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ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

NRC Project No. 732

Attention: Mr. N. Prasad Kadambi

Subject: PBMR Preapplication Phase 2 Interactions

This letter provides a summary of the preapplication outcome objectives and planned white paper submittals that PBMR (Pty) Ltd proposes to pursue during Phase 2 of the design certification preapplication interactions. This program is the result of our pre-application planning discussions from June through November of this year. Enclosure 1 provides a brief background for each focus topic and identifies the preapplication outcome objectives and planned white paper submittals. Enclosure 2 provides a table of planning dates for submittal of the papers, workshops and receipt of feedback from the NRC.

The general approach that PBMR (Pty) Ltd proposes for Phase 2 is to conduct initial familiarization sessions for the assigned NRC reviewers on the PBMR design, operations and safety approach followed by submittal of individual white papers addressing each of the focus topics identified during the Phase 1 Planning. Each white paper will comprise a substantive discussion on a specific topic, including technical, regulatory and policy issues pertinent to the topic. PBMR will also submit a comprehensive version of the format and content guide akin to RG 1.70 tailored to the submission of a non-LWR DC application. This last activity is intended to assure the requirements for a complete, high quality application are understood well in advance of the application submittal. .

To achieve these objectives, PBMR (Pty) Ltd proposes the following multi-step interactions:

- Following submittal of each white paper (or other defined product for NRC review and discussion for the defined outcome objectives), PBMR (Pty) Ltd would conduct a workshop to allow a free exchange on the content of the submittal, assuring a reasonable understanding of the paper intent. PBMR will

also provide the draft design certification application (DCA) section content specification for the topic during the workshop.

- The NRC reviews the white paper and provides formal RAI's to PBMR (Pty) Ltd for the outcome objectives identified. NRC also provides feedback on the content specification for the DCA for the focus area.

- PBMR (Pty) Ltd will review the RAIs, formulate proposed responses, and then conduct a follow-up workshop to discuss the RAIs and responses. This 2nd workshop also affords the opportunity for PBMR (Pty) Ltd and the NRC to agree on the final scope of the DCA content specification for the topic.

- A revised white paper that reflects NRC's feedback from the RAI process would then be submitted to the NRC to complete the PBMR preapplication inputs to NRC.

- NRC will document its conclusions on each focus area and identify any remaining issues for the DCA to address. NRC also confirms the final consolidated format and content guide for the PBMR application.

PBMR (Pty) Ltd will answer whatever questions you may have about the white papers submittal schedule and review approach in our upcoming meeting planned for December 12, 2005. To assist in our planning, PBMR (Pty) Ltd requests that the NRC provide a response no later than January 13, 2006 on the acceptability of our proposed dates for the familiarization sessions.

PBMR (Pty) Ltd. appreciates the opportunity to meet with the NRC as we initiate the next phase of our preapplication interactions. I would be pleased to answer any questions that you may have.

Yours sincerely,

Edward G. Wallace
Senior General Manager- US Programs
PBMR (Pty) Ltd

Enclosures

cc: Mr. Farouk Eltawila, RES
Mr. James Danna, RES
Mr. James Kim, NRR
Ms. Margaret T Bennett, RES
Mr. Stuart J. Rubin, RES

Preapplication Outcome Objectives and White Papers Overview

Licensing Basis Event Selection:

The definition and selection of licensing basis events (LBEs) is fundamental in safety analysis. For non-LWRs, the process for LBE selection is not well established in current regulatory practice or requirements. Modem techniques, including the role of probabilistic risk analysis insights, provide a broader base of plant understanding for safety analysis purposes when coupled with traditional deterministic methods. The issue is to establish the mechanisms and approaches to selecting LBEs for the PBMR design using a combination of probabilistic and deterministic methods.

The PBMR PRA will address all modes of operation including shutdown, and internal/ external events, and will include a comprehensive treatment of initiating events, sequences, and end states. PBMR's approach includes applicable operating experience from power industry including Light Water Reactors (LWRs), Magnox, Advanced Gas Reactors (AGRs), and High Temperature Gas Reactors (HTGRs). PBMR design characteristics support the use of integrated event tree structure from initiating events to end states for accident family consequences and frequencies, including uncertainties.

