February 21, 2017

MEMORANDUM TO: John P. Segala, Chief
Advanced Reactor and Policy Branch
Division of Engineering, Infrastructure, and Advanced Reactors
Office of New Reactors

FROM: William D. Reckley, Senior Project Manager **/RA/**
Advanced Reactor and Policy Branch
Division of Engineering, Infrastructure, and Advanced Reactors
Office of New Reactors

SUBJECT: SUMMARY OF FEBRUARY 2, 2017, PUBLIC MEETING TO DISCUSS ADVANCED REACTOR REGULATORY REVIEWS

On February 2, 2017, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17019A052), the U.S. Nuclear Regulatory Commission (NRC) staff held a Category 2 public meeting with stakeholders, Department of Energy (DOE), Nuclear Infrastructure Council (NIC), Nuclear Innovation Alliance (NIA), and Nuclear Energy Institute (NEI), to discuss ongoing initiatives within the industry and NRC related to the development and licensing of non-light water reactors. A list of individuals attending or participating in the meeting by webinar can be found as Enclosure 1 to this summary. The slides and meeting handouts used by the staff and other participants are available in ADAMS under Accession No. ML17037D371.

The staff supported a discussion of the NRC's "Vision and Strategy for Safely Achieving Effective and Efficient Non-Light Water Reactor Mission Readiness" (ADAMS Accession No. ML16356A670), dated December 2016, and the draft near-term implementation action plans (ADAMS Accession No. ML16334A495) made publicly available in November 2016 to support interactions with stakeholders. The staff and stakeholders agreed during the discussions that the plans under Strategy 2 include, whenever possible, the NRC taking advantage of computer codes and models developed or being developed by DOE or other parties. The staff noted that stakeholders were welcome to provide additional comments or questions about the vision and strategy document and implementation action plans, but NRC activities are currently moving beyond developing the plans and into implementation. The documents will be discussed with the Advisory Committee on Reactor Safeguards (ACRS) in March 2017 and subsequently provided to the Commission.

The staff summarized the regulatory roadmap (ADAMS Accession No. ML16291A248) discussed during previous stakeholder meetings. The roadmap describes how designers have the flexibility to interact with the staff and obtain regulatory feedback to support key decisions for advanced reactor designs with different technical readiness levels.

CONTACT: William D. Reckley
301-415-7490

Existing NRC guidance related to the format and content of applications and staff review activities are organized around the traditional 19 chapters in a final safety analysis report, program documents, and other parts of an application for an operating or combined license. A more function-based organization of the licensing basis information has been developed by the International Atomic Energy Agency and other regulatory bodies. The staff provided an opportunity for the meeting participants to express views on the organization of licensing basis information and stated that guidance for non-light water reactor (non-LWR) designs would likely follow the existing structure unless an alternative was proposed by stakeholders. The staff's enhanced safety-focused review for small modular reactors was described and offered as a starting point for developing content and NRC review approaches for advanced reactors. This approach focuses on the systems and programs with the most importance in limiting the risks posed by the operation of a subject nuclear power plant.

The staff's presentation listed the policy issues discussed in previous meetings with a request for stakeholders to consider if items were missing and to rank the issues to ensure appropriate priorities were being established. The staff emphasized that future meetings are expected to address specific technical and policy topics. It is important that NRC and stakeholder interactions begin focusing on specific topics to support discussions and subsequent resolution of issues important to the design and possible deployment of advanced reactors. Mr. Jeffrey Merrifield representing NIC stated that a discussion of policy issues would be held at an upcoming workshop and insights from that discussion would be shared with the staff. The staff ended its presentation with further discussion of schedules and agenda items for future meetings. The next meeting is tentatively scheduled for on or about March 23, 2017.

Mr. Jim Kinsey of Idaho National Laboratory provided an update of activities related to non-LWRs being conducted or sponsored by DOE's Office of Nuclear Energy. The update included information on DOE's vision and strategies document, which includes a near-term focus on establishing a regulatory framework for non-LWRs. The regulatory framework was characterized as including research and development of analytical tools, resolving policy issues and establishing licensing technical requirements, and establishing a staged or phased review process. Mr. Kinsey summarized current activities associated with DOE's Gateway for Accelerated Innovation in Nuclear (GAIN) program, including the formation of technology working groups, a modeling and simulation workshop, and other efforts to foster improved coordination and collaboration with the national laboratories.

Mr. Jeffrey Merrifield represented NIC during the meeting and his presentation is included in the meeting handouts (ADAMS Accession No. ML17037D371). Mr. Merrifield provided general and specific comments on the vision and strategy document and emphasized high-level policy issues such as NRC budgets and fee structure. Further insights on policy issues and priorities from NIC members are expected to be provided to the staff following a NIC-sponsored workshop being held during the week of February 7th.

