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Exelon Generation

NRC Project No. 713

November 15, 2001

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Subject: Response to NRC Letter dated September 26, 2001 Regarding the Pebble Bed Modular Reactor Technical Information Availability

Reference: September 26, 2001 NRC Letter from Thomas L. King, Director-Division of Systems Analysis and Regulatory Effectiveness to James Muntz, Vice President Nuclear Projects – Exelon Generation

Enclosed is the Exelon Generation Company (EGC), LLC response to the NRC request contained in the referenced September 26, 2001 letter. Specifically, this letter provides our assessment of whether or not the Pebble Bed Modular Reactor (PBMR) technical information identified by the NRC staff can be provided by December 2001, and if not, what would be alternate schedules.

The PBMR design has progressed from a conceptual design to its current level, known as the basic design phase, but has not reached final detailed design. Although the overall detailed design phase has been delayed in order to resolve a few key technical issues, the design is expected to make significant progress in 2002 and near completion during 2003. Therefore, given the current status and plans for the design, the enclosed response to your request itemizes what information can be provided regarding each identified issue, typically from both a near term and longer term perspective. We note, however, that this information is subject to change as the design process proceeds. Accordingly, we intend to notify the NRC of significant changes during the course of the pre-application interactions.

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Rec'd at NRC/DCD
12/17/01

We are available to discuss the information in the enclosure at your request. Please contact me, or R.M. Krich if you have any questions.

Sincerely,

James A. Muntz
Vice President, Nuclear Projects

Enclosure: Responses to Requests from September 26, 2001 NRC Letter

cc: Thomas King, Office of Nuclear Reactor Research
John Flack, Office of Nuclear Reactor Research
James Lyons, Office of Nuclear Reactor Regulation
Stuart Rubin, Office of Nuclear Reactor Research

Enclosure

Response to NRC Letter dated September 26, 2001 Regarding the Pebble Bed Modular Reactor Technical Information

This enclosure contains estimated dates when the information identified in the September 26, 2001 NRC letter from Mr. Tom King can be provided to the NRC. For convenience, the specific NRC requests are repeated here, with Exelon Generation Company's (EGC's) responses immediately below. Given the current status of the Pebble Bed Modular Reactor (PBMR) design and design development plans, the estimated response dates are presented in terms of near term and longer term dates. Note that these estimates are best judgments, based on current design status and design development plans, and are subject to change.

A) PBMR Design Basis

Issue 1: What are the events the PBMR will be designed for?

Information needed: Description of the off-normal events for which the PBMR is to be designed, the approach and criteria for their selection, their acceptance criteria, and the role of probabilistic risk assessment in the design and safety assessment. (It is recognized that on August 31, 2001, Exelon submitted a document describing their proposed approach and criteria for selecting events to be considered in the design).

Response:

Near Term: A preliminary description of licensing basis events (LBEs), and a discussion of the methodology that was used to identify these events, including the acceptance criteria and the role of probabilistic risk assessment (PRA), can be provided by January 31, 2002. At this stage, the list will be limited to at-power events, and will not include external events.

Longer Term: A complete description of LBEs and the updated basis for their selection is expected to be available by August 2003, following the upgrade of the PBMR PRA.

Issue 2: What systems, structures, and components will be considered "safety grade" and what requirements will be imposed as a result of this classification?

Information needed: List of "safety grade" structures, systems, and components (SSCs), how they were selected, and their key requirements (e.g., seismic, quality assurance (QA), environmental qualification (EQ), etc.)

Response:

Near Term: A brief description of the classification system currently in use at PBMR, the plans to transition to a risk-informed classification system, as well as a preliminary listing of safety grade SSCs, including their key requirements can be provided by February, 2002.

Longer Term: A complete list of safety grade SSCs, how they were selected and the associated qualification requirements will be available with the final design, and submitted as part of the combined license (COL) application. This will reflect the risk-informed approach described in our letter dated August 31, 2001, which contained our proposed licensing approach.

Issue 3: What is the basis for the source terms assumed in safety analysis?

Information needed: A description of the source terms used in the safety analysis (quantity, chemical form, and timing of release) and their technical bases for:

- normal operation, including anticipated operational occurrences
- design basis accidents, including any air and moisture ingress
- beyond design basis accidents, including air and moisture ingress

The contributions from graphite, graphite dust and its impurities should be included as well as fission products.

Response:

Near Term: A preliminary description of the source terms used in the safety analysis, the technical bases for normal and off-normal operations based on the reactor building design at that time, and an assessment of the sensitivity of the radioactive material release calculations to the building design can be provided by October, 2002.

