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DATE: 02/14/01

MEMORANDUM TO: The Commissioners

FROM: W. Travers

SUBJECT: PLAN FOR PREAPPLICATION ACTIVITIES ON A PEBBLE-BED MODULAR REACTOR (PBMR)

ORIGINATOR/SECRETARY: Angelina Chapeton or Patty Nielsen

ROOM NO./BLDG: T10 E 48
PHONE NO.: 415-5790

****

SIGN AND/OR

	CONCUR	DATE
1. King		/ /
2. Federline		/ /
3. Thadani		/ /
4. TECH Editor		/ /
5. Collins		/ /
6. Kane		/ /
7 OGC		/ /
8 CFO (Pulliam)		/ /
9 Paperiello		/ /
10. Travers		/ /

DUE TO EDO

ACTION:
APPROVAL:
AS REQUESTED:
COORDINATION:

CIRCULATED:
COMMENT:
NOTE & RETURN:
PER CONVERSATION:

FOR YOUR INFO:
SEE ME:
PREPARE REPLY:

FOR PARALLEL CONCURRENCE:

WITS 20000117 - due to EDO - 3/2/01

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FOIA- 2003-0032

Portions withheld - EX. 5

MM/o

2/21/01

FOR: The Commissioners

FROM: William D.Travers
Executive Director for Operations

SUBJECT: PLAN FOR PREAPPLICATION ACTIVITIES ON A PEBBLE-BED MODULAR REACTOR (PBMR)

PURPOSE

To request Commission approval to proceed with preapplication activities with Exelon Generation Company on the PBMR.

BACKGROUND:

On November 14, 2000, representatives from Exelon Generation Company informally expressed their desire for early (preapplication) interactions with the staff directed toward establishing the feasibility of licensing the PBMR (a modular high temperature gas-cooled reactor, HTGR, being developed in South Africa) in the U.S. Subsequently, Exelon, in a letter dated December 5, 2000, formally requested such early interactions (Attachment 1). An initial meeting with Exelon to discuss the PBMR design, technology and preapplication plans was held on January 31, 2001, at NRC-HQ. Based upon the initial meeting with Exelon, they have indicated that it is their desire to have the preapplication phase completed by July 2002. Subsequently, the Commission issued a Staff Requirements Memorandum (SRM), dated February 13, 2001, which requested the staff to assess its readiness for new nuclear plant construction and the pebble-bed reactor.

CONTACT: Thomas L. King, RES
301-415-5790

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DISCUSSION:

Consistent with my memorandum of November 14, 2000, on advanced reactors, RES has taken the lead (in coordination with NRR and NMSS) to develop a plan for preapplication activities with Exelon on the PBMR. This plan is attached (Attachment 2) and Commission approval is requested to begin the preapplication activities described in the plan. This plan takes into consideration the preapplication activities requested by Exelon and, we believe, is responsive to their request, although completion of certain activities may take a few months longer than Exelon has requested. For example, assuming a start date in late March 2001, completion of the preapplication activities would more likely be in the Fall 2002 in lieu of July 2002 as requested by Exelon. The purpose of the preapplication activities would be to have the staff become familiar with the design, its supporting technology and key safety issues with the goal of early identification of issues fundamental to licensing and the technical basis and/or policy implications for their resolution. In addition, NRC resource and infrastructure needs to conduct an actual licensing review of the PBMR would be identified. Such early interactions are encouraged by and consistent with the Commission's Policy Statement on Advanced Reactors and would build upon previous HTGR experience (both domestic and international) and the previous ALWR design reviews. Due to the active interest in the PBMR and requests of Exelon, this plan is being forwarded to the Commission in advance of the broader readiness assessment being developed in response to the February 13, 2001 SRM

RESOURCES:

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Even though DOE will fund all, or a portion, of the work there will be an impact on other currently planned work, due to reassigning staff to the PBMR. We will minimize the impact as much as possible; however, it is likely activities such as completion of the final IPEEE insights report and the resolution of GSI 156.6.1 "Pipe Break Effects on Systems and Components" will be delayed.

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COORDINATION:

The Office of the General Counsel has no legal objection of this paper. The Office of the Chief Financial Officer has reviewed this paper for resource implications and has no objections.

RECOMMENDATION:

That the Commission approve proceeding with preapplication activities on the PBMR as described in Attachment 2.