Mr. Peter Hastings, representing NIA, provided an update on their activities related to preparing guidance on what constitutes a "major portion" of a plant design. The guidance is expected to not only support potential applicants for a standard design approval (SDA), but may also provide insights into other aspects of a staged review process and the staff's planned use of an approach building off of the safety-focused reviews of SMRs. NIA expects to complete a draft white paper in March and this is a likely topic for the March meeting.

The discussions in the afternoon portion of the meeting were led by Dr. Karl Fleming, representing the utility-led licensing technical requirements modernization project (LTRMP).

The staff regrets that those participating in the afternoon portion of the meeting via webinar were not able to meaningfully participate due to problems with the telephone bridge. Dr. Fleming described the objectives of LTRMP as providing to the NRC for endorsement a technology-inclusive approach for identifying and analyzing licensing basis events for non-LWRs. The project is using the next generation nuclear plant (NGNP) licensing basis event white paper (ADAMS Accession No. ML102630246) as a starting point, considering feedback from the NRC staff and ACRS. The previous examples of the approach for a modular high temperature gas-cooled reactor will be supplemented with examples based on the PRISM sodium-cooled fast reactor. Dr. Fleming provided key definitions for the proposed approach and explained how the event selections would be performed and revised during various phases of the design process.

The NRC staff provided some discussion points or preliminary questions to the LTRMP working group prior to the meeting (Enclosure 2). The questions provided prior to and during the meeting do not reflect agency positions or endorsement of specific approaches or guidance, but instead are aimed at spurring discussions and identifying issues that should be addressed in future meetings and draft guidance documents. Some of the staff's questions and comments during the meeting dealt with the role of probabilistic risk assessment (PRA) and deterministic analyses. The staff commented that it would be helpful to provide a discussion within the paper of what is meant by deterministic analysis to ensure no significant differences exist in the use of terminology and what is accomplished through the deterministic aspects of defining and analyzing licensing basis events. An example from a previous white paper (Toshiba 4S) is provided as Slide 61 in the presentation materials and shows an approach where showing a barrier-related acceptance criteria could be used in lieu of or in addition to dose criteria. Approaches to deterministic analyses are also described in the Canadian Nuclear Safety Commission issued regulatory document REGDOC-2.4.1, "Deterministic Safety Analysis," and the International Atomic Energy Agency issued Specific Safety Guide SSG-2, "Deterministic Safety Analysis for Nuclear Power Plants." The staff also had questions on the role of PRA in selecting and analyzing events and how that would potentially impact the performance and review of the PRA. The PRA-related discussions also included the topic of external events, such as flooding and seismic, and how they would be addressed through possible combinations of probabilistic and deterministic analyses. Combinations of deterministic and probabilistic analytical approaches are reflected in guidance from the IAEA as shown in Slides 62-63 of the presentation. The staff also raised questions about the traditional approach to performing consequence analyses to support siting-related aspects of applications. In addition to siting, future discussions will also need to address the appropriate consequence analyses needed to support decisions on emergency preparedness, insurance, security, and other policy issues possibly facing non-LWR technologies and specific designs.

The staff expressed a willingness to accept draft documents and to provide questions, comments, and proposed alternatives during the development of the LTRMP white paper. A model for this approach is the more recently completed guidance documents addressing lessons learned from the Fukushima accident (e.g., NEI 13-02, "Industry Guidance for Compliance with Order EA-13-109").

Please direct any inquiries to me at (301) 415-7490 or william.reckley@nrc.gov.

Enclosure:
List of Attendees

SUMMARY OF FEBRUARY 2, 2017, PUBLIC MEETING TO DISCUSS ADVANCED REACTOR REGULATORY REVIEWS FEBRUARY 21, 2017

DISTRIBUTION:
PUBLIC
RidsAcrsAcnw_MailCTR Resource
RidsNroDeia Resource
RidsNroDeiaArpb Resource

ADAMS Accession Nos.:
Package ML17052A812
Memo ML17052A809
Meeting Slides ML17037D371

OFFICE	NRO/DEIA/ARPB
NAME	WReckley
DATE	2/21/2017

OFFICIAL RECORD COPY

Public Meeting to Discuss Non-Light Water Reactor Regulatory Reviews
February 2, 2017
Attendance List