The outcome objectives for the preapplication review are:

- Agreement on LBE selection method:
  - Use of PRA to select a comprehensive set of event sequences
    Inclusion of multiple and common cause failures
    Treatment of events affecting more than one reactor module
    Inclusion of external events and shutdown events
    Inclusion of statistically-combined uncertainties in frequencies and consequences
    Highlight defense-in-depth by explicitly considering all SSCs capable of performing a safety function
  - Based on the mean frequencies of event sequences per plant year
  - Event sequences < TBD/plant year need not be considered
- Agreement on the role of defense-in-depth in LBE selection
- Understanding of how PBMR's LBE selection process is aligned with the Staff's technology-neutral licensing framework initiative
- Understanding of the scope of documentation required in the DCA

PBMR (Pty) Ltd plans to submit two white papers that discuss:

- PRA approach
- LBE selection

Structures, Systems and Components Classification and Defense-in-Depth:

The classification of structures, systems and components (SSCs) stems from the role of each in preventing or mitigating licensing basis events. Whereas the approach to SSC safety classification for LWRs has evolved over several decades, the development of an acceptable approach for non-LWRs with a unique set of design basis event challenges has not been established. Advanced reactors contain inherent features and passive safety-related SSCs that have no reliance on AC power or other conventional active means of assuring safety. How defense in depth is factored into the design and the treatment of inherent and passive capabilities are different than traditional LWR conditions and require clarification of the requirements for advanced gas reactors. The issue is to establish the proper approach for determining the safety classification and special treatment for PBMR SSCs relied on or providing added safety margins during LBEs.

The outcome objectives for the preapplication review are:

- Clarity on what is meant by safety classification
- Agreement on the process by which SSCs are classified as safety-related and their regulatory special treatment
- Clear understanding of the kinds of regulatory review and treatment to be applied to SSCs that are not classified as safety-related
- Agreement on the definition and role of defense-in-depth within the PBMR design
- Understanding of how the PBMR's SSC classification process is aligned with the Staff's technology-neutral licensing framework initiative
- Understanding of the scope of documentation required in the DCA

PBMR (Pty) Ltd plans to submit white papers that discuss:

- SSC classification
- Defense-in-depth

Materials Selection and Codes & Standards:

The design philosophy for PBMR differs from that of LWR designs seeking design certification. The PBMR design makes extensive use of materials that conform to codes and standards found acceptable by the NRC in prior applications. However, PBMR utilizes several materials that, while known to the NRC, are used outside limits previously accepted. In select cases, PBMR uses materials that the NRC has not reviewed. Existing rules for LWR design codes, standards, regulations, and guidelines are not always directly applicable to HTGRs. In some cases new codes

and standards specific to HTGRs are needed. The PBMR design will also include ASME Code Cases not previously approved by the NRC.

The issue is to demonstrate the adequacy of PBMR's materials selection and qualification processes through confirmation of the acceptability of the unique suite of codes and standards used in the PBMR design. This issue contains subdivisions on carbon based ceramic materials, and metallic materials.

Processes to be addressed during preapplication include PBMR's process for material selection, including consideration of the operating environment and its effect on the performance of each material, and the process to determine material qualification requirements. The preapplication focus is on materials whose required performance falls outside existing codes and standards, with particular emphasis on confirming the adequacy of performance of materials designed to first principles.

The outcome objectives for the preapplication review are:

- Codes and standards
  - understanding of PBMR's use of NRC accepted conventional codes and standards where applicable
  - understanding of PBMR's use of other codes, code cases, and standards and the level of justification documentation required
  - confirmation of approach toward development of HTGR specific codes and standards where needed
  - identification of additional issues/questions that need to be clarified about the approach to these issues or documentation required in the design certification application (DCA)
- High temperature materials selection
  - agreement on the PBMR approach to materials selection and qualification
  - understanding of regulatory acceptance criteria for material qualification programs
  - understanding of the extent of DCA documentation required to describe the effects of helium chemistry, including impurities, during normal and upset conditions which affect component lifetimes and reliability

PBMR (Pty) Ltd plans to submit white papers that discuss:

- High temperature materials
  - the use of carbon based ceramic high temperature materials in the PBMR core structures
  - the use of high temperature metallic materials within the reactor and primary systems
- Electrical and I&C systems
- Inservice inspection

Fuel Design and Qualification:

A fundamental aspect of the PBMR application is the robustness of the PBMR TRISO coated particle fuel. The production of high quality fuel is essential for ensuring the retention of fission products during both normal operating and potential accident conditions. A set of well-defined manufacturing process and quality controls is critical to the consistent production of high quality fuel. The issue is to demonstrate the adequacy of the PBMR fuel qualification program through confirmation of the fuel performance envelope, the methods used to show conformance with that envelope, and the methods used to show equivalence in the German vs. PBMR fuel design and manufacturing process.