William D. Travers
Executive Director
for Operations

Attachments: (1) December 5, 2000, Exelon letter
(2) Plan

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William D. Travers
Executive Director
for Operations

Attachments: (1) December 5, 2000, Exelon letter
(2) Plan

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Exelon Generation

December 5th, 2000

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attn Mr William Travers

Subject: Pebble Bed Modular Reactor Review Requirements

Dear Mr. Travers:

As you are aware, Corbin McNeill, the co-CEO of Exelon Corporation, has expressed interest in the Pebble Bed Modular Reactor (PBMR) technology. Exelon and several partners are currently trying to determine the technical, economic, and licensing feasibility of the PBMR design worldwide, including here in the United States.

The NRC's "Statement of Policy for Regulation of Advanced Nuclear Power Plants" (July 8, 1986) encourages the earliest possible interaction between the agency and applicants to provide licensing guidance. In line with this policy, Exelon and our partners request to formally engage with the NRC Staff for exploratory discussions on how we could most efficiently proceed with licensing the PBMR. We expect these discussions to help us determine if the PBMR is a viable project, in advance of our decision to be taken later. We would expect to identify review assumptions, policy issues to be considered, and to establish an estimate of cost and schedule for preliminary NRC PBMR technology education and review. It is our intent that subsequent phases could be identified during these initial discussions. We would like to target completion of a first meeting by January 12, 2001.

If you have any questions, please do not hesitate to contact us.

Very truly yours,

James A. Muntz

James A Muntz
Vice President
Nuclear Projects

xc: C. A. McNeill, Jr.
E. F Sproat, III
D. Nicholls (Eskom)
P. H. Readle (BNFL)
J. Colvin (NEI)
Honorable B. Richardson (DOE)
W. D. Magwood (DOE)

Attachment 2

Plan for Preapplication Activities on the PBMR

INTRODUCTION

In a letter dated December 5, 2000, to William Travers, Exelon Generation Co. has requested preapplication interactions with NRC directed toward assessing the viability of certification of a pebble bed modular reactor (PBMR) in the U.S. The PBMR is a high temperature gas cooled reactor (HTGR), utilizing helium as the coolant and with online refueling capability, similar to that developed in Germany in the 1970s and 1980s. The current design is being developed in South Africa where a full scale prototype module may be built and demonstrated. In addition to being a non-LWR reactor, the PBMR has other unique features that make its approach to protecting public health and safety very different than designs currently licensed in the U.S. Chief among these features are:

- coated UO_2 fuel particles designed to contain the fission products and to be demonstrated to withstand very high temperature
- low power density (an order of magnitude below that for LWRs) with large thermal capacity that provides for slow transient behavior
- passive decay heat removal that is to be demonstrated to perform, even under loss of coolant conditions
- no conventional containment building
- significantly reduced emergency planning in one (EPZ)
- multi-modular site concept (each module being approximately 110 Mwe)
- the use of actual plant testing, using the full scale prototype reactor module, to verify analytical tools and safety in support of licensing.

The Commission's Policy Statement on Advanced Reactors encourages early interactions on such advanced designs so as to facilitate the resolution of safety issues early in the design process.

For NRC to be prepared to review the PBMR in a timely fashion, preapplication activities are proposed consistent with the Commission's Advanced Reactor Policy. The objectives of these activities would be to:

- conduct early interactions with Exelon on the PBMR design and proposed licensing approach
- educate a nucleus of staff in HTGR technology and safety
- identify key safety issues and an approach for their resolution
- evaluate the applicability of current regulatory criteria
- identify and solicit Commission guidance on policy issues
- address NRC infrastructure, research and resource needs to support a licensing review

The outcomes would be staff familiar with the PBMR; identification of key safety and policy issues; infrastructure, research and resource needs to perform an actual licensing review and preliminary guidance for the staff and potential applicants sufficient to establish the expectations for licensing. Documentation would be via SECY papers and letters to Exelon (i.e., a safety evaluation report would not be written).