Name	Organization	Name	Organization
Deborah Jackson	NRC/NRO/DEIA	Jim O'Driscoll*	NRC/NRO
John Segala	NRC/NRO/DEIA	Craig Welling	DOE
Amy Cubbage	NRC/NRO/DEIA	Trevor Cook	DOE
William Reckley	NRC/NRR/JLD	Jim Kinsey	INL
Joe Williams	NRC/NRO/DEIA	Mark Holbrook*	INL
Mark Caruso	NRC/NRO/DSRA	Wayne Moe*	INL
Nicholas McMurray	NRC/NRO/DEIA	George Flanagan*	ORNL
George Tartal	NRC/NRO/DEIA	Rebecca Moses*	ORNL
Jan Mazza	NRC/NRO/DEIA	Mark Linn*	ORNL
Suzanne Dennis*	NRC/RES/DRA	Askin Guler Yigitoglu*	ORNL
Martin Stutzke	NRC/NRO	Randy Belles*	ORNL
John Monninger	NRC/NRO	Pranab Samanta	BNL
Lynn Mrowca	NRC/NRO	Jim Higgins	BNL
Lucieann Vechioli	NRC/NRO	Lap Cheng	BNL
Andrew Yeshnik	NRC/NRO	Russ Bell	NEI
John Adams	NRC/NRR	Kati Austgen	NEI
Jim Hammelman	NRC/NMSS	Mike Tschiltz	NEI
Mary Drouin	NRC/RES	Nima Ashkeboussi	NEI
Steve Bajorek	NRC/RES	Staci Wheeler*	ATRC
Courtney St. Peters	NRC/NRO	Jeff Merrifield	Pillsbury/NIC
Michelle Hart	NRC/NRO	David Blee	USNIC
Marcia Carpentier	NRC/OGC	Peter Hastings	Hastings Group
Steve Lynch	NRC/NRR/PRLB	Amir Afzali	Southern Nuclear
Hanh Phan	NRC/NRO	Gary Ruf*	PSEG
Malcolm Patterson*	NRC/NRO	Mari Jaworsky*	Duke Energy
Dennis Andrukat*	NRC/NRO	Adam Reichenbach*	Duke Energy
John Lai*	ACRS	Ed Wallace*	GNBC Associates
Carolyn Wolf*	NRC/CA	Jana Bergman	Curtiss Wright
Jongseuk Park*	KINS		

Name	Organization	Name	Organization
Farshid Shahrokhi	Areva NP		
Patricia Campbell	GEH		
Robin Rickman*	Terresterial Energy		
Stephen Smith	Transatomic Power		
Wendolyn Holland	Transatomic Power		
Timothy Crook	Transatomic Power		
Dimitri Lutchenkov	X-energy		
Edward Burns	X-energy		
Steve Frantz	Morgan Lewis		-
George Honma*	Areva		
Alex Popova*	Oklo		
C Cochran*	Oklo		
Willis Poore*	ORNL		
Andrew Paterson	-		
Gilbert Brown	UMass Lowell		
Chantal Morin*	CSNC		
Tim Tovar*	NuScale Power		
Gordon Clefton*	-		
Jill Monahan*	Westinghouse		
Andrew Zach*	-		
Keith Consani	-		

* indicates individual participated by webinar

Preliminary questions/discussion topics offered by NRC staff
Provided via email on 1/31/2017 to support discussions during public meeting

1) Describe how performance requirements would be defined for SSCs beyond those required to limit the releases below the F/C curve. If barrier based or other surrogate measures are being used to define performance measures for specific SSCs, would such alternate measures be defined and become part of the licensing basis for the subject SSCs. Could the logic include meeting the F/C curve if an explicit safety criterion for a barrier has been met (this approach described in a Toshiba 4S report).

2) The construct for current LWRs could be described as including both a deterministic analyses (stylized, conservative, barrier-based acceptance criteria) and probabilistic analyses (best estimate, dose-based acceptance criteria), with a balancing of the approaches providing added confidence in designs and operations (assessing from somewhat different perspectives). How might incorporating different approaches to analyses and acceptance criteria be used for advanced reactors to gain similar confidence?

3) Beyond discussions of "engineering judgement" in defining and assessing LBEs, is it expected that all assessments would include a basic set of events challenging key safety functions of reactivity control, decay heat removal, and limiting the release of radioactive material.

4) How would the proposed approach change the treatment of the PRA and the content of applications? Currently the PRA is described in Chapter 19 in addition to the deterministic evaluations in Chapter 15. How would the combination of the two be reflected in the applications and the treatment of the PRA?

5) The scope of the PRA used to support the LBE selection approach includes all hazard groups (internal events and external events such as seismic, flooding, etc.):
    a. Currently, NRC accepts the use of a PRA-based seismic margins analysis (not a seismic PRA, which is necessary to estimate seismic sequence frequencies and consequences).
    b. How to determine an appropriate reference site for external hazard frequencies?

