

December 12, 2001

MEMORANDUM FOR: Michael Mayfield, Director  
Division of Engineering Technology  
Office of Nuclear Regulatory Research

FROM: Thomas L. King, Director /RA/  
Division of Safety Analysis and Regulatory Effectiveness  
Office of Nuclear Regulatory Research

SUBJECT: REVIEW OF INFORMATION FROM EXELON GENERATION  
COMPANY FOR THE PEBBLE BED MODULAR REACTOR (PBMR)  
PRE-APPLICATION REVIEW: HIGH TEMPERATURE MATERIALS  
GRAPHITE; CONTROL OF CHEMICAL ATTACK; AND DESIGN  
CODES AND STANDARDS

The NRC's objectives for the Pebble Bed Modular Reactor (PBMR) pre-application review are to obtain information from the Exelon Generation Company (Exelon) on the PBMR design and its technical basis in order to: (1) identify significant technical issues, safety issues and policy issues and (2) identify a path for resolution of the issues. Achieving these objectives is expected to enhance the effectiveness and efficiency of the staff's review of an actual license application and to provide guidance to Exelon that is useful in the application preparation.

Since June 2001, RES has held monthly meetings with Exelon and the Department of Energy (DOE) to receive presentations and information on a range of technical and programmatic topics supporting the PBMR pre-application review. The monthly meetings have provided a starting point for obtaining information from Exelon on the PBMR design and technical basis and to begin identifying significant issues for which resolution guidance will need to be identified. Table 1 in Attachment 1 provides the topics that Exelon has presented to date in these meetings. Table 2 in Attachment 1 documents the Exelon-requested outputs for the staff's review of each topic. This memorandum's purpose, as further explained in the paragraphs below, is to request the Division of Engineering and Technology (DET) to: (1) coordinate the review of the Exelon white papers on high temperature materials graphite, control of chemical attack, and design codes and standards provided in Attachment 2, and (2) develop and document appropriate requests for additional information (RAIs) on these three topics. It is requested that the DET-coordinated RAIs be provided to DSARE by February 15, 2002, for transmittal to Exelon.

To date, Exelon has presented 11 technical and programmatic topics as shown in Attachment 1, Table 1. DET has the lead review responsibility for several of these topics and a review support responsibility for other topics. Early on in the pre-application review, RES requested

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Exelon to formally document and submit for RES review the information that had been informally presented in these meetings. Exelon agreed to this request and has begun to submit the requested documents as technical "white papers" for each presentation topic. Also, in addition to Exelon's stated purpose for each topic presentation (see Attachment 1, Table 2), Exelon has requested feedback on the staff's technical, safety, or policy issues, including questions associated with each of these topical papers and related presentations. Exelon also has indicated that, where possible, they would respond to these issues and questions either during the pre-application review, or subsequently, as part of an actual application. Issues and questions that they can be responsive to during the pre-application review phase will also allow Exelon to revise and resubmit the associated white paper to include the substance of their response. The white papers, including any updates and formal responses to staff identified issues and questions, will provide the primary basis upon which the staff's pre-application review information, findings, conclusions, positions, and guidance will be based.

A request for additional information or questions on the white papers provides a formal process for the staff to identify and communicate its preliminary views on the potentially significant technical, safety, and policy issues and questions on each topic. The responses from Exelon may also provide important input for the development of staff guidance for resolving the significant issues and questions.

It is currently planned that the pre-application review results of the PBMR design and associated technical basis, including the identified staff issues and guidance for resolution, will be documented in a Commission paper submitted in the first quarter of CY 2003. The Commission paper will include the significant technical issues, safety issues, and programmatic issues that were identified by the staff and the staff's guidance for resolution of these issues as part of an actual application. The paper will also include the significant public health and safety issues requiring Commission policy guidance (e.g., containment functional requirements, licensing basis events, source term calculation and use, and emergency planning requirements). For Commission policy-level issues, the paper is expected to include the staff's policy guidance options and the staff's bases for any recommended guidance.

