 2013-07.	Revised in response to RAI-14.
3.2.1.2, "Cracking, Pitting, and Spalling"	3-9	Revised to expand discussion of operating experience from NRC Information Notice 2011-20.	Revised in response to RAI-14.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, Revision 2

Section	Page(s)	Change	Purpose
3.2.1.3, "Hydride Redistribution and Reorientation"	3-13	Added discussion of proposed CoC condition to limit the maximum decay heat load to 15 kW.	Revised in response to RAI-4.
3.2.2.1, "Other Degradation"	3-14, 3-15	Revised to eliminate use of "good condition".	Revised in response to RAI-15.
3.2.2.2, "Condition of MSB Shell"	3-16	Revised discussion of observed condition of the MBS shell from the 5-year inspections.	Revised in response to RAI-24.
3.2.2.4	3-18, 3-19	Revised to provide further justification for the selection of the cask used for the initial lead cask inspection.	Revised in response to RAI-34.
3.2.2.4	3-20	Revised paragraph at top of page for added clarity and added paragraph break before discussion of observations.	Editorial revisions.
3.2.2.4	3-20	Revised second paragraph to expand the discussion of the gap or void observed between the VCC bottom plate and VCC bottom concrete.	Revised in response to RAI-8.
3.2.2.4	3-20	Revised discussion of corrosion on VCC lid bolts in last paragraph on page.	Revised in response to RAI-9.
3.2.2.4	3-20, 3-21	Revised discussion to eliminate use of non-quantifiable terms to describe observed condition of the VCC subcomponents.	Revised in response to RAI-15.
3.2.2.4	3-20	Add sentence stating that no evidence of crevice corrosion was identified between the top end of the MSB assembly and the VCC shield ring.	Added in response to RAI-19.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, Revision 2

Section	Page(s)	Change	Purpose
3.3.2	3-22	Added item to list of TLAAs	Added in response to RAI-33.
3.3.3.7	3-26, 3-27	New section added to discuss TLAA for MSB Shield Lid neutron shielding material degradation.	Added in response to RAI-33.
3.4.2	3-27	Added second paragraph.	Added in response to RAI-35.
3.4.2.2	3-28 thru 3-30	Revised to add AMP requirements for visual examination of concrete-to-steel interfaces and corrosion of rebar, and expand discussion of corrective actions for ASR-induced degradation.	Revised in response to RAI-8, RAI-10, and RAI-29.
3.4.2.3	3-30	Added "and this AMP".	Editorial correction.
3.4.2.3	3-31	Revised last two sentences of paragraph at top of page to refer to "this AMP" rather than "TS 1.3.3".	Editorial correction.
3.4.2.3	3-31	Revised second paragraph on page to clarify extent of corrosion that is acceptable on the steel plates that line the VCC annulus and add required corrective actions for VCC assemblies that are determined to be unacceptable for continued storage.	Editorial corrections.
3.4.2.3	3-31	Revised third paragraph on page to discuss AMP requirements for verification of corrosion rate on MSB shell.	Revised in response to RAI-12.
3.4.2.4	3-32	Revise 1st paragraph to include ±1 year tolerance of frequency of examination.	Editorial change for consistency with Table 17.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, Revision 2

Section	Page(s)	Change	Purpose
3.4.2.4	3-32	Change timing of inspections to state that the initial inspection is to be completed within 2 years of the later of the 20th anniversary of the first cask loaded at that site of the CoC renewal date.	Added 2-year period to provide sufficient time for GLs to complete required planning and budgeting for activities. Revised timing to account for CoC renewal occurring after 20-year storage period based on timely application for renewal.
3.4.2.4	3-32	Revised 2nd paragraph to clarify the AMP scope includes examination of the optional VCC lifting lugs (if present) and delete measurement of neutron dose rate at the center of the VCC cask lid from the scope of the AMP.	Revised in response to RAI-31 and RAI-33.
3.4.2.4	3-32, 3-33	Revised paragraph starting at bottom of page 3-32 to discuss possible causes and consequences for water leakage through the VCC lid gasket.	Revised in response to RAI-3.
3.4.2.4	3-33	Revised 2nd paragraph on page to include VCC lifting lugs (if present).	Revised in response to RAI-31.
3.4.2.4	3-33	Revised 2nd paragraph to clarify what is acceptable corrosion.	Editorial clarification.
3.4.2.4	3-33	Added last sentence to 3rd paragraph to require replacement of VCC lid bolts with significant corrosion.	Revised in response to RAI-20.
3.4.2.4	3-33	Revised last paragraph on page to eliminate use of non-quantifiable terms to describe condition of MSB structural lid from initial lead cask inspection.	Revised in response to RAI-15.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, Revision 2

Section	Page(s)	Change	Purpose
3.4.2.5	3-34	Revised 1st paragraph to discuss scope, frequency, and timing of AMP examinations.	Revised in response to RAI-16 and for consistence with Table 18.
3.4.2.5	3-34, 3-35	Revised section to clarify AMP requirements for MTC assembly.	Revised in response to RAI-17.
3.4.3.2, "Lamellar Tearing in MSB Shell"	3-37	Revise discussion in the last paragraph of the section on the fracture mechanics analysis that addresses the effects of undocumented weld repairs in the MSB shell and bottom plate.	Revised in response to RAI-1.
3.4.4	3-43	Revised the first paragraph to clarify that the lead cask inspection performed at Palisades was an initial inspection to support the application and that each GL is required to perform lead cask inspections at their site, unless they can justify that the casks at their site are bounded by the lead cask inspections performed on similar systems at other sites.	Revised in response to RAI-34.
3.4.4	3-43	Change timing of inspections to state that the initial inspection is to be completed within 2 years of the end of the intial 20 year storage period or the CoC renewal date.	Added 2-year period to provide sufficient time for GLs to complete required planning and budgeting for activities. Revised timing to account for CoC renewal occurring after 20-year storage period based on timely application for renewal.
3.4.4	3-44	Added discussion of possible causes and consequences for water leakage through the VCC lid gasket.	Revised in response to RAI-3.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, Revision 2

Section	Page(s)	Change	Purpose
3.4.4	3-45	Added last sentence to 3rd paragraph to require replacement of VCC lid bolts with significant corrosion.	Revised in response to RAI-20.
3.6	3-49	Added references [3.38] and [3.39].	Added in response to RAI-14 and RAI-29.
Table 9	3-50	Added AMP to Aging Management Activities for corrosion of MSB shell.	Revised in response to RAI-12.
Table 9	3-50	Delete AMP from Aging Management Activities to manage loss of shielding effectiveness for the MSB shield lid neutron shield.	Revised in response to RAI-33.
Table 10	3-53	Added new row for "Shielding Ring Plates (Liner Assy.)" and revised description of existing component to "Shielding Ring Plates **(Shield Ring)**".	Added in response to RAI-5(a) to differentiate between two components with the common names and part numbers.
Table 11	3-54, 3-55	Revised to include Middle Shell, Trunnion Inner & Outer Plate, and Trunnion Lead/Neutron Shields.	Revised for consistency with Table 7 in response to RAI-5(b).
Table 12	3-56	Deleted previous note 2 and renumbered subsequent note accordingly.	Revised in response to RAI-5(c).
Table 13	3-57	Added loss of material due to corrosion of MSB shell to aging effects managed by AMP.	Added in response to RAI-12.
Table 13	3-57	Deleted loss of shielding effectiveness of the MSB Assembly Shield Lid Neutron Shield due to radiation from aging effects managed by AMP.	Deleted in response to RAI-33.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, Revision 2

Section	Page(s)	Change	Purpose
Table 13	3-57	Added loss of material due to corrosion of the Shielding Ring Plates (Liner Assy.) to aging effects managed by AMP.	Revised in response to RAI-5(a).
Table 13	3-57	Revised description of existing component to "Shielding Ring Plates **(Shield Ring)**".	Revised to differentiate between two components with the common names and part numbers.
Table 13	3-58	Added loss of material due to corrosion of the Rail Lower Plate and Shield Door to aging effects managed by AMP.	Revised in response to RAI-5(d).
Table 13	3-58	Revised Note 1 to clarify which surfaces of the VCC steel components are coated.	Revised in response to RAI-22.
Table 14, "Timing of Inspections"	3-59	Revised to require initial AMP inspection to be completed within 2 years following the later of the 20th anniversary of the 1st cask loaded at the site or the effective date of the CoC renewal.	Revised to account for CoC renewal occurring after 20-year storage period based on timely submittal and to allow sufficient time for GLs to complete planning and budgeting for AMP activities.
Table 15, "Scope"	3-61	Revised to include inspection of steel-to-concrete interface of the VCC bottom plate and VCC outlet assemblies.	Revised in response to RAI-8.
Table 15, "Parameters Monitored or Inspected"	3-61	Revised to include excretion of rust at crack opening due to rebar corrosion and gaps or voids at the steel-to-concrete interfaces of the VCC bottom plate and VCC outlet assemblies and delete monitoring for increased porosity and/or discoloration due to aggressive chemical attack.	Revised in response to RAI-8, RAI-10, and RAI-27.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, Revision 2

Section	Page(s)	Change	Purpose
Table 15, "Data Collection"	3-61	Revised to clarify requirements for data collection.	Revised in response to RAI-8 and RAI-10.
Table 15, "Timing of Inspections"	3-61	Revised to require initial AMP inspection to be completed within 2 years following the later of the 20th anniversary of the 1st cask loaded at the site or the effective date of the CoC renewal.	Revised to account for CoC renewal occurring after 20-year storage period based on timely submittal and to allow sufficient time for GLs to complete planning and budgeting for AMP activities.
Table 15, "Monitoring and Trending"	3-61, 3-62	Revised to include monitoring and trending of other aging effects besides cracks.	Revised in response to RAI-8, RAI-10, and RAI-27.
Table 15, "Acceptance Criteria"	3-62	Corrected grammar.	Editorial correction.
Table 15, "Corrective Actions"	3-62, 3-63	Revised to clarify corrective actions required for repair of defects, rebar corrosion, and aggregate reactions.	Revised in response to RAI-8, RAI-10, and RAI-29.
Table 15, "Operating Experience"	3-63	Added discussion of gap/void at steel-to-concrete interface between VCC bottom plate and VCC concrete.	Added in response to RAI-8.
Table 16, "Detection of Aging Effects"	3-64	Revised to include degradation of the coated carbon steel surfaces of the MSB shell.	Revised in response to RAI-12.
Table 16, "Method or Technique"	3-64	Added requirements for qualifications of personnel performing visual examination of the coated carbon steel surfaces of the MSB and VCC.	Revised in response to RAI-12.
Table 16, "Data Collection"	3-64	Revised to include condition of the MSB shell.	Revised in response to RAI-12.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, Revision 2

Section	Page(s)	Change	Purpose
Table 16, "Timing of Inspections"	3-64	Revised to require initial AMP inspection to be completed within the first 5 year period following the later of the 20th anniversary of the 1st cask loaded at the site or the effective date of the CoC renewal.	Revised to account for CoC renewal occurring after 20-year storage period based on timely submittal and to allow sufficient time for GLs to complete planning and budgeting for AMP activities.
Table 16, "Acceptance Criteria"	3-64	Added acceptance criteria for corrosion on MSB shell.	Revised in response to RAI-12.
Table 16, "Corrective Actions"	3-65	Added requirement for evaluation of corrosion on MSB shell. Also added corrective actions for MSB shell with corrosion exceeding acceptance criteria.	Revised in response to RAI-12.
Table 17, "Scope"	3-66	Delete the first sentence regarding measurement of neutron dose rate on top of VCC cask lid from scope of AMP. Added last sentence regarding replacement of VCC Lid Gasket to scope of AMP.	Revised in response to RAI-3 and RAI-33.
Table 17, "Parameters Monitored or Inspected"	3-66	Delete the first sentence related to monitoring the neutron dose rate on top of VCC cask lid.	Revised in response to RAI-33.
Table 17, "Detection of Aging Effects"	3-66	Delete the first sentence associated with detection of aging effects in the MSB shield lid neutron shield RX-277 material.	Revised in response to RAI-33.
Table 17, "Method or Technique"	3-66	Delete the first sentence regarding dose rate measurement technique.	Revised in response to RAI-33.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, Revision 2

