From: Yuri Orechwa
To: Amy Cubbage
Date: Wednesday, January 09, 2002 11:54AM
Subject: PBMR Chemical Attack White Paper RAIs

NRR

Amy,

Attached is my contribution to the RAIs with regard to Excelon's White Paper on chemical attack in the PBMR.

Yuri

CC: Frank Akstulewicz; Gary Holahan; Jared Wermiel; Ralph Caruso; Undine Shoop

B-27

Request For Additional Information with regard to "Control of Chemical Attack in the PBMR Presentation to USNRC In Support of PBMR Pre-application Activities"

In the subject presentation the claim is made that the PBMR design constrains the external dose to below 100 µS/hr. This claim is supported by two arguments:

A. The PBMR design is sufficiently different to preclude the events that have lead to chemical attack of graphite in the past in operating reactors. Such as:

i) Water ingress experienced by AVR and Fort St. Vrain

ii) Air ingress experienced at Windscale and Chernobyl

B. The PBMR design has taken account of the potential problem of water or air ingress through operating procedures and design features:

i) Water ingress is limited by operating procedures such as ensuring that the water circuits are not activated until the gas pressure exceeds the water pressure by a suitable margin.

ii) Air ingress in the case of small pipe breaks is limited physical considerations and result in a maximum corrosion fraction of 0.00005 of the graphite content of the RPV; for medium breaks both physical considerations and operator procedures result in a maximum corrosion fraction of 0.002 of the graphite content of the RPV; for large breaks, beyond the design basis, the assumption that the total inventory of air in the reactor building passes through the reactor results in the oxidation of < 0.01 of the graphite content of the RPV.

The first argument (A), based on a comparison with other reactor designs, is peripheral to the issue.

The second argument (B) is based on integral values of the maximum corrosion fraction, which are difficult to assess in light of the fact that corrosion is a local phenomenon depended on the local environment of the graphite. Moreover, the validity of the quoted estimated corrosion fractions is impossible to judge without a description and validation of the basic corrosion models which quantify the *potential* for corrosion over the parameter space of interest.

Thus, to judge the results of the subject report, we request the following additional information:

1. Identify the gas/graphite reactions germane to the air and water ingress analyses of PBMR.

2. Rank them in order of importance (high, medium, low) and identify those deemed sufficiently important to include in the analyses and those that were not and why.

3. Identify (if any) catalysts for the reactions used in the analyses.

4. Give the mathematical description of the models used to compute the oxidation rates. In particular:

a) How do you model the low temperature regimes, where reaction rates are slow and the oxygen can penetrate the graphite in depth, thereby, reducing strength without an apparent change in geometry.

b) Similarly, how do you model the high temperature regimes where chemical reactivity is high and all oxygen penetrating the laminar sublayer of the gas flowing past the hot graphite surface reacts immediately at the surface. Here the geometry of the graphite changes without damaging the material in depth.

5. Discuss the validation of the correlations and the uncertainty associated with the prediction over the parameters of interest in the PBMR.

6. Give the sensitivity of the prediction to the environmental variables in the correlation.

7. How do these issues (3, 4, 5, 6) differ with respect to grades of graphite used in the PBMR design.

8. Where in the PBMR do the highest reaction rates take place during steady state operation assuming the nominal design basis trace concentrations of reactive materials. At those locations give the graphite loss rate, the temperatures, the total graphite loss over the reactor residence time of the graphite, and the gas concentrations at those locations.

9. Where in the PBMR do the maximum reaction rates take place during the design basis transients that result in water or air ingress and were assumed in the subject presentation. At those locations, as a function of time over the duration of the transient, give the graphite loss rate, the temperatures, the total graphite loss, and the gas concentrations.

10. For the beyond the design basis case in the subject presentation give as a function of core height and function of time the radial core-average values for the graphite loss rate, the fuel element temperature, the total graphite loss, and the gas concentrations.

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Subject:	PBMR Chemical Attack White Paper RAIs
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