Longer Term: A complete description, addressing all the aspects specified in the "information needed" section above, can be provided by September, 2003.

Issue 4: What are the automated control features of the PBMR, including staffing plans and control room design features?

Information needed: Describe plans, requirements, and design criteria (e.g., standards) for safety-related PBMR I&C systems. Describe staffing plans, including how many control room operators and the control room layout, as well as the overall strategy for operation (i.e., role of the operator in normal and off-normal events)

Response:

Near Term: A description of PBMR safety-related instrumentation and control (I&C) equipment, including design requirements and criteria, will be available by end of February 2002.

Longer Term: Fully developed control room layout and staffing plans, including a description of human-machine interface and the role of the operator during normal and off-normal events will be available for the demonstration plant by end of 2002; preliminary information will also be available for a multi-module plant by this time, also.

More fully developed information for the multi-module control room layout, addressing the points in the "information needed" section above, will be available by July 2003.

B) PBMR Fuel

Issue 1: What will be done to demonstrate that the PBMR production fuel will have sufficient integrity and fission product retention capability to meet project goals for limiting initial defects, and achieving the desired irradiation performance and behavior under normal and accident conditions?

Information needed: A description of the in-reactor and ex-reactor fuel testing to be performed, including source and quantities of fuel to be tested, test conditions, test objectives, acceptance criteria, schedule, post test examinations to be performed and documentation to be prepared. Also, the strategy and schedule for obtaining the above data as it relates to supporting the COL application should be described.

Response:

Near Term: A PBMR Fuel report, which documents and elaborates on the material presented in the June 11, 2001 pre-application meeting, will be available by December 2001. This report will contain a description of the PBMR fuel element design, manufacturing process and design specifications. Also included in this report will be a discussion of the Tri-coated Isotropic (TRISO) fuel particle history and irradiation test results.

Longer Term: A comprehensive PBMR fuel test program is currently under development in collaboration with the PBMR project office in South Africa, EGC, the US Department of Energy (DOE) and Idaho National Engineering and Environmental Laboratory (INEEL). It is expected that the program will test existing German fuel elements and PBMR pre-production and production fuel. This testing is expected to be conducted in the US as well as internationally. Interactions with NRC on this plan, including the strategy and schedule of the test program as it relates to supporting the combined license COL application, are expected to be ongoing throughout 2002.

Contingent upon cooperation between the involved parties, the complete scope of the test program is expected to be defined by September 2002.

Issue 2: What will be done to ensure that the fuel quality is maintained over the life of the plant?

Information needed: Fuel fabrication and quality control and performance monitoring plans.

Response:

Information on this topic was provided in a presentation to the NRC on June 11, 2001, including fuel manufacturing process controls, quality control measures planned during fuel manufacturing and core condition monitoring. A written summary of this information will be provided by January 31, 2002.

Issue 3: How will the fuel ultimately be disposed of?

Information needed: Plans for packaging, transportation, and disposal of spent fuel, after on-site spent fuel storage.

Does Exelon anticipate the need for dry cask storage? Also, address any special provisions that would be necessary to dispose of the substantially larger volume of spent fuel (on a per MWe basis) associated with large scale deployment of the PBMR in the U.S.

Response:

PBMR spent fuel is expected to be disposed of in the same manner as other commercial reactor fuel (i.e., shipped to a US DOE repository for spent fuel and high level nuclear waste). Until that time, PBMR spent fuel will be stored on site in dry spent fuel storage tanks.

It is expected that the PBMR spent fuel will physically be larger in volume per megawatt electric (MWe), but will require less storage area in its final storage configuration than spent light water reactor (LWR) fuel, due to its lower heat load.

Longer Term: Detailed resolution of this issue is not seen as critical to pre-application activities; details are expected to be finalized in the 2003-2005 timeframe.

Issue 4: Fuel Fabrication

Information needed: How and where the initial PBMR fuel will be fabricated. Are there plans for fabricating PBMR fuel in the U.S. at some point in the future?

What special provisions might be required for transporting fresh PBMR fuel to the U.S. (e.g., due to the higher enrichment)?

Response:

PBMR fuel will be fabricated with methods which are which are directly consistent with the German method for production of TRISO fuel, as discussed in our presentation on June 11, 2001. Fuel fabrication details will also be included in the document described in Fuel Issue 1 above, to be provided by December, 2001. The initial fuel is expected to be fabricated at the Pelindaba facility in South Africa. Additional fabrication facilities, including in the US, will be decided based on future commercial considerations.

Shipment of fresh fuel will account for current licensing requirements including; low enrichments in excess of 5%, shipping container design, and transportation requirements.

