June 3, 2002

MEMORANDUM TO: Farouk Eltawila, Director
Division of Systems Analysis and Regulatory Effectiveness
Office of Nuclear Regulatory Research

FROM: John H. Flack, Chief ***/RA/***
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Division of Systems Analysis and Regulatory Effectiveness
Office of Nuclear Regulatory Research

SUBJECT: MEETING WITH EXELON GENERATION COMPANY, DEPARTMENT OF ENERGY, AND OTHER INTERESTED STAKEHOLDERS REGARDING THE PEBBLE BED MODULAR REACTOR (PROJECT 713), EARLY SITE PERMIT PROCESS AND FUEL QUALIFICATION TEST PROGRAM

On March 28, 2002, the Nuclear Regulatory Commission (NRC) staff met with representatives of the Exelon Generation Company (Exelon), the Department of Energy (DOE), and other interested stakeholders to discuss the pebble bed modular reactor (PBMR) preapplication review initiatives. This was the 10th meeting held to discuss preapplication activities related to the PBMR. Attachment 1 is the agenda. Attachment 2 is a list of the attendees. Attachment 3 is a copy of NRR presentation slides concerning "Early Site Permit Activities". Attachment 4 is a copy of slides used by Exelon for the "Pebble Bed Modular Reactor Fuel Qualification Test Program" presentation. Attachment 5 is the March 18, 2002, Working Draft paper on the "Pebble Bed Modular Reactor - PBMR - Fuel Qualification Test Program," that was available to attendees.

Stuart Rubin (NRC) opened the meeting by stating the purpose was to discuss preapplication activities of the PBMR, including Early Site Permit (ESP) activities and the fuel qualification test program being developed. He stated that important licensing issues include licensing basis events, fuel fabrication and qualification, and the containment functional design, and that the NRC staff output will be significant safety issues, Commission policy issues, and guidance to Exelon on resolving these issues. In his opening remarks, Kevin Borton of Exelon noted that representatives from Exelon and PBMR would be taking part in the Exelon presentation.

The following summarizes the subsequent presentations:

Early Site Permit Activities

Jack Cushing (NRC) made a presentation of early site permit activities, as outlined in Attachment 3. Edwin Fox (NRC) noted that a memorandum of understanding (MOU) between NRC and the Federal Emergency Management Agency (FEMA) had been noticed in FRN 47996, and he distributed copies of NUREG-0654, Rev. 1, Supp. 2, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of

Nuclear Power Plants, Criteria for Emergency Planning in an Early Site Permit Application, Draft Report for Comment," April 1996. Jack Cushing noted that NRC would follow NUREG-1555 in developing an environmental impact statement (EIS), and would obtain assistance from the National Labs.

Any draft EIS will be published for comment to the Public, Industry, Government Agencies, and other interested stakeholders. All parties will be required to provide comments concurrently during the comment period.

PBMR Fuel Qualification Test Program

Exelon presenters used Attachment 4 as a framework for their presentation concerning the PBMR fuel qualification test program. The presentation was made with periodic breaks for questions from the audience.

Fuel Testing and Licensing

Peter Pagano (Exelon) described Exelon's proposed approach to fuel testing and licensing. Points made during this initial portion of the presentation were that Exelon believes that (1) there is a large body of data available on fuel that has essentially the same design as that proposed for use in the PBMR, (2) the PBMR test program will be confirmatory in nature with test results used to show production fuel complies with "PBMR Licensing Basis Performance Requirements," (3) test results are not required for approval of a COL (combined construction and operating license), although "some early results may be relevant," and (4) manufacture of the initial core load could be completed prior to completion of the test program.

NRC staff responded with questions regarding (1) testing necessary to qualify the proposed PBMR design before a license could be issued, (2) applicability of data on AVR (former German HTGR) fuel in qualifying the fuel proposed for the PBMR, (3) relevance of data from the testing of fuel other than that proposed for the PBMR, if the fuel was different (e.g., enrichment and fuel loading) or would be exposed to different operating conditions, and (4) the need to identify the licensing basis events.

