

October 19, 2001

MEMORANDUM TO: Ashok C. Thadani, Director  
Office of Nuclear Regulatory Research

FROM: Thomas L. King, Director */RA/*  
Division of Safety 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

On August 15 and 16, 2001, the Nuclear Regulatory Commission (NRC) staff held a day-and-a-half meeting with the representatives of Exelon, the Department of Energy (DOE), and other interested stakeholders to discuss the Pebble Bed Modular Reactor (PBMR) preapplication review efforts. This meeting was the fourth in a series of planned monthly topical meetings to be conducted between the NRC staff, Exelon, and DOE during the course of a year.

Attachment 1 contains the meeting agenda. Attachments 2-a and 2-b contain a list of attendees for each day. Exelon's nonproprietary presentation material is included in Attachments 3-a through 3-d. Exelon discussed proprietary information in closed sessions on both days. The presentation materials used in the closed sessions are not being released to the public.

In his opening remarks, Stuart Rubin (NRC) reiterated that the main objectives of the PBMR preapplication review process are to develop and feed back to Exelon NRC guidance concerning significant issues related to the siting, construction, and licensing of a PBMR in the United States. During the first day of the meeting, discussions on the PBMR licensing approach were continued from the June and July meetings. A new topic, computer codes for design and safety analysis, was introduced on the second day.

Fred Silady (Exelon consultant) led the discussion on methods for safety classification and development of regulatory design criteria for the PBMR in the United States. Attachment 3-a contains the presentation material. The following points were noted during the discussions:

- (a) The proposed licensing approach will use probabilistic risk assessment (PRA) to check the adequacy of the initially selected licensing basis events and to identify additional events that may need to be analyzed.
- (b) The PRA calculations will take credit for all available systems, structures, and components (SSCs), whereas analysis of the selected licensing basis events will take credit only for those SSCs that are designated as safety-related.

- (c) Sabotage will be addressed through administrative requirements and the analysis of sabotage-related events will be considered outside the scope of licensing basis events.
- (d) As in the staff's preapplication review of the Modular High-Temperature Gas-Cooled Reactor in the late 1980s, the staff may require the analysis of postulated events in addition to the mechanistic events selected by the applicant.
- (e) A given SSC may play a preventive role in one event sequence and a mitigative role in another.
- (f) Special treatment of SSCs will be based on risk information. The traditional single-failure criterion will not be used.
- (g) The SSCs relied on for beyond design basis events and emergency planning basis events are the same as those relied on for design basis events and anticipated operational occurrences.

Comments were solicited from the public after the presentations on the first day. Dr. Edwin Lyman (Nuclear Control Institute) commented that (a) the proposed licensing approach is apparently being provided to justify the design, (b) the primary coolant system pressure boundary must be classified as safety grade, (c) fuel quality and performance issues need close scrutiny and confirmation, and (d) information that the public needs to see is being inappropriately designated as proprietary and withheld from the public. Dr. Larry Parme (General Atomics) commented that the licensing approach proposed by Exelon is very logical and systematic and is strongly endorsed by General Atomics.

On the second day of the meetings, Johan Slabber (PBMR) provided an overview of the analytical codes used for design and safety analysis of the PBMR. Nonproprietary and proprietary versions of the overview were given in the morning and afternoon sessions, respectively. Attachments 3-b and 3-c contain the nonproprietary presentation materials. Attachment 3-b is the presentation material from a short discussion on PBMR fuel testing that was led by Robert Calabro (Exelon consultant).

The following points were noted in the discussions during these presentations:

- (a) Exelon will be expected to submit topical reports on the computational codes and specific input models used in the PBMR safety analyses.
- (b) The staff noted that nuclear cross section libraries derived from Version IV of Evaluated Nuclear Data File B (ENDF/B-IV) should be checked for errors in the  $S(\alpha, \beta)$  bound thermal scattering data for graphite. Such errors are known to exist in all versions of ENDF/B prior to Release 3 of Version VI and have been shown to potentially distort the computed temperature coefficients of graphite and absorber materials in the core and reflectors.
- (c) The NRC's evaluation of fuel performance will consider parameters outside the design envelope criteria.

- (d) The maximum fuel temperature during normal operation was stated to be 1250°C, a significant increase over the 1060°C value indicated at the June meeting. This increase in the specified maximum fuel temperature during normal operation was said to be based in part on a preliminary critical review of the melt-wire test results from the German Arbeitsgemeinschaft-Versuchsreaktor, which were described by the NRC staff during the June meeting.

