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Burnup Credit in the Criticality Safety Analyses of Pressurized Water Reactor Spent Fuel in Transportation and Storage Casks

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General Comment

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See attached file(s)

Attachments

3

Holtec-Comments-on-ISG-8-R3

SUNSI Review Complete
Template = ADM-013

E-RIDS = ADM-03
Add = A. Barto (abb2)

We welcome this Revision of ISG-8, and congratulate SFST for providing this document which presents a major step forward in Burnup Credit application compared to the previous revision.

Comments:

1. General: The ISG does not specifically address how the maximum k-eff is to be calculated. The referenced recently published NUREGs list the following equation (based on ANSI/ANS-8.27):

kp+ Δkp+ βi+ Δki+ β + Δkβ + Δkx+ Δkm ≤ klimit

This equation adds uncertainties arithmetically. The ANSI standard clarifies that independent uncertainties may be combined statistically, but the NUREG is silent on this issue. The ISG should clarify that a statistical combination of independent uncertainties is acceptable.

2. Page 1, "This ISG revision also includes an increase in the assembly average burnup recommended for burnup credit." This sentence should be revised to clarify that the upper burnup limit is increased. As written, the sentence could be interpreted to state that there is a recommended burnup value for burnup credit, which is now higher than before.

3. Page 2: ISG-1 Rev. 2 distinguishes between intact and undamaged fuel, where undamaged fuel may have certain defects as long as the important performance functions of the fuel is not impaired. If it is in fact the intent to limit burnup credit to intact fuel, then this should be discussed and justified. Otherwise, "intact" should be changed to "undamaged".

4. Page 2, "accurate representation of the physics in the system. ". It should be clarified that if models, assumptions and inputs appropriately consider all phenomena discussed in the ISG, then the accuracy requirement is satisfied. Without such a clarification, an applicant would be unable to demonstrate that this accuracy requirement is fulfilled.

5. Page 3, Paragraph starting "YAEC-1937 ...". Recommend removing "for each burnup range" after "proposed contents". It implies that axial profiles are established for more than one burnup range, which may or may not be the case.

6. Page 4, Section starting "In lieu of an explicit benchmarking ...". Traditionally, one additional purpose of benchmarking was to qualify the individual or organization performing the calculations. How is this achieved now? Note that this aspect may be specifically important for depletion codes, which are more specialized and not as widely used as Monte Carlo criticality codes.

7. Page 6, Section starting "For code systems other than ....". Since this bias is for a cross section uncertainty, and the relative reactivity effect should be the same for all high quality criticality codes using those cross sections, it is not clear why an increase is necessary. Further, the increase by factor 2 does not appear to have a solid basis, making its justification, other than referencing the ISG, difficult or impossible. Finally, given industries request for a code-independent solution, and the considerable effort that went into developing the NUREGs, it is not clear why this approach was taken. The ISG should therefore either endorse the 1.5% for all high quality codes using ENDF/B-V, VI, or VII cross sections; or

provide for an easy verification method that other codes results are equivalent to SCALE so they can use the 1.5%.

8. Page 2, Licensing Basis Model Assumptions, and Page 7, Misload Analyses. Experience has shown that the attempt to cover large fuel populations (e.g. "all 17x17 assemblies") can result in extremely conservative assumptions and results. More site specific evaluations, utilizing site specific axial profiles, core operating conditions, burnable poison usage, fuel inventories for misloading evaluations, etc., may result in more favorable loading curves. The ISG does not specifically exclude such site specific evaluations. However, the discussions on axial burnup profiles and even more the misloading evaluations, seem to focus on large fuel populations. The ISG should clarify that site specific calculations and loading curves are permissible.

9. Page 7, Misload Analyses. The bulleted list should be expanded to include the misload analyses expected on poison rods, burnable absorber and control rods discussed later in that section. It should also be clarified if single or multiple misloads are to be considered for those conditions.

10. Page 8, "assurance that there is no fresh fuel in the pool during system loading". Given the fact that fresh assemblies can be easily identified, the requirement seems unnecessary, and also operationally impractical.

11. Page 8, "minimum required soluble boron concentration in pool water during loading and unloading." It is unclear what the basis for the determination of the minimum soluble boron requirement is. Please clarify.

12. Page A-12, Horizontal Burnup Profiles. The discussion seems contradictory. It states "In large rail casks, the probability that underburned quadrants of multiple fuel assemblies will be oriented in such a way as to have a substantial impact of k-eff is not expected to be significant.", but then requests a bias for the effect to be applied.

13. Page A-14 through A-16, Depletion Analysis Computational Model: This section specifies some overly restrictive and presumably unnecessary requirements:

First Paragraph: The depletion code needs to be validated using the approach documented in NUREG/CR-7108, and isotopic correction factors or bias and bias uncertainty are derived from this. After this, the number of isotopes that are tracked in the code appears irrelevant, since any possible shortcomings of the code would be captured by the benchmarking, and only isotopes qualified through the benchmarking are used. Further, even without benchmarking, it is not clear how the number of isotopes can be an objective indication of the quality of the code.

Third Paragraph: Likewise, after determination of isotopic correction factors or bias and bias uncertainty, the question whether or not a code uses lumped fission products appears irrelevant, since again any shortcomings introduced by those lumped fission products would be captured in the isotopic correction factors or bias and bias uncertainty.

Further, the first sentence in Paragraph 4 appears questionable, and seems to be based on a very narrow definition of "accurate". In fact, two-dimensional depletion codes have been used successfully in the industry for a long time.

Overall, this section seems to present preferences of one code over others based on qualitative and subjective judgment. However, instead, the qualification of a depletion code should be based on the proposed benchmarking outlined in NUREG/CR-7108. This section should therefore be removed, or at a minimum reduced to the essential content.

14. Page A-16, "A uniform loading of SNF at a specified assembly-average burnup, initial enrichment, and cooling time should be used for each cask analysis.". It is not clear why only uniform loading should be used. It may be beneficial to qualify certain locations for assemblies different burnups or cooling times, to increase the overall population of fuel that can be loaded.