Presentations for December 15, 2016 Public Meeting

on Advanced Reactor Regulatory Reviews

1) NRC Staff Presentation

2) Table of Small Modular Reactor and Advanced Reactor Technical and Policy Issues

3) Nuclear Innovation Alliance Presentation on “Major Portions” of a Standard Design Approval

4) Nuclear Infrastructure Council Presentation

5) Nuclear Energy Institute/Southern Company Services Presentation – Licensing Technical Requirements Modernization Project

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Public Meeting on Advanced, Non-light water Reactor Regulatory Reviews

Office of New Reactors

December 15, 2016

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Public Meeting

- Telephone Bridge

  (888) 570-6344

  Passcode: 3222936
- Opportunities for public comments and questions at designated times
- Please mute phones

  *6 – Self Mute/Unmute

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Agenda

- Morning
  - Vision and Strategies
    - Implementation Action Plans, Volume 2
      - ADAMS Accession No. ML16294A181
  - Draft Regulatory Review Roadmap
  - DOE Update
  - Nuclear Innovation Alliance
    - Major Portions Discussion
- Afternoon
  - Nuclear Infrastructure Council
  - Nuclear Energy Institute
    - Utility-Led Licensing Modernization Project

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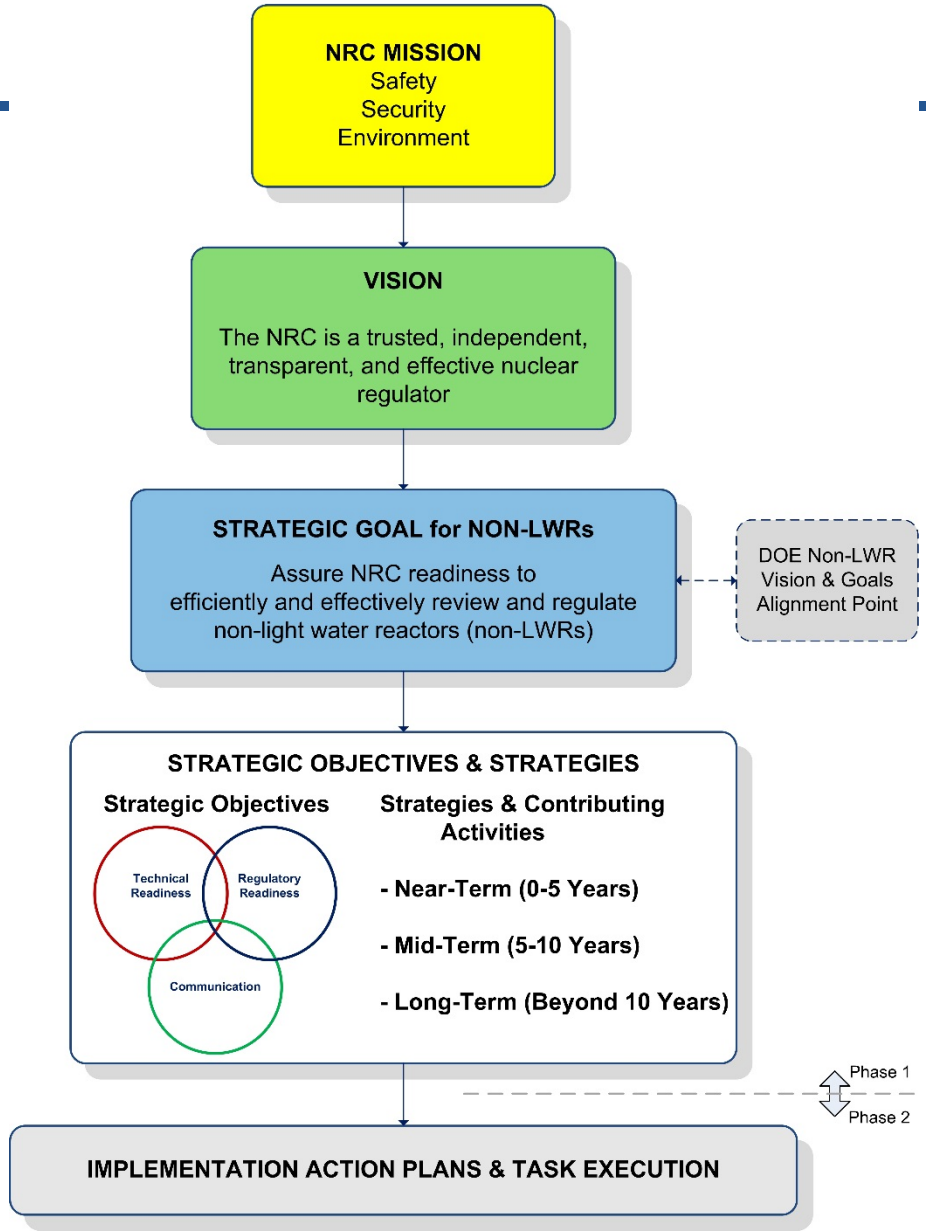
NRC Non-LWR Mission Readiness Roadmap



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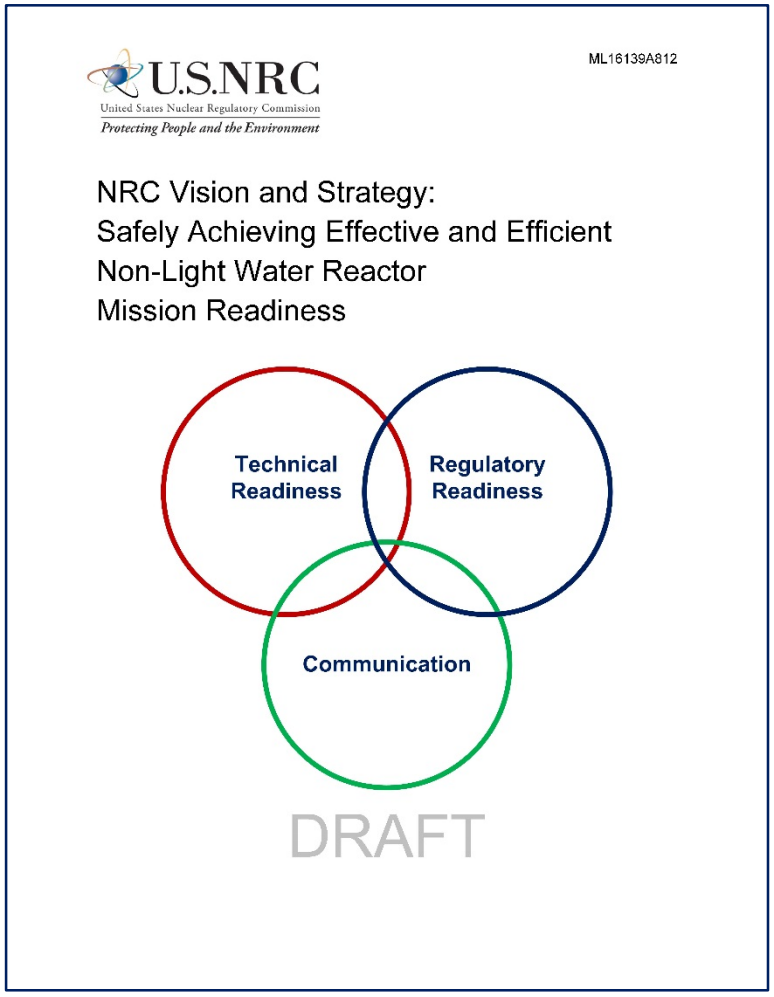
Non-LWR Vision and Strategy



- Draft NRC Vision & Strategy made public at DOE-NRC Workshop on June 7-8, 2016 (ML16139A812).
- Public comment period on the V&S document closed 09/19/2016.
- Final V&S document is in management review.

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Implementation Action Plans (IAPs)

- Development of the NRC's non-LWR readiness strategy consists of two phases:
  - Phase 1 – Vision & Strategy
  - Phase 2 – Implementation Action Plans (IAPs)

- The IAPs are planning tools that describe:
  - Work to be done to achieve non-LWR readiness,
  - Resources needed to accomplish the work,
  - How the work should be sequenced,
  - How to prepare the workforce to do the work, and
  - Considerations for organizing work execution for maximum effectiveness and efficiency

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Implementation Action Plans (IAPs) (cont'd)

- Draft near-term IAPs are intended to cover a timeframe of 0-5 years.
- Actual start dates and priorities of the activities shown in the IAPs are dependent on a range of factors, including NRC work prioritization, actual funding appropriations, industry maturity and application readiness, and similar factors.
- The IAPs are organized by Strategies, Contributing Activities, and Supporting Tasks.

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Near-Term Strategies

1) Acquire/develop sufficient knowledge, technical skills, and capacity to perform non-LWR regulatory reviews
2) Acquire/develop sufficient computer codes and tools to perform non-LWR regulatory reviews
3) Develop guidance for a flexible non-LWR regulatory review process within the bounds of existing regulations, including the use of conceptual design reviews and staged-review processes
4) Facilitate industry codes and standards needed to support the non-LWR life cycle (including fuels and materials)
5) Identify and resolve technology-inclusive policy issues that impact the regulatory reviews, siting, permitting, and/or licensing of non-LWR nuclear power plants (NPPs)
6) Develop and implement a structured, integrated strategy to communicate with internal and external stakeholders having interests in non-LWR technologies

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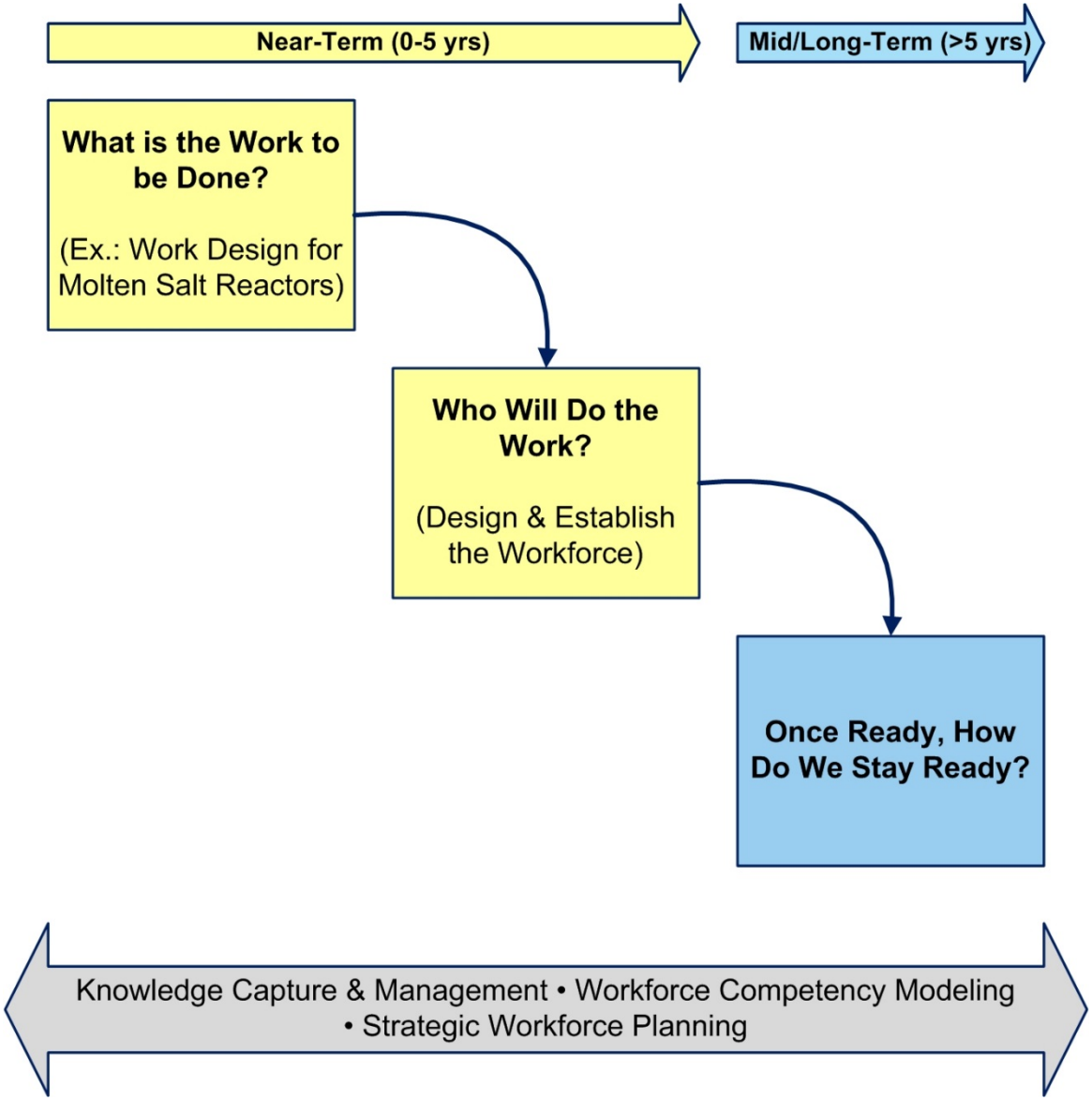
Strategy 1: Technical Skills



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Strategy 2: Computer Codes & Tools

Strategy 2 is designed to "Acquire/develop sufficient computer codes and tools to perform non-LWR regulatory reviews"

- Enables the staff to perform independent confirmatory analysis of safety significant design basis and beyond design basis accidents.
- Identifies experimental information necessary for regulatory decisions.
- Can provide the basis for rulemaking and regulatory guidance.