Section	Page(s)	Change	Purpose
Table 17, "Timing of Inspections"	3-66	Revised to require initial AMP inspection to be completed within 2 years following the later of the 20th anniversary of the 1st cask loaded at the site or the effective date of the CoC renewal.	Revised to account for CoC renewal occurring after 20-year storage period based on timely submittal and to allow sufficient time for GLs to complete planning and budgeting for AMP activities.
Table 17, "Monitoring and Trending"	3-66	Delete the first sentence regarding monitoring and trending of the neutron dose rate.	Revised in response to RAI-33.
Table 17, "Acceptance Criteria"	3-66	Delete the first sentence regarding acceptance criteria for the neutron dose rate on the VCC cask lid. Revise second sentence to remove non-quantifiable terms.	Revised in response to RAI-15 and RAI-33.
Table 17, "Corrective Actions"	3-67	Delete corrective actions associated with measurement of neutron dose rate on the VCC cask lid. Revised AMP to include consistent and appropriate corrective actions.	Revised in response to RAI-20, RAI-31, and RAI-33.
Table 18, "Scope"	3-68	Revised for consistency and clarity.	Revised in response to RAI-31.
Table 18, "Preventative Actions"	3-68	Revised for consistency and clarity. Removed requirement to maintain lubricant on sliding surfaces since lubricant is intentionally removed when MTC is placed in temporary storage.	Revised in response to RAI-31.
Table 18, "Parameters Monitored or Inspected"	3-68	Revised for consistency and clarity. Removed requirement to maintain lubricant on sliding surfaces since lubricant is intentionally removed when MTC is placed in temporary storage.	Revised in response to RAI-31.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, Revision 2

Section	Page(s)	Change	Purpose
Table 18, "Detection of Aging Effects"	3-68	Removed lubricants on sliding surfaces since lubricant is intentionally removed when MTC is placed in temporary storage.	Revised in response to RAI-31.
Table 18, "Frequency"	3-68	Revised frequency to 10-years (±1 year).	Revised in response to RAI-16.
Table 18, "Timing of Inspections"	3-68	Revised to require initial AMP inspection to be completed within 2 years following the later of the 20th anniversary of the 1st cask loaded at the site or the effective date of the CoC renewal.	Revised to account for CoC renewal occurring after 20-year storage period based on timely submittal and to allow sufficient time for GLs to complete planning and budgeting for AMP activities.
Table 18, "Acceptance Criteria"	3-68	Revised to include quantitative metrics for acceptance criteria for coating loss and corrosion.	Revised in response to RAI-15.
Table 18, "Corrective Actions"	3-68	Revised for consistency and clarity. Deleted corrective action to coat sliding surfaces with lubricant.	Revised in response to RAI-31.
Table 19, "Scope"	3-70	Revised for consistency and clarity.	Revised in response to RAI-31.
Table 19, "Preventative Actions"	3-70	Revised for consistency and clarity.	Revised in response to RAI-31.
Table 19, "Parameters Monitored or Inspected"	3-70	Revised for consistency and clarity.	Revised in response to RAI-31.
Table 19, "Detection of Aging Effects"	3-70	Revised for consistency and clarity.	Revised in response to RAI-31.
Table 19, "Frequency"	3-70	Added (±1 year) tolerance to frequency.	Revised in response to RAI-34.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, Revision 2

Section	Page(s)	Change	Purpose
Table 19, "Sample Size"	3-70	Revised to require lead cask inspection at each site.	Revised in response to RAI-34.
Table 19, "Timing of Inspections"	3-70	Revised to require initial AMP inspection to be completed within 2 years following the later of the 20th anniversary of the 1st cask loaded at the site or the effective date of the CoC renewal.	Revised in response to RAI-34 to account for CoC renewal occurring after 20-year storage period based on timely submittal and to allow sufficient time for GLs to complete planning and budgeting for AMP activities.
Table 19, "Acceptance Criteria"	3-71	Revised for consistency and clarity.	Revised in response to RAI-31.
Table 19, "Corrective Actions"	3-71	Revised for consistency and clarity.	Revised in response to RAI-20 and RAI-31.
Appendix A, Table A-1, FSAR Section 9.3.2	A-7	Revised list of TLAAs to include new TLAA for MSB lid RX-277 shielding material degradation.	Revised in response to RAI-33.
Appendix A, Table A-1, FSAR Section 9.3.2.6	A-10, A-11	Added new section to discuss TLAA for MSB lid RX-277 shielding material degradation.	Revised in response to RAI-33.
Appendix A, Table 9.3-1	A-15	Added AMP to Aging Management Activities for corrosion of MSB shell.	Revised in response to RAI-12.
Appendix A, Table 9.3-2	A-18	Added new row for "Shielding Ring Plates (Liner Assy.)" and revised description of existing component to "Shielding Ring Plates **(Shield Ring)**".	Added in response to RAI-5(a) to differentiate between two components with the common names and part numbers.

Summary of Changes, Certificate of Compliance Renewal Application for the VSC-24 Ventilated Cask Storage System, Revision 2

Section	Page(s)	Change	Purpose
Appendix A, Table 9.3-3	A-19	Revised to include Middle Shell, Trunnion Inner & Outer Plate, and Trunnion Lead/Neutron Shields.	Revised for consistency with Table 7 in response to RAI-5(b).
Appendix B	B-3 thru B-7	Added proposed changes to Section 1.1.2 of CoC Revision 0 and CoC amendments 1 through 6 for GLs to establish, implement, and maintain written procedures for each AMP and the lead cask inspection.	Revised in response to RAI-35.
Appendix B	B-3 thru B-7	Added proposed changes to Table 1 of CoC Revision 0 and CoC amendments 1 through 6 to reduce the maximum decay power per assembly to 0.625 kW for casks loaded after the initial storage period.	Revised in response to RAI-4.
Appendix B	B-3, B-4, and B-5	For proposed changes to CoC Revision 0 and CoC amendments 1 through 3 for HBU fuel, revised to clarify that changes are to Note (1) of Table 1	Editorial correction.

Enclosure 1

Responses to Request for Additional Information

(35 pages total)

The responses to the NRC 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. The NRC RAI questions, which are shown in *italics*, are followed by the ES response and a summary of the resulting changes to the VSC-24 CoC renewal application.

RAI-1. Justify the basis for the size of the bounding cracks in Section 3.3.3.6, "Palisades MSB-04 Weld Crack Growth Evaluation" of the renewal application and Section 3.4.3.2 "MSB Closure Weld Cracks" in the renewal application along with the applicable Time-Limited Aging Analyses (TLAAs) and associated calculations.

The bases for a bounding 1-inch long by ½-inch deep subsurface flaw and hypothetical ¼-inch deep by 6-inch long flaws are not clear.

This information is required to demonstrate compliance with 10 CFR 72.240(c)(2).

Response to RAI-1:

The 1-inch long by ½-inch deep flaw size used for the fatigue crack growth analysis of Palisades MSB-04 is longer and deeper than all indications identified in the shell seam welds, as discussed in Section 3.4.3.3. Therefore, the 1-inch long by ½-inch deep flaw size is bounding. A copy of the subject TLAA, which is documented in Calculation 1200250.301), is enclosed with the RAI response.

The discussion of the Linear Elastic Fracture Mechanics (LEFM) analysis presented in Section 3.4.3.2, "Lamellar Tearing in MSB Shell," has been revised based on Calculation CPC-06Q-303. The LEFM analysis presented in Calculation CPC-06Q-303, which was originally transmitted to NRC in a letter from Sierra Nuclear Corporation on June 26, 1998 in response to a Request for Additional Information concerning Corrective Action Letter 97-7-001, is conservatively based on the Double Edge Cracked Plate (DECP) model, which assumes opposing flaws on the inside and outside surfaces of the plate and infinite crack length (i.e., aspect ratio a/l = 0). The analysis results demonstrate that the 1/8-inch deep by 6-inch long defect in Palisades MSB-05 and any flaws resulting from undocumented weld repairs that could be present in the shell and bottom plate will not affect the structural adequacy of the components. A copy of Calculation CPC-06Q-303 is enclosed with the RAI response.

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

- List of Acronyms and Abbreviations: Added DECP acronym.
- Section 3.4.3.2, "Lamellar Tearing in MSB Shell": Revised discussion of the fracture mechanics analysis that addresses the effects of undocumented weld repairs in the MSB shell and bottom plate, based on Calculation CPC-06Q-303.

RAI-2. Provide the basis for the acceptance criteria in Table 15 which is no defects on the concrete exterior surface that are greater than ½ -inch in diameter (or width) and ¼-inch deep. Additionally, provide the basis for the 1-year inspection frequency.

Page 3-25 states, "Concrete defects that exceed ½-inch in diameter (or width) and ¼-inch deep are required to be repaired by re-grouting to prevent further degradation of the interior concrete and embedded steel reinforcing. Staff was unable to verify the source of the acceptance criteria.

Table 15 indicated that the inspection frequency for environmental degradation (i.e., cracks, corrosion, etc.) is yearly.

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

Response to RAI-2:

As discussed in Section 3.4.2.2 of the CoC Renewal Application, the VCC exterior surface inspection defect size criteria and inspection frequency are based on the requirements of the existing Technical Specification (TS) 1.3.2. 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 ¾-inch in diameter and spalling less than 3/8-inch in depth are "generally acceptable without further evaluation." Furthermore, the 1-year inspection frequency is consistent with the in-service inspection requirements of ASME Section XI, Division 1, Subsection IWL for concrete surface areas affected by repair.

Summary of Renewal Application Changes:

- None.

RAI-3. Provide a TLAA for the polymeric gaskets used for the weather covering and explain how the TLAA will be verified through inspections and justify the frequency of inspections. Alternatively, justify that failure of the polymeric gaskets will not lead to accelerated corrosion of the VSC-24 exteriors.

Polymeric materials, even if not in the presence of a radiation field, will embrittle, creep, and degrade over time. The staff finds that polymeric gasket materials may not function as intended over a 60-year lifespan. The integrity of the weather cover establishes the conditions for the aging management of the system and thus needs a TLAA.

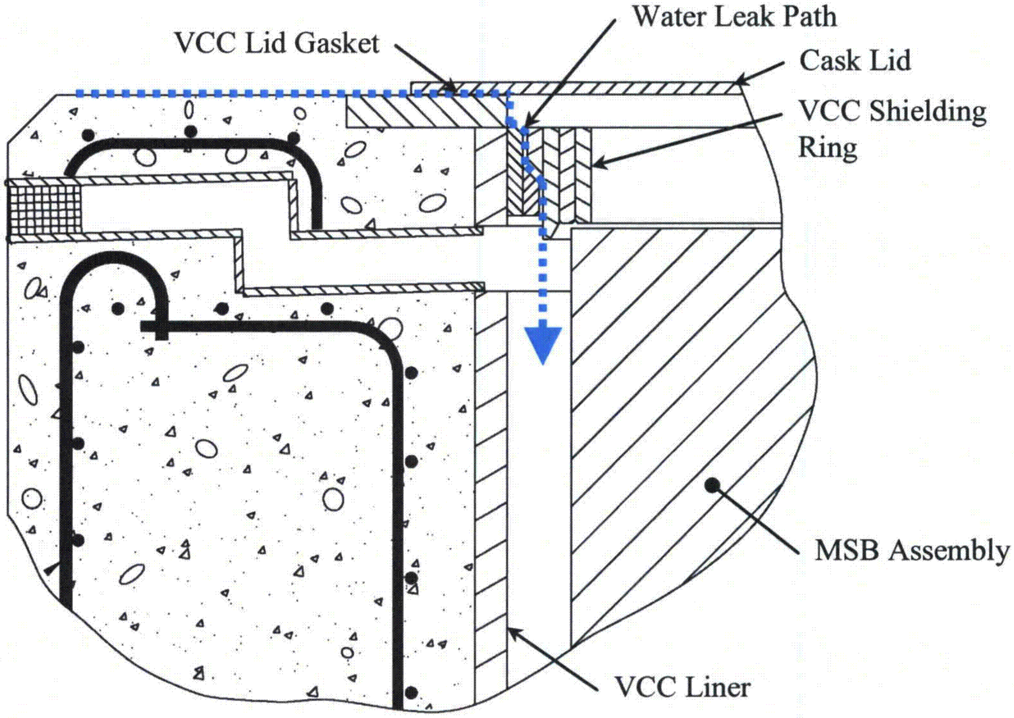
This information is required to demonstrate compliance with 10 CFR 72.240(c)(2).

