

June 6, 2012

MEMORANDUM TO: Amy E. Cabbage, Chief  
Policy Branch  
Division of Advanced Reactors and Rulemaking  
Office of New Reactors

FROM: Jonathan DeGange, Project Manager */RA/*  
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SUBJECT: SUMMARY OF APRIL 16-17, 2012, PUBLIC MEETINGS ON  
RISK-INFORMED PERFORMANCE-BASED LICENSING APPROACH  
AND FUEL QUALIFICATION AND MECHANISTIC SOURCE TERMS  
FOR THE NEXT GENERATION NUCLEAR PLANT PROJECT

On April 16-17, 2012, U.S. Nuclear Regulatory Commission (NRC) staff held two public meetings as part of its ongoing pre-application interactions with the U.S. Department of Energy (DOE) and its Idaho National Laboratory (INL) for DOE's Next Generation Nuclear Plant (NGNP) Project. The meetings were held at the NRC headquarters offices in Rockville, MD. The purpose of the meetings was to discuss issues identified in two recently completed NRC assessment reports on five white papers submitted by INL on behalf of the NGNP Project. The April 16<sup>th</sup> meeting addressed the three INL white papers that describe the proposed risk-informed, performance-based (RIPB) approach for NGNP licensing. The April 17<sup>th</sup> meeting addressed issues noted in the NRC assessment of the INL white papers on NGNP fuel qualification (FQ) and mechanistic source terms (MST). The meetings were the first in a proposed series of working meetings to be held over the coming months.

The associated meeting notices are available at NRC's Agencywide Documents Access and Management System (ADAMS) under accession numbers ML120930343, *Risk informed Performance Based Licensing Approach*, and ML12094A139, *Fuel Qualification and Mechanistic Source Terms*. The following provides a brief summary of the meetings.

### **Summary**

Dr. Donald Carlson, Policy Branch, Division of Advanced Reactors and Rulemaking (DARR), Office of New Reactors (NRO), opened the meetings on April 16<sup>th</sup> with an introduction and brief summary of the meeting agendas. The meetings addressed the following topics.

1. General Update on NGNP Interactions
2. Overview of Proposed RIPB NGNP Licensing Approach
3. Discussion of NRC Issues on NGNP FQ and MST

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### **General Update on NGNP Interactions**

Mr. Michael Mayfield, Director, DARR, opened the meeting with a brief summary of the status of NGNP interactions and noted that the current NRC assessment reports are not NRC staff positions but those of NRC working groups. Mr. Mayfield further established that the objective of interactions in 2012 is to potentially update the understanding and resolution of assessment open items so that they become NRC staff positions. Mr. Mayfield explained that an Advisory Committee on Reactor Safeguards subcommittee briefing on issues and resolutions is foreseen, but a SECY document will not be submitted to the Commission until it is clear that an application will be submitted. Mr. Mayfield also noted that the NRC is looking to the industry for a proposal on resolution of issues related to emergency planning for small modular reactors.

### **Overview of Proposed RIPB NGNP Licensing Approach**

INL staff gave a comprehensive overview of the RIPB approach proposed for NGNP licensing, with a focus on licensing basis event selection methodology. Slides of the presentation can be found in ADAMS (ML12104A150). INL staff answered many questions raised by NRC staff during the overview about a number of different issues associated with the proposed licensing approach, and a dialog between INL and NRC staff ensued.

Michelle Hart (NRO/DSEA/RPAC/RDAT) noted that since Title 10 of the *Code of Federal Regulations*, Part 20 reflects an annual limit, NGNP's proposed Frequency-Consequence curve would not assure compliance with this regulation. INL responded, stating that they recognize this and that the future license applicant will have to address this topic. Additionally, one of NRC's consultants noted a possible inconsistency in the NGNP white papers related to assumed plant lifetime. INL noted this and acknowledged the need to check to see if the 60-year life assumed for a "plant" in the RIPB papers is consistent with other NGNP white papers.