Strategy 2: Computer Codes & Tools

Near-Term Functional Areas

Reactor Kinetics and Criticality

Fuel Performance

Thermal-Fluid Phenomena

Severe Accident Phenomena

Offsite Consequence Analysis

Materials and Component Integrity

Primary Focus FY17-FY21

Secondary Focus

PRA

Instrumentation & Controls

Security

Human Factors

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Strategy 2: Computer Codes & Tools

General Objectives

- Phenomena, Scenario, and Issue Identification
- Identification of Applicable Computer Codes
  - Reactor Type a major consideration
  - May involve NRC developed codes or adoption of codes developed by DOE (CASL and/or NEAMS developed, ANL codes for sodium fast reactors)
- Identification of Experimental Data Needs for Assessment
  - Separate Effects Tests for phenomena
  - Integral Effects Tests for decay heat removal and system performance
  - Qualification of fuel behavior
- Codes and Standards Activities
- Path Forward for > FY22

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Strategy 2: Computer Codes & Tools

Summary:

- Initial plan has been generated and the staff is prepared to begin development of tools & capability to perform the technical review.
- Activities currently limited by funding level and available resources.
- Familiarization with new designs is necessary to increase staff knowledge level.

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Strategy 3: Review Processes

- Contributing Activity No. 3.1: Establish and document the criteria necessary to reach a safety, security, or environmental finding for non-LWR applicant submissions. The criteria and associated regulatory guidance are available to all internal and external stakeholders.
- Contributing Activity No. 3.2: Determine and document appropriate non-LWR licensing bases and accident sets for highly prioritized non-LWR technologies.
- Contributing Activity No. 3.3: Identify, document and resolve (or develop plan to resolve) current regulatory framework gaps for non-LWRs.
- Contributing Activity No. 3.4: Develop and document a regulatory review "roadmap" that reflects the design development lifecycle and appropriate points of interaction with the NRC, and references appropriate guidance to staff reviewers and applicants.
  - Ongoing – draft was discussed at 10/25/2016 meeting and will be discussed later in this presentation.

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Strategy 3: Review Processes

- Contributing Activity No. 3.5: Prepare and document updated guidance for prototype testing, research and test reactors.
  - Ongoing – Draft guidance has been developed and is in management review

- Contributing Activity No. 3.6: Engage reactor designers and other stakeholders regarding technology- and design-specific licensing project plans and develop regulatory approaches commensurate with the risks posed by the technology.

- Contributing Activity No. 3.7: Support longer-term efforts to develop, as needed, a new non-LWR regulatory framework that is risk-informed, performance-based, and that features staff review efforts commensurate with the demonstrated safety performance of the non-LWR NPP design being considered.

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Strategy 4: Codes & Standards

- It is expected that the use of codes and standards will be an integral part of the NRC's strategy to improve its readiness to regulate non-LWRs.
- The staff intends to apply its established process for incorporating codes and standards into its regulatory framework.
  - Contributing Activity No. 4.1 - Work with stakeholders to determine the currently available codes and standards that are applicable to non-LWRs and their associated fuels and waste, and to identify the technical areas (e.g., instrumentation and control, civil/structural, inservice inspection and testing, materials, equipment qualification, quality assurance, etc.) where gaps exist.
  - Contributing Activity No. 4.2 - Participate with the Standards Development Organizations that are actively involved in developing codes and standards for non-LWRs.
  - Contributing Activity No. 4.3 - Review codes and standards for endorsement

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Strategy 5: Policy Issues

- Early identification and resolution of policy issues provides regulatory certainty to stakeholders and helps to achieve the agency's strategic objectives for non-LWRs.
- Technology-inclusive issues have the broadest applicability for the non-LWR regulatory framework.
- We are seeking stakeholder input on what Policy issues we should focus on in the near term.

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Strategy 5: Policy Issues

List of Technical and policy issues related to SMRs and advanced reactors originally included in SECY-10-0034.

- License for Prototype Reactors
- License Structure for Multi-Module Facilities
- Appropriate Source Term, Dose Calculations, and Siting
- Offsite Emergency Planning (EP) Requirements
- Annual Fees
- Insurance and Liability
- Manufacturing License Requirements
- Use of Probabilistic Risk Assessment in the Licensing Process

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Strategy 5: Policy Issues

List of Technical and policy issues included in SECY-10-0034 (continued)

- Key Component and System Design Issues
- Operator Staffing for Small or Multi-Module Facilities
- Operational Programs for Small or Multi-Module Facilities
- Installation of Reactor Modules During Operation of Multi-Module Facilities
- Industrial Facilities Using Nuclear-Generated Process Heat
- Decommissioning Funding Assurance
- Implementation of Defense-In-Depth (DiD) Philosophy for Advanced Reactors
- Security and Safeguards Requirements for SMRs
- Aircraft Impact Assessments

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Strategy 5: Policy Issues

- Key Licensing Issues Identified during Next Generation Nuclear Plant (NGNP) Project
  - As outlined by the NRC in a letter to DOE dated February 15, 2012, the NRC staff focused its NGNP interactions with DOE/INL on the further assessment of technical and policy issues in key areas previously highlighted in the NGNP Licensing Strategy Report that NRC and DOE jointly issued to Congress in 2008. In its July 14, 2014, assessment (ML14174A626) the NRC staff discussed the following four issues
    - Licensing basis event selection
    - Source terms (Note: See item 3 in Table above for more recent discussion of source term for advanced reactors)
    - Functional containment performance
    - Emergency preparedness (Note: See item 4 in Table above for more recent discussion of Emergency Preparedness for advanced reactors

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Strategy 6: Communications

As shown in the NRC's non-LWR vision and strategy document, the strategic objective for optimizing communications is:

"The NRC will optimize its communication with non-LWR stakeholders by disseminating clear expectations and requirements for non-LWR regulatory reviews and oversight. These expectations and requirements will be expressed using multiple channels of communication appropriate to different stakeholder interests. NRC messaging will be consistent and tailored to audiences for maximum communications effectiveness. Stakeholder feedback paths to the NRC will also be optimized to ensure that feedback is received, considered, and addressed in a timely manner, as appropriate."

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Regulatory Roadmap

- Draft Regulatory Roadmap
  - ADAMS Accession No. ML16291A248
- Regulatory Effectiveness IAP (Strategy 3)
  - Establish criteria necessary for regulatory findings
  - Determine appropriate design bases and event selections
  - Identify and resolve gaps in regulatory framework
  - **Develop regulatory review roadmap reflecting design development lifecycle and appropriate interactions**
  - Develop prototype reactor guidance
  - Engage with technology- or design-specific licensing project plans and develop risk-commensurate regulatory approaches

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Regulatory Roadmap

- Design Processes (Critical Decisions, DOE model)
  - Preconceptual design process
  - Conceptual design process
  - Preliminary design process
  - Final design process
  - Construction
- Align with Technology Readiness
  - Research and development
  - Licensing project plans
- Other options available but desire to center around an approach to support common understandings

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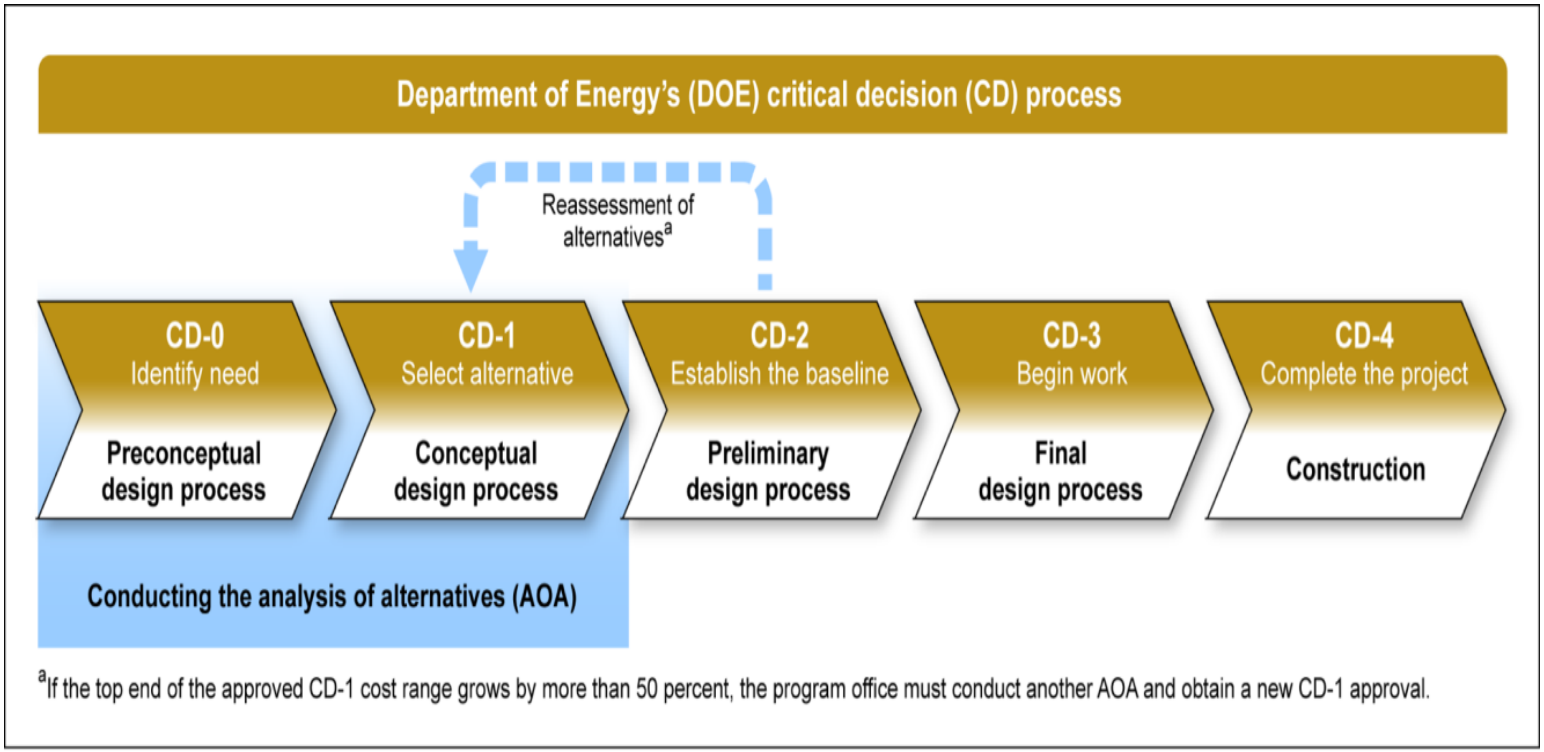
DOE Critical Decision Process