Response to RAI-3:

The VCC lid gasket lies in a sheltered environment with very low radiation levels. Only the inside and outside edges of the VCC lid gasket are directly exposed to an oxidizing atmosphere. Therefore, minimal degradation of the VCC lid gasket is expected to occur during the extended storage period. Unless the VCC lid gasket is disturbed, it is not expected that the lid gasket will allow any water to leak into the VCC cavity. The most likely disturbance of the cask lid is if the bolts and lid are removed, but as discussed in the response to RAI-20, the old lid gasket is required to be replaced with a new lid gasket the prior to re-installation of the cask lid, regardless of condition of the old lid gasket. Therefore it is highly unlikely for the lid gasket to degrade and leak. Nonetheless, in the unlikely event that degradation of the VCC lid gasket material results in a water leak, the design of the VCC shielding ring plates will direct water flow down the VCC annulus and prevent water from accumulating on the top of the MSB assembly, thereby preventing the possibility of accelerated corrosion of the MSB structural lid and closure weld.

The VCC shielding ring is placed on the top of the cask liner assembly after the MSB assembly is lowered into the VCC cavity. It fits loosely inside the cask support rings at the top of the cask liner and extends over the top corner of the MSB assembly. As shown in the figure below, any water that leaks through the VCC lid gasket will be directed down the annular gap between the cask liner and VCC shielding ring, where it will drip to the bottom of the VCC annulus, and will not collect on the MSB structural lid, thereby preventing accelerated corrosion of the MSB lid or welds. Any significant amount of water that drips to the bottom of the VCC annulus will drain out the VCC inlet channels. The carbon steel surfaces of the VCC liner and MSB assembly that form the VCC annulus are coated for corrosion protection. Moisture that accumulates on the coated surfaces of the VCC liner and MSB shell will evaporate or drain out of the VCC assembly. Therefore, failure of the VCC lid gasket is not expected to lead to accelerated corrosion of the VCC liner and MSB shell.

Corrosion of the coated steel surfaces on the inside of the VCC assembly is managed through several AMPs, as shown in Table 13 of the renewal application. Visual examination of the VSC top end steel components, as described in Section 3.4.2.4 of the renewal application, identifies any indications of water leakage through the lid gasket into the top end of the VCC assembly and confirms that the surfaces of the VCC cask lid, VCC liner flange, VCC shield ring plates, VCC lid gasket, VCC lid bolts, MSB structural lid, MSB valve covers, and MSB closure weld, many of which are normally inaccessible, are not experiencing any unanticipated degradation that could prevent them from performing their intended functions. Remote visual examination of the VCC annulus, as discussed in Section 3.4.2.3 of the renewal application, provides further visual evidence that the coated carbon steel surfaces of the MSB and VCC that form the annulus are not experiencing any unanticipated coating failure and corrosion. Finally, the lead cask inspection discussed in Section 3.4.4 of the renewal application includes visual examination of the VSC top end steel components and VCC annulus, similar to the AMPs discussed in Sections 3.4.2.4 and 3.4.2.3, respectively. Therefore, in the unlikely event that degradation of the VCC lid gasket material results in water leakage into the VCC assembly, accelerated corrosion, although not expected, will be managed through AMP inspections.



Potential Leak Path through VCC Lid Gasket

Summary of Renewal Application Changes:

- Sections 3.4.2.4 and 3.4.4: Revised discussion of consequences of water leakage through the lid gasket.
- Table 17, "Scope": Add replacement of VCC Lid Gasket.

RAI-4. Evaluate the potential for zinc-zircaloy interaction for a cask loaded under the renewed CoC at a higher heat load (up to 24kW). Further, submit a copy of WEP-109-003.12, Revision 2, "Generation of a Heat Load vs. Fuel Temperature Curve."

A copy of WEP-109-003.12, Revision 2 was referenced in enclosure SFD/NRC 13-003, enclosure 1, "Response to Supplemental Information," and should be provided to the staff to make a safety evaluation finding regarding the potential for zinc-zircaloy interaction for systems that could be loaded at heat loads up to 24kW under a renewed CoC.

This information is required to demonstrate compliance with 10 CFR 72.240.

Response to RAI-4:

The renewal application has been revised to include a proposed condition to limit the maximum decay power per assembly to 0.625 kW (i.e., 15 kW per cask) for casks loaded under the renewed CoC. This proposed condition will assure that the peak temperature within the MSB remains below 300°C (i.e., the temperature above which zinc-zircaloy interaction can theoretically occur.) A copy of Calculation No. WEP-109-003.12, Revision 1 is enclosed with the RAI response. Revision 2 of the subject calculation package was referenced in error in the Aging Management Review (Calculation No. VSC-04.3101, Revision 2). The revision number of the reference is corrected in Revision 3 of Calculation No. VSC-04.3101, Revision 3, a copy of which is enclosed with the RAI response.

Summary of Renewal Application Changes:

- Section 1.0: Revised to include a proposed condition limit the maximum decay heat to 15 kW.
- Section 1.1.2: Added footnote discussing proposed condition to limit the maximum decay heat to 15 kW.
- Section 2.2.1.1: Added discussion of proposed condition to limit the maximum decay heat to 15 kW.
- Section 3.2.1.3: Added discussion of proposed condition to limit the maximum decay heat to 15 kW.
- Appendix B: Added proposed changes to Table 1 of CoC Revision 0 and CoC amendments 1 through 6 to reduce the maximum decay power per assembly to 0.625 kW for casks loaded after the initial storage period.

RAI-5. Update the application to address the following.

a. Include the shield rings labeled as Part Nos. VCC-039 and 040 in Drawing No. VCC-24-002 in Table 6. These rings are in addition to those currently listed in that table.
b. Include the hydraulic cylinder assembly and the light MSB Transfer Cask (MTC) shield door lead plug in Table 11.
c. Show where note 2 is used in Table 12.
d. Include the MTC's rail lower plate and shield door in Table 13.

These items appear in other tables of the application and the drawings in the revisions of the final safety analysis report (FSAR) but are missing from these tables. Also,

Table 12 includes a note 2, but this note is not used anywhere in that table.

This information is needed to confirm compliance with 10 CFR 72.240.

Response to RAI-5:

a. Table 6 has been revised to include Part Numbers VCC-039 and VCC-040 from Drawing Number VCC-24-002. Parenthetical descriptors have also been added to differentiate the Shielding Ring Plates included in the Liner Assembly from those included in the Shield Ring. Similar changes have also been made to Tables 10, 13, and Appendix A, Table 9.3-2.

b. Table 11 has been revised to include the Middle Shell, Trunnion Inner & Outer Plate, Trunnion Lead/Neutron Shields, Hydraulic Cylinder Assembly and the Light MTC Shield Door Lead Plug that are included in Table 7. Similar changes have also been made to Appendix A, Table 9.3-3.

c. Note 2 is not used in Table 12, and therefore it is deleted and the table notes are renumbered accordingly.

d. Table 13 has been revised to include the Rail Lower Plate and Shield Door.

Summary of Renewal Application Changes:

- Tables 6, 10, 11, 12, 13, and Appendix A, Tables 9.3-2 and 9.3-3: Revised as noted in response above.

RAI-6. Provide the following regarding the RX-277 neutron shield materials.

a. A copy of the RX-277 Shielding Material Product Data Sheet, Bulletin S-73N for review.
b. Differences between the neutron shield material in the multi-assembly sealed basket (MSB) lid and the MTC.
c. Impacts of neutron and gamma radiation in combination.
d. An analysis for the potential of hydrogen build up associated with off-gassing of the RX-277 and corrosion of steel over a 60-year time period.

The staff requests a copy of RX-277 Shielding Material Product Data Sheet, Bulletin S-73N prepared by Reactor Experiments, Inc., Sunnyvale, CA, August, 1991 to assess the conditions necessary to establish integrity of the material. Further, the properties seem to differ between the neutron shield in the MSB lid and the MTC, at least beginning with FSAR Revision 5. Any variations in neutron shield material properties from FSAR revision to FSAR revision should also be described and considered. Additionally, the radiation effects appear to be considered separately and not in combination. Since the material experiences gamma and neutron radiation at the same time, the application should address the effects in combination. Finally, off-gassing

RX-277 neutron shielding material in the MSB shield lid can be a potential source of corrosion in carbon steel.

This information is required to demonstrate compliance with 10 CFR 72.236(d) and 240(c).

Response to RAI-6:

a) A copy of Bulletin S-73N is enclosed with the RAI response package.

b) The same RX-277 material is used in the MSB shield lid and MTC assembly. However, beginning with FSAR Revision 5, the RX-277 in the MSB shield lid is baked to remove unbound moisture present in the material to prevent off-gassing within the shield lid neutron shield cavity during fuel storage, whereas standard (i.e., unbaked) RX-277 material is used in the MTC neutron shield cavity. For this reason, two different RX-277 material descriptions are presented in the shielding evaluation, beginning with FSAR Revision 5.

   The RX-277 material properties modeled for the MTC's radial neutron shield are based upon the density and composition data provided in Bulletin S-73N. To conservatively account for potential variations in RX-277 material composition, as well as small amounts of moisture loss that could occur, the densities of the primary active constituent elements (i.e., hydrogen and boron) of RX-277 in the MTC shielding model were reduced by 10%. The oxygen density was also reduced by 10%, as the hydrogen content is primarily in the form of water.

   The RX-277 material properties modeled for the MSB lid neutron shield are also based upon the density and composition data provided in Bulletin S-73N. However, in the case of the MSB lid, the hydrogen density is reduced by 50%, the boron density is reduced by 10%, and the oxygen density is reduced such that the overall RX-277 density is reduced by 32%. Those larger reductions account for the effects of the baking process on the RX-277 material in some of the MSB lids. Dose rates calculated based on the "baked" RX-277 material model are bounding for MSB lids with unbaked RX-277.

c) As discussed in Section 3.3.3.4 of the renewal application, the gamma radiation dose seen by the MSB lid RX-277 over a 60-year storage period is 150 times smaller than the exposure limit presented in Bulletin S-73N, while the neutron exposure (and fluence) is five orders of magnitude smaller than the associated limit presented in Bulletin S-73N. There is no reason or basis to expect any kind of synergistic effect between the neutron and gamma fluences. Thus, summing the impacts of the gammas and neutrons provides a reasonable estimate of the overall cumulative effect. As the neutron fluence is a negligible fraction of the allowable value, it does not add significantly to the impact of the gammas, whose exposure level is 150 times smaller than the limit. Thus, it can be conservatively concluded that the combined impact of the neutron and gamma fluences is less than 1% of the overall fluence/exposure limit of the material. In summary, neither the neutrons nor the gamma radiation will have any significant impact on the RX-277 material properties, and, by extension, the combination of the two (fluences) will not have any significant impact either.

d) As shown in Figure 4.4-5 of the VSC-24 FSAR, the peak temperature of MSB lid RX-277 material is approximately 140°F for a 24 kW heat load, which is much lower than the 350°F service temperature limit given in Bulletin S-73N. Thus, no significant off-gassing is expected from the RX-277 material. However, moisture from un-baked RX-277 will be available to produce corrosion in the surrounding carbon steel. For many MSBs, the RX-277 material did not undergo a baking process. As the MSB lid RX-277 material has a significant volume, and contains both bound and unbound water, lack of moisture availability is not likely to be a limiting factor with respect to corrosion of the carbon steel that surrounds the RX-277 material. Instead, the level of corrosion will be governed by chemistry, and the behavior of the carbon steel itself (e.g., the corrosion rate for the metal and any passivation layer that may form).

