

**NRC staff clarifications regarding Holtec's response to a request for additional information (RAI) for:
HI-2210161 Rev. 2, "Topical Report on the Radiological Fuel Qualification Methodology for Dry Storage Systems"**

RAI 1: OK

RAI 2: OK

RAI 3: (3b) Section 2.8.5 states that the water density for boiling water reactors (BWRs) is to be 0.3. Holtec needs to clarify if this is in fact water density or void fraction as there are no units and BWR moderators are usually described in terms of void fraction. The 0.3 value would be conservative as a water density (in g/cc) but non-conservative as a void fraction. In addition, Holtec should review area of applicability for pressurized water reactor (PWR) moderator density as it seems very restrictive.

Holtec Response: It has been clarified in the report that the value of 0.3 for BWR is in g/cc. Additionally, the range of densities for PWR has been slightly enlarged, based on a review of available information for PWR plants.

RAI 4: OK

RAI 5: More details on the method used to generate the Co-60 source term from stainless steel replacement rods within reconstituted fuel is needed. Section 6.6 of ORNL/SPR-2021/2373 (<https://info.ornl.gov/sites/publications/Files/Pub170905.pdf>) shows that reconstituted fuel rods can have a significant effect on dose rates. Alternatively, since outer assemblies would be able to shield the Co-60 if it's in an inner assembly, Holtec may restrict placement of reconstituted fuel to inner locations within the basket.

Holtec Response: Given the possible significant effect of such rods, we have added more detailed instruction on how they must be considered in the analyses.

Note that in the topical report we do not want to prescribe any loading restrictions for assemblies with such rods, in order not to limit the loading flexibility. However, the qualification reports may introduce such restrictions to reduce their dose effects.

RAI 6: OK

RAI 7: OK

RAI 8: OK

RAI 9: (9a) Maximum mass needs to be added to the area of applicability in Table 2.2 for nonfuel hardware (NFH) because this directly determines how much Co-60 is produced. Even though what is proposed is applicable to NFH in open literature, all NFH designs are not known nor are restrictions to future designs known which may have a larger impact if used for higher burnup fuel. Previous analyses that have shown that NFH is not a large impact on dose are typically from analyses that restrict these components to the inner assemblies, therefore, as an alternative, Holtec may restrict placement of NFH inserts to inner assembly locations as part of use of this topical report. Note for underground or horizontal systems where outer assemblies may not obviously shield NFH in inner assemblies, additional studies or restrictions would need

to be placed on certain inserts that may have a larger contribution to dose to the top or bottom, such as (thimble plug devices) TPDs or (axial power shaping rod assemblies) APSRs.

Holtec Response: Holtec has consulted the users of our system and they have informed us that such information about NFH is not readily available. We therefore propose to leave the approach as it was initially established, based on the amounts previously established. However, we added a requirement to check for any indication that the values listed may be exceeded, and if so, adjust the source terms accordingly.

With respect to restrictions in the location of NFH, please note that in the topical report we do not want to prescribe any such loading restrictions, so there is flexibility in loading those. However, the qualification reports may introduce such restrictions to reduce their dose effects.

RAI 10: (10b) Additional information is needed on the area of applicability in Table 2.2 for neutron source assemblies (NSAs), see information related to RAI 9 above. Alternatively, similar to RAI 9 above, the gamma source term would be shielded by outside assemblies if NSA assemblies are limited to inner assemblies and restrictions on the placement to inner locations could be used in lieu of this additional information.

Holtec Response: See responses to RAI 9a above.

RAI 11:

(11c) There is a typo on Step 2, "For any NFH, develop the modeling in accordance with Sections 3.2, 3.5 or 3.5, as applicable." One of the "3.5" entries should be "3.4."

Holtec Response: The revised report (Revision 3) shows the correct numbers.

(11i) This item should be discussed with Holtec. The strategy for reducing the number of calculations proposed in Section 2.6 (bottom of page 7) for regionalized loading is not clear and does not appear to take into account that some zones and source terms will have higher contribution to dose than others. A different strategy needs to be discussed that requires more representation of burnup, enrichment and cooling time (BECT) points in the outer zone(s) that contribute more to dose. In addition, since inner assemblies have a proportionally higher neutron contribution than gamma dose contribution, instead of randomly selecting from the inner zones, it would be more conservative to choose the BECT with the highest burnup for the inner zones. For underground or horizontal systems where outer zones are not obviously the highest contributing zones, special considerations need to be proposed, otherwise all fuel qualification points need to be explicitly modeled.

Holtec Response: The section is revised, describing a revised strategy with two options, none of which include a statistical approach. Both options evaluate each BECT for each region in order to identify the conditions with the highest contribution from each region to each dose location.

RAI 12: OK

RAI 13: OK

RSI 5: Appendix E and F which includes an example of the qualification report needs to be discussed with Holtec as it is currently presented as an alternative way of documenting the qualification report. In addition several updates need to be made to these proposed tables consistent with the body of the topical report:

- Burnup/enrichment/cooling time in Appendix E and F is inconsistent with what topical allows in Table 2.2.
- Treatment of the Co-60 impurity needs to be added to the table
- Analysis of control rods if insertion is greater than 10%
- Alternatives and justification if specific power is adjusted needs to be included

Holtec Response: Appendix E and F have been revised to clarify that the approach presented in these appendices is the only acceptable approach for the qualification report. Consequently, Appendix D has been removed.

The tables in both Appendices have been updated to address the items above, and hence make them consistent with the main part of the topical report.