As stated earlier, the pre-application review information provided by Exelon, including their response to staff questions, comments, and issues, will provide the principle basis for the staff's assessment of each topical area. The assessment will include identification of the key issues and guidance (on the further information and actions) needed for their resolution. However, it is expected that the staff will utilize other relevant PBMR-specific and HTGR-generic information, resources and perspectives to conduct its review of Exelon's white papers and presentation information. Such other information include: (1) "Introduction to the Pebble Bed Modular Reactor (PBMR)" submitted by Exelon (to be distributed by the end of CY 2001); (2) the modular HTGR course (and course materials) presented by the Department of Energy in September and October 2001; (3) the IAEA HTGR technical documents (TECDOCS) available at <http://www.iaea.or.at/inis/aws/htgr/abstracts/> and on CD (see Chester Gingrich); (4) staff technical review documents and Commission policy documents (compiled and available for reference in the NRC library) associated with previous staff reviews of modular HTGRs (see Raji Tripathi); (5) significant modular HTGR design, technology and safety assessment reference documents and information obtained from foreign organizations in connection with recent NRC staff and Commission visits to South Africa, the United Kingdom, Germany, China and Japan (translations and copies in progress - see Donald Carlson); (6) DOE laboratory

specialized contractor input and information (e.g., nuclear graphite, modular HTGR accident analysis, and coated particle fuel irradiation testing), and (7) the October 2001 HTGR Safety Issues and Research Workshop (see Raji Tripathi) .

In the letter dated November 15, 2001, Exelon informed RES of its revised plans for submitting safety significant PBMR pre-application review topics (Attachment 3). The November 15, 2001, letter summarizes Exelon's planned schedule for providing technical white papers on additional safety significant pre-application review topics (beyond those listed in Attachment 1, Table1) during CY2002 and CY2003. The revised schedule will result in a significant lengthening of the pre-application review period. However, based on discussions with Exelon, NRC has determined that the PBMR pre-application review will only encompass those topics that can be presented, documented, and submitted by Exelon through the end of CY 2003. Accordingly, Attachment 3 should be viewed as an interim reference on additional technical and programmatic pre-application review topics for which DET resources and support may be needed during FY 2002 and early FY 2003.

Finally, Attachment 4 contains the handouts provided by Exelon for the presentations on "High Temperature Materials Graphite" and "Control of Chemical Attack" given at the October 25, 2001, NRC public meeting with Exelon and the handouts on the "Design Codes and Standards" presentation given at the July 18, 2001, meeting.

If you or your staff have any questions on this request or require additional information, please contact me (415-7499) or the RES project manager for the PBMR pre-application review, Stuart Rubin (415-7480).

Attachments: As stated

cc w/o atts.:

A. Thadani, RES

R. Zimmerman, RES

J. Stronider, NRR

C. Ader, RES

S. Newberry, RES

J. Lyons, NRR

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Distribution w/o atts.:

FEltawila, NRR  
RTripathi, RES

Distribution w/atts.:

ACubbage, NRR  
GBagchi, NRR  
JMuscara, RES  
SArndt, RES  
CGingrich, RES  
DCarlson, RES  
CGreene, RES  
HGraves, NRR  
NTrehan, NRR  
HLi, NRR

HAshtar, NRR  
TCheng, NRR  
FGrubelich, NRR  
YOrechwa, NRR  
EConnell, NRR  
WKoo, NRR  
DTerao, NRR  
SSteele, NMSS  
WGleaves, NMSS  
TSullivan, NRR

**ADAMS PACKAGE NO.: ML013460548**  
**ATTACHMENT 2: ML012980116**  
**ATTACHMENT 3: ML013480132**  
**ATTACHMENT 4: ML013180284 and**  
**ML012140193**