Carbon steel, when in contact with cementitious material having low-chloride content, such as the RX-277 material in the MSB shield lid, undergoes a rapid period of "acute" corrosion, followed by an indefinite "chronic" corrosion period, where the rate of corrosion is constant. Based upon a corrosion prediction model presented in Sections 4.4 and 4.5 of SA/ENV-0841, "A Survey of Steel and Zircaloy Corrosion Data for Use in the SMOGG Gas Generation Model" (a copy of this reference is included in the RAI response package), carbon steel in aerobic conditions at 50°C (roughly the peak temperature seen by the MSB lid RX-277 material during the extended storage period) will quickly develop an "acute" corrosion layer of approximately 1.2 μm, followed by "chronic" corrosion ranging from 0.2 to 2.0 μm/year. For anaerobic conditions at 50°C, an "acute" corrosion layer of approximately 1.0 μm develops, followed by "chronic" corrosion ranging from 0.005 to 0.1 μm/year. Even if the upper bound corrosion rate of 2.0 μm/year is assumed for the more conservative aerobic conditions, the total corrosion layer thickness after 60 years of storage would be approximately 121 μm (0.005 inches). This small amount of corrosion will have no significant effect on the intended structural and shielding design functions of the MSB shield lid.

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

- None.

RAI-7. Provide the TLAA for the bounding Palisades MSB-04 fatigue crack growth analysis.

The calculations supporting the conclusions in Section 3.3.3.6 should be submitted for staff review.

This information is required to demonstrate compliance with 10 CFR 72.240(c)(2).

Response to RAI-7:

A copy of the Palisades MSB-04 fatigue crack growth TLAA (Calculation No. 1200250.301) is enclosed with the RAI response.

Summary of Renewal Application Changes:

- None.

RAI-8. Justify that the three foot long by 1/8-inch wide gap created by inspecting the lead cask will not create a pathway for trapping water between the bottom base plate of the VCC and the VCC concrete, leading to conditions promoting additional corrosion and concrete degradation. Further, justify why there is no Aging Management Program (AMP) to cover this issue.

The large gap created by inspecting the lead cask may have the potential for creating an environment conducive for corrosion or concrete degradation.

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

Response to RAI-8:

As discussed in the VSC-24 Lead Cask Inspection Report that was provided to NRC on February 14, 2013 in Enclosure 1 of the Response to Request for Supplemental Information [NRC Accession No. ML13050A323], the gap or void that was identified between the VCC bottom plate and VCC bottom concrete during the lead cask inspection was approximately 3-feet long by 3/8-inch wide by 3/8-inch deep. The subject void was not caused by flexing of the VCC bottom plate, as previously indicated in Section 3.2.2.4, rather it is believed that the void resulted from the concrete pouring operation during VCC construction. Furthermore, the VSC-24 Lead Cask Inspection Report indicates that no flexing of the VCC bottom plate was observed when the VCC was lowered onto the ISFSI pad, indicating that it remains firmly attached to the VCC bottom concrete. Therefore, this void does not create a pathway for water to collect between the VCC bottom plate and VCC bottom concrete, and it will not lead to conditions promoting additional corrosion and concrete degradation.

Section 3.4.2.2 and Table 15 have been revised to require visual examination of the concrete-to-steel interfaces at the VCC bottom plate and VCC outlet assemblies for gaps or voids. In addition, Table 15 has been revised to include the operating experience from the lead cask inspection related to the gap/void between the VCC bottom plate and the VCC bottom concrete.

Summary of Renewal Application Changes:

- Section 3.2.2.4: Revised to better describe the observed gap or void between the VCC bottom plate and VCC bottom concrete and explain why it will not lead to any unacceptable degradation during the extended storage period.
- Section 3.4.2.2 and Table 15: Revised to add AMP requirements for visual examination of the concrete-to-steel interfaces at the VCC bottom plate and VCC outlet assemblies for gaps or voids.
- Table 15, "Operating Experience": Revised to include discussion of the gap/void identified between the VCC bottom plate and the VCC bottom concrete.

RAI-9. *Provide a corrosion analysis with the predicted corrosion rate for the VCC bolts over the 40-year renewal period. Explain how the predicted corrosion rate is determined and verified through inspections and justify the frequency of inspections.*

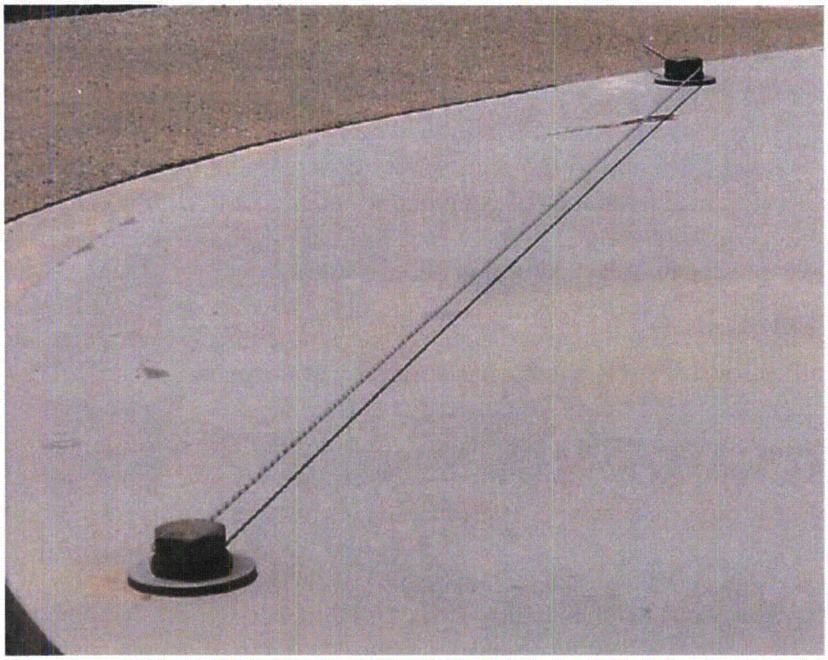
Section 3.2.2.4 of the renewal application states that some corrosion was observed on the cask lid bolts, but the VCC lid bolts were in acceptable condition.

This information is required to demonstrate compliance with 10 CFR 72.240(c)(2).

Response to RAI-9:

The VCC lid bolts are made from A307 carbon steel with a zinc coating or other protective finish. The protective finish on the VCC lid bolts is intended to inhibit corrosion. However, the VCC lid bolts may experience some corrosion during the extended storage period, as operating experience shows. As noted in the Palisades Lead Cask Inspection Report, when the VCC lid bolts were removed, some corrosion was identified on the bolts. However, as shown in the picture below, the amount of corrosion on the VCC lid bolts of the Palisades lead cask was limited to local discoloration of the surface finish, and as such, they were determined to be acceptable for continued use.

Potential aging effects in the VCC lid bolts are managed by AMP, not TLAA. The AMP requirements for managing aging effects in the VCC lid bolts are discussed in the response to RAI-20.



Condition of Palisades Lead Cask VCC Lid Bolts

Summary of Renewal Application Changes:

- Sections 3.2.2.4: Revised to clarify that the corrosion on the VCC lid bolts was limited to discoloration of the surface finish (i.e., rust bloom) and that the bolts were determined to be acceptable for continued use.

RAI-10. Provide an AMP for the concrete reinforcements. The AMP should explain how the corrosion is being accessed, assessed, and verified through inspections and justify the frequency of inspections.

Section 3.2.1.2, "Reinforced Concrete," subsection "Loss of Material," of the renewal application states that the AMP will address degradation of the rebar in Section 3.4 of the renewal application. Table 9 in Section 3.4 of the renewal application states that corrosion of the rebar is part of the AMP, but it is not clear how the aging effects are being accessed or evaluated, since inspection of the rebar is not being considered.

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

Response to RAI-10:

Rebar corrosion is managed by AMP, as shown in Table 13 and discussed in Section 3.4.2.2 and Table 15. Visual examination of the readily accessible concrete exterior surfaces is performed yearly on all casks to identify aging effects that indicate rebar corrosion, such as splitting cracks (i.e., longitudinal cracks that propagate along the rebar) and excretion of rust (i.e., discoloration or staining at or below cracks on the concrete surface). Also, monitoring and trending of cracks on the concrete surface is performed (using crack maps, etc.) to identify progressive or accelerated crack growth that may indicate rebar corrosion. The primary means by which rebar corrosion is managed is by repair of defects in the concrete exterior surface to prevent prolonged exposure of the rebar to oxygen and moisture. As discussed in Section 3.4.2.2, defects in the concrete surface that are greater than ½-inch in diameter (or width) and ¼-inch deep are repaired by filling the defects with grout.

If an adverse trend of increasing concrete cracking, pattern concrete cracking, or other indications of significant rebar corrosion are observed, the AMP requires that it be addressed using the GL's corrective action program. Options of further evaluation that may be considered (by the GL) at that point include developing some alternative means of non-destructive examination of the embedded rebar, performing some limited form of destructive examination (followed by concrete repair), or possibly replacing the VCC.

As shown in Tables 6.2 and 6.3 of ACI 364.1 R-94, electrical potential measurements can be used to detect corrosion in concrete rebar. This method requires access (connection) to the rebar, and therefore is not entirely non-destructive. Another, indirect method is acoustic testing, which simply involves striking the concrete with an object (e.g., a hammer) and analyzing the resulting sound waves. This process detects delamination in the concrete which often results from rebar corrosion.

The combination of visual inspections, monitoring and trending, and corrective actions included in this AMP are sufficient to manage corrosion of rebar. Routine and frequent identification and repair of surface defects stops oxygen and moisture from reaching the rebar which prevents the electro-mechanical process of corrosion. Rust staining on the concrete surface is used as another means to identify potential rebar corrosion. Monitoring and trending of cracks and defects on the concrete surface is used to identify progressive or accelerated crack growth, which may indicate rebar corrosion. Non-destructive examination of the cask concrete, using a method such as acoustic impact, shall be performed when visual inspection and/or monitoring and trending results indicate signs of potential significant rebar corrosion, such as splitting cracks or accelerated crack growth.

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

- Section 3.4.2.2 and Table 15: Expanded discussion of AMP elements for corrosion of rebar.

RAI-11. Revise the renewal application to address the following issues that may arise due to the potential for additional licensees to use the cask under the renewed CoC.

a. Use of the cask by a licensee under different environmental conditions (i.e., marine or other environments). It is not clear that the evaluations in the current *application address this scenario and address the spectrum of potential aging mechanisms that can occur at different sites.*

b. Use of galvanized steel grate (vs. ceramic tiles) as allowed by the technical drawings in the revisions of the FSAR and the implications for corrosion of the MSB base.

c. Use of the cask by a licensee at the design basis heat load.

While the current licensees using the cask are not located in a marine environment and use ceramic tiles to support the MSB in the VCC, this may not be true of future licensees that use the cask under the renewed CoC. Additionally, a current licensee may, in the future, load a cask and use galvanized steel grates instead of ceramic tiles. Current or future licensees may also load a new cask at the design basis heat load, which could impact evaluations dependent upon the cask heat load (e.g., evaluations of cladding temperatures and fuel rod internal pressures vs. values of 400°C and 90MPa, respectively, and the effects on cladding/fuel rod integrity). Thus, the analyses in the renewal application should be expanded to address these three scenarios or condition the CoC (and amendments) to prevent these three scenarios.

This information is needed to confirm compliance with 10 CFR 72.240.

