May 25, 2001

Mr. Kevin F. Borton, Manager Licensing
Exelon Generation
300 Exelon Way
KSB3-S
Kennett Square, PA 19348

Dear Mr. Borton:

The purpose of this letter is to confirm our telephone discussion on May 21, 2001. This discussion addressed the agenda and content for the next public meeting between the Exelon and the NRC staff on the pre-application review of the Pebble Bed Modular Reactor (PBMR). The next meeting is scheduled for June 12-13, 2001, at NRC Headquarters in Rockville MD.

A significant discussion topic for the June meeting is the PBMR fuel. The scope of the NRC's pre-application review, as it relates to the PBMR fuel, involves assessing the plans and basis for establishing its performance and qualification. The goal of these discussions is to reach a common understanding during the pre-application phase of what has been done and what will still need to be done (after the pre-application phase) to demonstrate acceptable PBMR fuel performance over the life of the fuel and over the life of a plant. In this regard the breadth and depth of the information Exelon provides over the course of the pre-application review on this subject should be sufficient to enable the NRC to understand: the design of the PBMR fuel and the basis for its design; the fabrication and quality assurance plans for the PBMR production fuel and; the experience, experimental, analytical and testing bases for PBMR fuel performance. To achieve these outcomes our telephone discussion provided a series of questions related to the above that we believe should be the focus of our pre-application interactions on PBMR fuel. The enclosure to this letter provides a summary of the questions. I hope that these will assist in preparing for the discussions on PBMR fuel, beginning with the June meeting.

If you or your staff have any questions or require additional information please do not hesitate to contact either me (301-415-5790) or Stuart Rubin (301-415-7480).

Sincerely,

/RA/
Thomas L. King, Director
Division of Risk Analysis & Applications
Office of Nuclear Regulatory Research

Project No. 713
Enclosure: As stated (See previous concurrence)
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Enclosure

Pebble Bed Modular Reactor
Fuel Performance and Qualification

Fuel Design and Analysis

Discuss (and compare to the PBMR fuel) the design, design characteristics and safety-performance acceptance criteria of the reference pebble fuel design on which the PBMR fuel design is based.

To the extent that there are differences between the reference design characteristics and the PBMR design characteristics discuss these differences and the technical basis and safety impact for these differences.

Discuss the Licensing Basis Events (normal operation, anticipated operational occurrences, design basis events, severe accidents, and emergency planning basis events) for which fuel performance is to be analyzed in the safety analysis. Discuss the significant operating conditions (e.g., fluence or fuel burn-up level, fuel temperature, chemical loadings such as oxidation) and any fuel-related safety-performance acceptance criteria that are associated with these events. Discuss whether or not fuel safety performance/failure will be analyzed for events such as air intrusion, moisture or water intrusion. If not, explain why.

Discuss the analytical codes and methods and associated empirical data that will be used to predict coated particle fuel performance and fuel failure during normal operation and licensing basis events (e.g., heat-up, reactivity insertion, air intrusion, steam intrusion, water intrusion, rapid oxidation). Discuss the fuel failure mechanisms that are modeled and the empirical data or test data upon which these codes, methods and models are benchmarked/based. Discuss the key fuel design, fuel fabrication and in-reactor environmental parameters that are accounted for in the fuel failure models.

Describe the plans or actions already taken to validate and verify the fuel design-analysis codes, models, and methods, including any comparisons with the results of PBMR fuel irradiation experience and tests.

Describe the plans and/or actions already taken to determine the ranges of fuel temperatures and fuel-temperature durations (i.e., time at temperature) expected during normal operation of the PBMR. Evaluate and discuss the effects on fuel temperature and fuel performance of in-core hot spots, such as those indicated by the higher-than-expected maximum coolant temperatures (>1280 °C) seen in the results of monitor-pebble tests at the Arbeitsgemeinschaft Versuchsreaktor (AVR).

Fuel Fabrication

Discuss the reference PBMR fuel particle/pebble fabrication process and its relation (if any) to previously used particle/pebble fuel fabrication processes of other fuel designers/fabricators. Discuss the plans for ensuring equivalency with any reference fabrication process including replicating the process equipment and process controls that will be used to manufacture the PBMR fuel. Identify any areas where important differences might occur by intent or due to lack information. Describe any differences in the specific materials used to make the particle coatings.

Define fuel "defect rate" as it will be used for the PBMR fuel manufacturing process. Identify the defect rate limit specification for the manufacturing process and the expected/target defect rate for PBMR production fuel. Discuss the limits and target in relation to the defect rate experience of previous pebble fuel production facilities.

Discuss the characterization/measurement techniques and statistical analysis methods that will be used to determine the actual manufacturing defect rate for the coated particle fuel and pebbles during the manufacturing process.

Discuss the qualification program plans for the fabrication of the PBMR coated particle fuel and pebbles.

Fuel Performance During Normal Operation

Describe the in-reactor fuel/core monitoring instruments and analysis methods that will be used to monitor fuel integrity and verify that the fuel operating conditions are maintained within the specified design envelop for temperature, power level, coolant purity, chemistry, etc.

Describe the ex-reactor fuel handling system equipment and methods that will be used to ensure that fuel integrity limits and burn-up limits are not exceeded. Describe the fuel management methods that will be used to ensure that the fuel burnup limit is not exceeded for high burnup fuel selected for a final pass through the core.

Discuss the design-analysis methods and operational-analysis methods that will be used to determine the total in-reactor irradiation-induced defective particles during the PBMR fuel operating cycle, up to and including EOL.

Discuss the test data or analysis of the fuel pebble movement through the core which ensures PBMR fuel pebbles and graphite pebbles will maintain an annular geometry and move through the core as desired.

Prior Fuel Operating and Test Experience

For TRISO particle pebble fuel design and manufacture on which PBMR fuel design and fabrication are based:

Describe the previous irradiation and testing experience on the reference design. Compare the fuel design and the irradiation test conditions to the PBMR fuel design and the PBMR conditions for normal operation, design basis transients and accidents, and events beyond the

design basis. Explain the failure mechanisms that were identified by these irradiation and testing experience and the fuel performance during the experiments.

Discuss the tests or experiments that have been conducted to assess the chemical interaction characteristics of irradiated pebbles when exposed to air, steam, or water at high temperatures.

Discuss the Irradiation testing and post-irradiation testing that provides the basis for the fission product release source term used in for design basis events and accidents beyond the design basis.

Ongoing and Future plans for PBMR Fuel Operating and Test Experience

Describe your plans (if any) to repeat or supplement previous irradiation operating experience and testing experience for PBMR pre-production prototype fuel, including tests or experiments to assess the chemical interaction characteristics of the pebble fuel when exposed to air, steam, or water at high temperatures and irradiation testing and post-irradiation testing that provides the basis for the fission product release source term used in for design-basis events and beyond the design-basis accidents. Describe your plans for irradiation proof testing and post-irradiation design-basis event simulation proof testing of production PBMR fuel (1) in advance of initial fuel loading in the PBMR demonstration reactor (2) in a PBMR demonstration reactor and (3) periodically, to assure fuel quality performance over the life of the fuel and over the life of the plant.

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