



**Office of Nuclear Regulatory Research
Summary of Advanced Reactors Activities
June 4, 2001**

John H. Flack (Branch Chief) and Stuart D. Rubin (Senior Advisor) from the Division of Systems Analysis and Regulatory Effectiveness (RES), Regulatory Effectiveness and Human Factors Branch (REAHFB), provided an overview of the historical and current role of RES in pre-application reviews of advanced reactors. Pre-application interactions with potential licensee applicants will help NRC prepare for future submittals, through the development of the infrastructure necessary for licensing application reviews. RES has the lead for non-LWR advanced reactor pre-application initiatives and longer-range new technology initiatives. An advanced reactor group has been formed in REAHFB, and is currently performing a pre-application review of Exelon's Pebble Bed Modular Reactor. Recent industry requests for future pre-application interaction include General Atomics' Gas Turbine-Modular Helium Reactor (GT-MHR) and Westinghouse International Reactor Innovative and Secure (IRIS) design. RES advanced reactors activities also include participation as an observer in DOE's Generation IV initiative.

Pre-Application review objectives include the development of regulatory guidance, licensing approach, and technology-basis expectations for licensing advanced designs, including identifying significant technology, design, safety, licensing and policy issues that would need to be addressed in the licensing process. In addition, the pre-application review will help to develop necessary analytical tools, obtain contractor support, train staff to achieve fully the capacity and the capability to review advanced reactor license applications.

The presentation described the pre-application process for the Exelon PBMR. NRC first identifies additional information following topical meetings with Exelon, and Exelon formally documents and submits required topical information. The staff then develops a preliminary assessment and drafts a response which is followed by stakeholder input and comments at a public workshop. Preliminary assessments are discussed with ACRS and ACNW, and Commission papers are written which provide staff positions and recommendations on proposed policy decisions. Some of the significant areas for the PBMR include:

- Process Issues, Legal & Financial Issues
- Regulatory Framework
- Fuel Performance and Qualification
- Traditional Engineering Design (e.g, Nuclear, Thermal-Fluid, Materials)
- Fuel Cycle Safety Areas
- PRA, SSC Safety Classification
- PBMR Prototype Testing

Sources of expertise for the PBMR include, RES, NRR, NMSS, OGC technical expertise and associated regulatory experience, contractor support from National Labs,

prior NRC Modular HTGR pre-application review experience, design, operating and safety review experience for Fort St. Vrain HTGR, International HTGR experience including IAEA, Japan, China, Germany, UK, and external stakeholder comments, ACRS and ACNW advice and insights.



*United States
Nuclear Regulatory Commission*

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Introduction

- Historical role of RES in preapplication reviews
- Preapplication review of advanced reactors
- Current role of RES in advanced reactor reviews
- Advanced reactor group in Division of Systems Analysis and Regulatory Effectiveness (RES)

Advanced Reactor Activities

- Advanced reactors have greater reliance on new technology and safety features.
- Preapplication interactions and reviews will help NRC prepare for licensing application
- NRR has lead with RES support for LWR advanced reactor preapplication initiatives and licensing application reviews
- NMSS has lead for fuel cycle, transportation and safeguards
- RES has lead for non-LWR advanced reactor preapplication initiatives and longer-range new technology initiatives
- Recent industry requests for preapplication interactions:
 - Westinghouse: AP1000 (5/4/00)
 - Exelon: Pebble Bed Modular Reactor (12/5/00)
 - General Atomics: Gas Turbine-Modular Helium Reactor (3/22/01)
 - Westinghouse: International Reactor Innovative and Secure (4/06/01)
- NEI Risk-Informed framework for Advanced Reactor Licensing

RES Advanced Reactors Activities

- PBMR:
 - Request for pre-application interactions received from Exelon
 - NRC response
 - Plan developed (SECY-01-0070)
 - Pre-application work underway (FY2001-2002)
 - Objective - identify issues, infrastructure needs and framework for PBMR licensing
 - Develop nucleus of staff familiar with HTGR technology
- GT-MHR
 - Request for pre-application interactions received from General Atomic
 - NRC Response

RES Advanced Reactors Activities (cont.)