Response to RAI-11:

a) The VSC-24 system is designed to be used in different environmental conditions, including marine environments. The MSB shell and bottom plate are designed with a bounding corrosion allowance of 0.003 inch/year conservatively based on uncoated carbon steel in a marine environment. As discussed in Section 3.3.3.3 of the renewal application, the bounding corrosion evaluation of the MSB shell and bottom plate in a coastal marine environment has been extended for a 60-year service period. Furthermore, degradation of other VCC and MSB assemblies in any environment is adequately managed by AMP, as summarized in Table 13 of the renewal application. Therefore, use of the VSC-24 system under different environmental conditions (e.g., in a marine environment) is addressed in the renewal application.

b) Section 1 of the renewal application has been revised to include a proposed CoC condition to preclude the use of galvanized steel grate as an alternative to the ceramic tile supports for the MSB assembly, as currently permitted by Drawing No. VCC-24-002, Revision No. 5, Note 6, for all VCC assemblies fabricated after the renewal date. None of the fifty eight (58) existing loaded VCC assemblies have been constructed using galvanized steel grate in place of the ceramic tiles.

c) Section 1 of the renewal application has been revised to include a proposed CoC condition to reduce the maximum decay power per assembly to 0.625 kW (i.e., 15 kW for 24 fuel assemblies) for all MSBs loaded under the renewed CoC. As discussed in the RAI-4 response, this condition will assure that the peak fuel cladding temperature does not exceed 300°C (i.e., much lower than 400°C) during vacuum drying in order to prevent any significant zinc-zircaloy interaction. As discussed in Section 1.1.2 of the renewal application, the maximum initial heat load of the fifty eight (58) existing loaded VSC-24 casks is less than 15 kW, and therefore none of them are significantly affected by zinc-zircaloy interaction.

Summary of Renewal Application Changes:

- Section 1: Revised to include proposed CoC conditions to; (1) preclude the used of galvanized steel grate as an alternative to the ceramic tile supports for the MSB assembly for all VCC assemblies fabricated after the renewal date, and (2) limit the total heat load to 15 kW for all MSBs loaded under the renewed CoC (as previously described in the RAI-4 response).

- Section 1.1.2: Added footnote 2 to note proposed CoC condition to limit the total heat load to 15 kW for all MSBs loaded under the renewed CoC (as previously described in the RAI-4 response).

- Section 2.2.1.1: Revised to discuss maximum heat load of loaded casks and the proposed CoC condition to limit the total heat load to 15 kW for all MSBs loaded under the renewed CoC (as previously described in the RAI-4 response).

- Section 3.2.1.3, "Hydride Redistribution and Reorientation": Revised to discuss maximum heat load of loaded casks and the proposed CoC condition to limit the total heat load to 15 kW for all MSBs loaded under the renewed CoC (as previously described in the RAI-4 response).

RAI-12. Provide the reference(s) for the carbon steel corrosion allowance of 0.003-inch/year that is assumed for the TLAA in Section 3.3.3.3 of the application. Further, explain how the corrosion rate is verified over the 40-year renewal period.

The source for the expected 0.003-inch/year corrosion loss is not described.

This information is required to demonstrate compliance with 10 CFR 72.240(c)(2).

Response to RAI-12:

The 0.003 inch/yr corrosion rate allowance is based on Reference 3.2.1 (M. G. Fontana, "Corrosion Engineering," McGraw-Hill Book Company, 3rd Edition) of Calculation No. VSC-04.3200, Revision 1. A copy of Figure 8.1 from the reference is included in Figure 6-1 of the calculation package, which is enclosed with the RAI response package. The figure provides typical corrosion rates of ordinary carbon steel in a marine environment (i.e., in the sea) for a variety of conditions. The corrosion rate for "marine atmosphere" located outside the slash zone is used for the VSC-24 system since an ISFSI would not be located within the splash zone of the sea. The calculation package also includes corrosion rate data from another reference (ASTM G101) for comparison purposes.

Based on the above reference data, the corrosion rate of 0.003 inch/year is bounding for all environments in which the VSC-24 system may be deployed. Furthermore, the MSB shell and bottom plate are shown to satisfy the applicable allowable stress design criteria after experiencing general corrosion at a rate of 0.003 inch/year over a 60-year storage period. Given that this degradation mechanism is evaluated and addressed using a TLAA, it is not considered necessary to verify the corrosion rate through an AMP over the 40-year renewal period. However, the condition of the MSB shell is verified during the visual examination of the VCC assembly annulus, as discussed in Section 3.4.2.3.

The visual examination of the VCC annulus is performed on the first VSC-24 cask loaded at each site on a 5-year frequency. Although the primary objective of this AMP is to monitor the VCC ventilation ducts and annulus for blockage, the coated carbon steel surfaces of the MSB and VCC that form the annulus are monitored for coating failure and corrosion. If the visual examination identifies corrosion on the MSB shell, it shall be evaluated by a qualified inspector to determine if it exceeds the design-basis 0.003 inch/year corrosion rate.

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

- Section 3.4.2.3: Revised to discuss AMP requirements for verification of corrosion rate on MSB shell.
- Tables 9 and Appendix A, Table 9.3-1: Revised Aging Management Activities for corrosion of the MSB Shell to include AMP.
- Table 13: Added AMP for corrosion of MSB Shell.
- Table 16, "Detection of Aging Effects": Revised to include degradation of the coated carbon steel surfaces of the MSB shell.
- Table 16, "Method or Technique": Added requirements for qualifications of personnel performing visual examination of the coated carbon steel surfaces of the MSB and VCC.
- Table 16, "Data Collection": Revised to include condition of the MSB shell.
- Table 16, "Acceptance Criteria": Added acceptance criteria for corrosion on MSB shell.
- Table 16, "Corrective Actions": Added requirement for evaluation of corrosion on MSB shell. Also added corrective actions for MSB shell with corrosion exceeding acceptance criteria.

RAI-13. Reconcile statements in Section 3.4.2.4 and 3.4.4, the "Safety analyses of the MSB structural lid and closure weld are based on nominal dimensions and do not include a corrosion allowance" with that of Section 3.3.3.3, where the corrosion allowance of

0.003-inch/year is assumed in the TLAA.

The two statements appear to contradict each other, requiring clarification.

This information is required to demonstrate compliance with 10 CFR 72.240(c)(2).

Response to RAI-13:

The statements made in Sections 3.4.2.4, 3.4.4, and 3.3.3.3 are correct. The discussion in Section 3.3.3.3 refers to the 0.003-inch/year corrosion allowance that is taken on the MSB radial shell and bottom plate, and the TLAA that was performed to evaluate that corrosion allowance for a 60-year storage period. The text in Sections 3.4.2.4 and 3.4.4 refers to the MSB structural lid and closure weld, for which no corrosion allowance is taken.

Summary of Renewal Application Changes:

- None.

RAI-14. Revise the operating experience section, as appropriate, of the AMPs to incorporate NRC Information Notice 2013-07, "Premature Degradation of Spent Fuel Storage Cask Structures and Components from Environmental Moisture," [April 16, 2013] and NRC Information Notice 2011-20, "Concrete Degradation by Alkali-Silica Reaction," [November 10, 2011].

These two information notices address recent operating history for dry cask storage systems.

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

Response to RAI-14:

Aging effects that have actually occurred based on industry and site operating experience are discussed in Section 3.2 of the renewal application, whereas the discussion of operating experience sections of the AMPs specifically involves the AMPs. The discussion of "Cracking, Pitting, and Spalling" in Section 3.2.1.2 of the renewal application, which already addresses NRC Information Notice 2011-20, has been revised to expand the discussion of the observed ASR-induced degradation at the Seabrook Station.

NRC Information Notices 2013-07 was issued on April 16, 2013, after the last submittal date of the renewal application, and therefore it was not discussed in the renewal application. The discussions of "Loss of Material" and "Cracking, Pitting, and Spalling" in Sections 3.2.1.1 and 3.2.1.2, respectively, of the renewal application have been revised to address the operating experience discussed in NRC Information Notice 2013-07.

Summary of Renewal Application Changes:

- Section 3.2.1.1: Revised to address the operating experience discussed in NRC Information Notice 2013-07 for galvanic corrosion.
- Section 3.2.1.2: Revised to address the operating experience discussed in NRC Information Notice 2013-07 for concrete cracking due to freeze-thaw cycles and expand the discussion of operating experience discussed in NRC Information Notice 2011-20 for ASR-induced degradation.
- Section 3.6: Added Reference for NRC Information Notice 2013-07.

RAI-15. Revise the renewal application to provide quantitative metrics or measures that define "good condition".

Page 3-18 of the renewal application states, "Upon removal of the VCC cask lid, the VCC lid gasket was found to be in "good condition with no evidence of leakage during the initial storage period". The coating on the MSB structural lid and closure weld was also found to be in good condition, with a few small areas that had "bubbled" but were still intact." Note that this could be an indication of under paint corrosion.

This information is required to demonstrate compliance with 10 CFR 72.11.

Response to RAI-15:

The renewal application has been revised to remove non-quantifiable terms, such as "good condition." Quantitative metrics are provided in the AMP "Acceptance Criteria" contained in Tables 14 through 19.

Summary of Renewal Application Changes:

- Sections 3.2.2.1, 3.2.2.4, and 3.4.2.4, and Table 17: Revised to eliminate use of non-quantifiable terms.
- Table 18, "Acceptance Criteria": Added quantitative metrics for acceptance criteria for coating loss and corrosion on the MTC assembly.

RAI-16. Revise the renewal application to include inspecting the MTC and provide and justify the inspection intervals.

The current language in Section 3.4.2.5 of the license renewal application permits the MTC to remain in a sheltered environment for over 40 years without inspection. Degradation of lubricants, hydraulic fluids, etc. and corrosion of uncoated carbon steel *surfaces would be expected over 40 year renewal period.*

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

Response to RAI-16:

Section 3.4.2.5 and Table 18 have been revised to require inspection and testing of the MTC assembly on a 10 year (± 1-year) frequency, starting on the 20th anniversary of the date on which the first cask was loaded at the site or on the effective date of the CoC renewal, whichever is later. The 10-year inspection interval, which is based on the inspection program requirements of ASME Section XI, Article IWE-2000, will assure that the intended functions of the MTC assembly are maintained during then extended storage period.

Summary of Renewal Application Changes:

- Section 3.4.2.5 and Table 18: Revised as discussed above.

RAI-17. Reconcile statements in Table 18 of the renewal application, "Examination of MTC Assembly" and Section 3.4.2.5, "Examination of the MTC Assembly."

Section 3.4.2.5 states that "If it is determined that corrosion on the underlying steel has resulted in loss of material (as opposed to just discoloration), then the MTC assembly shall be evaluated for continued use and the corroded surfaces shall be repaired."

Table 18, "Preventative Actions," states "Identification and repair of corrosion on the exposed surfaces of the MTC assembly...protects pool chemistry during fuel loading/unloading operations..."

Table 18, "Acceptance Criteria," states no coating degradation that exposes the underlying carbon steel surface and no corrosion of the underlying carbon steel surfaces that results in significant loss of material and prevents the MTC assembly from performing its intended structural and shielding functions.

It is unclear to the staff if uncoated steel that shows signs of discoloration, e.g., rust blooms, is acceptable. Uncoated steel in the spent fuel pool may cloud the pool during loading/unloading operations, which may contradict the statement in Table 18, "Preventative Actions."

This information is required to demonstrate compliance with 10 CFR 72.236(h).

Response to RAI-17:

While most surfaces of the MTC assembly that are exposed to the spent fuel pool water are coated, some are not. Table 13 of the renewal application specifies which MTC assembly subcomponents are coated or not coated. The uncoated carbon steel surfaces are portions of the MTC assembly on which coating is not practical, such as bolts, or areas where coating would likely be damaged during cask operations, such as the lifting trunnions or sliding surfaces. Since the total surface area of uncoated carbon steel on the MTC assembly is small, it does not have any significant impact on pool chemistry or clarity, as shown by the operating experience for all previously loaded VSC-24 casks.

