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**From:** Stuart Rubin R&S
**To:** Anthony Ulses RES
**Date:** Mon, Apr 15, 2002 9:45 AM
**Subject:** RAIS on PBMR Analytical Codes and Software Control - Fuel Analysis

Tony:

Attached are the RAIs for the "Fuel Analysis" analytical codes discussed in Exelon White Paper # 5 "PBMR Analytical (Computer) Codes Data Table"

Please merge the attached RAIs into the integrated set of RAIs for White Paper # 5.

Thanks.

Stu

**CC:** Donald Carlson; Farouk Eltawila; John Flack; Ralph Caruso; Ralph Meyer; Steven Arndt; Undine Shoop; Yuri Orechwa

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Request for Additional Information for Exelon PBMR White Paper:
PBMR Analytical (Computer) Codes Data Table
(Fuel Analysis)

Exelon Request: NRC to identify specific list of codes and models that are needed from PBMR to become familiar with and be ready for an application.

1. Codes that are needed from PBMR for the NRC to become familiar with and be ready for an application: PANAMA, FRESCO

2. Models (used by the above codes) that are needed from PBMR for the NRC to become familiar with and be ready for an application.

   PANAMA

   Models for calculating stress on the SiC layershell
   Models for determining tensile strength of SiC layer

   FRESCO

   Model(s) for release of FPs into the kernel
   Model(s) for diffusion of FPs through the kernel to its surface
   Model(s) for diffusion of FPs through each coating of the particle (IPyC, SiC, OPyC)
   Model(s) for diffusion of FPs through the graphite matrix

NRC Request for Additional Information (RAIs)

Significant Pre-Application Review Issues:

PANAMA:

5.1.1 Discuss how the code predictions will be used for calculating failed particle fraction in PBMR fuel elements in the PBMR licensing safety analysis in comparison with the failed particle fractions that can be provided for the PBMR licensing safety analysis by the statistical analysis of the PBMR fuel irradiation test program particle failures.

5.1.2 Discuss how, if at all, the code will be used (vis-a-vis PBMR fuel irradiation test program data) for determining PBMR fuel-related limiting conditions for operation, safety limits and input to the accident source term.

5.1.3 Discuss how will the mechanistic failure models of the code will be verified or adjusted, if at all, based on the PBMR fuel irradiation testing experimental data, including the specific conditions (e.g., irradiation temperature) of these tests.

5.1.4 Discuss how the mechanistic failure models of the code will be verified or adjusted based on the PBMR fuel heat-up testing experimental data. What heating test data that were (and/or will) used for particle failures from internal gas pressure

5.1.5 Cite and discuss and any other sources of experimental data that are used to establish the mechanistic failure models. Discuss the applicability of this data to the PBMR fuel.

5.1.6 Discuss the quality assurance procedures that were or will be used in the experiments that provide the data used to establish the mechanistic failure models.

FRESCO:

5.1.7 Discuss the experimental data basis that is used for developing and/or validating the models (i.e., for intact coated particles, for failed coated particles, for fuel elements). Discuss the PBMR fuel coated particle and PBMR fuel element test data that will be used for developing and/or validating these models.

5.1.8 Diffusion through the graphite matrix is a significant factor in the release of metallic FPs. German fuel irradiation and post-irradiation heat-up tests had how that matrix graphite diffusion coefficients for metallic FPs for normal operation and accident temperature conditions can differ by an order of magnitude or more, depending on the graphite used. In this regard the original petroleum coke source that was used to make the German fuel matrix graphite is no longer available for making the matrix graphite for the PBMR production fuel. Accordingly, the PBMR production fuel matrix graphite will be different from that used in the German fuel (i.e., tests). Discuss any plans for developing or validating the PBMR fuel matrix graphite diffusion coefficients for use in the metallic FP release calculations.

Significant License Application Review RAIs and Issues

PANAMA and FRESCO:

5.2.1 PANAMA and FRESCO and related method applications will need to conform to the guidance provided in DG-1096 and SRP 15.0.2. This includes providing the source code in electronic form for all code reviews.

5.2.2 Discuss how the temperature and power cycling associated with multipass pebble fuel cycling and is treated in modeling and calculating FP diffusion and FP release in FRESCO.

5.1.3 Discuss the key assumptions and boundary conditions (e.g., BU, accident temperature, FP concentration at the outer surfaces of layers and pebble graphite matrix) for conservative mechanistic calculation of integrated core-wide FP release based on FP diffusion and release from fuel in using FRESCO.

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