PROPOSED PLAN

This paper describes a plan for preapplication activities directed toward preparing the agency for a possible application to license the PBMR in the U.S. consistent with the above objectives. It is based upon experience in the past with preapplication reviews including a preapplication review of a DOE sponsored modular HTGR, and would build upon that previous work The plan describes preapplication activities that would last approximately 18 months and consists of the following elements:

- familiarization with the design, safety and research issues via:
  - interaction with Exelon
  - interaction with foreign partners and domestic organizations with HTGR design and operating experience
  - interaction with the South African regulatory organization

- identification of current requirements which may not be applicable to the PBMR and areas where new requirements may be needed.
- identification of process, safety and policy issues and a proposed approach for their resolution
- infrastructure and contractor support
- staffing, training, schedule and resources

Each of these elements is discussed below:

Familiarization with Design, Safety and Research Issues

Initial staff efforts will be directed toward becoming familiar with the PBMR design, technology, safety issues and research needs. This will be accomplished first through discussions and interactions with Exelon and others with PBMR and HTGR experience. An initial meeting was held with Exelon on January 31, 2001, at NRC-HQ to discuss the PBMR design, safety issues and proposed Exelon schedule and approach for pre-application interactions. Additional followon meetings will be scheduled on an as needed basis to discuss specific topics and issues. In parallel with interactions with Exelon, the staff will contact others with HTGR experience relevant to the PBMR to obtain their insights and views on safety issues and technology. These contacts are discussed below and include international as well as domestic organizations.

NRC has a number of agreements with foreign countries that provide a mechanism to cooperate on a wide variety of safety matters. Some of our foreign partners have HTGR experience and some also have currently operating HTGRs (which utilize Helium coolant and

coated fuel particle designs.) Specifically, Germany has had many years experience with small (~45 Mwt) and large (~750 Mwt) scale HTGRs, including those of pebble-bed design. Although the German HTGRs are no longer operating, their experience is relevant to the PBMR. Japan currently has an operating research HTGR (~30 Mwt), although not of the pebble-bed design. It does, however, utilize coated fuel particles, He coolant and operates at high temperatures. China has recently begun initial startup of a small (~10 Mwt) pebble-bed research HTGR, from which experience should be obtained. In addition, they are developing a larger (200 Mwt) modular design. The U.K. operates 14 Advanced Gas Reactors (AGRs). Although they are different than the PBMR (i.e., they use CO_2 as a coolant and the fuel is not the coated particle design), they are graphite moderated and some experience may be relevant to a PBMR. Russia has had some HTGR development efforts in the past and is currently engaged in a joint effort with General Atomics (sponsored by DOE) to develop a modular HTGR (although not a pebble-bed) for Pu disposition. In addition to the above, IAEA has some activities (in both the development and safety areas) looking at the PBMR design and safety. We would also build upon and utilize their work in our activities. Finally, we would plan to discuss with the South African regulatory authorities their views on the PBMR design, safety issues and research conducted (or to be conducted) to address the issues. In 2001, we would intend to arrange interactions with our international partners to discuss their experience with HTGRs and their views on safety issues.

Domestically, there remains some HTGR expertise, primarily Los Alamos National Laboratory (LANL), Oak Ridge National Laboratory (ORNL) and at General Atomics (GA). Preliminary discussions have been held with LANL and ORNL regarding the feasibility of drawing upon their expertise. Relevant experience at the other DOE labs will also be determined. Access to expertise at GA may be limited due to GA being an NRC licensee. In addition, for the past several years MIT has led an effort to design a modular pebble bed HTGR. Their experience will also be sought. Finally, previous NRC experience with HTGRs (e.g., Ft. St. Vrain and the NRC review of a DOE sponsored modular HTGR in the late 1980s and early 1990s) and the ALWRs would be utilized to help identify issues, research needs and approaches to their resolution.

Approach to Licensing

Exelon has proposed an approach to licensing that includes building a single module in the U.S. under the combined license provision of 10 CFR 52 and, based upon that experience and the results of a test program using a prototype module in South Africa, subsequently certifying the design.

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Early interaction to identify and address such issues would be part of the plan.

Requirements, Safety and Policy Issues

An important output from the preapplication interactions will be identification of applicable requirements, key safety and policy issues. This will involve looking at the requirements in 10 CFR (and their supporting Reg Guides) and identifying those that are unique to LWRs (and thus not applicable to the PBMR) as well as by looking at the PBMR design, technology and safety issues and identifying unique aspects that are not covered by current requirements.

The interactions with Exelon, our foreign partners and domestic experience described above, as well as the experience with the Ft. St. Vrain reactor, the review of a DOE sponsored modular HTGR in the late 1980s, and the ALWR reviews would be utilized in reviewing the applicability of the requirements and in identifying unique issues associated with the PBMR. It is expected that this will lead to the identification of certain safety and policy issues needing resolution in order to proceed with a review.

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It is likely that the issues will include such items as:

- how to ensure fuel quality over the life of the plant
- use of fuel enrichments greater than 5%
- what accidents should the plant be designed for?
- containment vs. confinement
- source term
- control rooms design and staffing
- extent of prototype testing necessary.
- reduced EPZ

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Policy issues would be provided to the Commission for guidance. A combination of traditional engineering and a risk-informed approach to addressing the issues would be utilized.