The AMP requires that any coated surfaces of the MTC assembly that have experienced coating degradation are further examined to determine if the underlying carbon steel is corroded. Corrosion of the coated and uncoated steel surfaces that results in loss of material, as opposed to only surface discoloration (e.g., rust blooms), shall be evaluated for continued use. Furthermore, the AMP requires that areas with coating degradation and/or corrosion be repaired and recoated, as applicable, prior to use.

Thus, if coating degradation exposes the underlying steel, but the underlying steel is not corroded, the coating must be repaired before the MTC assembly is returned to service. If the underlying steel is determined to be corroded, but evaluations show that the steel component can still perform all of its design functions, the corrosion must be removed from the steel surface and the coating must be repaired before the MTC assembly is returned to service. If there is significant loss of material from corrosion, and evaluations show that the component is not suitable for continued use (i.e., that it is not able perform its design functions) then repair or replacement of the component must be performed before the MTC assembly is returned to service.

Summary of Renewal Application Changes:

- Section 2.2.1.4: Revised to clarify that most, but not all, of the exposed MTC surfaces are coated.
- Section 3.4.2.5: Revised to clarify requirements for inspection of the MTC assembly coated and uncoated surfaces.

RAI-18. Justify reliance on a corrosion allowance for the MSB bottom plate and shell in the current renewal application to support not needing an AMP for these components. Also, explain how the corrosion allowance will be verified.

Section 2.2.1.2 describes a corrosion allowance for the MSB bottom plate and shell and uses that in a TLAA for the MSB shell and bottom plate. It also uses this allowance to justify not needing an AMP for these MSB components. At least in terms of the shielding analyses in the FSAR, no allowance for corrosion is available since the shielding analyses use the nominal dimensions in the technical drawings, or in some cases appear to use dimensions that exceed those in the technical drawings for these MSB components. Thus, it would seem that an AMP may be needed for these MSB components.

This information is needed to confirm compliance with 10 CFR 72.236(d) and 72.240.

Response to RAI-18:

As discussed in Response to RAI-12, the corrosion allowance of 0.003 inches per year (of metal loss) is a conservative, bounding value, which is based on an uncoated carbon steel surface in a marine environment. The lead cask and 5-year inspections have shown that, in actual operating experience, the MSB exterior coating has remained intact, and that no significant MSB radial shell corrosion has occurred. Periodic visual examination of the MSB shell will verify that no significant corrosion occur on the MSB shell. Corrosion identified during the periodic visual inspection will be evaluated by qualified inspectors to determine if it exceeds the corrosion allowance of 0.003 inches per year.

A TLAA evaluation that addresses the structural effects of MSB shell and bottom plate corrosion (at a rate of 0.003 inches/year) is discussed in Section 3.3.3.3 of the license extension application. After 60 years of storage, the maximum loss of metal (thickness) due to corrosion, on the MSB shell and bottom plate, is 0.18 inches. As shown in the TLAA, the MSB would still meet its structural requirements with those metal thickness reductions.

With respect to shielding, not only has the coating remained intact and prevented significant corrosion, but even if corrosion were to occur, mass loss (and loss of shielding effectiveness) will not occur unless the rust spalls off (detaches from) the MSB surface and moves to a different location. This is not expected to occur to any significant degree; the oxide (rust) layer will remain adhered to the metal surface.

Even if it is assumed that the MSB shell and bottom plate corrode at a rate of 0.003 inches/year, and that any rust immediately disappears (leaves the metal surface), dose rates will still decrease with time, due to decreasing gamma source strengths. In fact, after only two years of storage, the gamma source strengths of the VSC-24 assembly payload will have decreased enough to offset the loss of 0.18 inches of steel (i.e., the maximum total amount of corrosion that will occur after 60 years).

For ~1.25 MeV gammas (which contribute the majority of cask exterior gamma dose rates), a steel thickness reduction of 0.18 inches results in a cask-exterior gamma dose rate increase of ~22%. For softer, ~0.5 MeV gammas (which contribute a very small fraction of overall cask exterior gamma dose rates), a 0.18 inch steel thickness reduction yields a higher dose rate increase of ~35% (due to the stronger attenuation of lower-energy gammas in steel). Gammas with energies lower than ~0.5 MeV do not contribute significantly to cask exterior gamma dose rates.

Examination of energy-dependent, spent PWR fuel gamma source strengths (produced by the ORIGEN2 code), and their dependence on decay time, shows that the 0.575 MeV gamma energy line (which is most affected by the loss of steel and also has the slowest rate of decay) falls by over 40% in five years, which is more than enough to offset the ~35% increase in its gamma dose contribution from the loss of 0.18 inches of steel. All other (higher) gamma energy lines, as well as gammas from Co-60 in activated hardware, fall by more than 48% in five years, which offsets the ~22% increase in its gamma dose contribution from the loss of 0.18 inches of steel by a wide margin. Thus, in conclusion, the reduction in gamma source strengths after only five years is more than enough to offset the loss of 0.18 inches of steel from the MSB shell and bottom plate; a metal loss that will take 60 years to occur.

Based on the above, it is concluded that the shielding evaluations do not need to address potential impacts from MSB shell and bottom plate corrosion. Even with the bounding, maximum allowable rate of corrosion, the decrease in payload gamma source strengths (with time) will more than offset any metal losses from corrosion, by a very wide margin. Thus, the cask exterior dose rates calculated by the licensing-basis shielding evaluations will clearly remain bounding for the entire, 60-year storage period.

Summary of Renewal Application Changes:

- None.

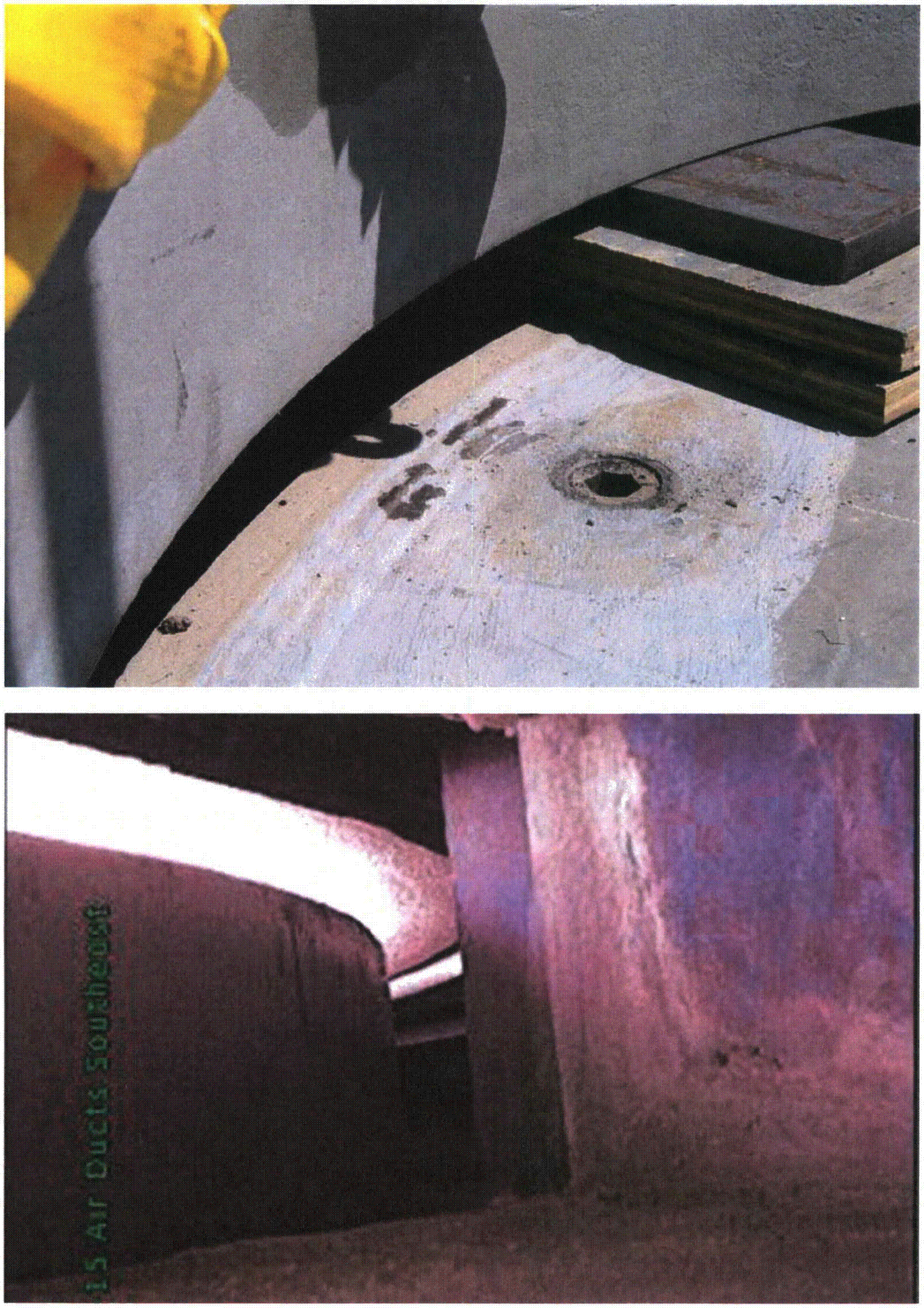
RAI-19. Provide evidence or justification demonstrating the lack of general, crevice, pitting, or other corrosion mechanisms between the VCC shield lid and MSB.

Section 3.2.2.4 notes that the VCC shield ring was, "lifted a small amount" but does not provide any details about the inspection for potential corrosion.

This information is required to demonstrate compliance with 10 CFR 72.11.

Response to RAI-19:

As discussed in Section 3.2.2.4, the VCC shield ring was lifted by a small amount (approximately 3-inches) to allow visual inspection of the MSB top corner region (i.e., the MSB closure weld), as shown in the first figure below. The visual examination did not identify any evidence of crevice corrosion occurring between the top end of the MSB assembly and the VCC shield ring. Further evidence of the lack of crevice corrosion at the top end of the MSB assembly is shown in the photographs provided below, which are included in the Palisades Lead Cask Inspection Report. The first photograph shows the top edge of the MSB shell exposed after lifting the shield ring. There are no visible signs of corrosion on the top corner of the MSB shell, although some coating was inadvertently scraped off, as discussed in Section 3.4.4 of the renewal application. The second photograph, which is taken from inside one of the VCC air outlet assemblies looking at the top corner of the MSB assembly, shows some discoloration of the coating at the top end of the MSB shell due to high temperatures experienced during the closure welding process, but no signs of corrosion.



Photographic Evidence of No Crevice Corrosion at MSB Top Corner

Summary of Renewal Application Changes:

- Section 3.2.2.4: Revised to discuss inspection results that provide evidence that crevice corrosion has not occurred between the top end of the MSB assembly and the VCC shield ring.

RAI-20. Clarify if the VCC lid bolts for each VCC storage system will be replaced or justify the bolts are acceptable for extended service.

The acceptability of bolts for extended service should be checked and the potential failure problems unique to bolts must be analyzed.

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

Response to RAI-20:

Potential aging effects in the VCC lid bolts are managed by AMP, not TLAA. As shown in Tables 10 and 13 of the renewal application, corrosion of the VCC lid bolts during the extended storage period is managed by two AMPs: (1) Section 3.4.2.4, Examination of VSC Top End Steel Components, and (2) Section 3.4.4, Lead Cask Inspection. In both cases, the VCC lid bolts are removed from the cask and visually inspected for corrosion. Examination of VSC Top End Steel Components (Section 3.4.2.4) is required on the first cask loaded at each site on a 10-year frequency (± 1-year), starting after the latest of the 20-year anniversary of cask loading or the effective date of the CoC renewal. Similarly, Lead Cask Inspection (Section 3.4.4) is required on one or more casks at each site on a 20-year frequency (± 1-year), with the initial inspection completed within 2-year of the end of the initial storage period or effective date of the CoC renewal, whichever occurs later. The 10-year inspection frequency is adequate to effectively manage the aging effects in the VCC lid bolts.

VCC lid bolts with significant corrosion (i.e., more than discoloration of the surface finish) shall be replaced. Furthermore, if significant corrosion is identified on the VCC lid bolts, the extent of condition must be evaluated, which may require examination and replacement of VCC lid bolts on other casks.