Issue 5: Security and Safeguards

Information needed: Does the PBMR design pose any unique security or safeguards concerns?

Are there special provisions for material control and accounting (MC&A)?

Response:

We will be ready to provide security and safeguards information in early 2002. We do not envision that special provisions are needed for MC & A.

C) PBMR Materials

Issue 1: What graphite will be used for the reflector and other in-vessel structures and how will its physical properties (e.g., thermal conductivity, strength, dimensions, etc.) as a function of temperature and irradiation be determined?

Information needed: Description of the graphite to be used (e.g., fabrication standard, fabrication process, source of feed material, etc.) and the plans to obtain its physical properties as a function of temperature, time, and irradiation.

Code, standards or acceptance criteria for analysis of integrity of graphite structures.

Response:

This information was provided during the meeting held on October 25, 2001 and by our letter dated October 23, 2001.

Issue 2: What materials and design codes are to be used for the reactor pressure vessel and connecting piping?

Information needed: Grade of steel, service conditions (normal and off normal), and design codes to be employed.

Procedures and databases for conducting fatigue and creep analyses including the effects of high-temperature helium with impurities on degradation of fatigue life, stress corrosion cracking resistance and creep properties.

Effect of graphite particles and helium impurities on carburization and degradation of metal surfaces.

Inservice inspection plan, including frequency and components to be inspected.

Response:

Near Term: Preliminary material and service conditions, and codes to be used were presented during the July 18, 2001 pre-application meeting, supplemented by our letter dated October 30, 2001. We expect to be able to provide additional written information regarding the primary pressure boundary, responsive to the first three points in the "information needed" specified above, by the end of 2001.

Longer Term: The preliminary reactor pressure vessel (RPV)/primary pressure boundary ISI plan, including design inputs, inspection methods and inspection frequencies, is expected to be available for both the RPV and the connecting piping by September 2002. This will factor in other HTGR experience, where possible.

Issue 3: What concrete and design codes are to be used for the reactor cavity?

Information needed: Type of concrete, service conditions (normal and off normal) and design information (e.g., code).

Response:

Near Term: A preliminary report addressing the information needed will be available by end of June 2002.

Longer Term: Complete information, responsive to the "information needed" specified above, will be available in a timeframe consistent with module building design completion, targeted for August 2003.

D) PBMR Safety Analysis Tools

Issue 1: How will analytical tools used to assess plant response to accident conditions be validated? This includes analytical tools for analysis of:

- fuel temperature and burnup during normal and off-normal events, including accounting for uncertainties due to pebble location and residence time.
- fission product release and transport during normal and off-normal events, including beyond design basis accidents.
- reactor pressure vessel and connecting piping temperatures, stresses and time history during normal and off-normal events.

Information needed: Analytical tool description, including range of applicability, scaling considerations and plans for validation of models and methods (e.g., thru comparison with experimental data, benchmarks, etc.).

Response:

Near Term: An initial presentation to NRC regarding PBMR analytical tools (i.e., computer codes) was provided on August 16, 2001, supplemented by information contained in our letter dated October 30, 2001. The verification and validation (V&V) of various analytical computer codes is to be done in stages; the initial strategy and plans will be available by mid-2002.

Longer Term: Computer code V & V activities will be ongoing over the next four years. A final version of the V&V plans, including the status of V & V activities for various codes, will be available by April 2003.

Issue 2: How will testing using the demonstration plant in South Africa be used to support an application in the U.S.?

Information needed: Description of the tests to be performed including test objectives, schedule, acceptance criteria, test conditions, additional instrumentation and documentation.

Response:

Near Term: As background for discussing the relevance of demonstration plant testing to US licensing, we intend to discuss what testing may be needed to support a COL for an advanced reactor, in the November 29-30, 2001 pre-application meeting with the NRC.

Longer Term: A document describing any inter-relationship between demonstration plant testing and US licensing will be provided by September 2002. Details of specific tests which are of interest to the NRC, such as that enumerated in the "information needed" section above, are expected to be available by December 2003.

E) PBMR Containment vs. Confinement

Issue: What is the basis for proposing a design with a confinement building vs. a pressure retaining containment building?

Information needed: The criteria and rationale for confinement, including the advantages and disadvantages of containment vs. confinement considering the potential dose to workers and offsite from factors such as:

- routine operation
- design basis accidents
- beyond design basis accidents
- acts of sabotage
- impact on offsite response

The design conditions and codes and standards for the containment/confinement.

Response:

A report assessing the functions of the reactor building design, including design conditions and codes and standards, will be prepared by July 2002, based on preliminary design and source term work.