R. Krich said the PRA (probabilistic risk assessment) is being developed and that the PRA and peer review would address emergency planning basis events, that is, beyond design basis events. He also stated that the proposed PBMR will have a containment, but the containment leakage characteristics will be different from that of existing LWR (light water reactor) containments. John Flack (NRC) noted that there is a future meeting planned for containment/confinement.

Production of PBMR Fuel

Peter Pagano continued the presentation with material on the production of PBMR fuel. The main point was that the TRISO fuel proposed for the PBMR was essentially the same as the German AVR 21-2 fuel, on which data was available.

NRC staff responded with questions regarding (1) parameters to be monitored and fed back into the fuel fabrication process, (2) the basis for selecting pebbles for testing considering the possible variability of batches, (3) if pebbles will be selected randomly for testing after production has reached equilibrium, what is the specification for the point at which equilibrium

has been reached, (4) if AVR 21-2 is the reference fuel that PBMR plans to produce, how are data on other fuels relevant, if they have different distributions of parameters and properties, and (5) if tests were performed on a defect rate, how would they be designed to reflect normal operating and accident conditions.

J. Venter stated that coated particle design does not change, although enrichment and other things might. R. Krich added that they want to test to confirm that the proposed fuel behaves the same as fuel tested previously.

When asked when the NRC will get to consider the characteristics of the final fuel design, which is now proprietary, R. Krich replied that it will be some time later this year. When NRC staff noted the is a need to know the key process variables, J. Venter replied that it is at the basic design development stage. Staff noted the test fuel should meet the final fuel specifications.

Supporting International Data

P. Pagano continued the presentation with material on supporting international data. The main point was that much data is available on UO_2 TRISO fuel similar to that proposed for the PBMR, much of which is documented in IAEA-TECDOC-978, "Fuel Performance and Fission Product Behavior in Gas-Cooled Reactors".

When J. Venter stated that no problems had been experienced for the 81-88 TRISO group of fuel, called "low enriched TRISO" with 8-16% enrichment, NRC staff asked whether testing had been done of pebbles with the same proposed number of coated particles, and how the key parameters varied with changes in conditions. J. Venter said that you are really testing the coated design, and that all TRISO family fuel is similar in that they use the German fuel design. When asked why there was no mention of results from US experience, J. Venter replied that the US fuel was not the same and produced bad results. NRC staff noted the US data would be useful because it shows possible fuel behavior.

When NRC staff asked whether data was available for operation under conditions similar to load following (mode of plant operation in which power is cyclically increased and decreased to satisfy changing load conditions in a pattern that might be repeated, e.g., on a daily basis), R. Krich stated there is no plan to have load following in the licensing basis. J. Venter noted that load can followed simply by changing the helium mass flow.

NRC staff continued with questions regarding (1) whether the test reactor data was representative, as the IAEA report showed higher particle failures that did not seem to show up in the test reactor results, (2) how testing will be done to simulate temperature transients similar to that for accident conditions for the PBMR, (3) the maximum temperatures that will occur in the PBMR, the technical basis for the maximum temperature, and how we know they will be as expected (Venter replied that no one knows what the highest temperature will be), and (4) since most testing has been out-of-pile heatup testing, how would you show in-pile heatup would be the same in an accident?

J. Venter said you can cycle in a test reactor by changing temperature, but that it was difficult to change temperature smoothly. He added that in 45 hours, you could cause a change similar to that for an accident, but if you want to test, you should test realistically.

NRC staff continued with questions regarding (1) the reasons for the fuel specifications, (2) computer codes that will be submitted for the proposed design, in order to get approval for the test program, (3) source terms for the spectrum from normal to accident conditions, and for conditions like air ingress. J. Flack noted that questions about the codes could be included in an RAI (request for additional information). When R. Krich said they do not expect significant air or moisture ingress, J. Flack emphasized that the NRC needs to know about air and moisture ingress.