Summary of Renewal Application Changes:

- Sections 3.4.2.4 and 3.4.4: Revised to clarify AMP requirements for the VCC lid bolts.
- Table 17: Revised "Timing of Inspections" to account for a CoC renewal date that may occur after the 20^{th} anniversary of the first cask loaded at a site.
- Table 17 and 19: Revised "Corrective Actions" to clarify requirements for bolt replacement and actions required to address extent of condition.

RAI-21. Clarify the use of ACI 201.1 R-08 in the renewal application.

In response to Observation 2 of the NRC's Request of Supplemental Information, the applicant stated that, "in Section 3.4.2.2, the exposed surfaces on the sides and top of the VCC assembly are visually examined in accordance with ACI 201.1R-08..." The staff cannot find a reference to ACI 201.1R-08 in Section 3.4.2.2 or Table 15 of the renewal application, although it is listed in Section 3.4.2.2 Examination of the VCC Assembly Exterior Concrete".

This information is required to demonstrate compliance with 10 CFR 72.11.

Response to RAI-21:

Reference is made to ACI 201.1R-08 in the Section 3.4.2.2 text, as well as in Table 15. ACI 201.1R-08 is Reference 3.34, described in the Section 3.6 reference list of the application.

Summary of Renewal Application Changes:

- None.

RAI-22. Clarify which surfaces of the VCC Assembly are coated with Dimetcote 6, or equivalent, as described in Section 2.2.1.3 of the renewal application.

The subject section notes that "exposed" steel is also coated with Dimetcote 6 or equivalent. The term "exposed" also refers to an external environment in contact with the outside atmosphere as described in Section 3.1.2, "Environments" of the renewal application. The understanding of the staff is that surfaces that are in contact with the atmosphere but are in a sheltered environment are coated with Dimetcote 6 or equivalent.

This information is required to demonstrate compliance with 10 CFR 72.236(d).

Response to RAI-22:

The description in Section 2.2.1.3 and Note 1 of Table 13 have been revised to clarify which surfaces of the VCC assembly are coated with Dimetcote 6, or equivalent. All carbon steel surfaces of the VCC assembly subcomponents that are not embedded inside, or in direct contact with, the VCC concrete are coated with Dimetcote 6, or equivalent. The use of the term "exposed" to describe the surfaces on which the coating is applied has been eliminated since that term is used in a different context in Section 3.1 to describe an environment for SSCs.

Summary of Renewal Application Changes:

- Section 2.2.1.3 and Note 1 of Table 13: Revised to clarify which surfaces of the VCC assembly are coated with Dimetcote 6, or equivalent.

RAI-23. Identify in Section 2.2.1.3 of the renewal application the intended purpose and nuclear service level for the Dimetcote 6 inorganic zinc paint coating. Verify that the equivalent coating(s) to be used will be of the same nuclear service level. Identify also the industry standard(s) that will be used to reapply the coating to components on the VCC. Provide data to support the expected service life of the Dimecote 6 coating.

The renewal application states that the metal surfaces of VSC-24 VCC's steel components are coated with industry standard coating, Dimetcote 6, or the equivalent for preventing corrosion of the metal components. Typically, these types of coatings are used to protect the steel from excessive corrosion and facilitate decontamination of the surfaces.

This information is required to demonstrate compliance with 10 CFR 72.236(d).

Response to RAI-23:

As stated in Section 2.2.1.3, the intended purpose of the coating is "to protect against corrosion during storage." The coating on the VCC steel components is classified as Important To Safety (ITS). Equivalent coatings to be used on the VCC steel components are also ITS. Coatings (including coating repairs) are applied to the VCC steel components in accordance with the coating manufacturer's instructions. Degradation and aging effects for the coating on the VCC steel components are managed through the AMPs described in the CoC renewal application, not through TLAA. Therefore, data are not provided to support the expected service life of the coating.

Summary of Renewal Application Changes:

- None

RAI-24. Update Section 3.2.2.2 of the renewal application to justify how local coating failure and corrosion were determined on the MSB from the 5-year inspection. Explain the basis for the 5-year inspection interval. Also, quantify what does "very little coating degradation" mean and explain what does "significantly less than design basis" mean.

Page 3-15 discusses the condition of the MSB shell during the 5 year inspection interval. The results of the 5-year inspections showed that only local coating failure and corrosion had occurred on the MSB shell, and the amount of corrosion is significantly less than the design basis. However, it is unclear what was performed for the determination.

This information is required to demonstrate compliance with 10 CFR 72.240.

Response to RAI-24:

As stated in the first paragraph of Section 3.2.2.2, the examination of the ventilation ducts and annulus of the first cask placed in service at each site is a visual examination. Visual examinations are performed by qualified inspection personnel using remote video equipment (e.g., a bore-scope and video recorder). The inspection results are based upon the visual observations of the qualified personnel that performed the inspections. No other non-destructive examination methods were used for the 5-year inspections.

The 5-year frequency of the interior VCC surface inspection is specified in Technical Specification 1.3.3. The basis for the inspection requirement is provided in B.1.3.3, although no basis is stated for the 5-year inspection frequency. However, the 5-year frequency is considered sufficient to manage degradation mechanisms that may affect system performance as such mechanisms occur over time. It is also noted that the required inspection frequency is more frequent that the 10-year inspection interval for in-service inspection requirements of ASME Section XI for nuclear power plant components.

The majority of the coating degradation occurred around the entire top end of the MSB shell, where the coating is discolored from the high temperatures that occurred in the heat affected zone of the MSB closure weld. Other small areas of light oxidation or discoloration are generally 2 to 3 in^2, as described in the GL's inspection reports. The discussion in Section 3.2.2.2 has been revised to include this information.

As discussed in Section 3.3.3.3, a uniform corrosion rate of 0.003 in/year, which is based on uncoated carbon steel in a marine environment, is assumed for the MSB shell and bottom plate. No credit is taken for corrosion protection provided by the coating on the MSB shell and bottom plate during storage. Therefore, in reference to the corrosion observed during the inspections performed at 5, 10, and 15 years after loading, the design-basis corrosion values for the MSB shell and bottom plate are 0.015 inches, 0.030 inches, and 0.045 inches, respectively.

Summary of Renewal Application Changes:

- Section 3.2.2.2: The "Condition of MSB Shell" discussion is revised based on the responses above.

RAI-25. Describe how the necessary torque values of the bolts will be verified.

Staff was unable to verify this information in the renewal application for the VSC-24.

This information is required to demonstrate compliance with 10 CFR 72.236(e).

Response to RAI-25:

Bolt are tightened to necessary torque values using calibrated torque wrenches, when required.

Summary of Renewal Application Changes:

- None.

RAI-26. Revise Table 17 of the AMP (Examination of VSC Top End Steel Components) to indicate the standard for bolt procurement.

Bolts that are improperly heat-treated may crack in service under normal conditions (if tempered too little) or under off-normal (accident) conditions (if tempered too much).

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

Response to RAI-26:

The material specification for the VCC Lid Bolt (Item No. 5 on FSAR Drawing No. VSC-24-002) is ASTM A307. All replacement bolts shall conform to all requirements of ASTM A307, including heat treatment requirements. It is not necessary, nor appropriate, to include this information in Table 17 of the renewal application, as suggested in RAI-26, since replacement parts must satisfy the design requirements of the FSAR.

Summary of Renewal Application Changes:

- None.

RAI-27. Include item #2 of the "parameters monitored" (aggressive chemical attack...) in the monitoring and trending column of Table 15 (Examination of VCC assembly exterior concrete).

The monitoring and trending AMP element discusses what will be done for cracking, but chemical attack is not discussed.

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

Response to RAI-27:

As discussed in Section 3.2.1.2, "Cracking Pitting and Spalling," chemical attack is not expected to be a significant source of degradation for the VSC-24 system since it is an "above-ground" structure. Section 3.2.1.2, "Loss of Strength," states that CaOH leaching is a potential form of degradation that must be managed with an AMP. Thus, CaOH leaching appears as an aging effect managed by AMP for the VCC concrete in Table 13, but aggressive chemical attack does not.

Thus, text is added to "Monitoring and Trending" section of Table 15 which states that trending evaluations of increased porosity or discoloration will also be performed, in order to detect any degradation due to CaOH leaching. Text in the "Parameters Monitored or Inspected" section of Table 15 is revised to remove reference to aggressive chemical attack.

Summary of Renewal Application Changes:

- Table 15: Revised text in the "Parameters Monitored or Inspected" and "Monitoring and Trending" as noted in the response above.

RAI-28. Explain in Table 15 how the interval between inspections may be changed as a result of inspection findings from environmental degradation (blisters, spalling, ASR, etc.) of concrete.

Table 15 states that detection of aging is done only at a frequency of one year.

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

Response to RAI-28:

As discussed in Section 3.4.2.2 and Table 15 of the renewal application, defects in the concrete exterior surface that exceed the acceptance criteria are required to be documented and evaluated in accordance with the GL's corrective action program. Depending on the cause and nature of the degradation, the corrective actions may include additional examination, testing, and/or monitoring and trending. These corrective actions, which are in addition to the required annual visual inspection, may be performed on a different frequency, in accordance with the GL's corrective action program, but the frequency for the base scope of the AMP will not change.

For example, per the expanded discussion in Section 3.4.2.2 and Table 15 (revised in response to RAI-29), if the results of the visual inspection indicate evidence of ASR-induced degradation (e.g., severe expansion and pattern cracking, surface discoloration, gel exudations) and field testing confirms the presence of silica gel on the concrete surface, then Crack Index (CI) measurements are required to be taken to determine the extent of ASR-induced degradation in the concrete. If the initial CI measurements exceed the acceptance criteria, then CI measurements shall continued to be taken at least twice a year for a minimum of 3 years, to monitor the progression of ASR induced degradation. After 3 years, the CI measurement frequency may be reduced to once every 5 years if the CI shows no significant increasing trend.

Summary of Renewal Application Changes:

- None.

RAI-29. Explain in Table 15 what additional actions will be taken to confirm the extent and driving force that will cause ASR-induced degradation or leaching of CaOH of the VCC. These actions should also consider the potential degradation of the [VCC] from leaching of the concrete.

Section 3.4.2.2 of the renewal application indicates that if performance monitoring indicates the potential presence of ASR-induced degradation or leaching of CaOH, then additional actions shall be taken to confirm the presence of the degradation mechanism.

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

Response to RAI-29:

Section 3.4.2.2 and Table 15, "Corrective Actions," have been revised to expand the discussion of the actions required to confirm the presence of ASR, quantify the extent of ASR-induced degradation (i.e., expansion to date, expansion rate, potential for future expansion), and select the appropriate remedial actions and mitigation measures.

Summary of Renewal Application Changes:

- Section 3.4.2.2 and Table 15, "Corrective Actions": Revised as noted above in the Response to RAI-29.
- Section 3.6: Added reference [3.39].

RAI-30. Justify that the proposed condition to allow use under Amendment 4 or later of VSC-24 SSCs constructed under the initial CoC and Amendments 1, 2 and 3 avoids the problems associated with the initial CoC and Amendments 1, 2 and 3. Also, confirm that differences in hardware or operations requirements between amendments will allow SSCs constructed under Amendment 4 or later to be used with the previous amendments.

The applicant proposed a certificate condition to condition the initial CoC and Amendments 1 through 3 to require new SSCs be constructed per Amendment 4 or later. The condition also allows for SSCs already constructed under the initial CoC and Amendments 1 through 3 to be used as long as they are loaded per Amendment 4 or later. Recognizing that the later amendments were developed to address various issues encountered under the earlier amendments (i.e., pre-Amendment 4), it is not clear that a condition that allows use of SSCs constructed under the previous amendments precludes continuance of the issues associated with those amendments (e.g., hydrogen-induced cracking, hydrogen generation, welding electrode selection, *clouding of the spent fuel pool). Also, it is not clear that SSCs constructed to later amendments will meet the requirements of earlier amendments, including for hardware or operations, and thus be useable under those earlier amendments in accordance with the proposed condition.*

This information is needed to confirm compliance with 10 CFR 72.240.