- IRIS
 - Developed under DOE-NERI program
 - Initial meeting on 05/07/01

- Generation IV
 - International activity coordinated by DOE
 - Longer term
 - NRC participating as an observer

- Generic Framework:
 - NEI developing proposal
 - Need for NRC to establish an effective and efficient risk-informed, and where appropriate, performance-based licensing framework

Significant Technology Issues:

- Unique, First of a Kind Major Components
- Fuel Design, Performance, Qualification, & Manufacture
- Source Term
- Thermal-Fluid Flow Design
- Hi-Temperature Performance
- Containment
- Fuel Cycle Safety & Safeguards
- Prototype Testing and Experiments
- Human Performance and I&C
- Probabilistic Risk Assessment Methodology and Data
- Emergency Planning
- Regulations Framework
 - design basis accident selection
 - safety classification
 - acceptance criteria
 - GDC,
 - use of PRA
 - Safety Goals

PBMR Pre-Application Review Objectives

- To develop guidance on the regulatory process, regulations framework and the technology-basis expectations for licensing a PBMR, including identifying significant technology, design, safety, licensing and policy issues that would need to be addressed in licensing a PBMR.
- To develop a core infrastructure of analytical tools, contractor support, staff training and NRC staff expertise needed for NRC to fully achieve the capacity and the capability to review a modular HTGR license application.

PBMR Pre-Application Review Guidance

- Commission Advanced Reactor Policy Statement
- NUREG-1226 on the Development And Utilization of the Policy Statement
- Previous Experience with MHTGR Pre-Application Review
- Identify Safety, Technology, Research, Regulatory & Policy Issues

PBMR Pre-Application Review Scope

Selected Design, Technology and Regulatory Review Areas:

- Fuel Design, Performance and Qualification
- Nuclear Design
- Thermal-Fluid Design
- Hi-Temp Materials Performance
- Source Term
- Containment Design
- PBMR Regulatory Framework
- Human Performance and Digital I&C
- Prototype Testing Program
- Probabilistic Risk Assessment
- Postulated Licensing-Basis Events
- Fuel Cycle Safety
- Emergency Planning
- SSC Safety Classifications

PBMR Pre-Application Review Process

- Conduct Periodic Public Meetings on Selected Topics:
 - Process Issues, Legal & Financial Issues, Regulatory Framework (4/30)
 - Fuel Performance and Qualification (6/12-13)
 - Traditional Engineering Design (e.g., Nuclear, Thermal-Fluid, Materials)
 - Fuel Cycle Safety Areas
 - PRA, SSC Safety Classification
 - PBMR Prototype Testing
- NRC Identifies Additional Information Following Topical Meetings
- Exelon/DOE Formally Documents and Submits Topical Information
- NRC Develops Preliminary Assessment and Drafts Documented Response
- Obtain Stakeholder Input and Comments at a Public Workshop
- Discuss Preliminary Assessments With ACRS and ACNW
- Commission Papers Provide Staff Positions and Recommend Policy Decisions
- Commission Provides Policy Guidance and Decisions
- NRC Staff Formally Responds to Exelon with Positions and Policy Decisions

PBMR Pre-Application Review Sources of Expertise

- RES, NRR, NMSS, OGC Technical Expertise and Regulatory Experience
- Contractor Support From National Labs and Design/Technology Experts
- Prior NRC Modular HTGR Pre-Application Review Experience
- Design, Operating and Safety Review Experience for Fort St. Vrain HTGR
- International HTGR Experience: IAEA, Japan, China, Germany, UK
- Exelon and DOE Design, Technology and Safety Assessments
- External Stakeholder Comments
- ACRS and ACNW Advice and Insights

PBMR Safety Significant Review Issues/Topics

- Fuel Performance and Qualification
 - High Temperature Material Issues
 - Passive Design and Safety Characteristics
 - Accident Source Term and Basis*
 - Postulated Licensing Basis Events*
 - Prototype Testing Scope and Regulatory Credit
 - Containment Functional Design Basis*
 - Emergency Planning Basis*
 - Risk-Informed Regulatory Framework*
 - Probabilistic Risk Assessment
- * Commission Policy Decision Likely Is Needed