Source: GAO analysis of DOE's Order 413.3B. | GAO-15-37

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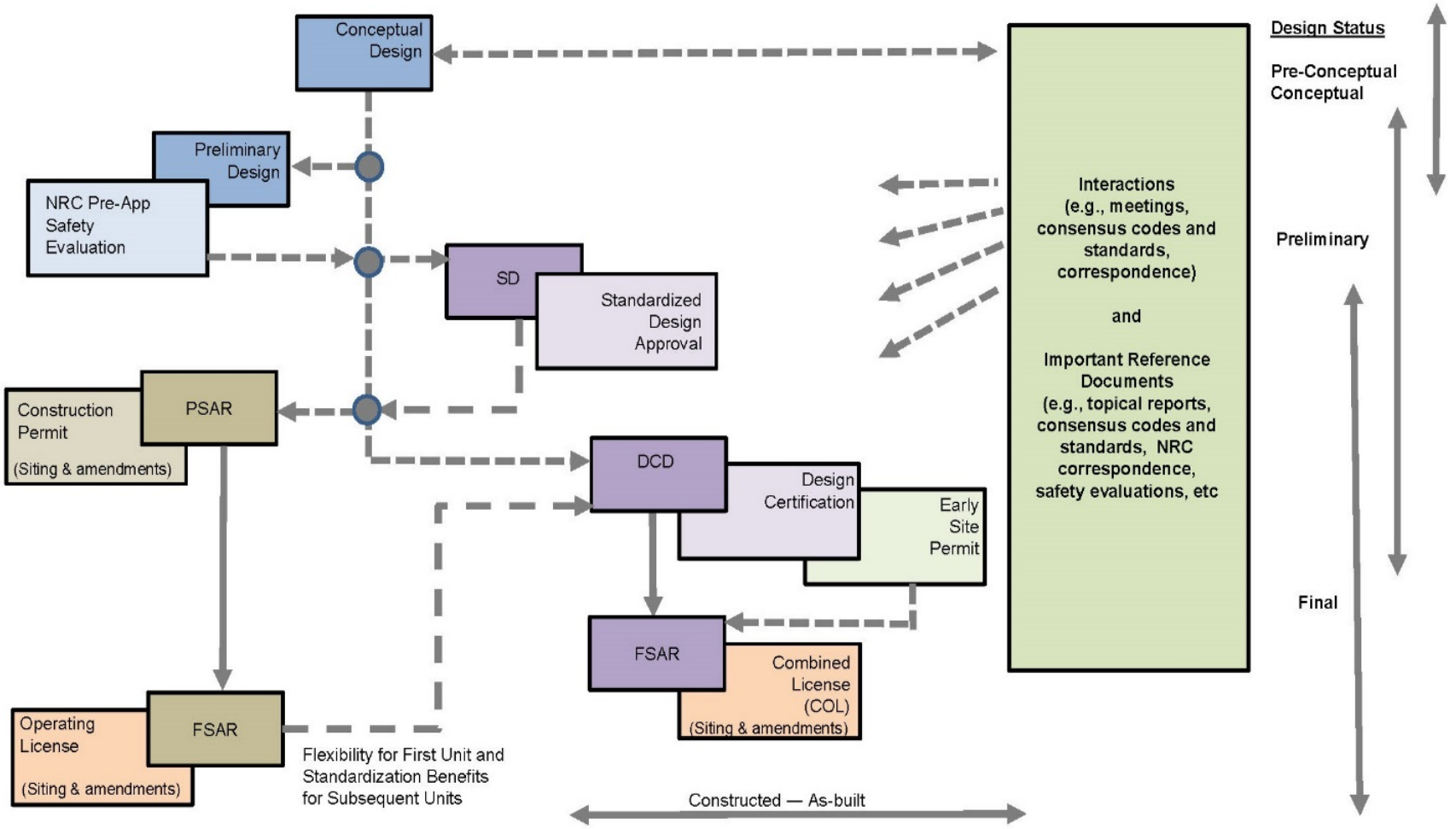
NRC Licensing-related processes



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Interactions/Outcomes

Non-Application Interactions

- Meetings
- Correspondence
- White papers
- Technical reports
- Topical Reports
- Consensus codes and standards
- Rulemaking and regulatory guidance
- Research plans
- Other supporting documents/programs

Outcomes

- Information exchange
- Initial feedback
- Conditional staff findings
- Conclusive staff findings
- Final agency position

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Pre-application & Applications

- **Conceptual Design**
- **Preliminary Design**

Feedback, white papers, topical reports, preliminary design assessment,

- **Standard Design Approval**
- **Construction Permit and Operating License**
- **Design Certification**
- **Combined License**
- Early Site Permit
- Manufacturing License
- Research/Test Reactor Licensing
- Fuel facility licensing
- Waste storage and transportation

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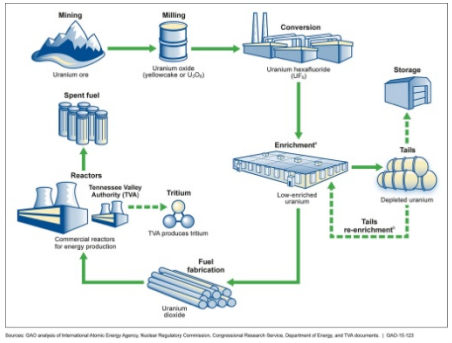
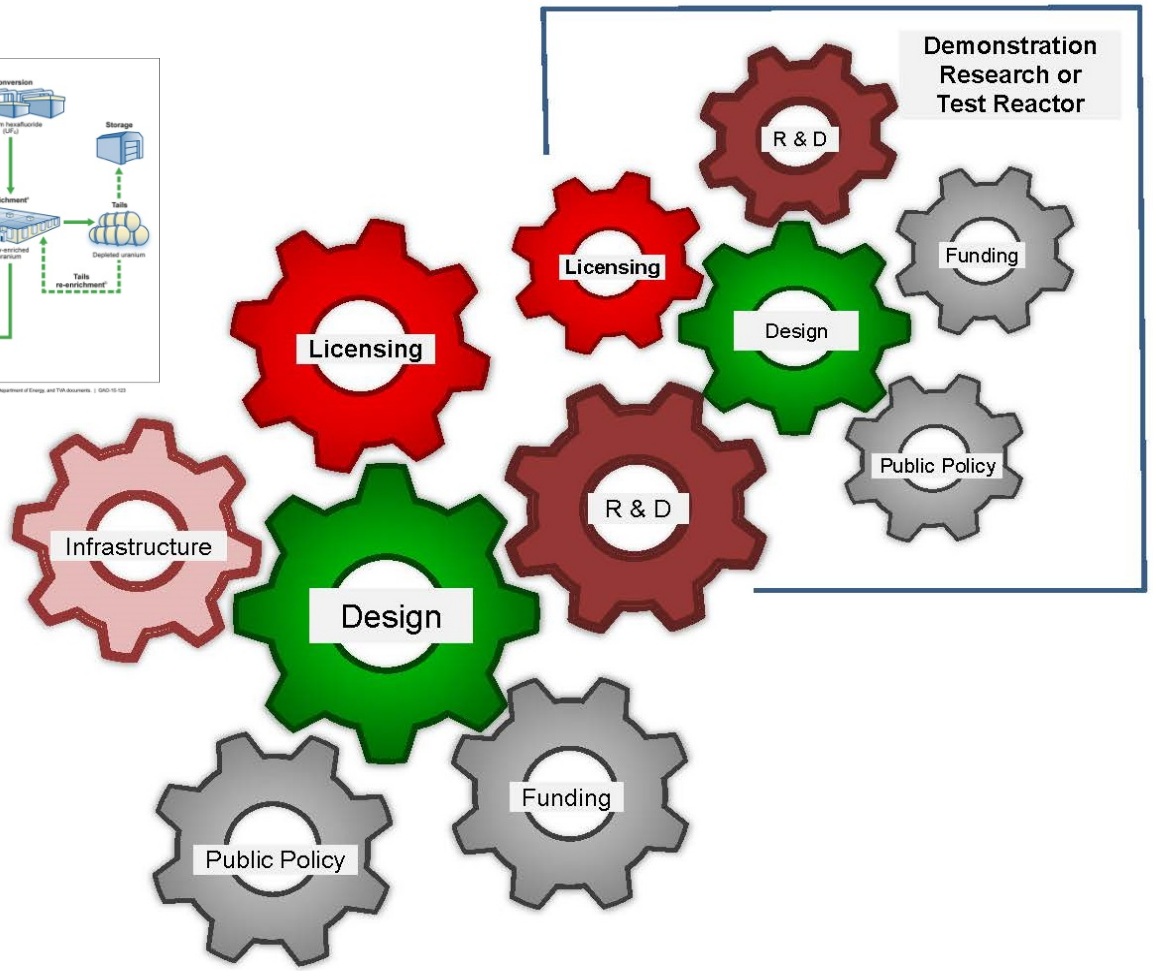
Licensing as Subpart of Overall Development Program





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Licensing Project Plans

- Licensing project plans allow the designer and NRC staff to prioritize issues and optimize interactions to address design alternatives or address issues most important to the overall program
- Reflects the technology readiness level of the reactor design, including innovative features, and the related research and development activities
- Mutual agreement on the desired outcomes of defined interactions and estimated costs and schedules for defined reviews
- Particular attention to near-term activities needed to support the critical decision process (see DOE figure)

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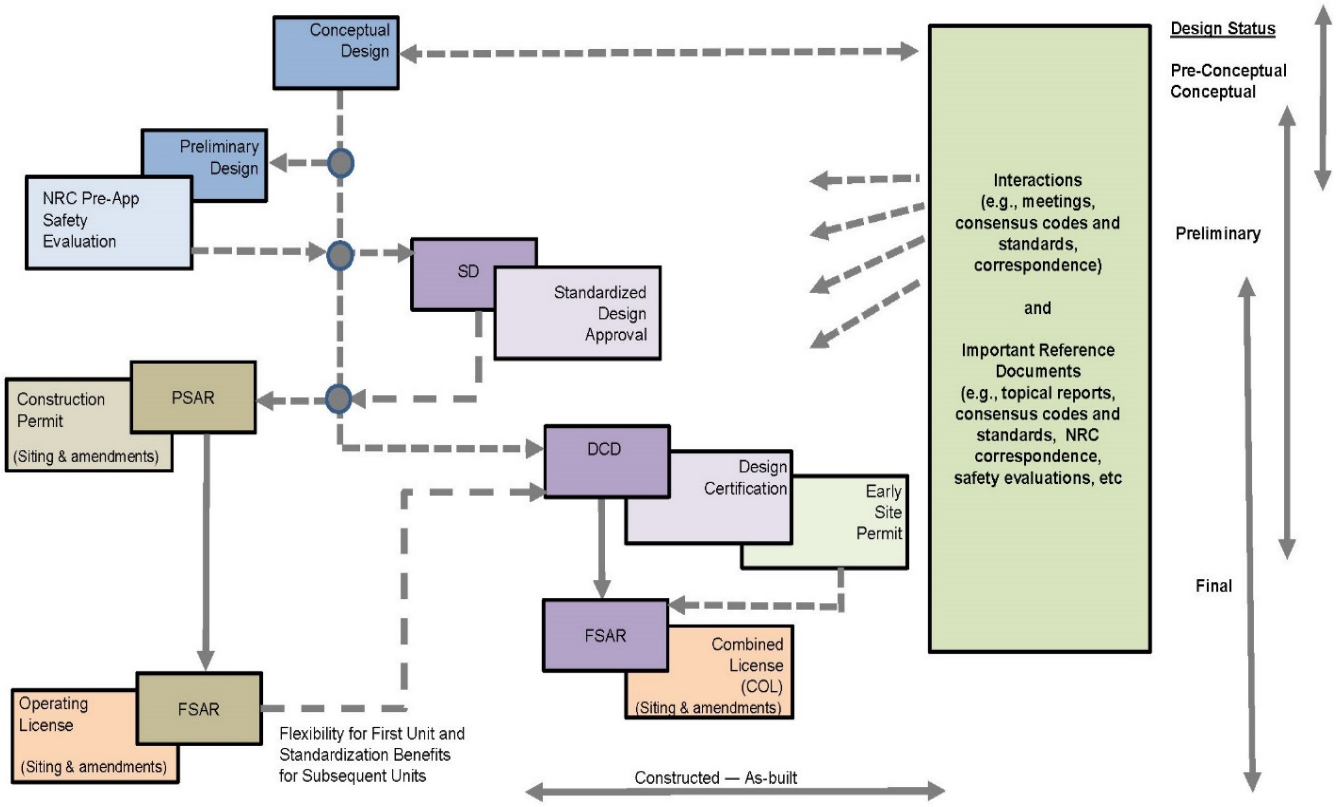
Discussion/Questions



- Specific examples or issues to address ?

