

Items / Requests for Additional Information (RAIs) discussed in phone call with Holtec International (Holtec) on January 11, 2022:

- General: Holtec stated - After addressing all RAIs, the level of detail in the method will far exceed that outlined in the final safety analysis report (FSAR) which is being used to justify the Burnup, Enrichment, and Cooling Times (BECTs) currently defined in the CoC. We want to have a brief discussion on this.

U.S. Nuclear Regulatory Commission (NRC) clarification: This is necessary as current FSARs have Fuel Qualification Tables (FQTs) that are generated at time of design approval. With these FQTs, there are certain assumptions implicit to the method that may not be necessary to define because staff can determine whether the system meets regulations based on examining the FQT values alone. Also, there is inherent conservatism when defining FQTs in a generic way because more bounding parameters need to be used in order for the system to be applicable at a generic level. The topical will allow for site, even canister specific modeling which could remove much of this conservatism. As this is a change in how systems are being certified, there will be a change in what information is used to justify that systems meet regulatory limits.

- RAI-2: Holtec stated - need some clarification on the last two sentences, starting “The staff understands ...”, it’s not clear what the expected action for that is, if any.

NRC clarification: The “staff understands...” sentence was added to communicate that it understands that Holtec has stated within the topical that fuel assemblies with axial blankets will be handled within the axial burnup profile assumed for the FSAR calculations and is not looking for Holtec to repeat this nor is the staff opposed to this approach. Rather the staff is requesting that Holtec clarify the topical for a more well-defined area of applicability and to make clear statements that include (or exclude) fuel assemblies with axial blankets and define how enrichment is to be treated when fuel assemblies have axial blankets. As stated in the RAI, this is similar to what is done in current FSARs.

- RAI-3a: Holtec stated - We understand that “unrestricted” should be replaced by some appropriate parameter range. We just want to make sure that we do not unintentionally exclude some fuel that would be perfectly acceptable by providing hard limits.

NRC clarification: The intent of the RAI is not to exclude acceptable fuel. However, it is intended to ensure that analysts use reasonable analytical assumptions for fuel that is depleted within the range in which these parameters have been studied. The staff would expect that if an analytical assumption is being used that is not based on the actual fuel being loaded, then it is reasonably conservative as compared to the actual parameter, or at least having minimal impact on dose. For example, Oak Ridge National Laboratory research shows that a reasonable range of boron concentration is between 0 and 2000ppm (see [ML21258A368](#)). NUREG/CR-6802 shows that there is not much variation to effect on nuclides contributing to dose rates between 0-1100ppm, and staff has seen additional studies up to 1750ppm that continue to support that there is not much variation in dose rates up to 1750ppm boron concentration. A cycle average boron concentration that would be within this range would encompass the vast majority if not all spent nuclear fuel (SNF) and would not exclude any fuel that would be acceptable. Going too far beyond studied parameter ranges would not be acceptable. It is known that with increasing concentration of

soluble boron the spectrum will shift to higher energy and create more actinides due to a proportionally higher absorption of neutrons by U-238. Significantly higher than studied boron concentrations may not be represented by the assumptions used in the supplied TRITON libraries. The staff understands that these are not restrictions in current FSARs, however current FSARs that have FQTs have conservatisms that may no longer be present when using this topical as the topical would allow more site-specific depletion parameters resulting in less conservative analyses. Other parameters, such as specific power can be varied within ORIGAMI and the staff would expect the allowable range to be what is physical and allowed by ORIGAMI and would expect that calculations be performed with either bounding or actual values (justified by a site). None of these considerations would exclude fuel that would be acceptable but would exclude fuel that is not acceptable and cannot be modeled using these methods.

- RAI-3b: Holtec stated – pressurized water reactor (PWR): It appears that the lower bound density value of 0.3 and the 30% impact listed in the NUREG is for boiling water reactor (BWR) fuel, not for PWR fuel. For PWR it just states the impact is low. BWR: given the large range of water densities over the axial height and irradiation history, we need to discuss what the basis for the selection of the parameter should be. While the value may be low (e.g., 0.1) for a certain location, and certain point in the irradiation history, that appears to be excessively conservative as an assumption for the entire fuel and irradiation.