Public comments were again solicited after the nonproprietary presentations on the second day. Dr. Edwin Lyman (Nuclear Control Institute) noted that high-burnup fuel from light-water reactors has recently been tested and re-evaluated for the effects of rapid reactivity insertion accidents; he questioned whether PBMR fuel has been or will be tested for similar accident conditions. The staff's response noted that the NRC research program is considering the need for such pulsed tests and other tests that would explore the integrity and failure thresholds for PBMR fuel. Dr. Lyman also asked whether the peak fuel temperature had been analyzed for depressurized loss of forced circulation accidents with assumed loss of water from the reactor cavity cooling system (RCCS). Exelon responded that this event sequence has been analyzed and that the predicted peak fuel temperature is essentially the same as with the RCCS fully operational. Stephen Antonelli (Public Citizen's Critical Mass) expressed concern over (a) withholding proprietary information from public scrutiny, (b) reliance on German fuel designs and test data, and (c) adequate consideration of events with moisture ingress or rapid withdrawal of the in-reflector neutron absorber elements.

Exelon proposed meeting again on September 19 to continue discussions on the licensing approach and to discuss the status of legal and financial issues. The meeting adjourned at 2:15 p.m. on August 16<sup>th</sup>. Any questions regarding this meeting should be addressed to Stuart Rubin ([SDR1@nrc.gov](mailto:SDR1@nrc.gov)), (301) 415-7480.

Attachments: As stated

cc w/o attachments: See attached list

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SUBJECT: MEETING WITH EXELON GENERATION COMPANY, DEPARTMENT OF ENERGY, AND OTHER INTERESTED STAKEHOLDERS REGARDING THE PEBBLE BED MODULAR REACTOR

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Agenda  
 NRC Meeting with Exelon and DOE on PBMR  
 August 15, 2001, 9:00 a.m. – 2:15 p.m.  
 August 16, 2001, 9:00 a.m. – 3:15 p.m.  
 ASLBP Hearing Room T3 B45

Day: Wednesday		Date: August 15	
9:00–9:15 a.m.	Introductory Remarks (S. Rubin)	NRC	
9:15–9:30 a.m.	Introductory Remarks (K. Borton)	Exelon	
9:30–1:45 p.m.	Licensing Approach: Selection of SSCs (Fred Siladay)	Exelon Consultant	
9:30–10:45 a.m.	Background, Required Functions, Selection of Safety-Related Equipment (Fred Siladay)		
10:45–11:00 a.m.	Break		
11:00–11:45 a.m.	Development of Regulatory Design Criteria (Fred Siladay)		
11:45–12:00 a.m.	Stakeholder Comments		
12:00–1:00 p.m.	Lunch		
1:00–1:45 p.m.	Comparison of Approach with Current Regulatory Practice (Fred Siladay)		
1:45–2:00 p.m.	Stakeholder Comments		
2:00–2:15 p.m.	Closing Comments and Adjourn		





Agenda  
 NRC Meeting with Exelon and DOE on PBMR  
 Aug 15, 2001, 9:00 a.m. – 2:15 p.m;  
 Aug 16, 2001, 9:00 a.m. – 3:15 p.m.  
 ASLBP Hearing Room T3 B45

Day: Thursday		Date: August 16
9:00–9:15 a.m.	Introductory Remarks, S. Rubin	NRC
9:15–10:00 a.m.	Introduction to Analytical Codes Used for PBMR Design and Analysis (Non-Proprietary), Johan Slabber	Exelon
	Thermal-Hydraulic, Nuclear, Engineering Analysis, Reactor Analysis, Radiation Analysis, Fuel Performance, Risk and Consequence Analysis (I.e., non-PRA);	
10:00–10:30 a.m.	PBMR Pre-Application Fuel Design Approach (Non-Proprietary), R. Calabro	Exelon Consultant
10:30–10:45 a.m.	Break	
10:45–11:30 a.m.	PBMR Core Design (NON-PROPRIETARY), J. Slabber	PBMR
	Physical Layout, Core Pebble Flows, Use of Analytical Codes	
11:30–12:15 p.m.	PBMR Core Heat Removal (NON-PROPRIETARY), J. Slabber	PBMR
	Normal Operation, Transients and Design Basis Events	
12:15–12:30 p.m.	Stakeholder Comments	
12:30–1:30 p.m.	Lunch	
1:30–2:30 p.m.	PBMR Core Design Analysis Results (PROPRIETARY), J. Slabber	PBMR
2:30–3:30 p.m.	PBMR Heat Removal Analysis Results (PROPRIETARY), J. Slabber	PBMR
3:30–3:15 p.m.	Closing Comments, Administrative Items and Adjourn	NRC/ Exelon

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