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Example

Example: Conceptual design, considering alternatives for primary and secondary reactivity control systems

Possible Approach

- Initial interactions on design concept/regulatory issues
- Conceptual design submittals on reactivity control
  - white paper, topical report
- Preliminary (pre-application) design assessment submittal
  - Scope, schedule & resources per licensing project plan and NRC review plan; addresses licensability, R&D plans, possible issues
- Application for standard design approval (SDA)
  - Major portion of design per licensing project plan and NRC review plan
- Application for Design Certification
  - Essentially complete design per licensing project plan and NRC review plan; no site specific activities

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Preliminary (pre-application) design assessment

Draft Roadmap: … The potential range of potential applicants, designs, and degrees of design completeness limits the ability to define a single product cost and schedule for the review of a preliminary design. Instead, the NRC will work with a designer to establish a mutually agreeable review plan for a specific preliminary design that includes a defined scope and level of review, desired outcome in terms of regulatory observations, particular areas of focus, review costs, and review schedules.

CNSC GD-285, "Pre-licensing Review of a Vendor's Reactor Design"
Phase 1 review – Compliance with regulatory requirements
- 8 – 12 months, 4,000 hours

Phase 2 review – Pre-licensing assessment
- 12 – 18 months, 9,500 hours

Phase 3 review – Pre-construction follow-up
- review is tailored on a case-by-case basis

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Example

Example: Preliminary design, well established design , previous regulatory feedback, additional work pending policy/funding issues

Possible Approach

- Initial interactions on design /project status/regulatory issues
- Develop licensing project plan, with possible contingencies
  - Resolve key issues via white papers, topical reports
- Application for construction permit (assuming site/operator)
  - Construct, complete/modify design during construction
- Application of operating license

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DOE Update

Small Modular Reactor (SMR) and Advanced Reactor Technical and Policy Issues

The table below provides a list of technical and policy issues related to SMRs and advanced reactors that the NRC has been tracking to resolution since 2010. This list was originally included in SECY-10-0034 and has been updated periodically to show the current status of the issues.

Item No.	Issue Title/Applicability	Status	References
1	License for Prototype Reactors **Applicability:** Principally non-LWRs	No policy issues or rulemaking needs were identified by staff in SECY-11-0112, which informed the Commission of the results of the staff's assessment of several potential licensing issues and key technical issues for SMRs that were identified in SECY-10-0034. The staff developed and implemented issue resolution plans for each issue discussed in SECY-10-0034. While there is no Commission policy issue to be addressed, misunderstanding of the term "prototype" by stakeholders contributes to uncertainty about what constitutes a prototype and the licensing criteria for a prototype. **Disposition:** The staff is developing draft guidance regarding implementation of the prototype language in 10 CFR 50.43(e), and plans to seek stakeholder input in late 2016.	SECY-11-0112 (08/12/11) SECY-10-0034 (03/28/10)
2	License Structure for Multi-Module Facilities **Applicability:** SMRs and multi-module non-LWRs	In SECY-11-0079, the staff reviewed three potential licensing structure alternatives for multi module facilities and determined that Alternative 3 - licensing each module individually was preferred. Additional analysis will be performed by the staff to determine how best to address specific details associated with this alternative, including: licensing of common SSCs associated with the modules; the license duration for individual modules; and decommissioning considerations. In the SECY, the staff committed to further develop specific aspects of Alternative 3 and will submit a specific proposal to the Commission for its consideration and approval. **Disposition:** The staff evaluated this issue and determined its preferred path forward in the 2011 SECY. A staff proposal will be developed using specific aspects of Alternative 3 and licensing experience with vendors proposing multi module facilities.	SECY-11-0079 (06/12/11)

3	Appropriate Source Term, Dose Calculations, and Siting for SMRs **Applicability:** SMRs and non-LWRs	In the Commission Memo dated December 29, 2011, the staff stated it would remain engaged with SMR stakeholders regarding applications of a mechanistic source term (MST) methods, review of pre-application white papers and topical reports it receives from potential SMR applicants concerning source term issues that discuss design-specific proposals to address MST, and considerations of research and development in this area. If necessary, the staff would propose revised review guidance or regulations, or propose new guidance to support reviews of SMRs. In Commission Memos dated May 30, 2013 and June 20, 2014, the staff provided updates on interactions with DOE and nuclear industry organizations regarding MST. NRO developed Information SECY 16-0012, dated February 12, 2016, which addressed this item. The paper concluded that (1) SMR and non-LWR applicants can employ modern analysis tools to demonstrate quantitatively the safety features of those designs, (2) MST analysis methods can also be used by applicants to demonstrate the ability of the enhanced safety features of plant designs to mitigate accident releases allowing future COL applicants to consider reduced distances to EABs and LPZs, and potentially increased proximity to population centers. At this stage, no applicant has requested siting that the staff would consider causing 10 CFR 100.21(h) to be the limiting site requirement. **Disposition:** The paper stated that the staff will engage on these issues proactively with interested stakeholders over the next 12 to 18 months and inform the Commission, as necessary.	SECY-16-0012 (02/07/16) Commission Memo (06/20/14) Commission Memo (05/30/13) Commission Memo (12/29/11)

4	Offsite Emergency Planning (EP) Requirements for SMRs **Applicability:** SMRs and non-LWRs	In SECY-11-0152, staff identified a possible approach for a scalable EPZ for SMRs. The NRO staff is working with NSIR and NRR on an internal working group to review these issues further. The SECY stated that the staff would liaise with other stakeholders (DHS/FEMA, EPA, DOS, DOC, NEI, ANS, and the public) to consider industry position papers on this topic, and develop recommendations. In a 2013 Commission Memo dated 05/30/2013, the staff provided updates on staff activities. The staff stated that it would not go further in proposing new policy or revising guidance for specific changes to EP requirements absent specific proposals from industry. On December 23, 2013, NEI submitted a white paper on this topic. The staff conducted a public meeting to discuss the white paper on April 8, 2014, issued follow-up questions to NEI on June 11, 2014, and NEI responded in November 2014. SECY-15-0077 regarding EP for SMRs and non-LWRs was issued on 05/29/2015, and the SRM was issued on 08/04/2015. The Commission approved the staff's recommendation to initiate a rulemaking. Staff developed notation vote SECY 16 0069, which discussed the rulemaking plan and schedule. On June 22, 2016, the Commission approved the staff's plan and schedule for the rulemaking pertaining to emergency preparedness for small modular reactors and other new technologies. **Disposition:** The rulemaking will disposition EP issues for future SMRs, non LWR and other new design technologies such as isotope producing facilities. The Commission directed the staff to utilize exemptions in the interim (e.g. for the TVA ESP) until completion of the EP rulemaking. The draft regulatory basis is currently under development consistent with the Commission approved schedule.	SRM-SECY-16-0069 (06/22/16) SECY-16-0069 (05/31/16) SRM-SECY-15-0077 (08/04/15) SECY-15-0077 (05/29/15) NEI Response to NRC Questions on White Paper (11/19/14) NRC Letter to NEI (R. Bell) (06/11/14) NEI White Paper (12/23/13) Commission Memo (05/30/13) SECY-11-0152 (10/28/11)

5	SMR Variable Annual Fees **Applicability:** SMRs only	In a February 7, 2011 memorandum from the Chief Financial Officer (CFO) to the Commission, the staff developed an approach to address the equitable assessment of annual fees to small modular reactors (SMRs). The memo stated that Commission approval for the approach will be requested during development of the proposed rule. In July 2014, the Office of the Chief Financial Officer established a follow-up working group to draft a SECY paper, proposed rule, and final rule for the SMR variable annual fee structure. SECY-15-0044 for proposed SMR variable annual fees was issued on 03/27/2015 and the SRM was issued on 05/15/2015. In the SRM, the Commission approved the staff's recommendation to initiate rulemaking. The proposed rule was issued for public comment on 11/4/2015. The final rule became effective on June 23, 2016. **Disposition:** The NRC published the proposed rule, "Variable Annual Fee Structure for Small Modular Reactors," in the Federal Register for public comment on Nov. 4, 2015, and held a public meeting on Nov. 16, 2015. The final rule (with administrative corrections) became effective July 15, 2016. The rulemaking dispositions this issue for SMRs. In the future, the OCFO staff will likely reconsider the specific values used in determining the variable annual fees based on experience with the first SMRs, and periodically into the future, just as is done with the existing reactor fleet. Additionally, the staff will review this policy topic at the appropriate time in the future for applicability to small non-LWRs.	Final Rule Variable Annual Fee Structure for Power Reactors (05/16/16) Draft Regulatory Analysis (10/06/15) SRM-SECY-15-0044 (5/15/15) SECY-15-0044 (03/27/15) Memo to Commission from CFO (02/07/11)

6	Insurance and Liability for SMRs **Applicability:** SMRs and non-LWRs *This issue only applies to multi-module designs with electrical power generation less than 100 MWe per module, such as the NuScale design or small non-LWR designs; or for reactors designed for process heat generation with a rated output greater than 10 MWt.*	In SECY-11-0178, the staff identified a potential inequity between the insurance requirements for power reactors producing electrical power equal or greater than 100 MWe per unit and those SMR designs with individual modules producing less than 100 MWe. Specifically, staff raised the question of whether there would be insurance and indemnity coverage sufficient to pay all public claims in the case of an insurable event for an SMR with an individual module sized at less than 100 MWe under the current Price-Anderson Act and associated regulatory language. Since completing that paper, staff prepared a comparative analysis of different SMR designs to further explore the potential inequity. Staff is using this analysis, and other inputs, to develop a SECY paper for this topic. In the paper, staff will identify whether rulemaking or a change to the current interpretation of the definitions given in the Price-Anderson Act, is recommended. **Disposition:** This is a narrowly focused issue, and is related to other multi-module issues, such as the multi-module licensing process. Staff intends to complete the SECY paper in early 2017.	SECY-11-0178 (12/22/11)
7	Manufacturing License Requirements for Future Reactors **Applicability:** SMRs and non-LWRs	Staff has studied the issue and discussed it with the SMR community in public meetings. No current technical issue or policy issue was identified for resolution and no interest in obtaining a manufacturing license from near-term SMR applicants was expressed. **Disposition:** This issue is closed and no further staff action is needed at this time.	Commission Memo (03/27/13)

8	Use of Probabilistic Risk Assessment in the Licensing Process for SMRs **Applicability:** SMRs and non-LWRs	The staff has engaged with public stakeholders and has developed expanded guidance for this topic by providing criteria to ensure appropriate treatment of important insights related to multi-module design and operation. The expanded guidance is consistent with current Commission policy and objectives for the use of probabilistic risk assessment (PRA) in the design, certification, and licensing of advanced light-water reactors. Additionally, the staff plans to implement a risk-informed review methodology for SMRs, such as the NuScale design, that uses a four-category structures, systems, and components (SSCs) review approach: (1) safety-related and risk significant; (2) safety-related and non-risk significant; (3) non-safety-related and risk significant; and (4) non-safety-related and non-risk significant. **Disposition:** This additional PRA guidance has been incorporated into SRP 19.0, Revision 3, "Probabilistic Risk Assessment and Severe Accident Evaluation for New Reactors," which was issued in the Federal Register on February 09, 2016. The effective date is March 10, 2016. This issue is considered closed.	SECY-11-0079 (06/12/11)
9	Key Component and System Design Issues for SMRs **Applicability:** SMRs and non-LWRs	Policy impacts on key components and system designs are design-specific and will be evaluated for individual applications. Examples of potential design features that could have policy impacts have been identified for the NuScale design. These include the use of a common pool as the ultimate heat sink for all plant modules and spent fuel, and the proposed electrical system design without the need for offsite power sources. **Disposition:** This issue is considered closed and no further staff action is needed at this time because it has been determined to be design-specific.	No further general references have been developed by the staff for this item
10	Appropriate Requirements for Operator Staffing for Small or Multi-Module Facilities **Applicability:** SMRs and non-LWRs	In SECY-11-0098, staff concluded that evaluating applicant operator staffing exemption requests is the best short-term response for this issue. The SECY discussed performing updates of NUREG-0800, NUREG-0711, and NUREG-1791 for guidance of the short-term evaluations. Staff now concludes that the existing version of SRP Chapter 18 and Revision 3 to NUREG 0711 (published November 2012) comprise adequate guidance for performing the exemption request evaluations. As experience is gained in performing the operator staffing exemption requests, the need for a long-term approach will be further evaluated. **Disposition:** This issue is considered closed and no further staff action is needed at this time.	NUREG-0711, Rev. 3 (11/2012) SECY-11-0098 (07/22/11)

