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SUNI Review Complete
Template=ADM-013
E-RIDS=ADM-03

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Comment (1)
Publication Date: 4/21/2022
Citation: 87 FR 23891

As of: 6/7/22 6:55 AM
Received: May 27, 2022
Status: Pending_Post
Tracking No. l3o-o1yr-qgvx
Comments Due: June 21, 2022
Submission Type: Web

Docket: NRC-2021-0179
Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Plants

Comment On: NRC-2021-0179-0001
Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors

Document: NRC-2021-0179-DRAFT-0004
Comment on FR Doc # 2022-08519

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General Comment

Section 2 of DG-1389, Attributes of an Acceptable Accident Source Term, describes an acceptable analytical procedure (within Appendix J) for calculating steady-state fission product release fractions. While this acceptable analytical procedure allows the use of plant-specific fuel designs and plant-specific bounding fuel rod power histories, it still appears to produce a composite worst-case set of steady-state release fractions. Appendix J (second paragraph, first page) states that the steady state fission product gap inventories calculated using this analytical approach will be significantly larger than realistic fuel rod source terms.

1. The defined composite worst-case approach introduces unnecessary conservatism. Applicants should be able to calculate burnup-dependent sets of radionuclide releases which more accurately reflect the physics. For example, an applicant should be allowed to postulate multiple FHA scenarios involving an incident with a 1st, 2nd, and 3rd burned fuel assembly. Each FHA scenario would employ a set of radionuclide release fractions representative of their burnup interval. This approach removes the non-physical, overly conservative aspects of assuming a single fuel assembly has a beginning-of-life Iodine-131 release fraction and end-of-life Krypton-85 release fraction.

2. The analytical procedure appears to model an imaginary worst single rod which operated on a bounding rod power history. Licensees use high fidelity lattice physics and reload depletion models capable of predicting individual fuel rod power for the upcoming cycle. Together with the “known” power operating history from past reload cycles, the complete power history for each fuel rod is understood.
a. Applicants should be able to calculate burnup-dependent release fractions for each fuel rod predicted to experience cladding failure during each DBA.
b. Applicants should be able to use the actual fuel rod power history and peaking factor to calculate the quantity of radionuclides (i.e., moles of gas) for each fuel rod predicted to experience cladding failure during each DBA.
c. Applicants should be able to combine these individual releases to determine the RCS coolant activity (or release during a FHA outside reactor).

3. Many of the conservative analytical techniques of combining worst-case parameters to achieve a composite worst-case result date back to a time when computers were limited and expensive. Modern computation methods allow more rigorous engineering. The composite worst-case fuel rod is overly conservative. And this approach become even more non-physical when the DBA involves larger quantities of fuel rods where the assumption is that every failed fuel rod is the worst fuel rod operated at the TS/COLR peaking factor. Even for a FHA involving damage to a single fuel assembly, there is a distribution of power histories and thus differences in radionuclide quantities and release fractions. For DBAs involving larger populations of damaged fuel rods (e.g., PWR RCP locked rotor), this simplified approach is even more non-physical and introduces unnecessary conservatism.
a. Given the capability to predict both burnup-dependent release fractions and quantities for each radionuclide for each failed fuel rod, applicants should be able to employ more explicit predictions (e.g., weighted average release) when determining RCS activity (or release during a FHA outside reactor).
b. Knowledge of burnup-dependent fuel rod power distributions throughout the core are already part of the plant's licensing basis and is used to predict the number of rods which experience boiling crisis (e.g., DNB) during DBAs. Applicants should be able to use this same information to predict the releases from those same failed fuel rods.

4. Section J-3 of the analytical procedure describes the application of uncertainties to achieve an upper tolerance value.
a. Section J-3.2 states that the model uncertainties may be applied either deterministically or statistically when calculating long-lived radionuclide release fractions. I agree that the applicant should have this option, especially when considering releases from multiple fuel rods.
b. Section J-3.1 identifies that the 2011 ANS-5.4 standard recommends a deterministic multiplier of 5.0 on the best-estimate predictions for short-lived isotopes. It seems odd that NRC has defined such a detailed analytical procedure with all of these attributes, yet the results of these explicit calculations are multiplied by a factor of 5.0. The NRC should define an uncertainty distribution (e.g., mean, std. dev.) for this term so that it may also be sampled.