NRC clarification: For moderator density, the staff has seen studies where dose rate can vary as much as 30% for neutron dose rate for both BWR and PWR. Although it would be conservative to bound entire fuel assembly for the entire irradiation, the staff understands that this is not realistic and will review/discuss any proposal and justification submitted by Holtec that provides representative moderator density/void fraction for PWRs and BWRs.

- RAI-4: Holtec stated - Need to discuss in general. This goes way beyond the level of dose locations evaluated for the current BECT qualification in the FSAR.

NRC clarification: The topical needs to have more detail than what is currently present in determining the dose locations. The language in the RAI is an example of something that would be acceptable to the staff, Holtec may propose different considerations that will be evaluated by the staff. Staff does not believe that the example considerations go beyond current qualifications in FSARs. However, as this topical will replace FQTs and loading patterns, it may be necessary, in some cases, to have additional dose points if what is in current systems is not detailed enough. For example, since loading patterns may no longer be specified at time of design approval, dose points capable of accounting for highly heterogeneous loading patterns would need to be added for systems where more uniform patterns were previously established or perhaps if a system had heterogeneous loading patterns but locations of highest dose were previously established based on the specific loading patterns.

- RAI-7: Holtec stated - Need to discuss why the energy structure will become a condition. This would make the general acceptance more complicated, since other users of the topical report may be currently using a different energy structure from that in those tables.

NRC clarification: The energy group structure was included in the topical, therefore the staff is evaluating whether or not it is appropriate as well as statements regarding the variation in group structure. Holtec may choose to remove the energy structure from the topical and it can be evaluated during the design approval phase where the shielding methodology will be approved to account for using different energy structures for different systems.

From staff experience and as stated in NUREG/CR-6802, group structure can have an effect on dose rates. Staff has found certain coarse group structures being more conservative than fine group structures. Also, certain energy lines need to be adequately represented (for example, Co-60 that has very distinct gamma lines that should be represented). If maximum energies are used, then variations in group structure are less likely to be of concern as this is conservative and variations in energy group structure are not likely to have an effect on dose rates. Staff would have to evaluate further the allowable variations in group structure if mid-point or histogram structure is used.

The topical report seems to indicate that the acceptable method for dose rate evaluations would be based on the response function method. Using this method, pre-determined dose rates per starting particle at a specific energy as defined by the energy group structure are generated using the shielding geometry of the storage system and then dose rates for cask loadings are calculated by summing up the dose rate contributions for each energy group multiplied by the activity in that group which is determined from the BECT for each assembly or assembly group. Since the dose rate per particle is calculated for a single energy for each group, the staff is unsure if it is the maximum or mid-point energy but would need this to be a condition of a system that uses this topical based on the response to this RAI if this information is used to determine the group structure, and its allowed variation, is acceptable. Staff believes that the histogram structure would likely be used for a more direct calculation of dose rates that does not incorporate the response function method however staff would like to understand better how group structure is accounted for in the response function method when sampling source from a histogram.

- RAI-8: Holtec stated - There is little “hard” information on Co-59 content of the materials, this would all go back to the fuel manufacturers, which have historically little interest in dry storage. One way forward would be to require the more conservative values currently used in the FSAR (which should be considered appropriate) but allow the use of more realistic values in the qualification reports, if supported appropriately (e.g., with information from the fuel vendors).

NRC clarification: Staff agrees.

- RAI-13: Holtec stated - need to discuss our intent of using limits for an average dose rate in addition to local limits.

NRC clarification: The topical needs to have more detail than what is currently present in determining how averaging of dose rates is performed. The language in the RAI is an example of something that would be acceptable to the staff, Holtec may propose different considerations that will be evaluated by the staff.