11	Operational Programs for Small or Multi-Module Facilities **Applicability:** SMRs and non-LWRs	The potentially unique design features and operating characteristics of SMRs may require new or revised operational programs to maintain appropriate periodic surveillance and operational oversight. Examples of these features could include helical coil steam generators, allowances for extended refueling cycles, and the use of robotic machines for component disassembly and reassembly. In SECY-11-0112, the staff determined that these design-specific features and programs would be adequately reviewed during technical application reviews with no additional guidance, rulemaking, or policy changes needed. **Disposition:** This issue is considered closed and no further staff action is needed at this time.	SECY-11-0112 (08/12/11)
12	Installation of Reactor Modules During Operation of Multi-Module Facilities **Applicability:** SMRs and multi-module non-LWRs	The proximity of individual modules within common structures or facilities for multi-module SMRs could introduce technical concerns such as heavy load handling, potential refueling operation impacts with operating modules, and installation of new modules in an operating plant environment. As discussed in SECY-11-0112, the staff determined that these technical matters will be identified by the applicant and assessed by the staff during design certification application reviews. Therefore this issue can be addressed with current guidance, and no rulemaking or policy changes are needed. **Disposition:** This issue is considered closed and no further staff action is needed at this time.	SECY-11-0112 (08/12/11)
13	Industrial Facilities Using Nuclear-Generated Process Heat **Applicability:** SMRs and non-LWRs	The co-location of a nuclear power plant (NPP) and an industrial facility using process heat from the NPP introduces a number of technical and regulatory jurisdiction issues into the NRC's licensing process. As discussed in SECY-11-0112, with the exception of liability and insurance considerations, these issues are expected to be primarily technical in nature and will not require policy changes. Issues identified during technical reviews are expected to be addressed using current guidance; no rulemaking or policy changes should be needed. Examples of the potential technical issues include the effects of the reactor on the adjacent industrial facility products and staff. Other related issues, such as plant siting, would be reviewed on a case by case basis in accordance with existing guidance and requirements. This approach may be re-assessed in the future depending on the technical details of a specific application However, since there are so many potential configurations of NPP designs and industrial facilities, the staff cannot make further judgements at this time. **Disposition:** This issue is considered closed and no further staff action is needed at this time.	SECY-11-0112 (08/12/11)

14	Decommissioning Funding Assurance for SMRs **Applicability:** SMRs and non-LWRs	SECY-11-0181 informed the Commission of the staff's plans to ensure that SMR licensees provide reasonable assurance that funding will be available for decommissioning. The near-term approach will be to consider allowing SMR applicants to deviate from existing regulations through exemption requests with supporting analysis. Applicants may submit a site-specific estimate of decommissioning costs with a supporting analysis and adequate justification for an exemption to the minimum funding requirements for large LWRs shown in 10CFR50.75. The estimate to be provided will account for individual modules and common elements and structures as applicable. **Disposition:** This issue is considered closed and no further staff action is needed at this time.	SECY-11-0181 (12/22/11)
15	Implementation of Defense-In-Depth (DiD) Philosophy for Advanced Reactors **Applicability:** SMRs and non-LWRs	As described in SECY-10-0034, the issue of DiD was focused on non-light-water SMRs. In SECY-09-0056, the staff proposed to defer development of a DiD policy statement pending gaining additional experience and related insights from Next-Generation Nuclear Plant or other non-LWR reviews. More broadly, the concepts and goals of DiD as applied generally to a technology neutral regulatory framework was discussed in Enclosure 3 of the staff's recommendations for disposition of NRC Fukushima Near Term Task Force Recommendation 1 (SECY 13 0132). In SRM-SECY-13-0132, the Commission disapproved SECY-13-0132 Improvement Activity 2, "Establish Commission Expectations for Defense-in-Depth" and directed the staff to re-evaluate the topic as appropriate in the context of the Commission direction on a long-term Risk Management Regulatory Framework (RMRF). **Disposition:** In SRM-SECY-15-0168 on RMRF, the Commission approved the staff's recommendation that the NRC **not** develop a definition of and criteria for determining adequacy of defense in depth and directed the staff to expeditiously complete the revision to Regulatory Guide 1.174 on defense in depth, in order to improve the clarity of the guidance. NRO staff will implement the Commission decision with respect to DiD. Further, DiD is considered to be part of a risk-informed review framework, such as the one planned for use with the NuScale SMR design.	SECY-15-0168 (12/18/15) SRM-SECY-13-0132 (05/19/14) SECY-13-0132 (12/11/13) SECY-13-0132, Enclosure 3: Defense-In-Depth Observations and Detailed History (12/11/13) Regulatory Guide 1.174, Rev. 2 (05/31/11) SECY-09-0056 (04/07/09)

16	Security and Safeguards Requirements for SMRs **Applicability:** SMRs and non-LWRs	Staff determined in SECY-11-0184 that the current regulatory framework is adequate to certify, approve, and license light-water SMRs, the manufacturing of SMR fuel, transportation of special nuclear material and irradiated fuel, and the interim storage of irradiated fuel proposed for light-water SMRs under 10 CFR Parts 50, 52, 70, 71, and 72, respectively. The staff also determined that security and material control and accounting (MC&A) requirements in 10 CFR Parts 72, 73, and 74, respectively, are also adequate. In the case of non-LWRs, the staff's preliminary conclusion is that the current security regulatory framework is comprehensive and sufficiently robust to certify, approve, and license non LWRs. Sufficient provisions are available to provide flexibility for designers and applicants to meet performance-based and prescriptive security requirements and to apply methods or approaches to achieve the objective of high assurance that activities involving special nuclear materials (SNM) are not inimical to the common defense and security, and do not constitute an unreasonable risk to public health. NEI has submitted a white paper on a "Proposed Consequence-Based Physical Security Framework for Small Modular Reactors and Other New Technologies." This paper "...proposes an approach to security that appropriately considers the enhanced safety and security incorporated into these designs and provides a more effective and efficient means to protect the public health and safety." In the transmittal letter, NEI requests that "...the NRC establish regulatory positions on this approach and the associated policy and technical issues." NEI submitted a fee waiver request for NRCs review of this white paper. The NRC denied this request on July 1, 2016. **Disposition:** Review activities on NEIs white paper are on hold pending further action requested by NEI.	NRC Fee Waiver Denial (07/01/16) NEI White Paper (11/30/15) SECY-11-0184 (12/29/11)

17	Aircraft Impact Assessments for SMRs **Applicability:** SMRs and non-LWRs	10 CFR 50.150 requires design and license applicants for new nuclear power reactors to perform a design specific assessment of the effects on a facility of the impact of a large commercial aircraft. Using realistic analyses, the applicant shall identify and incorporate into the design those design features and functional capabilities to show that, with reduced operator actions: (i) The reactor core remains cooled, or the containment remains intact; and (ii) spent fuel cooling or spent fuel pool integrity is maintained. In SECY 11 0112, the staff determined that this technical issue did not involve a policy question, and that the issue could be addressed with current guidance during the design certification and licensing reviews. No rulemaking or policy changes are needed. **Disposition:** For LWR designs, this issue is considered closed and no further staff action is needed at this time. As described in the referenced SECY, for non LWRs, additional guidance may be beneficial to address potential unique features of the advanced designs, such as the majority of structures being located below grade. The staff will keep the Commission informed and will develop the guidance at a time consistent with the maturity of the design (industry), if necessary.	

Project on "Major Portions" of a Standard Design

NRC Meeting on Regulatory Process Improvements for Advanced Reactor Designs

December 15, 2016

Background

- **10 CFR Part 52, Subpart E allows an applicant to seek standard design approval for either an entire plant or "major portions" thereof**
- **The April 2016 NIA report identified the Standard Design Approval as a potentially useful tool in advanced reactor licensing**
- **NRC has since confirmed this in** *A Regulatory Review Roadmap for Non-Light Water Reactors* (NRC, Oct 2016, ML16291A248)
- **At an October 25, 2016 public meeting, NRC asked NIA to pursue clarifying the meaning of "major portions"**
- **This project aims to address that request**

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Near-term Project Approach

- Development of a proposed framework/process for defining “major portions” of a Standard Design Approval
- Goal is to make the SDA process useful for advanced reactor developers
- Drafting products for review, revision, etc., with input from industry representatives (and NEI/ARWG) for delivery to the NRC for their initial review

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Core Team

- Dr. Ashley Finan, Project Director (CATF/NIA)
- Peter Hastings, Sr. Licensing Consultant (NEC, Inc.)
- Louis Lanese, VP for Engineering (NEC, Inc.)
- David Matthews, Sr. Regulatory Consultant (NEC, Inc.)

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Schedule/Milestones

- Work Initiated Nov 2016
- Initial Presentation to NRC Dec 2016
- Submittal of Report to NRC Mar 2017

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Initial Considerations:

What factors should be assessed in defining "major portions"

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What is a developer's purpose for an SDA?

- Save initial development cost
  - Defer portions of the plant to subsequent licensing steps (e.g., CPA or COLA)
  - Defer portions that are significantly site- or purpose-specific (e.g., process heat, desalination, 50-Hz electrical generation)
- Approval for portion of design for other commercial purposes (e.g., for customer planning deployment via CPA, for deployment outside the US, etc.)
- Part of "staged licensing," i.e., to demonstrate incremental progress
- Approval for portion of design with significant programmatic risk (e.g., FOAK)
- Early approval to lock in portions of design for future DC

These are brainstorming examples; additional input being solicited, particularly from those contemplating an SDA

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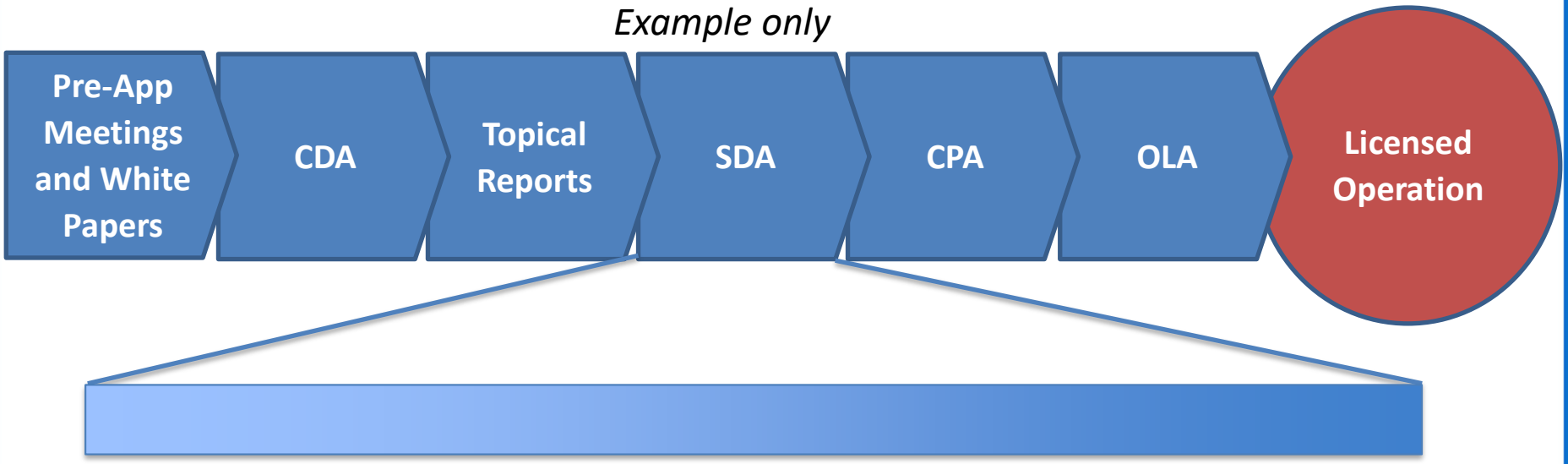
Context within NRC interactions continuum

Example only



SDA could describe novel or high-risk "major portions" less fully developed than DCA

Lots of "in between"

SDA similar to DC, but with fewer SSCs; level of design detail for "major portions" would be similar to DCA with significant conceptual design information (CDI)

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What is the scope of an SDA?