Response to RAI-30:

The proposed condition to allow use under Amendment 4 or later of VSC-24 SSCs constructed under the initial CoC and Amendments 1, 2, and 3 has been deleted.

Summary of Renewal Application Changes:

- Section 1: Delete last sentence of second bullet.

RAI-31. Revise the renewal application to provide consistent descriptions of the AMPs and to ensure the AMPs include appropriate corrective actions, inspection intervals, and operating experience.

Sections 3.4.2 and 3.4.4 describe the proposed AMPs. These AMPs are summarized in Tables 14 through 19. Table 13 also summarizes which AMPs are applied to which SSC components. However, the information provided is not consistent. Thus, the scope of components covered by each AMP and the actions that should be taken is not clear. For example, it seems that Table 13 should include AMP Section 3.4.2.4 for the MSB structural lid and shell covers. Also, based on the AMP descriptions, the MSB shell is included in the AMPs and should also be listed in Table 13. In some cases the AMP scope in the summary table is not as extensive as in the AMP section; in other cases it is the opposite. In some cases, the summary table is internally inconsistent, leaving out SSC components in one element that are included in other elements of the AMP. Some AMP tables also seem to be missing some appropriate corrective actions. For example, an indication of a problem with the MSB neutron shield in Table 17 would seem to necessitate a check of the neutron shields for other MSBs. Also, in Table 16, the actions would seem to need more than just an evaluation of the condition's extent and continued usability. The table should describe the actions to take in the case where continued use is not possible.

This information is needed to confirm compliance with 10 CFR 72.240.

Response to RAI-31:

Table 13 and the six AMP tables (Tables 14-19) have been checked for internal consistency and consistency with each other with respect to the list of applicable components, and were revised as necessary. Consistency with the section text was also checked.

The example issues given in the RAI were resolved per NRC's recommendations with one exception. Potential corrosion of the MSB shell is addressed through the use of a corrosion allowance (in the applicable licensing analyses) and an associated TLAA. It is not addressed with an AMP. Thus, references to the MSB shell in the AMP tables have been removed. The MSB radial shell is examined during the 5-year and lead cask inspections (described in the Tables 16 and 19 of the renewal application). However, the results of those inspections are only used to provide additional assurance of the lack of corrosion of the MSB shell. However, those inspections are not required, as part of the AMP. Thus, references to MSB shell corrosion have been removed from Tables 16 and 19 of the renewal application.

Text is added to Table 16 which states that a VCC may have to be unloaded if the GLs evaluation shows that continued use is not possible.

Summary of Renewal Application Changes:

- Tables 13 through 19: Revised for consistency.
- Sections 3.4.2.1 through 3.4.2.5: Revised for consistency.

RAI-32. Revise Section 3.2.1.4 to evaluate the potential for creep or slumping of the lead in the MTC during extended storage due to gaps from tolerances.

During extended storage, the lead should not creep or slump to any extent that critically impairs the safety function.

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

Response to RAI-32:

The maximum stresses at the bottom of the MTC lead shield due to dead load are very small (less than 80 psi), even if friction between the lead shield and the adjacent shells is conservatively ignored. The creep rate in common lead at room temperature at this low stress level is negligible. As a result, no significant creep in the MTC lead shield is expected to occur during the extended storage period. Furthermore, the height of the MTC lead shield extends above the top end of the MSB cavity by over 10 inches for the standard MTC assembly configurations and by nearly 4.5 inches for the light MTC assembly configuration. Due to this geometry, the MTC lead shield would need to slump by nearly these distances before the peak dose rate near its top end would surpass the peak side dose rate. Lead slump of these amounts is not likely to occur.

The MTC assembly is only used within the fuel handling building and therefore it has no significant affect on the site boundary dose rates. However, dose rates on the surface of the MTC assembly do affect occupational exposure. In accordance with ALARA principles, the GLs perform a radiation survey of the MTC assembly during any MSB loading or unloading operation. In the unlikely event that lead slump causes the dose rate at the top end of the MTC assembly to exceed the peak side dose rate, the GL may implement additional measures for ALARA, such as administrative controls or the addition of temporary shielding. These changes would be evaluated in accordance with the requirements of 10 CFR 72.48.

Summary of Renewal Application Changes:

- None.

RAI-33. Clarify how dose rate measurements have been and will be used, provided the effectiveness of that approach can be justified, to identify degradation that could impact safety functions and for:

a. The performance monitoring described in Section 3.2.2.3 and

b. The examination of the VSC top end components described in Section 3.4.2.4 of the application.

The applicant describes the dose rate surveys that have been performed by the licensees that currently operate the VSC casks. The applicant also includes neutron dose rate measurements as part of a proposed AMP for the VSC top end components. The purpose in both cases has been, or is, to identify degradation of VSC components that have a shielding function. It is not clear that the current criterion of an increase in dose rates is adequate to identify degradation that "could possibly impact" safety functions or to verify the shielding effectiveness. Though recognized by the applicant, it is not clear if and how the criterion accounts for decay of the source term with time. Thus, degradation may be occurring but not to the extent that causes dose rates to increase, at least until the degradation has significantly progressed. Therefore, verification of shielding effectiveness may be performed by comparison of measured dose rates versus expected dose rates for the source in the contents. It is not clear that the proposed Aging Management Plan provides this kind of verification.

This information is needed to confirm compliance with 10 CFR 72.240.

Response to RAI-33:

Technical Specification 1.2.4 limits the external surface average dose rate (neutron + gamma) on the top of the VCC to 200 mrem/hour. While the MSB shield lid neutron shield serves a shielding function during the initial storage period, it is not required to satisfy the dose rate limits on the external surfaces of the VCC after the initial 20-year storage period. A shielding analysis (i.e., Calculation No. VSC-04.3206, Rev. 0) has been performed to demonstrate this. The analysis shows that the reduction in neutron source strength alone over the initial 20-year storage period more than offsets the shielding contribution of the MSB shield lid neutron shield RX-277 material. The VCC top surface average neutron dose rates at the end of the initial 20-year storage period, with the RX-277 removed, are lower than those calculated in the design-basis shielding evaluation. Also, due to the significant reduction in gamma source strengths over the initial 20-year storage period, the total dose rate (neutron + gamma) on the VCC top surface is lower than the 200 mrem/hr limit by a wide margin. The above conclusions apply for all assembly payloads allowed for loading in the VSC-24 cask (i.e., all allowable combinations of assembly burnup, initial enrichment, and cooling time). A copy of the subject shielding evaluation is included in this RAI response package. This TLAA evaluation is discussed in Section 3.3.3.7, which is added to the renewal application.

Since the RX-277 in the MSB shield lid neutron shield does not serve a shielding design function after the initial 20-year storage period, performance monitoring of its shielding effectiveness during the extended storage period is not necessary. For that reason, Section 3.4.2.4 and Table 17 of the renewal application have been revised to remove the requirement to measure the neutron dose rate on the top surface of the VCC cask lid.

For other components that have shielding design functions, and whose degradation could affect cask exterior dose rates, such as the MSB lid and shells, the VCC inner liner, the inlet and outlet duct steel structures, and the VCC concrete, degradation is addressed by means other than dose rate measurements. For the MSB shell and bottom plate, degradation is address through TLAA, assuming a bounding corrosion rate of 0.003 in/year. As discussed in the response to RAI #18, the reduction in gamma source strengths over time more than offsets the loss of 0.003 inches of steel per year. Corrosion on the VCC liner and inlet and outlet duct steel surfaces is addressed with the AMP described in Section 3.4.2.3 and in Table 16 (primarily using 5-year visual inspections of those surfaces). Corrosion on the MSB top surface and VCC lid surfaces is addressed with the AMP described in Section 3.4.2.4 and in Table 17 (primarily using 10-year visual inspections of those surfaces). Concrete degradation is monitored and addressed using the AMPs described in Sections 3.4.2.2 and Table 15. Thus, dose rate measurements are not needed to monitor degradation of those components.

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

- Section 3.3.2: Added new TLLA to list of TLAAs.
- Section 3.3.3.7: Section added to discuss new TLAA.
- Section 3.4.2.4 and Table 17: Deleted requirement for measurement of neutron dose rate on top of VCC lid from AMP.
- Table 9: Deleted AMP as an aging management activity for the MSB assembly shield lid neutron shield.
- Table 13 and Appendix A, Table 9.3-1: Deleted shield lid neutron shield from the MSB assembly subcomponents with aging effects managed by AMP.
- Table A-1, FSAR Section 9.3.2: Added new TLLA to list of TLAAs.

- Table A-1, FSAR Section 9.3.2.6: Added new section to discuss TLLA for MSB lid RX-277 neutron shielding material degradation.

RAI-34. Justify why a lead cask inspection was not done at Arkansas Nuclear One (ANO) and Point Beach.

Section 3.2.2.4 of the application provides some basis for the decision to perform the lead cask inspection at Palisades. However, considering the past issues with the VSC-24 (i.e., hydrogen induced cracking) the application should provide a justification for the decision to not have a lead cask inspection at all three sites. It should be noted that environmental degradation that leads to corrosion is very different at the three sites.

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

Response to RAI-34:

The criteria for the selection of the cask used for the initial VSC-24 lead cask inspection to support the CoC renewal application is based on the guidance provided in Appendix E of NUREG-1927, which states that "A lead canister is selected on the basis of longest time in service, or hottest thermal load, and/or other parameters that contribute to degradation." These parameters considered in the selection of the VSC-24 cask(s) for the initial lead cask inspection to support the CoC renewal application include time in service, initial heat load, design configurations (e.g., dimensions, materials, and coatings), operating history and operating conditions, and environmental conditions. Section 3.2.2.4 has been revised to discuss the parameters other than time in service, initial heat load, and environmental conditions and to justify why ANO and Point Beach cask(s) were not selected for the initial lead cask inspection to support the CoC renewal application.

As discussed in Section 3.2.2.4, there are no significant differences in the environmental conditions at Palisades, Point Beach, and ANO that would lead to corrosion. All three VSC-24 ISFSIs are located on bodies of fresh water; none are in a marine environment which is the primary consideration for corrosion. In addition, the annual monthly temperature range at all three sites are similar, with Palisades and Point Beach average temperatures being slightly lower than those at ANO. While the difference in the average temperatures is expected to lead to increased concrete degradation at the colder sites, it is not expected to have any considerable effect on corrosion. No environmental conditions were identified that would lead to greater corrosion at any of the three sites.

Section 3.4.4 and Table 19 have also been revised to require each general licensee to perform a lead cask inspection on one or more casks at their site after the initial storage period, unless they provide justification that their casks are bounded by lead cask inspection(s) performed for similar storage system(s) at other site(s), and complete the initial lead cask inspection within 12 months of the CoC renewal effective date.

Summary of Renewal Application Changes:

- Section 3.2.2.4: Revised to provide further justification for the selection of the cask used for the lead cask inspection.
- Section 3.4.4 and Table 19: Revised to clarify the required frequency, sample size, and timing of lead cask inspections at each GLs site.

RAI-35. Revise Section 3 of the application to indicate if AMPs and TLAAs will be changed as a result of inspections and operating experience.

Section 3 of the renewal application does not indicate that that AMPs and TLAAs will be updated as a result of inspection findings or current knowledge from operating experience from the industry.

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

Response to RAI-35:

Section 3.4.2 has been revised to require each GL to establish, implement, and maintain an operating procedure for each AMP and the lead cask inspection, including provisions for changing elements of the operating procedures to address new information on aging effects based on inspection findings and/or industry operating experience identified during the renewal period.

Summary of Renewal Application Changes:

- Section 3.4.2: Revised as noted above.
- Appendix B: Add requirements discussed above to Section 1.1.2, "Operating Procedures," of the Conditions for Cask Use and Technical Specifications of CoC Revision 0 through Revision 6.