PBMR Pre-Application Review Schedule

- About 18 months to Complete
- Monthly Public Meetings To Discuss Topics
- Feedback on Legal, Financial and Licensing Process Issues (~9/01)
- Feedback on Regulatory Framework (~12/01)
- Feedback on Design, Safety, Technology & Research Issues (~6/02)
- Feedback on Policy Issues (~10/02)

Regulatory Infrastructure Development Needs

- Staff Training Course for HTGR Technology
- Analytical Codes and Methods for Advanced Reactor Licensing Reviews
- Regulatory Framework for Advanced Reactor Licensing Reviews
- Core Staff Capabilities for Advanced Reactor Licensing Reviews
- Contractor Technical Support Capabilities
- Possible RES Confirmatory Testing and Experiments
- Possible Codes and Standards for Advanced Reactor Design and Technology

G. Apostolakis, Chairman, ACRS: If someone comes to you using Part 52, is there anything there that says that you need the risk-informed, performance-based system?

J. Flack, RES: There's nothing in Part 52 that says that we need to have a risk-informed, performance-based licensing approach.

G. Apostolakis, Chairman, ACRS: So they could approach the licensing issue without using risk information. Could they?

J. Flack, RES: Yes, I would expect that would be the case.

G. Apostolakis, Chairman, ACRS: Is there anything that gives you the authority to request risk information?

J. Wilson, NRR: The Part 52 licensing process is just that, it's a licensing process, and so it references back to parts 20, 50, 70 and 100 for the actual safety requirements. So whether or not those safety requirements remain as they are or change as a result of some risk-informed process, it will use whatever is the requirement that's currently in place.

G. Apostolakis, Chairman, ACRS: What if the industry doesn't want to use risk information? What if they just want to use existing regulations with exemptions or changes and maybe they feel that going to a risk-informed system adds an impediment because we have to understand it and do it. It's new. And try to go with the existing system and maybe a PRA would be an assessment at the end if you guys request it but maybe it will be a good idea not to bring it up at all. Why is that the need?

J. Flack, RES I think it would be to their advantage to come in that way.

G. Apostolakis, Chairman, ACRS: We heard today from several speakers, I think, that they're trying to reduce involvement of the humans. Do you think that the human performance issue will be as important here as in the current reactors?

J. Flack, RES: I've discussed this at length. I don't know whether we can say it's going to be less important. I mean it's going to be a different environment which that human operates in, and one has to understand that environment and what's changing in that environment. So it's something that one has to look at very carefully. So it's hard to say.

D. Powers, ACRS Member: It seems to me that the change is really entertaining and in the direction that's most difficult for us because as they design the plants to be less and less dependent on the human operator intervening. We become more and more worried about the fact that the operators are not going to sit there and do nothing. They will intervene and the potential for them to intervene incorrectly in a system that's designed to operate with rather minor low head forces operating on it. So you get into

the problem of errors of commission that we are most incapable of addressing. It's a subtle problem.

J. Flack, RES: Yes. The environment changes and you don't really have as much data as you wish you'd have to go on.

J. Garrick, Chairman, ACNW: This is probably the question that I was half asleep on when George asked the question about the risk assessment. But you mentioned that on the PBMR you're going to get a risk assessment. What's the nature of that? Has that been requested?

S. Rubin, RES: We have urged Exelon to provide as much information on the current risk assessment that they've done for the plan to support our review of this risk-informed framework for making licensing decisions. I wouldn't call it a risk-informed regulations framework as the extent of wholly replacing Part 50 but we think we now understand that this framework is not quite going to do that but will through risk insights be able to identify systems requirements for mitigation, prevention, the level of redundancy in those systems, which systems should be designated as safety significant and also things like what are the special treatment requirements on the system. But we're not talking about a regulations framework which covers all of Part 50.

But to answer your question, we have asked for that and we've also asked, to the extent possible, that we get information on the design itself. We have not yet, except for these kinds of viewgraphs that we've seen today, gotten what I would call a significant design description and principles of operation document from Exelon. I think the staff would very much like to get both a PRA and a design description so we have a context for reviewing this framework. It is on our schedule. We talked about that. It's not now but it is later.