- What portions of design can be described in sufficient detail to warrant NRC review and SER
- What boundary conditions can be defined:
  - Interfacing systems (not in SDA) and risk significance
  - Bounding conservative assumptions to enable evaluation of SSCs within SDA
  - Controls on interfaces/boundary conditions and validation at CPA/COLA
- Is there a different way to define SDA scope for more discrete/specific set of SSCs – e.g., for early review of FOAK portions of design
- Recognize implications of review of less than "complete design"
  - Future licensing/redesign risk
  - Need for preliminary/bounding information on SSCs outside of "major portions"

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What practicalities should be considered?

- No precedent for SDA; prior “final design approval” was part of design certification process
- Is information required to demonstrate SSCs outside “major portions” are not risk significant sufficiently burdensome that it would be nearly as straightforward simply to pursue a DC?
- How will plant design issues outside the SDA be resolved; what programmatic risks are incurred as a result?
- Level of design detail sufficient to justify an SER?
- Is extent of requested review sufficiently discrete/ compartmentalized that one or more Topical Reports could accomplish the same goal?
- Is additional overall cost of review justified?

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What downsides should be considered? How are those risks mitigated?

- SDA results in SER but no DC rule
  - Less finality
  - Comparatively greater downstream licensing risk
- Risk mitigated by:
  - Substantial NRC/ACRS review earlier in development
  - SER that provides substantial confidence in NRC position
  - Ability to reference SDA in CPA or COLA, and finality of staff review

- More expensive overall in some cases, e.g., if a DC sought later
- Mitigated by
  - Earlier NRC approval of “major portions”
  - Possibility that SDA may obviate DC (depending on circumstances and developer’s strategy)

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What analogs might be useful?

- CDI: use of CDI within a DCA could be considered analogous to deferring SSCs (i.e., not including in "major portions")
- COL info items and ITAAC: provide for COL applicants or licensees to demonstrate compliance with assumptions made in the DC; may be useful ways to consider reconciling/validating conservative assumptions made about boundary conditions in SDA
- Plant parameter envelope: may be analogous to possible assumptions regarding SSCs not included within "major portions"
- Major features of emergency plan: not directly analogous, but NRC guidance on "major features" may provide insight
- Topical Reports: experience with TRs may provide insight into scope of submittal and evaluation that is not "the complete design"
- I&C DSRS: recent mPower and NuScale DSRS may provide insight into how to set aside design information (i.e., for SSCs not within "major portions," using criteria-based assumptions)

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Process should maintain flexibility

- Flexibility for developers to define what they want approved
- Scope definition (i.e., more “DCA-like” or “CDA-like”); developer should have the flexibility to decide and defend
- Ensuring SDA scope is substantive enough to warrant an SER
  - Not so broad that it might as well be a DC
  - Not so limited that a Topical Report would suffice

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Thank you

Feedback & Questions

Please feel welcome to send additional input at any time to Ashley Finan (afinan@catf.us).

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Regulatory Improvements in Advanced Reactor Designs

USNRC Meeting On Advanced Reactors Licensing

U.S. Nuclear Infrastructure Council

December 15, 2016

Overview

- NIC commends the staff of the U.S. Nuclear Regulatory Commission (NRC) for organizing this meeting
- We believe this meeting provides a meaningful and timely forum to share views
- For over five years, NIC has advocated on behalf of the safety and economic advantages represented by these innovative Advanced Reactor technologies
- Given the growing recognition of the benefits of Advanced Reactors, it is vital that the NRC provides a predictable and efficient means to license these designs
- NIC has testified before both the Senate EPW and House E&C Committees regarding the need for NRC reform and modernization
- NIC believes that the NRC is continuing to make progress in preparing to license non-light water technologies

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Overview (2)

- NIC is encouraged by the bi-partisan support existing in both the House and Senate for the types of reforms that NIC has advocated over the last few years
- We are confident the new Administration and Congress will be supportive of a continued robust Advanced Reactor deployment program
- NIC continues to believe that a pre-licensing design review process similar to that in Canada is appropriate and that some developers would welcome a design review process that is phased in a manner appropriate to the financial abilities of the individual developers
- The recent NRC meetings on Advanced Reactor designs have been productive and demonstrated the willingness of the NRC to recognize the enhanced safety principles represented in these designs
- We look forward to continuing to work with the Agency to identify ways to enable the deployment of Advanced Reactors through a timely, risk-informed, performance-based licensing process consistent providing adequate protection to the public

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Overview (3)

- NIC has been working to identify sources of higher levels of enriched LEU for the use by Advanced Reactors and recognizes that this material will be critical to the effective deployment of some Advanced Reactor designs
- NIC appreciates the recent industry/DOE meetings to identify the challenges in deploying higher-assay LEU. We encourage the NRC to actively engage on this matter early in 2017
- NIC also strongly supported efforts to provide sufficient off-the-fee-base funding for the NRC's Advanced Reactor activities including the $5 million requested for FY17. NIC supports efforts to use unallocated off-the fee based funding for this purpose in FY17 despite the $5 million not being included in the recent continuing resolution
- NIC has reviewed "Volume Two of the NRC Non-Light Water Reactor Vision and Strategy- Staff Report: Near-Term Implementation Action Plan ("Staff Report")
- The remaining comments today focus on the Staff Report

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NRC Vision and Strategy Volume 2 Staff Report – General Comments

General Comments

- In the document (p.7), the Staff Report states that the timetable is aligned with the DOE –
  - *NIC believes the DOE timetable is overly conservative on the schedule for Advanced Reactor deployment and as consequence we also believe the NRC's adoption of this schedule is also overly conservative*
- The Staff Report (p.7) states that the assumptions are not constrained by resources
  - *While NIC appreciates the approach the Agency has taken to understand what it needs to license Advanced Reactor designs, we believe the Commission should carefully review the Staff Report to make sure it is sufficient to achieve Adequate Protection but not overly conservative or needlessly costly*
- The Staff Report focuses heavily on the role of the Office of New Reactors
  - *Given the importance of fuel related issues for Advanced Reactor designs, NIC believes a more holistic integration of the role of NMSS should be included*

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NRC Vision and Strategy Volume 2 Staff Report – General Comments 2

- The Report (p.16) states “the staff must have adequate computer models and analytical tools to conduct it review of non-LWR designs in an independent manner”
  - *While NIC concurs in the need for the NRC to be able to conduct an independent review, we strongly urge the Agency not to create new models and computer codes when existing tools are available from DOE and the industry*
- The Report (p.21) states “if U235 enrichment greater than 5% is part of the design, then criticality safety methodologies and benchmarks will need to be adapted…”
  - *NIC Advanced Reactor developers have made it clear that most of them will want to use higher assay LEU if available. Therefore, sufficient resources will need to be programmed by the NRC to meet this need*

NRC Vision and Strategy Volume 2 Staff Report – General Comments 3

- NIC is concerned about the potential conservatism in the Offsite Consequences Codes and Methods efforts (p.96) - "With non-LWRS desiring smaller EPZ's than large LWRs, MACCS models may need updates to consider close-in population in greater detail than is done for a traditional 10-mile plume exposure pathway EPZ."
  - *The Agency's role is to provide "Adequate Protection of Public Health…". NIC doesn't understand why greater detail is needed in this analysis if the source term is reduced – the NRC's analysis and treatment of close in populations should be the same whether it is a 10 mile, 5 mile of 500 yard EPZ*

- Resource Loading
  - *While NIC recognizes that the level of funding the NRC will request for these programs is currently under consideration by the NRC Staff and Commission, we believe this is an important priority and NIC urges the Commission to seek at least $10 million in Off-fee Base Funding for FY18*

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Closing Comments on Pre-Licensing

- As a strong advocate of a pre-licensing design review process, NIC is encouraged by the willingness of the Agency to review pre-licensing methodologies
  - NIC continues to believe the Agency should seek to identify a regulatory model equivalent to the Canadian Nuclear Safety Commission – Pre-Licensing Design Review
- We believe it is positive that the staff has indicated that it will consider developing new guidance for a conceptual design assessment and staged regulatory review
- For innovative technology developers, it is critical that early indications regarding of the viability of their designs be provided to guide future investment decisions
- We continue to look forward to working with the staff to achieve this important policy outcome

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Summary

- NIC appreciates the opportunity to participate
- We look forward to our continuing involvement in these meetings
- Advanced Reactor progress is a national priority and while the NRC must independently license these designs, it shouldn't be an impediment.
- U.S. needs to continue to be a global trailblazer in safe nuclear energy
- Window of opportunity is finite – these technologies can and will go abroad
- Ramped-up programmatic, funding and regulatory commitment is vital to promote innovation along with investment in infrastructure

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Appendix

Additional Specific Comments on the Staff Report

NRC Vision and Strategy Volume 2 Staff Report – Additional Specific Comments (1)

- On page 41, there are specific comments referencing a vendor of a Molten Salt Reactor design. While NIC does not object to this work, we wonder if this report should be sufficiently bounded so as not to require design specific references

- On page 43, the Staff makes reference to Molten Salt Reactor activities underway in the Czech Republic. We would be interested in better understanding the basis for this staff comment and what interactions have prompted this reference

- On page 52, the report states that "Much of the interest today in reviving the MSR concept relates to using thorium". While that is a focus of some MSR developers, not all will be utilizing thorium in their designs

- On page 88, the report states that it is "not known what experiments would be needed to carry out a molten salt severe accident review." NIC believes the NRC must actively and quickly engage with MSR developers and prioritize the identification of these needs

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NRC Vision and Strategy Volume 2 Staff Report – Additional Specific Comments (2)

- On page 96, the report states "if non LWRs themselves, or because of their potential co-location with industrial processing plants, create greater likelihood of chemical releases to the environment, additional codes and models may be needed to also consider non-radiological public health impacts.
  - *NIC objects to the implied assumption that co-location would have adverse chemical consequences. Additionally, protection against non-radiological chemical releases do not appear to be within the NRC's regulatory jurisdiction*

- On page 102, the report states "While no MSR has been built…"
  - *This is not accurate. The Molten Salt Reactor Experiment (MRSE), which was an 8 MW reactor, operated for over four years at Oak Ridge (1965-69) . Additionally, according to the World Nuclear Association, a Molten Salt Reactor operated in the UK from 1968-73.*

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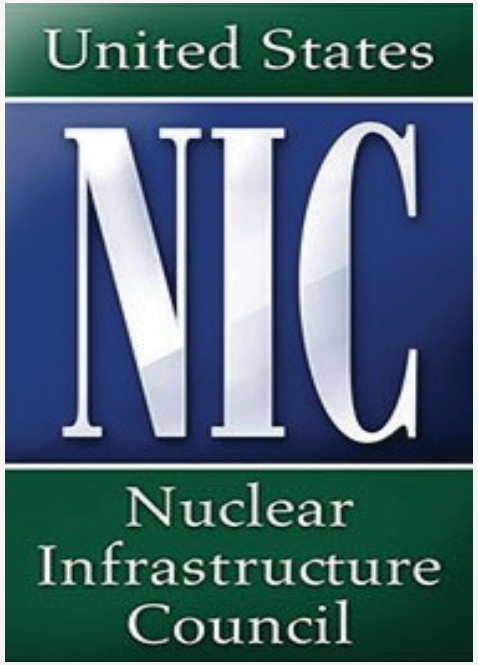
NRC Vision and Strategy Volume 2 Staff Report – Additional Specific Comments (3)