It is expected such safety and policy issues could be developed and provided to the Commission in approximately 18 months. Although RES would have the lead, this effort would involve close coordination with NRR and NMSS. The staff will also interact with ACRS and other stakeholders. As an interim step a preliminary set of the key safety and research issues associated with the PBMR would be provided to the Commission for information in approximately 9 months.

Expertise and Infrastructure Needs

Along with the identification of key technical and safety issues associated with the PBMR, the staff will also identify the infrastructure needs to be ready to review an actual application. This will include in-house and contractor expertise needs, analytical tools needs and the resources to obtain them. It is expected that the expertise needs will be in those areas unique to HTGR technology and include:

- fuel design, fabrication and performance
- high temperature materials performance
- helium turbine technology
- accident analysis

- HTGR risk analysis

A complete identification of infrastructure needs is, to some extent, dependent upon the identification and nature of the safety issues. However, regarding analytical tools it is desirable for the agency to have an independent capability to calculate the plant response to accidents, particularly, those related to loss of coolant, decay heat removal and reactivity insertion. Such independent capability is valuable in providing a deeper understanding of plant behavior under a wide range of off-normal conditions, which can result in insights that contribute to the quality and thoroughness of the staff review and determine confidence in information provided by the applicant. This approach has, in the past, led to the identification of significant safety issues which may have otherwise gone undetected (e.g., AP-600 fourth stage depressurization valve undersizing). Currently, NRC does not maintain any analytical tools, data bases or activities on HTGRs. The most recent efforts in this regard were approximately 10 years ago when the agency had underway a pre-application review of a DOE sponsored modular HTGR (MHTGR) design in accordance with the Commission's Advanced Reactor Policy Statement.

A draft pre-application safety evaluation on the MHTGR was issued in 1989 for comment (NUREG-1338); however, although a final NUREG was prepared in the early 1990s, it was never issued since DOE canceled the program. In developing NUREG-1338, the staff utilized contractor support and analytical tools from ORNL and Brookhaven National Laboratory (BNL). Since that time, ORNL has remained active in the HTGR field and currently supports DOE sponsored work on HTGRs for Pu disposition. Accordingly there is expertise at ORNL (including analytical tools) which the agency could draw upon in the preapplication phase to assist the staff in the identification of issues and approaches for the PBMR review, as well as getting the staff familiar with the available analytical tools, their basis and how to use them. In this regard, ORNL has available the GRSAC code (a three dimensional T/H code with point kinetics reactor physics) that they are using in assisting DOE and that is an improved version of a code used in the staff's review of the DOE modular HTGR ten years ago. Other expertise and codes are also available and those would be reviewed for their applicability and possible assistance.

Staffing, Training, Schedule and Resources

One outcome of the preapplication work would be the development of a small nucleus of staff familiar with HTGR technology and the unique attributes of the PBMR such that they can participate and facilitate an actual application review, if and when an actual application is received. This nucleus would include staff from RES, NRR and NMSS.

To help achieve this outcome a training program will also be included in the preapplication work. The training program will consist of information on basic HTGR technology, design, operation and experience. Contractor assistance will be used to develop the training program which will be targeted to be available in approximately one year.

The preapplication activities will be a joint RES/NRR/NMSS effort with RES having the overall lead.
Interoffice coordination and responsibilities would include:

- RES Role (overall lead for project)
  - organize, conduct and document meetings
  - organize and participate in ACRS presentations and stakeholder workshop
  - draft SECY papers
  - preliminary identification of issues, research needs, applicable requirements, etc.

- NRR Role (overall lead for process issues related to the actual application)
  - participate with RES on preparing papers, participate in meetings, giving presentations, identifying technical issues
  - concur on all papers to ACRS, EDO or Commission

- NMSS Role (overall lead for fuel fabrication, transportation waste and safeguards issues)
  - participate with RES on team preparing papers, participate in meetings, giving presentations, identifying technical issues