Issues regarding potential confusion over interpretation of the definition of anticipated operational occurrences (AOOs) were brought to attention by NRC staff. INL staff identified the need to highlight differences between AOOs that would be covered in Chapter 11 versus Chapter 15 of a future safety analysis report. INL staff indicated that they would either clarify their terminology or develop new terminology to eliminate this confusion.

During discussions of the expected events to be found in Chapter 15, Sudhamay Basu (RES/DSA/FSCB) noted that 8 of the 11 design basis accidents for the Modular High Temperature Gas Cooled Reactor (MHTGR) - another high temperature gas-cooled reactor (HTGR) design that NRC has reviewed have event sequences that fall in the Beyond Design Basis Event (BDBE) range. The need to decide whether future license application contents will include BDBEs in Chapter 15 or in Chapter 19 was then discussed. INL staff then agreed to expand upon this topic with the staff at a future meeting.

INL staff requested NRC staff review of INL's NGNP Probabilistic Risk Assessment (PRA) methodology white paper (ML11265A082). Additionally, INL staff agreed on the need to

establish a punch list of the current issues related to functional containment. In support of this, NRC requested that NGNP provide a list of previously transmitted documents and/or slide sets so that they can begin a more focused review of this topic. The NRC staff and NGNP agreed to have a conference call approximately two weeks after the current meeting to define the items to be addressed at the next meeting with INL.

### **Discussion of NRC Issues on NGNP FQ and MST**

INL discussed with staff a number of issues from the NRC assessment report of the INL white papers on NGNP FQ and MST. A tabulated summary of issues was used for discussion during the meeting and can be found in ADAMS (ML12104A212). Discussions during the meeting focused on the issues noted in table items 2, 3, 7, 9, 10, 12, 13, 15, 16, 17, 21, 28, 36, 38, 39, and 41.

INL and NRC staff held in-depth discussion on the nature of the physical environment for fuel irradiation tests in the Advanced Test Reactor (ATR) at INL, with emphasis on the issue of plutonium burnup (fissions from bred plutonium) in fuel irradiated in the ATR test rigs versus in the NGNP reactor core. NRC previously requested data from INL regarding parameters that address maximum plutonium burnup and maximum time-at-temperature. The NRC working group stated that they have given consideration to performing independent NRC analyses of test irradiation conditions in the ATR and associated fuel burnup isotopics and would be willing to pursue arrangements for gaining access to the detailed ATR information that would be needed for doing so.

Related issues of palladium interactions with the silicon carbide (SiC) fuel coating layer were also discussed. NRC agreed that effects of rare earths are not a concern based on INL's responses to related requests for additional information. INL staff concluded that the NGNP Project will consider how to provide the information of interest and will follow up with NRC. INL noted that some of the information of interest will become available as the NGNP Project's fuel irradiation and post-irradiation test program progresses, including measurements of palladium penetration into the SiC coating.

The NRC assessment report noted potential issues regarding parameter path dependence, targeting information on how fuel temperature, burnup, and neutron fluence vary with location and operating time in the NGNP core in relation to the combinations of fuel temperature, burnup, and fluence addressed by accelerated irradiation testing the ATR. In response to INL comments, Dr. Carlson clarified that the issues of path dependence pertain equally to fuel performance under normal operating conditions and accident conditions. INL staff stated that they had not seen evidence of path dependence for fuel performance during normal operation. NRC will document a clarification of the basis for this follow up item. NGNP will respond to the clarified follow up item.

A discussion subsequently followed regarding a request by NRC to formulate explicit definitions to describe Tristructural-isotropic fuel particle states with descriptive terms such as defective, failed, and functionally-failed, relative to fuel particles and individual coating layers and explain

how fuel performance and radionuclide transport and release are considered and modeled in each case. INL staff provided a handout at the meeting that described INL's definition of Intact Particle (a particle with all coatings structurally intact), Functionally Degraded Particle (a particle with one or more coatings degraded such that additional metallic fission products are released) and Failed Particle (a particle with an open pathway from the kernel to the outer surface of the particle). Various topics regarding fuel fabrication variability, fuel characterization, and quality control were also discussed. Additionally, INL staff discussed details of the proposed fuel manufacturing processes and efforts to simulate the characteristics of fuel fabricated in a production facility. The extent to which NRC review and monitoring of fuel fabrication process parameters are needed and the extent to which fuel product characterization methods and procedures at the production scale may vary from those used for the fuel development program will be an item for future review.

