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From: Amy Cubbage NRR
To: Flack, John; Rubin, Stuart RES
Date: Tue, Mar 26, 2002 4:04 PM
Subject: fuel design RAIs

Stu - Fuel design RAIs attached from SRXB. These questions have been reviewed by Ralph Caruso.

Amy

>>> Stuart Rubin 03/26/02 03:36PM >>> RES
The RAIs for the attached white paper review areas are due to Farouk by March 29, 2002. The lead RES staffer for each area should have been coordinating with his/her NRR/NMSS staff counterparts for each white paper. (But I don't have a good feeling that this was being done in all cases.)

Amy Cubbage promised me today that NRR would provide their input on time.

We need to start formally assigning work like Amy does in NRR.. This management control system enhancement is on Peggy's "to do list."

Stu

CC: Bennett, Margaret; Caruso, Ralph; Lu, Shanlai; Orechwa, Yuri; Shoop, Undine; Wilson, Jerry

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From: Yuri Orechwa > NRR
To: Amy Cubbage
Date: Tue, Mar 26, 2002 3:50 PM
Subject: Fuels RAI

Amy,

Attached are Undine's and my questions.

Yuri

CC: Ralph Caruso; Shanlai Lu; Undine Shoop

RAI on PBMR Nuclear Fuel

prepared by NRR/DSSA

1. What are the deformation limits of the porous carbon layer? What is the maximum stress that the porous carbon layer can withstand and still maintain integrity? What delta in size of the particle does this correlate too? Please provide the same information for the other three coating layers.

2. What mechanisms can defeat the particle coating layers causing a loss of integrity? Individually and collectively?

3. It is mentioned that the fuel pebbles are carbonized. How does this process differ from graphitization? Please explain how you carbonize the fuel pebbles and provide the physical properties and characteristics of this carbonized fuel pebble. Also, please quantify the property and characteristic differences between carbonized and graphitized material.

4. It was previously stated that the fuel kernel needs to be perfectly centered in the particle or else the kernel will migrate out of the particle. Therefore, what stresses are introduced on the particle during the formation of the fuel pebble? What is the impact on fuel particle deformation and subsequent fuel kernel migration?

5. It is discussed that the graphite powder contains a mixture of two separate graphite powders. What properties do each of the powders contribute to the mixture and final product and why was this proportion of the two powders chosen?

6. Please provide additional information of the how the over coating in the "sweetie barrel" takes place.

7. It has been mentioned that the fuel particles maintain integrity up to 1600 degrees C. During the fuel pebble annealing process, the temperature approaches 2000 degrees C. Please describe how the annealing process is performed while maintaining fuel particle integrity.

8. Figure 5 demonstrates data based on burnup and fast neutron fluence. Please provide the correlation between the data, including the uncertainty analysis. Also, provide a justification for why the temperature and other parameters (including the difference in the number of fuel particles per pebble) can be excluded from consideration. Please also provide additional information on the HFR tests used in creating the correlation.

9. One of the SiC layer tests showed some degradation of the layer following 500 hours at 1600 degrees C. Please justify why the conclusions section mentioned that damage would only occur after long periods of time (>500 hours) based on the results of one test. Also justify the statistical significance of the database used for this conclusion.

10. Any conclusion that is supported by a database needs to justify why other parameters were

considered insignificant of unimportant in the uncertainty analysis.

11.Information is provided for failed particle fractions that were determined for HTR-module. Is PBMR proposing to use the same values and/or use the same methods for determining the values?

12. What is the final conclusion of the Phase I tests in relation to PBMR? It is not clearly stated nor directly supported in the paper. Please clarify.

13. What is the distribution of the stress on the SiC layer as a function of temperature and fluence assumed in estimating of the failure probability of the SiC layer?

14. Over the residence time of the fuel in the core, how much local cyclic fluctuation in the fuel temperature is there? Has this any effect on the prediction of the fuel failure probability?

15. How will the German fuel performance data be combined statistically with PBMR fuel testing to arrive at the probabilistic PBMR fuel performance measures.

16. Since it is unavoidable that a certain number of pyrolitic carbon coatings will not be round, and which in addition with irradiation by fast neutrons causes further anisotropic structural changes in the particles, what is the contribution to the failure probability of the production tolerance with regard to particle roundness?