6) What are the appropriate quality requirements for thermal-hydraulic codes (analogous to MAAP and MELCOR) and consequence analysis codes (MACCS) used to the support a PRA that forms the basis of the LBE selection? Does RG 1.203, "Transient and Accident Analysis Methods," apply?

(7) The NGNP LBE selection approach bins PRA sequences into AOOs, DBEs, and BDBEs based solely on the sequence frequencies. The proposed approach will produce AOOs and DBEs that are different in character than have traditionally been defined. For example:

- The design basis accident for evaluating ECCS performance in LWRs is a large LOCA, followed by an assumed loss of offsite power and the worst-case single failure. This sequence does not result in core damage, and its frequency is well below 10^{-4}/y.
- The design basis accident for an LWR containment assumes (in accordance with 10 CFR 50.34) a fission product release into the containment due to a substantial meltdown of the core. The frequency of this accident is less than 10^{-4}/y.

When defining DBEs, it seems necessary to first identify the SSCs whose performance is to be assessed using the DBE, then map relevant PRA sequences to the identified SSCs. The 10^{-4}/y frequency boundary between AOOs and DBEs seems higher than used for current LWRs.

(8) The non-LWR PRA standard is a high level standard and tells the user what is needed, and how to implement. Since the PRA is going to have a much bigger role, how will the applicant and NRC ensure there is technical adequacy? Does this change the nature of the peer review?

(9) In the iterative process of using PRA in the design (i.e., PRA insights are fed into the design), how are the uncertainties addressed? How is the design process used to address the known uncertainties? How are safety margins and defense-in-depth addressed?

(10) <u>Dose & Siting Questions</u>:

<u>Intro</u>: The regulations on safety analysis information related to design and siting for construction permits and operating licenses under Part 50 and Design Certifications, COLs, Standard Design Approvals and Manufacturing Licenses under Part 52, (10 CFR 50.34(a)(1) and 10 CFR 52.47(a)(2)(iv), 52.79(a)(1)(vi), 52.137(a)(2)(iv), and 52.157(d), respectively), require design basis accident radiological consequences analysis that includes an evaluation of safety features and the barriers that must be breached before a release of radioactive material to the environment can occur. The regulation further states that this analysis shall assume a large fission product release from the core into the containment, and an evaluation and analysis of postulated fission product release using the demonstrable containment leak rate and any release mitigating systems to evaluate the offsite radiological consequences (dose at EAB and LPZ). DBA radiological consequence analyses for large LWRs have included such following features – a standardized assumed release to the containment based on full core melting without vessel breach, assumed release from the containment is based on leak rate tested through technical specifications surveillance program (La at Pa), credit for only ESF SSCs unless non-safety-related SSCs make the radiological release or consequences greater, other release pathways including estimated potential leakage from liquid containing systems outside of the containment, 95th percentile atmospheric dispersion coefficients for the specific site (i.e., dispersion is worse only 5% of the time resulting in radioactive material concentration at dose receptor locations at the higher end of projected values) or a site parameter used in design certifications, standard design approvals and manufacturing licenses, and the evaluation of

radiological consequences of atmospheric release (plume) resulting in the calculation of maximum 2-hr dose at EAB and dose at LPZ for duration of the plume passage. Control room radiological habitability analysis uses the same DBAs as evaluated for offsite doses, and includes the evaluation of the control room habitability SSCs.

Questions:

1. Do advanced reactors propose to comply with the regulations on DBA dose siting and safety analysis, or are exemptions under consideration?
2. Does the DBA dose siting and safety analysis fit in the overall licensing basis event classification, or is it a separately postulated analysis or set of analyses?
3. Considering the current regulatory requirements how will the DBA dose siting and safety analysis assumptions (accident scenario, transport modeling, fission product removal modeling, etc.) be determined for advanced reactors?
4. How do you envision that core damage frequency, release frequency or scenario likelihood would play a role in the selection of the DBA for radiological consequence assessment for siting and safety analysis? How does the selection of the DBA consider defense-in-depth or other factors not related to risk assessment?
5. How will advanced reactors that may not have leak-tight pressure retaining containments propose to comply with the current siting and safety analysis regulations with respect to the assumptions on release to containment and subsequent release from the containment at a rate that is able to be demonstrated over the life of the facility?
6. For advanced reactor designs that can acceptably demonstrate that radiological release through core damage events is not physically possible, how would the design meet current regulatory requirements?
7. Is there a desire to maintain references to the existing DBA siting criteria and include the EPA PAG limit as a goal, or might the EPA PAG limit at design-specific distances be used as a more established design limit?