The outcome objectives for the preapplication review are:

- Identification of scope of the fuel qualification test program
- Agreement on methods and monitoring to confirm that the fuel design complies with the performance envelope
- Understanding of the scope of documentation required in the DCA

PBMR (Pty) Ltd plans to submit three white papers that discuss:

- Irradiation test program and performance envelope
- Operating controls and monitoring limits
- Fuel manufacturing process and production controls

Analytical Code Verification and Validation:

Analytical tools used to assess the PBMR plant responses to normal, abnormal and accident conditions will be reviewed by the NRC as part of the design certification. While many of the PBMR safety related computer codes and evaluation models are familiar to the NRC, several of the codes, evaluation models, and applications are not. Early NRC review, especially of some of the tools developed by German and South African designers (unfamiliar to the NRC), would be beneficial to ensure an efficient DCA review. The issue is to confirm that PBMR's computer model verification and validation (V&V) processes and use of evaluation models and code suites are properly developed and suitable for use in the DCA.

The PBMR V&V process for safety related computer codes closely follows the process described in NRC's draft Regulatory Guide DG-1120, "Transient and Accident Analysis Methods". Included is the use of Phenomena Identification and Ranking Tables (PIRTs) to help identify and rank the factors, characteristics, and phenomena associated with normal operation, design basis events, severe accidents, etc. Additionally, existing test data on TRISO fuel and data from existing/

planned test facilities in South Africa and elsewhere are expected to fully support the safety related computer code V&V process.

The outcome objectives for the preapplication review are:

- Agreement on the PBMR Evaluation Model Development and Assessment Process (EMDAP)
- Agreement on the scope of the evaluation model/computer code suites used in the PBMR safety analyses
- Agreement on the scope for the PBMR test program for computer code / evaluation model V&V
- Understanding of the scope of documentation required in the DCA

PBMR (Pty) Ltd plans to submit a series of white papers that discuss:

- PBMR's EMDAP process
- PIRT comparisons and application to the PBMR design
- the evaluation models and code suites used in
  - fuel response modeling
  - systems response modeling
  - source terms and releases modeling
- PBMR test program

Single vs. Multi-Module Certification:

The modular approach to the PBMR design allows for the placement of one, two, four, or more modules as an integrated plant within a contiguous structure at a single site. The issue is how best to encompass these variations of the basic module design within the context of a Part 52 design certification. The feasibility of obtaining a design certification on a single reactor module and having that certification apply to any subsequent combination of modules is the crux of this issue. PBMR's approach will be to establish that the safety case can be developed on a single module basis with appropriate requirements to ensure that there are no interfaces or adverse feedbacks from additional modules that could invalidate the safety of the plant.

The outcome objectives for the preapplication review are:

- Agreement on approach
  - The fundamental safety case can be established on a single module basis.
  - Interface requirements can be specified for systems that are wholly or partially outside the scope of the PBMR basic module that assure that module safety is maintained and an understanding of what those interface requirements must address.

  - Shared systems, common cause failures, and systems interactions criteria are addressed in the DCA and verified during COL review.
- Understanding of the level of detail needed to describe the various options for the configuration of the design, including variations in, or sharing of, common systems as well as the information needed to define boundary conditions for simultaneous operations and construction.

PBMR (Pty) Ltd plans to submit one white paper that discusses the design, safety and regulatory implications of a single module design certification approval.

Physical Security Protection by Design:

The NRC Staff recently received approval from the Commission of its proposal to initiate rulemaking requiring applicants to submit a security assessment and target set analysis. The benefits of the rulemaking are that nuclear plant designers would analyze and establish, at an earlier stage, security design aspects such that there would be an improvement in overall facility design resulting in a more robust and effective security posture, and less reliance on operational security programs.

The outcome objectives for the preapplication review are:

- Review of recommended NRC policy statements / current practices for access to DBT information for plant designers
- Development plan for security feature assessment of design for a PBMR plant
  - Importance of inherent and passive safety in design
  - Importance of slow response behavior
  - Understanding of site specific conditions that could influence physical module/plant design
- Obtaining review and feedback on preliminary physical security assessment
- Understanding on the scope of documentation required in the DCA

PBMR (Pty) Ltd plans to submit a preliminary physical security assessment during the preapplication period. The timing and scope of the submittal will be determined following additional discussions with NRC Staff and obtaining of security clearances for select PBMR individuals.