Fuel Qualification Testing, Overview, Fuel Failure Mechanisms, Key Parameters, Testing Considerations, and Statistical Considerations

P. Pagano continued the presentation with material on fuel qualification testing, fuel failure mechanisms, and testing and statistical considerations. In the Overview section, P. Pagano noted that "safety (heatup) testing" would be performed at 1600° C. (degrees centigrade), and limited testing above this.

NRC staff responded with questions regarding (1) how data from this testing will compare with model validation data for the source term, (2) plans to model diffusion coefficients in graphite, considering the graphite matrix material can cause an order of magnitude difference in the diffusion coefficients, (3) whether fuel performance can be related to operating data, or whether fuel failures will be latent, that is, failure prone fuel will not exhibit failures until an accident occurs, (4) PBMR data that will be used to indicate weakened fuel, and (5) the method that will be used to determine why a particular batch of fuel exhibited a higher failure rate than expected. NRC staff recommended they consider draft Regulatory Guide DG-1096 (Transient and Accident Analysis Methods) for methods to quantify uncertainty, when developing experiments, and that this be done both for normal operations and transients.

When P. Pagano stated that "large air or water ingress and large reactivity insertion events are low probability events," NRC staff asked for a definition of "large," and Pagano replied that large was something that would significantly damage the fuel. Pagano added that Exelon did not feel these were licensing basis events and therefore did not plan to do testing for this.

Fuel Irradiation and Fuel Safety Testing, Post Irradiation Exams, and Review of Objectives

P. Pagano continued the presentation with material on fuel irradiation and fuel safety testing, and post irradiation exams. He then reviewed the objectives.

NRC staff said there was a need to understand where fuel begins to fail and how much margin there is before failure. R. Krich said that the behavior of the fuel is well known and there is no need to take the fuel to the failure point, because they already know they will not get to that point during operation.

NRC staff observed that testing at 1600° C. + 100° C., say "hot plus 100 degrees," was something, but what if you start with a larger "hot"? It was also noted that information was needed on the ALARA issue, that is, what will be the expected doses to workers.

Meeting Concluded

Edwin Lyman (Nuclear Control Institute) stated it was a mistake to think the proposed project (1) did not need a containment [with design similar to that required for existing light water

reactors], and (2) did not need full testing to prove the fuel would perform as predicted. Another comment made was that HTGR particles with identical manufacturing backgrounds performed differently.

S. Rubin noted that there was a future meeting planned specifically for containment/confinement issues. S. Rubin thanked the meeting participants and attendees. He noted that the RAIs are due in early May. He also noted that while this was not an application stage, the white papers should be revised and supplemented to resolve the things that came up at this meeting.

Attachments: As stated

cc w/o atts: See attached list

Memorandum dated:

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cc w/o atts: See attached list

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AGENDA

NRC Meeting with Exelon and DOE on the PBMR
March 28, 2002, 9:00 AM - 2:00 PM;
ASLBP Hearing Room T3B45

9:00-9:15 AM	Introductory Remarks (Stuart Rubin)	NRC
9:15-9:30 AM	Early Site Permit Application (Jack Cushing)	NRC
9:30-10:45 AM	PBMR Fuel Qualification Test Program (Peter Pagano)	Exelon
11:45-11:00 AM	Break	
11:00-12:00 AM	PBMR Fuel Qualification Test Program (Peter Pagano)	Exelon
12:00-1:00 PM	Lunch	
1:00-1:45 PM	PBMR Fuel Qualification Test Program (continued as needed)	Exelon
1:45-2:00 PM	Stakeholder Comments	
2:00-2:15 PM	Closing Comments	NRC/Exelon

NRC/EXELON/DOE MEETING ATTENDANCE LIST
MARCH 28, 2002

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