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OAD in ADAMS? (Y or N) Y ADAMS ACCESSION NO.: ML013460588 TEMPLATE NO. RES-006  
Publicly Available? (Y or N) Y DATE OF RELEASE TO PUBLIC                      SENSITIVE? Y  
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OFFICE	REAHFB		C:REAHFB		D:DSARE	
NAME	SRubin:mtb		JFlack by MCheck		TKing	
DATE	12/11/01*		12/11/01*		12/12/01*	

Table 1: PBMR Pre-Application Review Technical and Programmatic Topics  
Presented and Documented by Exelon

Meeting Date	Topic Number	Meeting Presentation Technical Topic	White Paper Date	Lead Review Organization
Jun 12-13	1	Fuel Overview -Design, Manufacturing, QC and Qualification	11/16/01	DSARE
Jul 17-18	2	Design Codes and Standards	10/30/01	DET
	3	Fuel Irradiation Program	11/16/01	DSARE
Aug 15-16	4	<u>Analytical Codes and Software Control</u> 1. Engineering Analysis 2. Reactor Analysis 3. Radiation Analysis 4. Fuel Performance Analysis 5. Risk and Consequence Analysis	10/30/01	DSARE DSARE&DET DSARE DSARE DSARE DRAA
	5	Fuel Design Logic	11/16/01	DSARE
	6	Core Design	11/16/01	DSARE
Sept 18		None	N/A	N/A
Oct 25	7	High Temperature Materials Graphite	10/23/01	DET*
	8	Control of Chemical Attack	10/23/01	DET* DSARE
	9	PBMR Systems Design Approach and Status	N/A	N/A
	10	High Temperature Materials	TBD	DET*
Nov 29-30	11	PBMR Operational Modes and States	11/28/01	DSARE
	12	Testing Requirements for a Combined License	11/28/01	NRR

\* review support available from ORNL  
N/A Not Applicable

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Attachment 1

Table 2: Exelon Objectives for NRC's Pre-application Review  
by Presentation Topic

Topic No.	Exelon's Documented or Stated Objectives for NRC Pre-application Review
1	NRC to identify potential opportunities for NRC involvement in fuel qualification process.
2	NRC to provide comments/feedback/issues/questions on the reference design codes and standards to be used in the PBMR design. [Also: NRC requested to review and approve ASME Code Cases N-499 and N-201.]
3	NRC to provide comments/feedback/issues/questions on the proposed fuel testing program and the general approach to be used in analyzing the acceptability of the fuel design.
4	NRC to identify specific list of codes and models that are needed from PBMR to become familiar with and be ready for an application.
5	NRC to provide comments/feedback/issues/questions on the proposed PBMR fuel testing program and the methodology to be used in analyzing the design. [Exelon would like to use the next 18 months (i.e., by November 2002) to reach agreement <sup>1</sup> with the NRC on the adequacy of the testing and methodology to be used prior to a license application. Exelon would like feedback from the NRC on the process for reaching agreement on the fuel testing and methodology.]
6	Exelon would like to obtain NRC agreement <sup>1</sup> on sufficient design information and analytical methodologies to support a US license application.
7	No specific NRC action is requested by Exelon. The purpose of the presentation was to highlight the safety issues related to the use of graphite technology in HTGRs and to identify options that can lead to the successful resolution of these issues
8	NRC to provide comments/feedback/issues/questions on the approach to the control of chemical attack in a PBMR
9	No specific NRC action is requested by Exelon. (Information presentation)
10	NRC to provide comments/feedback on the use of high temperature materials in a PBMR. [Also the planned use of ASME Code Case N-201 for the core barrel is noted.]
11	No specific NRC action is requested by Exelon. (Information presentation)
12	Exelon would like NRC agreement on a decision process and issue- specific testing expectations for a COL.

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<sup>1</sup> "Agreement" is not likely to be achievable during the pre-application review. It is expected that NRC will be able to identify issues and guidance to resolve these issues.