INL staff stated that they were expanding technology development work related to moisture ingress and summarized plans for future air and steam oxidation tests at elevated temperatures, likely to be performed with fuel irradiated in Advanced Gas Reactor 5/6. NRC requested to be kept informed as the future test plans are developed. NGNP agreed to submit its test plan for air and moisture ingress effects after the revision that is currently in progress is completed, expected around mid June.

Discussions were held regarding modeling uncertainty and "completeness uncertainty" as elements of overall uncertainty analysis. INL staff stated that they will determine the statistical distribution of event consequences, from which consequences at both the mean (50 percent confidence) and conservative (95 percent confidence) levels can be determined and compared with the appropriate criteria. NRC also inquired about the approach to be taken to the bounding siting event as well as equipment survivability for such an event. NRC staff noted that the assumptions underlying the bounding siting event for Light Water Reactors are not really technology neutral (HTGRs and their safety characteristics were not considered when the requirements were developed) and indicated it would like to discuss the NGNP approach in a future meeting. INL staff responded, saying that they will consider these issues and address them in a future meeting with the staff. Additionally, INL staff committed to a peer review of all PRA elements and independent review of the NGNP safety analyses, including source term calculations.

Enclosure:  
Attendance List

cc w/encl: See next page

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**ADAMS Accession Number: ML12132A457** **\*via e-mail** **NRO-001**

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**NEXT GENERATION NUCLEAR PLANT  
RISK-INFORMED PERFORMANCE BASED LICENSING APPROACH MEETING  
April 16, 2012**

**Attendance List**

<b>Name</b>	<b>Organization</b>	<b>Name</b>	<b>Organization</b>
Jeff Cruz	NRC/NRO/DARR	Mark Holbrook	INL
Donald Carlson	NRC/NRO/DARR	Fred Silady	Technology Insights
Jonathan DeGange	NRC/NRO/DARR	Peter Lowry	PNNL/NGNP
Shie-Jeng Peng	NRC/NRO/DSRA	Michael J. Kania	BNL
Joe Williams	NRC/NRO/DARR	L. Y. Cheng	BNL
Stewart Magruder	NRC/NRO/DARR	James Kinsey	INL/DOE
Lynn Mrowca	NRC/NRO/DSRA	Farshid Shahrokhi	Areva
Bill Reckley	NRC/NRO/DARR	Jason Tokey	DOE
Jeffrey Cruz	NRC/NRO/DARR	Masrur Khan	Bechtel
George Thomas	NRC/NRO/DSRA	Jeff Wood	NRC/RES/DRA
John McKirgan	NRC/NRO/DSRA	Michelle Hart	NRC/NRO/DSEA
Tom Kevern	NRC/NRO/DARR	Sudhamay Basu	NRC/RES/DSA
Mark Caruso	NRC/NRO/DSRA	Neil Ray	NRC/NRO/DE

**NEXT GENERATION NUCLEAR PLANT  
FUEL QUALIFICATION AND MECHANISTIC SOURCE TERM MEETING  
April 17, 2012**

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Jeff Cruz	NRC/NRO/DARR	James Kinsey	INL/DOE
Donald Carlson	NRC/NRO/DARR	Mark Holbrook	INL
Jonathan DeGange	NRC/NRO/DARR	David Alberstein	INL
Shie-Jeng Peng	NRC/NRO/DSRA	Madeline Feltus	DOE
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Mark Caruso	NRC/NRO/DSRA	Richard Hobbins	INL
John McKirgan	NRC/NRO/DSRA	Jason Tokey	DOE
Bill Reckley	NRC/NRO/DARR	Michael J. Kania	BNL
George Thomas	NRC/NRO/DSRA	L. Y. Cheng	BNL
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