- On pages 110-117 of the report, there are various references to stakeholders and "generic groups (e.g., NEI),".
  - *As it represents over 14 Advanced Reactor developers and 100 nuclear suppliers, NIC would request equivalent recognition as a "generic group".*

- On page 119 of the report, the schematic at the top of the page references the development of prototypes.
  - *NIC does not believe this is an appropriate representation as some Advanced Reactor developers do not intend to develop "prototypes". For some, first of a kind is a more accurate reference*



For more information visit www.usnic.org

U.S. Nuclear Infrastructure Council
1317 F Street, NW – Suite 350 – Washington, DC 20004
(202) 332-8155

About the USNIC

- Leading business consortium advocate for increased U.S. nuclear use and global deployment of U.S. nuclear technologies and services
- Represents 100 member companies encompassing wide representation of the nuclear energy supply chain and key movers
- Member of the Civil Nuclear Trade Advisory Committee
- Strongly supports Gen 3+ reactors, small modular reactors and advanced reactors moving in parallel paths
- Organizer of the 2017 Advanced Reactors Technical Summit IV & Technology Trailblazers Showcase on February 8-9 at Argonne National Laboratory

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Licensing Technical Requirements Modernization Project

Amir Afzali

Southern Company Services

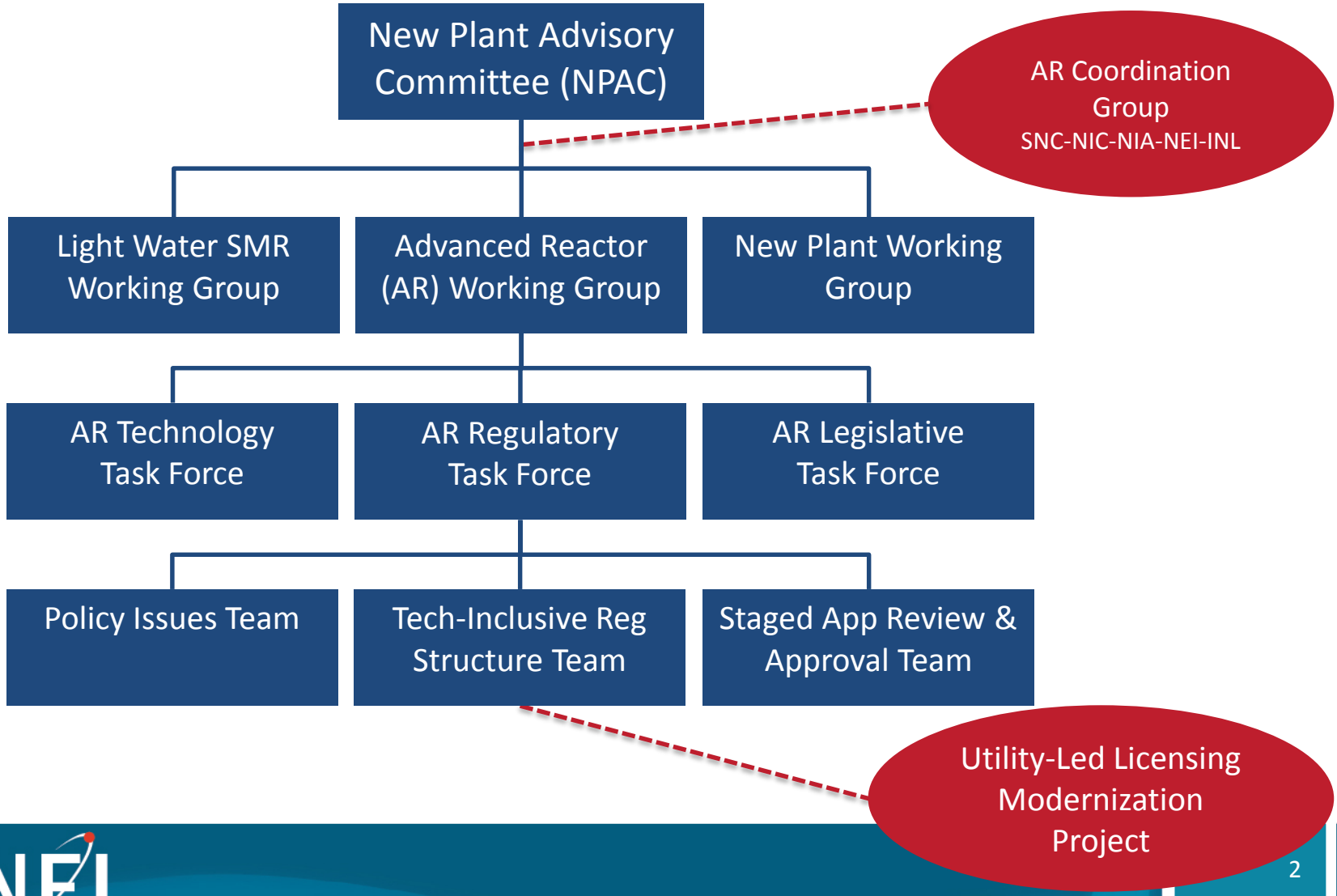
Ed Wallace

GNBC Associates, Inc.

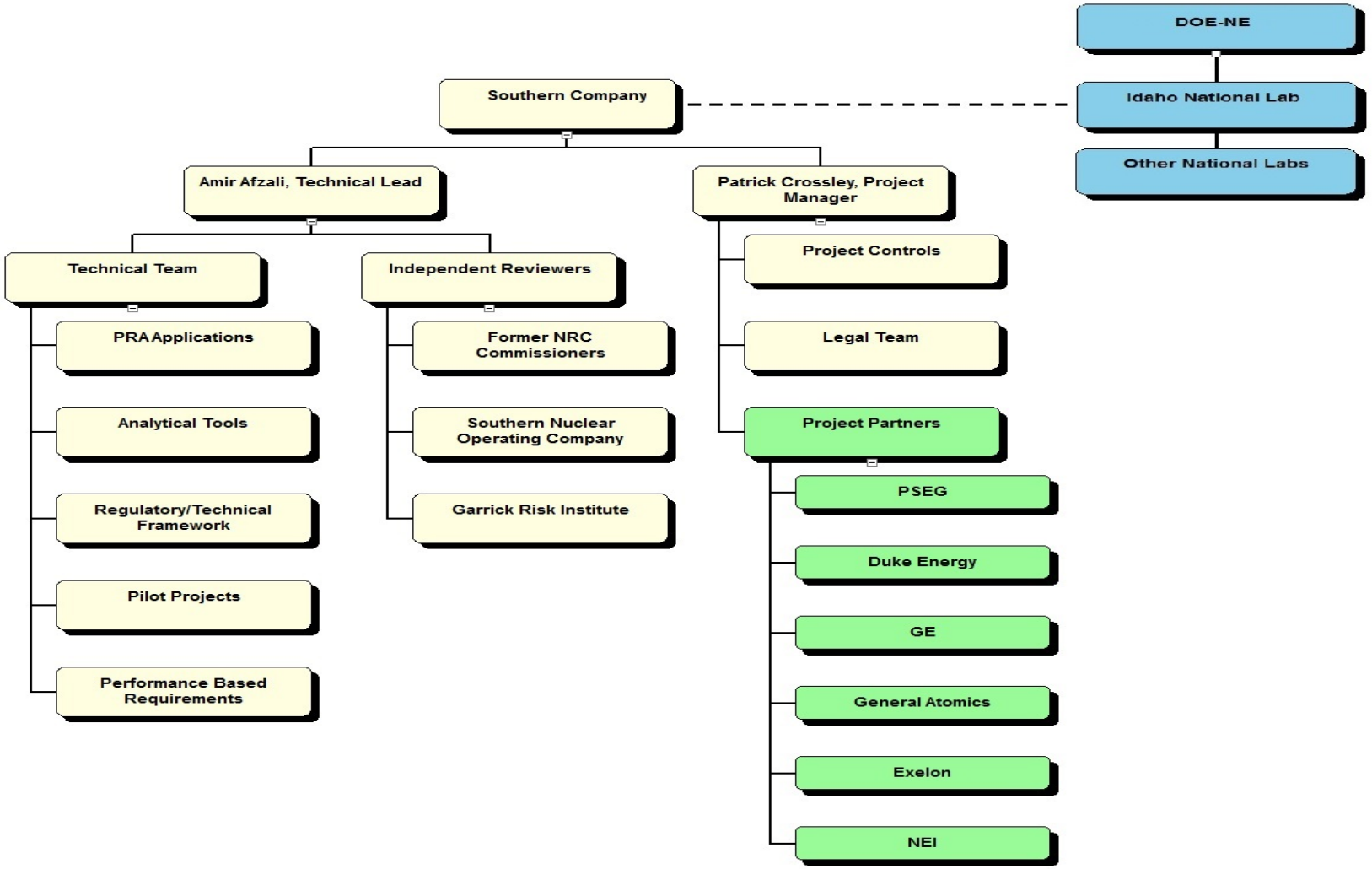
Possible Regulatory Process Improvements for Advanced Reactor Designs

December 15, 2016 • NRC

Industry Interfaces



Project Structure



Utility-Led Initiative Key Attributes

- **Technology-Inclusive** to enable and incentivize innovation across a broad spectrum of advanced reactor concepts
- **Systematic Risk-Informed** to facilitate a systematic and robust consideration of the risk to the public during design and licensing
- **Performance-Based** to facilitate clear and (to the extent practical) direct relation between advanced reactor performance and the licensing requirements for adequate safety determination

Regulatory Framework – Constituents

- **Regulatory Framework**
  - Application Process Requirements - Options Part 50, Part 52, or other combinations
  - Administrative Process Requirements (e.g., ACRS review, public hearings, etc.)
  - Technical Requirements
    - Top Level Technical Requirements and Safety Goals (e.g., in terms of dose. part 100 requirements)
    - Technical requirements provide **adequate assurance** that public safety objectives are met based on
      - **Selection of postulated events and their consequences – No current systematic process- Should be immediate target for modernization**
      - **Adequate safety determination too subjective and bigger challenge for non-LWRs**
      - Appropriate design criteria to protect against postulated events and their consequences (e.g., Advanced Reactors Design Criteria (ARDC) for non-LWRs)

Southern *Near Term* Focus

DOE – NRC – GAIN Vision & Execution Plans

Present → **2020**

DOE Vision & Strategy: Development and Deployment of Advanced Reactors

- **Strategic Objective**: Support the establishment of an efficient and reliable regulatory framework for advanced reactors

NRC Vision & Strategy: Implementation Action Plans

- Develop guidance for a flexible non-LWR reg. review process within the bounds of existing regulations
- Facilitate industry codes and standards needed to support the non-LWR life cycle
- Identify and resolve technology-inclusive policy issues that impact the regulatory reviews, siting, permitting, and/or licensing of non-LWR nuclear power plants

GAIN Execution Strategy: Regulatory framework for advanced reactor technologies

- Technology neutral regulatory framework jointly with NRC
- Gradual licensing risk-reduction strategy jointly with NRC
- Risk-informed decision-making framework jointly with NRC
- Data and methods sharing with NRC

Products for NRC and Time Line

- White Papers on selected proposals that:
  - Propose improvements for design and licensing of advanced non-LWRs and provide technical basis for the proposals
  - Propose a strategy for implementation of the proposal
- Near term plans include (letter to be issued shortly):
  - LBE Selection White Paper projected completion 2Q CY2017
  - PRA Technical Adequacy for LBE Selection and Road Map projected completion 3Q CY2017

PRA Discussion Topics

- PRA White Paper objectives
- Technical issues and challenges
- PRA development plan
- White paper development approach
- Milestones and deliverables

PRA White Paper Objectives

- Provide an approach for performing a PRA to support risk-informed, performance based decisions under consideration in the LTRMP project
- Two PRA WP documents:
  - Input to selection of licensing basis events (LBEs) and later
  - Input to SSC safety classification and special treatment
  - Input to risk-informed evaluation of defense-in-depth
  - Input to other risk-informed applications
- Provide an approach that can be applied to advanced non-LWRs e.g., HTGRs, LM reactors, molten salt reactors, etc
- Provide roadmap for integrating and maturing the PRA and using as additional input to design as the design matures
- Define the approach to ensuring PRA technical adequacy ("Fit for Purpose") at each stage of design and licensing

