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September 3, 2008
Contract No. NRC–02–07–006
Account No. 20.14004.02.003
WM–00011

ATTN: Document Control Desk
Mr. Michael D. Waters
Division of Spent Fuel Storage and Transportation
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, Maryland 20852

SUBJECT: Deliverable 20.14004.02.003.815, Final Letter Report—Survey and Recommendations for Potential Spent Nuclear Fuel Verification and Qualification Issues with Transportation, Aging, and Disposal Canister System Design

Dear Mr. Waters:

The purpose of this letter is to transmit the subject deliverable. Please note that this report was revised as necessary in response to U.S. Nuclear Regulatory Commission comments.

If you have any questions about this report, do not hesitate to contact me at 210.522.2951 or Dr. O. Povetko at 210.522.5258.

Sincerely yours,

K Axler

Keith Axler, Ph.D., Manager
Corrosion Science and Process Engineering

KA:jg

Attachment

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COMMENTS AND RESPONSES ON DRAFT REPORT
SURVEY OF POTENTIAL SNF VERIFICATION AND
QUALIFICATION ISSUES FOR TAD CANISTER SYSTEM DESIGN

Comments	Responses
1. **General comment.** Please include a section on nomenclature for technical terms that appear in the text of the report.	Accept. The Section 7 Glossary is added.
2. **General comment.** Replace the references to the referenced documents listed in Section 6 by numbers rather than by year as is currently done.	Deny. The references format follows the format of the documents prepared by NRC staff according to NUREG–1379, NRC editorial style guide. Please see Section 2.1 and Appendix Section 2.1 of the guide.
3. **Sections 2 and 3.** Since the Section 3 on regulatory criteria is the centerpiece of the report, it is requested that this section be made the first part of the discussion (Section 2). Current Section 3 contains parameters that must be qualified. This section will be followed by description of any issues with respect to quality of fuel records, and/or impacts from misleads (as described in current Section 2).	Accept. The former Section 3 is moved up in made new Section 2.
4. **Section 1.1, p. 1-1, Para. 1** It is suggested that the sentence "*For example, any nuclear parameters of the assembly that are unqualified or unverified with respect to initial enrichment and burnup prior to loading could increase neutronic reactivity.....*" be revised to explicitly describe the terms: *nuclear parameters, unqualified* and *unverified* and the process by which the reactivity is increased.	Accept. The terms *nuclear parameters, unqualified* and *unverified* are explicitly described in paragraph 1 of Section 1.1.
5. **Section 1.1, p. 1-2, Para. 2. and Table 3-1.** In addition to listing the requirements from 10 CFR Parts 63, 71, and 72, and since 10 CFR 50.68 is applicable to cask transfer operations in the spent fuel pools, it is suggested that 10 CFR 50.68 and any other applicable sections of 10 CFR 50 be included in the discussion and in Table 3-1. Also, expand the Table 3-1 by adding the following topics in the Regulatory Framework/SNF parameter in Table 3-1. ❖ Dose and release criteria for both normal conditions of transport and hypothetical accident conditions	Partially accept. It is assumed that the third sentence in the Comment 5 refers to the old Table 3-2, not 3-1. Per discussions with NRC staff the during July 16–17, 2008, meetings at the CNWRA, the scope of the comment was reduced. In response to the reduced scope, the new Table 2-1 was reformatted. The applicable sections of 10 CFR 50 are included in the new Table 2-1. Consideration of spent fuel cooling time is included in the new Table 2-2 as part of criticality portion of the table.

❖ Minimum SF cooling time ❖ Clad temperature ❖ Cask internal pressure ❖ Cask surface temperature ❖ Material specifications, fabrication and welding ❖ Lifting attachments ❖ Quality assurance ❖ Review plans	
5a. **Section 1.1, p. 1-1, Para 3**. Explain what is meant by "compliance period" in the text, by specifying the duration, and any other pertinent details.	Accept. The term "compliance period" is explained in Section 1.1, paragraph 7.
6. **Section 2.1, Figure 2-1.** Text for Figure 2-1 states, "*The 5 data points for each initial enrichment correspond to 20, 50, 80 and 100 percent of minimum required burnup.* There are only 4 values mentioned in the text, but there are five data points. Please correct the statement by listing the 5th data point.	Accept. The text is modified to "*The 5 data points for each initial enrichment correspond to 0, 20, 50, 80 and 100 percent of minimum required burnup...*"
7. **Section 2.1, Para. 1.** If the ORNL document titled, "Review of Information for Spent Nuclear Fuel Burnup Confirmation" is available by the time this report will be finalized, include the information from the ORNL document in your report on Task 3.	Accept. The ORNL report was not available by the time the report is finalized, therefore the information from that report is not included in the final report.
8. **Section 2.1, p. 2-4, 5th line up from bottom**. Comment on the sentence, "*The differences between these two values, measured-converted and calculated, (is) about 2 percent.* EPRI report TR–112054, "Determination of the Accuracy of Utility Spent Fuel Burnup Records" concludes that fuel assemblies in instrumented locations in a first cycle, the burnup uncertainty is 2.49%, for assemblies in instrumented locations in the second cycle, the burnup uncertainty is 1.67% and for assemblies in instrumented locations in the third cycle; the burnup uncertainty is 1.99%. It is suggested that the text reflects this information.	Accept. The sentence is modified to *"The study concludes that fuel assemblies in instrumented locations in a first cycle, the burnup uncertainty is 2.49%, for assemblies in instrumented locations in the second cycle, the burnup uncertainty is 1.67% and for assemblies in instrumented locations in the third cycle; the burnup uncertainty is 1.99%."*