Administrative Matters – DCA Specification

Within each of the focus topic areas there is a need to obtain an understanding of the scope of the documentation required to be submitted in the DCA. The existing guidance for structuring a DCA is based on the use of the format and content provided in Regulatory Guide 1.70, with additional guidance on the development of a Design Control Document (DCD) obtained through recent DC applications. While

most of this LWR derived documentation structure is usable, some aspects require modification for a gas-cooled reactor design and to address the modular design of the PBMR. The concurrent development of the DCA content specification during preapplication will assure that both PBMR and NRC are aligned on the format and content of the DCA including the information on unique characteristics of an advanced gas reactor when the DCA is submitted.

PBMR (Pty) Ltd plans to submit a DCA specification that outlines the proposed format and content of the PBMR Design Control Document (DCD).

PBMR Preapplication Phase 2 Interactions Schedule (2006–*2007*)

Familiarization Sessions	**Duration**	**Timing**
Plant layout and systems, and fuel design / fueling operations	2-3 days	Feb 28 – Mar 2
Safety design and analysis, and plant operations and events	2 days	Mar 15-16

White Papers	**Submittal of White Paper**	**1st Workshop**	**Issuance of RAIs**	**2nd Workshop**	**Submittal of Revised White Paper**	**Final NRC Feedback***
LBE Selection						
PRA approach (A)	May 1	mid-July	end of Aug	mid-Oct	November	*January 2007*
LBE selection (A)	May 1	mid-July	end of Aug	mid-Oct	November	*January 2007*
SSC Classification and Defense-in-Depth						
SSC classification (A)	June 19	end of July	mid-Sep	mid-Oct	December	*February 2007*
Defense-in-depth (A)	June 30	end of July	mid-Sep	mid-Oct	December	*February 2007*
Materials Selection and Codes & Standards						
High temperature materials – ceramics (A)	May 1	mid-June	mid-July	end of Sep	November	*January 2007*
High temperature materials – metallics (A)	June 1	mid-June	mid-Aug	end of Sep	November	*January 2007*
Electrical and I&C systems (C)	June 30	end of July	mid-Sep	end of Oct	December	*February 2007*
Inservice inspection (B)	June 30	end of July	mid-Sep	end of Oct	December	*February 2007*
Fuel Design and Qualification						
Irradiation test program and performance envelope (A)	May 15	end of July	end of Aug	end of Oct	December	*February 2007*
Operating controls and monitoring limits (A)	June 30	end of July	end of Aug	end of Oct	December	*February 2007*
Fuel manufacturing process and production controls (B)	Aug 18	mid-Sep	end of Oct	December	*February 2007*	*April 2007*

White Papers	Submittal of White Paper	1st Workshop	Issuance of RAIs	2nd Workshop	Submittal of Revised White Paper	Final NRC Feedback*
Analytical Code V&V*						
EMDAP process (A)	May 1	mid-May	mid-July	end of Aug	October	December
PIRT comparisons and application to PBMR design (A)	June 19	mid-July	end of Aug	mid-Oct	December	*February 2007*
Fuel response modeling (A)	July 14	end of July	mid-Sep	end of Oct	December	*February 2007*
Systems response modeling (A)	Sep 1	mid-Sep	mid-Nov	*January 2007*	*February 2007*	*April 2007*
Source terms and releases modeling (B)	Oct 2	mid-Oct	mid-Dec	*February 2007*	*April 2007*	*June 2007*
PBMR test program (A)	July 14	end of July	mid-Sep	end of Oct	December	*February 2007*
Single vs. Multi-module Certification						
Design, safety and regulatory implications for modular design (A)	Aug 18	mid-Sep	end of Oct	December	*February 2007*	*April 2007*
Physical Security Protection by Design						
Preliminary physical security assessment (B)	TBD					
Administrative Matters						
Design certification application specification (B)	June 30	n/a	end of Sep	n/a	*February 2007*	*June 29, 2007*

(A, B, C – PBMR Priority, A high)

* Issues that contain NRC policy matters may have a later final feedback date as needed to complete the policy work. All feedback is requested no later than December 2007.