THE PRINCIPAL CHALLENGES

- Varying degrees of PRA practitioner experience with non-LWR PRA development
- Limited design and operational details for pre-operational PRA development
- Limited service experience to support PRA data for unique design-specific components and events
- Increased reliance on inherent safety features and passive systems performance predictions
- Broader scope of PRA supports LBE selection within and beyond design basis
- Need for technology inclusive risk metrics, e.g. QHOs, frequency vs. dose, defined in non-LWR PRA standard
- Need to develop design strategies to manage the risk of event sequences involving two or more reactor modules or radionuclide sources
- Limited experience for staffing PRA peer review teams
- Need to incorporate insights from six PRA pilots for ASME/ANS PRA (Trial Use) Standard for Advanced non-LWRs

PRA Development Plan Concept

- PRA insights most valuable if introduced in earliest design phases; i.e., pre-conceptual design phase when design most flexible
- PRA will be developed continuously, keyed to evolution of design, operation and maintenance requirements, and site characteristics
- Maintain level of detail and completeness consistent with that of the design as it matures
- Risk-informed decisions supported by the PRA can be made and reaffirmed in an iterative fashion as the design and PRA matures
- PRA models, success criteria, plant transient response to events, mechanistic source terms, and offsite consequences initially based on assumptions and replaced by supporting analyses as the analysis tools become available

PRA WP Development Approach

- Use NGNP PRA WP as a starting point
  - Revise outcome objectives for alignment with LTRMP objectives
- Revise/update regulatory basis to reflect
  - Feedback from NRC staff and ACRS reviews of NGNP papers
  - More recent documents e.g. NUREG-2150, NTTF issues
  - Review of PRAs for licensing applications (e.g. ALWRs, iPWRs, Yucca Mountain)
- Restructure approach to make it technology inclusive
  - Technology inclusive process
  - Incorporate NUREG-1860, 2150, other insights
  - Build on MHTGR examples
  - Add PRISM examples
- Revise/enhance PRA technical adequacy approach
  - Incorporate ASME/ANS PRA Standard for Advanced non-LWR issued as TUPA in 2013)
  - Incorporate input from NUREG-1860 and NUREG-2150
  - Provide more detail on PRA evolution and requirements for supporting LBE selection
- Plan for second PRA white paper focusing on RI-PB decisions beyond LBE selection (e.g., SSC safety classification, RI evaluation defense-in-depth)

ASME/ANS PRA Standard for Advanced Non-LWRs

- PRA technical adequacy levels must support RI-decision made throughout the design development cycle, i.e., be “Fit for Purpose”.
- PRA requirements for technical adequacy developed on a reactor technology inclusive basis
  - User defined release categories and event sequence families
  - Supports TI risk metrics such as QHOs, frequency of dose
  - Does not use LWR metrics such as CDF, LERF or Level 1-2-3 PRA
- Roughly 80% of the requirements are common to LWR PRAs
- Supports full scope, all modes, all hazards PRA similar to LWR Level 3 PRA (sequences developed to dose)
- Supports PRAs done during pre-operational phases
- Supports PRAs on multi-module plants

PRA WP Milestones

- Annotated outline (completed 10/31/16)
- Review of applicable background documents and conduct selected interviews (12/31/16)
- Garrick Institute review of NGNP WPs (1/31/17)
- Draft white paper for internal review (3/3/17)
- Revised white paper for INL review (2Q/17)
- Issue white paper for external consideration (3Q/17)

QUESTIONS?

LBE Discussion Topics

- LBE White Paper objectives
- Challenges to effective LBE selection
- White paper development approach
- Milestones and deliverables

LBE White Paper Objectives

- Provide a risk-informed performance-based approach for selecting licensing basis events for advanced non-LWRs
- Provide an approach
  - That can be applied to likely advanced non-LWRs including HTGRs, LM fast reactors, molten salt reactors and employing multi-reactor module designs
  - That LBE selection method is capable of identifying unique non-LWR design-specific events
  - That yields the right events from a risk-informed and performance-based design process for DBA treatment
  - That provides a rational interface with regulatory expectations

PRINCIPAL CHALLENGES

- Broader scope of PRA supports LBE selection within and beyond design basis potentially expanding licensing effort in areas of low safety significance
- Need for non-LWR TI-PB evaluation and acceptance criteria for broader set of LBEs
- Need to evaluate design solutions to manage any significant risk of event sequences involving two or more reactor modules or radionuclide sources for inclusion in LBE set
- Need to consider TI-LBE insights from PRA pilots on non-LWR event selection e.g. PRISM, HTR-PM, Traveling Wave

LBE WP Development Approach

- Use NGNP LBE WP as a starting point
  - Revise outcome objectives for alignment with LMP objectives
  - Update interfaces with PRA WP
- Revise/update regulatory basis to reflect
  - Feedback from NRC staff and ACRS reviews of NGNP LBE approach
  - More recent documents e.g. NUREG-1860, NUREG-2150, NTTF report
  - Yucca Mountain Pre-Closure Safety Analysis lessons learned
- Restructure approach to make it technology inclusive
  - Technology inclusive process for “front end” of design-specific development
  - Incorporate applicable NUREG-1860 insights
  - Incorporate UCLA Garrick Institute Review
  - Build on MHTGR examples
  - Add PRISM examples
  - Identify other LBE or DBA selection challenges unique to non-LWR advanced designs

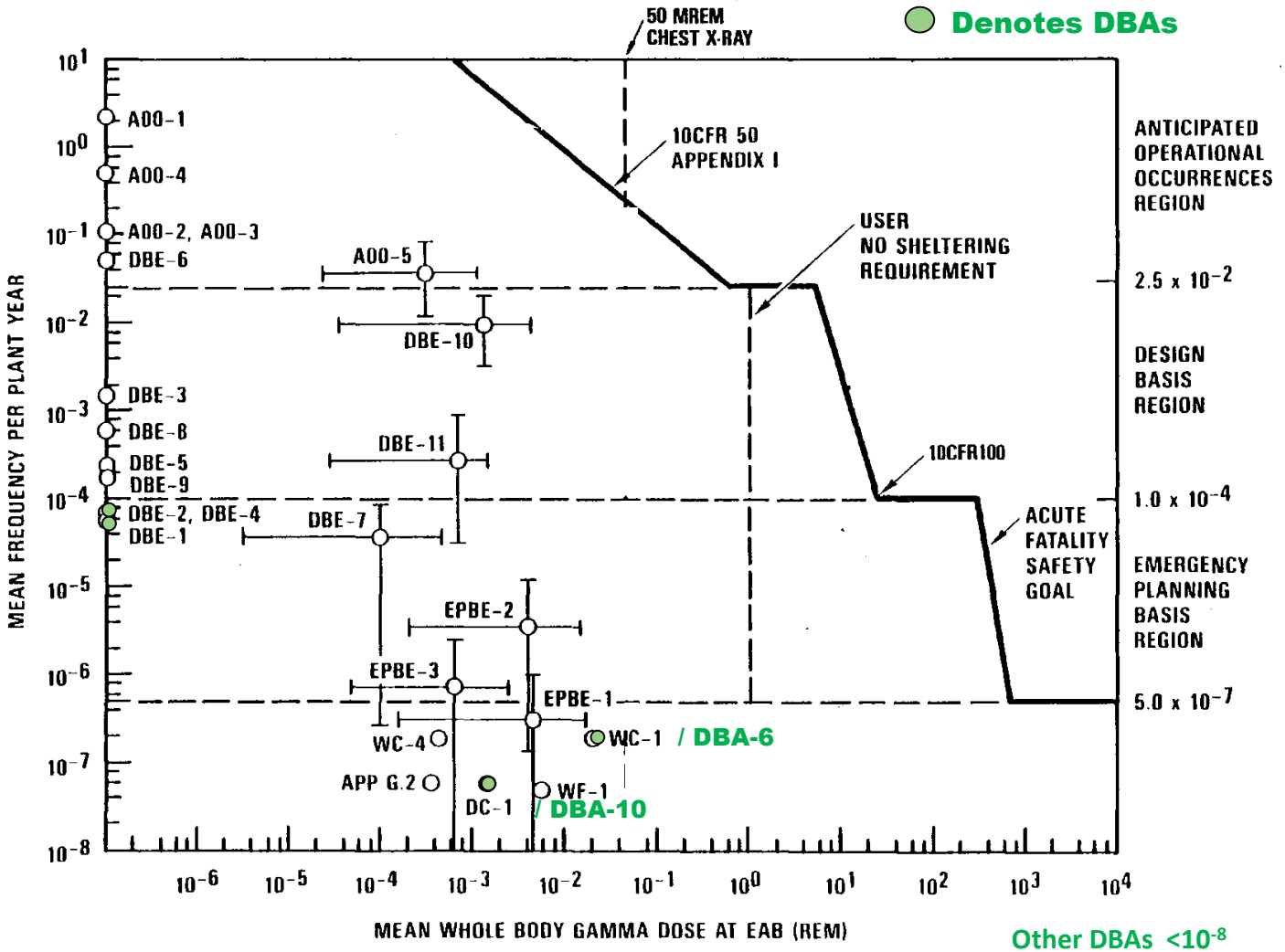
Categories of LBEs

- LBEs include all the events used to develop design bases and licensing requirements. They cover a comprehensive spectrum of events from normal operation to rare, off-normal events. There are four categories of LBEs:
  - **Anticipated Operational Occurrences (AOOs)** encompass planned and anticipated events. The radiological doses from AOOs are required to meet normal operation public dose requirements. AOOs are utilized to set operating limits for normal operation modes and states.
  - **Design Basis Events (DBEs)** encompass unplanned off-normal events not expected in the plant's lifetime, but which might occur in the lifetimes of a fleet of plants. The radiological doses from DBEs are required to meet accident public dose requirements. DBEs are the basis for the design, construction, and operation of the structures, systems, and components (SSCs) during accidents.
  - **Beyond Design Basis Events (BDBEs)** are rare off-normal events of lower frequency than DBEs. BDBEs are evaluated to ensure that they do not pose an unacceptable risk to the public.
  - **Design Basis Accidents (DBAs)**. The DBAs for Chapter 15, "Accident Analyses," of the license application are deterministically derived from the DBEs by assuming that only SSCs classified as safety-related are available to mitigate the consequences. DBAs are also derived from any high consequence BDBEs, defined as those with radiological consequences exceeding DBA dose limits, whose frequencies could increase into the DBE region if one or more safety related SSCs were postulated to fail. The public consequences of DBAs are based on mechanistic source terms and are conservatively calculated. The conservatively estimated dose of each DBA must meet the 10 CFR §50.34 consequence limit at the Exclusion Area Boundary (EAB).

Concept for PRA Input to LBE Selection

- PRA event sequences developed sufficiently to define mechanistic source terms and to resolve offsite radiological consequences (similar to LWR Level 3 PRA)
- Event sequence families grouped by similarity of initiating event, plant response, number of reactor modules affected, and mechanistic source terms
- Event sequence families categorized by mean frequency range:
- DBAs: deterministically derived from DBEs and high consequence BDBEs to meet 10CFR50.34 dose criteria using conservative assumptions relying only on safety related SSCs to perform required safety functions
- LBE frequencies and dose consequences compared to TLRC and EPA PAG dose limits
- Event sequences are combined into an integrated evaluation to confirm that QHOs are met
- DBEs and high consequence BDBEs evaluated using deterministic rules to select DBAs for conservative safety analyses in Ch. 15
- PRA information is used to identify and quantify uncertainties, evaluate radionuclide barriers, and capabilities of SSCs in the prevention and mitigation of accidents as part of a risk-informed evaluation of defense-in-depth

Example MHTGR LBEs, DBAs on F-C Plot (circa 1987)



LBE WP Milestones

- Annotated outline (completed 11/15/16)
- Review of applicable background documents and conduct selected interviews (12/31/16)
- Draft white paper for internal review (2/28/17)
- Revised white paper for INL review (3/15/17)
- Issue white paper for external consideration (2Q/17)

QUESTIONS?