<table>
<tr><td>9. Section 2.2, line 11 from top of paragraph. What are "certain specified thermal conditions" under which the peak cladding temperature should remain below 350 °C [662 °F]? Specify/elaborate those thermal conditions.</td><td>Accept. Table 3-1 is added which outlines the certain specified thermal conditions.</td></tr>
<tr><td>10. Table 3-2 (See also Comment #13). Table 3-2 compiles SNF parameters for disposal, transportation and interim storage analyses in NRC staff guidance documents, NUREG 1567, NUREG 1617, and NUREG 1609.

It is suggested that for ease of comparison between the three guidance SRPs, please change the format of the Table as shown below.

<table>
<tr><th rowspan="2">Object of Analysis</th><th colspan="3">Comments</th></tr>
<tr><th>NUREG 1567</th><th>NUREG 1617</th><th>NUREG 1609</th></tr>
<tr><td>Criticality</td><td></td><td></td><td></td></tr>
<tr><td>Decay Heat Removal</td><td></td><td></td><td></td></tr>
<tr><td>Material Temperature Limits</td><td></td><td></td><td></td></tr>
<tr><td>Shielding</td><td></td><td></td><td></td></tr>
<tr><td>Thermal Output</td><td></td><td></td><td></td></tr>
</table>
</td><td>Accept. The new Table 2-2 is reformatted as requested.</td></tr>
<tr><td>11. Table 3-2, p. 3-8. SAS2H/ORIGEN system of codes is currently validated up to about 50 GWd/MTU. Please make the correction to the statement "many libraries are not appropriate for burnup exceeding of 33,000 MWd/MTU...".</td><td>Partially accept. The statement "...many libraries are not appropriate for burnup exceeding of 33,000 MWd/MTU..." is an excerpt from NUREG–1617, therefore it was not modified. The following table bottom note regarding fuel burnup is added: "The validation of ORIGEN-ARP is based primarily on the validation of TRITON/NEWT which is used to generate the cross-section libraries (Bowman, S. "Latest Validation Reports." E-mail communication (July 1) to R. Nes, Center for Nuclear Waste Regulatory Analyses. Oak Ridge, TN: ORNL. 2008). The highest burnup for which these cross-section libraries are validated is 47 GWd/MTU (NRC. NUREG/CR–6798, "Isotopic Analysis of High-Burnup PWR Spent Fuel Samples From the Takahama-3 Reactor," ORNL/TM–2001/239," Washington, DC: NRC. 2003)."</td></tr>
</table>

12. **Table 3-2, p. 3-8.** Shielding analyses for transportation and storage casks has shown that gamma energies as low as 0.4 MeV provide contribution to external radiation levels. Therefore add a statement to this effect in the text here.	Accept. The statement *"In general, only gammas from approximately 0.8 to 2.5 MeV significantly contribute to external radiation levels..."* is an excerpt from NUREG–1617, therefore this text was not changed. The following table bottom note regarding contributions of low energy gammas to the external radiation levels is added: *"In common NRC practice, however, the lower limit for gamma energy contributing to external dose is extended to approximately 0.4 Mev (Holtec International, "Final Safety Analysis Report for the HI-STORM 100 Cask System", Holtec Center, Marlton, NJ, 2006)."*
13. **Table 3-3.** (a) Change the burnup unit from MWd/MTU to GWd/MTU; (b) For Assembly Structural Materials, Parameter Range Studied (cladding) should be changed to Zircaloy; (c) For Fuel assembly type, other fuel assemblies that are used by utilities should be listed; such as AREVA, Siemens, Advanced Nuclear Fuel (ANF), Exxon Nuclear Fuel, General electric (Global Nuclear) fuel; (d) Weight percent of Gd_2O_3 can range from 2 to 12 weight percent, not restricted to 5 weight percent as listed in the table; (e) In some older reactors there can be Hafnium flux suppression rods in their fuel assemblies for neutron flux flattening objective; (f) Provide a better and clearer explanation for the column for "Observed Variation" in the table.	Partially accept. (a) Units are modified as requested; (b), (c), (d), and (e) Per discussions with NRC staff on July 16–17, 2008, it was clarified that new Table 2-3 presents results of a limited parameter study conducted by ORNL; the study is not comprehensive and does not cover all fuel designs and parameter ranges utilized by industry. To combine review of the results of this study with new Table 2-4 created in response to Comment 17 below, the new Section 2.3 titled *"The Most Important and Typical Commercial SNF Parameters Provided in Safety Analysis Reports"* is added to the report. The three new sentences are added to the section top, so the beginning reads as follows: *"To support the NRC licensing procedures for SNF dry storage casks, Oak Ridge National Laboratory performed a study (NRC, 2001a) to identify and rank potential SNF specification parameters needed for criticality safety and radiation shielding and rank their importance relative to a potential compromise of the margin of safety. The study results for the shielding parameters are summarized in Table 2-3. They are not intended to cover the full range of SNF and assembly designs. The results provide only a rough guide to the importance of the fuel specifications as they affect storage cask surface total (i.e., gamma and neutron) dose rates..."*