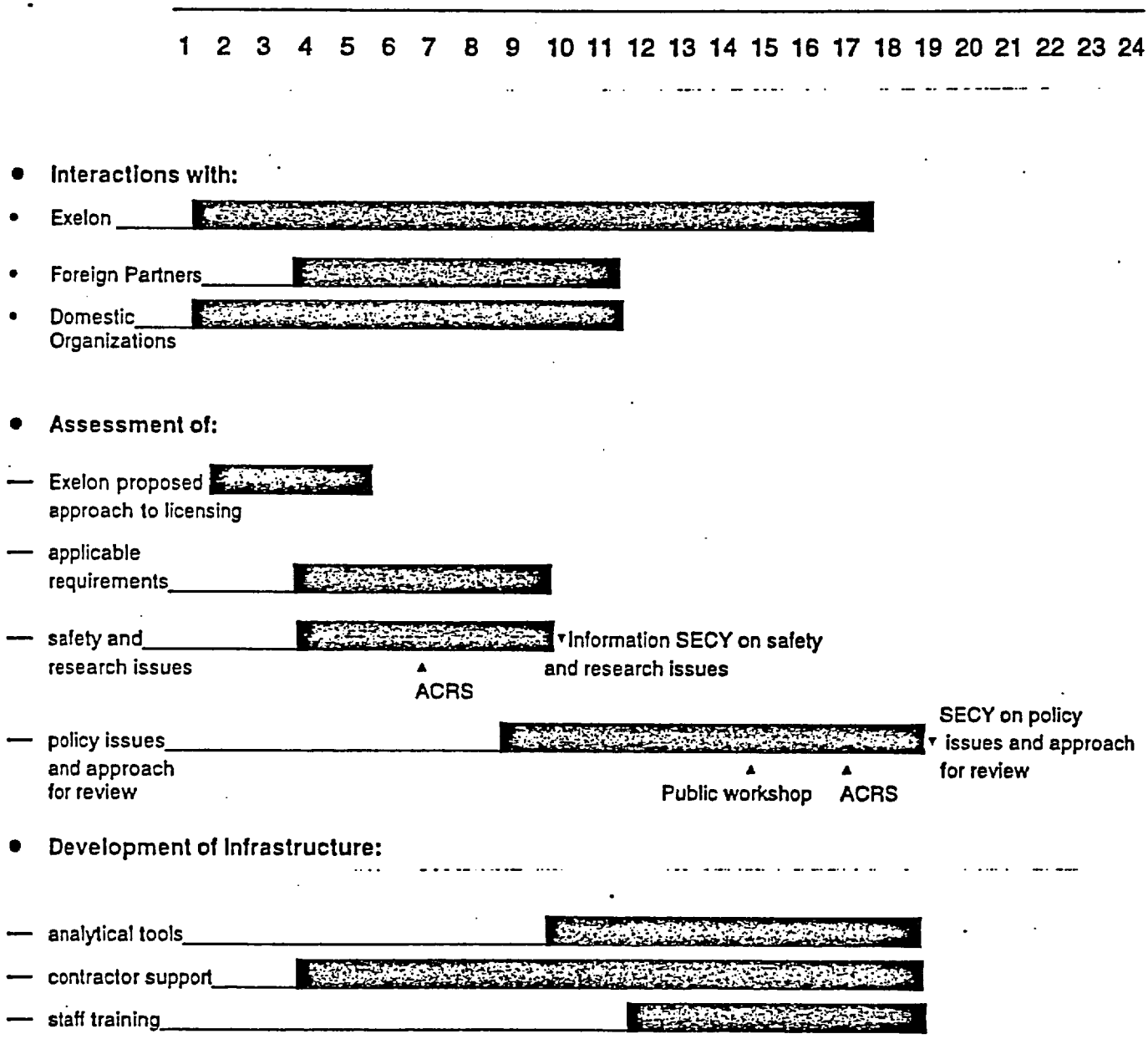
- concur on papers to ACNW, EDO or Commission involving fuel fabrication, transportation, waste or safeguards issues

- OGC Role (overall advise on legal matters)

NRC staff work would focus on the review of applicable requirements, identification of important accident scenarios, infrastructure, research and resource needs. Contractor work would focus on review of PBMR analytical tools, training, and calculational support

A schedule for the activities described above is shown in the attached figure. It is recognized that this schedule is dependent upon many factors, however, it does represent the approximate time (18 months) necessary to accomplish the preapplication activities.

To accomplish the preapplication activities, it is expected that approximately 7 FTE will be necessary over the 18 month period. This will include four FTE in RES, two in NRR and one in NMSS. Also, for contractor support in providing training, reviewing analytical tools and providing calculational assistance to the staff it is estimated that 1000K will be needed over the 18 month period.

RES 4
NRR 2
NMSS 1
7

Preliminary Schedule for PBMR Preparatory Activities (in months)