14. **Section 4-1, Table 4-1.** (a) Correct the unit for Burnup to GWd/MTU; (b) Table 4-1 lists a Burnup range of 10–78 GWd/MTU. Section 4.3 indicates that the author intends to use the SCALE/ORIGEN code system (SAS2H-ORIGEN) to perform depletion calculations to obtain the inventory of isotopes present in the irradiated fuel. Section 4.4 indicates that the 15 × 15 ORIGEN-ARP libraries pregenerated for Westinghouse 15 × 15 assembly provided with the software is used in the depletion calculation. It is to be noted that the SAS2H-ORIGEN code system is validated for fuels with burnups less than 50 GWd/MTU. Therefore, for irradiated high burnup fuel of burnups greater than 50 GWd/MTU, other software such as NEWT-TRITON combination may have to be used.	(a) Accept. The units are corrected; (b) Partially accept. Per communication with ORNL SCALE developers (see the bottom note to Table 2-2), the validation of ORIGEN-ARP is based primarily on the validation of TRITON/NEWT, which is used to generate the cross section libraries. The highest burnup for which these cross section libraries are currently validated is 47 GWD/MTU. Therefore, TRITON/NEWT cannot be used to generate heat output for burnups higher than 47 GWD/MTU. The results for higher burnups are presented for illustration purposes only, the values are italicized in Table 4-1, Appendices A and B, and the text in the second paragraph of the Section 4.3 is modified as follows: *"The ORIGEN-ARP was extensively validated; the validation reports are available from the website of the code developer (Oak Ridge National Laboratory, 2008). Table 4-1 lists a burnup range of 10-78.26 GWd/MTU. The ORIGEN-ARP module contains cross-section libraries for this burnup range. According to the code developers, however, the validation of ORIGEN-ARP is based primarily on the validation of TRITON/NEWT SCALE module which is used to generate the cross-section libraries (Bowman, 2008). The highest burnup for which these cross-section libraries are validated is 47 GWd/MTU [Sanders, 2003], therefore, in Table 4-1 and in Appendix 1 the results corresponding to 50, 60, 70 and 78.26 GWd/MTU are presented for illustration purposes only and are given in italics to distinguish these illustrative values from those for which the current validation of the cross-section libraries currently extends."*
15. **Table 4-2.** (a)There is no need to express Boron concentration (ppm) with 4 decimal places. Express the Boron Concentration as 553 or 552 ppm depending on the application (whichever is conservative).	Accept. The boron concentration value is modified as requested.

16. **Appendix A.** The staff questions the need/relevance to include the Appendix A with Task 3 report. The staff would like to suggest that the Appendix A be transferred to Tad thermal analysis report for Task1. The staff is open for discussion on this comment.	Partially accept. Per discussion with NRC staff on July 16–17, 2008, it was agreed, that the more appropriate place for the Appendix A would be in Task 1 final report, but because the preparation and submission timing of the Task 1 and Task 3 final reports is different, it was decided to leave the Appendix A in Task 3 final report.
17. **General Comment (See also Comment #10):** Per discussion between CNWRA and NRC staff, please add a section in Chapter 3 which will list explicitly all fuel/fuel assembly parameters required to be used in criticality, shielding, containment and thermal evaluations of TAD canister. The users (nuclear plants) will be required to assemble these parameters for potential analyses required to be performed on TAD canister with the spent fuel assemblies prior to transportation and storage at Yucca mountain repository. One of the ways to produce a master list of analyses parameters is to modify and expand Table 3-2 using the NUREG/CR–1617 and applications from cask licensees The parameters for the analyses can also be found in a typical application which the CNWRA might have on file. If needed, we will send more SARs for your use. Add a bulleted list of the type of reactor fuel records that may be reviewed to qualify fuel for loading. Along with this list, a fuel qualification analyses be developed to accompany this list. The analysis will use records such as fuel vendor/fabrication, fuel type, reactor burnup, cooling time, non-conformance, and any other specifications needed for fuel qualification and verification.	Partially accept. Per discussions with NRC staff during July 16-17, 2008, meetings at the CNWRA, the scope of the comment was reduced. In response to the reduced scope, the new Table 2-4 is added to the Section 2.3. This table compiles (i) the typical list of parameters used by cask/canister vendors in their safety analysis reports and (ii) TAD canister system performance specifications for SNF parameters.
18. NRC staff would like to have teleconference or a meeting with your staff to discuss the draft report.	Accept. The meetings took place on July 16–17, 2008, during the visit of NRC staff to the CNWRA.